

From strategic supplier to knowledge broker in the learning economy

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Introduction

The role of strategic suppliers as contributors to the innovative abilities of manufacturers has been acknowledged in the strategy and management literature (Dyer & Hatch, 2004; Steensma & Corley, 2000; Kaufman, Wood, & Theyel, 2000). Strategic collaboration with suppliers allows manufacturers to focus on their core capabilities and leave the co-innovation of vital complementary components to suppliers with leading capabilities in their field (Quinn & Hilmer, 1995).

Traditionally, there has been a strong territorial element in the relationship between strategic suppliers and manufacturers. Innovative firms are not spread evenly across the globe, but tend to agglomerate around distinct innovative regions and districts (Porter, 1998). The strategic interaction between buyers and strategic suppliers is strongly dependent on the co-localization of manufacturers and strategic suppliers, which provides rich interaction possibilities in localized communities of practice (Hanssen-Bauer & Snow, 1996; Nooteboom, 1999). This role is strongly contingent on the preferred suppliers' favorable location relative to key customers and reflects their internal and external organization. However, in step with ongoing globalization, a key strategic driver of manufacturers located in the OECD countries has been moving up the value chain and increasingly

specializing in high-value added activities, while offshoring or even outsourcing a growing proportion of production activities (OECD, 2007). Numerous indicators¹ show that most OECD countries are deindustrializing, whereas investments in knowledge-intensive activities are increasing (Pilat et al, 2007). Manufacturing and development activities are becoming increasingly separated in time and space (Dicken, 2003; Zysman, 2004). These fundamental changes are spurring new divisions of work and new corresponding business models.

These changes challenge strategic suppliers located in OECD countries in two ways. First, the business model based on physical proximity to key manufacturing activities is under pressure. Storper & Venables (2004) suggests that the relative advantage of spatial proximity for achieving innovation and coordination benefits decreases with increasing possibility for information richness communication enabled by ICT. Second, incumbents are being squeezed by up-and-coming suppliers from low-wage countries, which are increasingly enhancing their skill base by their involvement in production activities, as the loci of market growth as well as the production of new goods move abroad (Puga & Trefler, 2007). For this reason, many strategic suppliers are at a crossroads with respect to capitalizing on their relational assets to lead manufacturers. Typically, akin to the notion of production-dominant logic (Vargo & Lusch, 2008) their strategies, structures, and processes were molded in a world where manufacturing activities were central to their customers' strategic conduct, but must now be refitted to align with environmental changes, as the relative strategic importance of ownership control over production capabilities diminish with the increasing availability of such competence from capable suppliers of low-cost manufacturing in countries such as China and India. Strategic suppliers' current strategic position in the business network is therefore under pressure. From a value network perspective, positioning strategy includes the choices of 1) where to aim for participation in the business network (position) and 2) how to interface with other business actors, such as buyers, suppliers and complementors from this position (roles). Strategic suppliers face a

¹ These indicators of the changing role of manufacturing in OECD countries include a decreasing number of industrial employees in OECD countries and the growth of exports and imports of manufactured outputs (see Pilat et al., 2007).

fundamental choice between strategies intending to fortify existing positions and roles in order to maintain a position as providers of production activities against new rivals; for instance by following manufacturers' relocation of production activities or in other ways match de-location or liability of foreignness issues emanating from the evolution of value chains (Andersen & Christensen, 2005) or seeking to reposition themselves in the business network and as part of this process fundamentally redefine their capabilities. This paper addresses the principal challenges and issues associated with strategic suppliers seeking to implement the latter strategy. We focus on the challenges of transforming organizational mindsets, capabilities, and routines as well as dynamically reconfiguring relationships with actors in the strategic suppliers' network to reposition the organization as a supplier and broker of knowledge. A knowledge broker is a company that discovers value-generating possibilities through combining knowledge of customer needs with insight into technical capabilities (Hargadorn, 1998). We ask what firm and network-related factors influence the strategic supplier's ability to *reposition* itself as a knowledge broker. We do so from a particular conceptual point of departure, citing case examples throughout the paper.

This research question has yet to be addressed in the literature on global sourcing and value chain reconfiguration. Although increasing attention is being paid to the globalization of manufacturing capabilities and to how the rise of manufacturing and manufacturer sophistication in emerging economies (e.g., Brazil, Russia, Asia, and India) is impacting the strategic possibilities of manufacturers located in developed economies, how these developments are impacting the strategies and corresponding strategic models of firms further upstream in the value chain has yet to be addressed (Mathews, 2002; Gadiesh & Vestring, 2008; Bhattacharya & Michael, 2008). In marketing theory, the increasing role of intangible activities or services have increasingly been addressed in the so-called service-dominant logic approach, which suggest a new perspective for envisaging the creation from value as created by products in themselves or the services they may render for users (Vargo & Lusch, 2008). Our discussion complements some of these issues by discussing the strategic and managerial implications a strategic suppliers faces when seeking to redefine their capabilities as

centered on production to those centered on strategic suppliers' provision of (knowledge) services in business networks. We contribute to the field by developing a range of empirically testable propositions regarding the transition of suppliers and by raising strategic concerns for managers in strategic supplier companies.

The paper is structured as follows. First, we review relevant existing literature on knowledge brokerage as part of the increasing emphasis on catering to manufacturers' innovation activities. Next, we discuss four generic challenges facing strategic suppliers with respect to capturing and reusing knowledge obtained from collaboration. These challenges pertain to supplier factors, buyer factors, project and relationship factors, and supplier portfolio factors. We develop propositions in relation to each factor and ground them empirically, citing case examples. In the concluding part of the paper, we discuss avenues for further research.

Innovation and knowledge brokerage

How are innovation and knowledge brokerage related, and what is the rationale for having a knowledge broker in this process? With respect to knowledge, we refer to Bessant and Tidd (2007, p. 188), who define it as "... information that has been contextualized, given meaning and therefore made relevant and easier to use. The transformation of information into knowledge involves making comparisons and contrasts, identifying relationships and interferences." For strategic suppliers as knowledge brokers, knowledge becomes the most crucial asset and commodity. This knowledge can be technical knowledge, market knowledge, and/or knowledge of how to serve markets (Shane, 2000). It also can be architectural knowledge, i.e., knowing how to combine or recombine existing product components and services for superior value creation (Henderson & Clark, 1990). In the present context, we understand innovation as the process through which ideas are conceived and implemented in business contexts. Innovation differs from invention, in the sense that innovation may (and often does) include preexisting knowledge (Jon & Delbecq, 1977). In the literature, therefore, innovation is strongly linked to the combination and recombination of knowledge. As

pointed out by Hargadon (2002), two preconditions for creating innovation through knowledge brokerage are the recombinant and fragmented natures of knowledge. Regarding the first point, Schumpeter (1934/1961) treated innovation as the carrying out of new combinations. Likewise, regarding the second, Hayek (1945) pointed out that, in market economies, possibilities for creating innovation entail the distribution of knowledge, which no one understands in its totality. Economic actors possess knowledge of circumstances of the fleeting moment, which may be translated into economic value by interlinking actors with complementary schemata of needs and wants. These preconditions suggest that (re)combining knowledge is in itself central to the entrepreneurial process (Shane, 2000).

Acknowledging the importance of knowledge recombination to innovation does not, however, in itself explain the rationale for knowledge brokering as a specialized role for suppliers in the emerging division of work. From an economic viewpoint, knowledge is often treated as a public good, which means that it can be transferred and applied at little or no cost. Underlying this is a notion of knowledge as little more than information that is codified to a greater or lesser extent (Arrow, 1962). However, researchers have identified the conceptual flaws in treating knowledge as a market commodity. Knowledge is bound up within a social context (Lave & Wenger, 1991). This entails knowing *who* as well as *how elements* may emerge from the interrelationships among actors in a community interrelating with heed—for example, in managing complex and dangerous activities onboard a warship (Weick & Roberts, 1993). Because of its social element, knowledge is frequently too complex to be regarded as comprising codifiable recipes (Johnson, Lorenz, et al., 2002). This also helps explaining why knowledge may flow relatively easily within a socio-professional context, where the cognitive distance among those sharing the knowledge is relatively small, while being extremely difficult to transfer from one social context to another (Nooteboom, 1999). Therefore, there is clearly room for economic actors to take on the function of matching and conjoining the diverse learning profiles of firms, which are dispersed in economic space but which may have complementary needs to exchange knowledge in the eyes of the actor. Knowledge brokers as

organizational entities specialized in managing the abovementioned problems of knowledge transfer may thus be essential (Katz & Allen, 1982; Katz & Tushman, 1980). For the broker at the core, the advantage of this arrangement clearly lies in its ability both to source and supply knowledge for firms in its surrounding network. For the manufacturers, the basic incentive lies in the ability to participate in a buyer–supplier relationship with a capable and innovative supplier.

The generic tasks of knowledge brokers

Four principal tasks are general to organizations in an economy increasingly driven by value-generation from learning. These tasks are also mirrored in the role of the knowledge broker. First, there is the task of identifying learning problems and accessing solutions to them that are crucial and generic to a group of firms. Second, knowledge generated in bilateral collaboration with producers needs to be captured for reuse in other contexts and applications. Third, potential application fields for knowledge acquired in a distinctive context need to be identified. Fourth, the process of knowledge development needs to be coordinated internally in the organization and repackaged for subsequent reuse in other relationships. Figure 1 contrasts the traditional model of strategic suppliers with the emerging model of knowledge brokerage.

*** insert Figure 1 about here ***

Identifying and accessing learning problems

Problems in which it is worth investing resources in order to solve them do not automatically make themselves known. Their discovery depends on the intentionality and framing capability of specific actors, who may identify the possibility of facilitating problem solving across a range of industries. This form of enterprising behavior is clearly linked to entrepreneurship. Kirzner (1979) describes an entrepreneur as a person who assiduously exploits opportunities by organizing those in control of resources. From the perspective of entrepreneurial actors in the learning economy, the industrial context presents itself as a set of complex interdependencies that may be arranged according to their

capacity to be interpreted. A learning exchange opportunity arises when the entrepreneur invents and devises a pattern that is seen as exchange effective by other actors (Snehota, 1990). Successful actors possess unique capabilities in this respect and exploit knowledge matching opportunities rather than simply learning opportunities.

One example of a strategic supplier actively defining the scope of knowledge matching opportunities is Tempress, a supplier of systems for measuring temperature, pressure, and level used in vessel machinery and in process industries in a wide range of industrial sectors. At the core of Tempress' sales and development activities is in-depth knowledge of customer process activities that are used in many projects. Moreover, Tempress has applied this experience in collaborating with the nanotechnology research centre at Aarhus University in developing a hypersensitive membrane that substantially increases the precision of measuring equipment and other sensor technologies. By actively matching knowledge of process technologies with knowledge of nanotechnology, Tempress has provided its customers with innovative products that exceed existing market standards.

The ability to spot matching knowledge opportunities often goes hand in hand with network position, as knowledge is localized and situational in a market economy (Hayek, 1945). Entrepreneurs, like anybody else, obtain information in a social context and make judgments based on their interaction with others. Hence, opportunities to spot opportunities and access actors often coexist. In itself, accessibility presents a unique problem to the broker. Even though firms may find it relevant to engage in interfirm learning, they may also be reluctant to undertake this type of activity, as it presents the threat of potentially being "outlearned." As described by Hamel (1991), interfirm collaboration may be conceptualized as a competitive race to get to the future first. Providing access to other firms may therefore entail a problem of establishing safeguards, so the challenge for brokers is to achieve interlocked intentionality. They must convince potential partners that being involved in learning collaboration are worth the effort and not associated with problems pertaining to the moral hazard of partnership. Given the temptation to defect because the advantage of doing so may

outweigh associated costs, a broker fulfils the role of establishing order through fostering trust among the partners involved. Hence, all partners must trust a third party regarding both competence and intent. The broker must have a credible reputation for competence; it must be clear to the involved parties that acting as a partner of these particular firms is complementary to any other business activity taken on by the broker (Nooteboom, 1999). By being viewed as competent and trustworthy by all parties involved, the knowledge broker can assess both the value and relevance of knowledge exchange without actually revealing (and thereby supplying) this valuable knowledge. By being viewed as competent and trustworthy by all parties involved, the knowledge broker can assess both the value and relevance of knowledge exchange without actually revealing (and thereby supplying) this valuable knowledge. This is closely connected to the intellectual property right (IPR) issue of knowledge brokering by strategic suppliers, an issue of increasing importance.

One example is Bosch, the world's largest independent parts supplier to the automotive industry. Bosch develops leading-edge automotive technology in research centers around the world and has developed a credible reputation as an innovative and trustworthy partner in the automobile industry. Bosch collaborates with lead manufacturers such as Mercedes-Benz, McLaren-Mercedes, and BMW in developing next-generation automotive technology such as new engine and electronic systems or new technology for chassis welding.

It is a vital and strategic interest of Bosch to exploit the technological knowledge gained in such collaborations in other customer relationships, even if those customers are direct competitors of Mercedes or BMW. However, such knowledge reuse is only allowed after a certain time lag. Powerful customers such as Mercedes-Benz or BMW typically work out exclusivity agreements with Bosch. Such agreements are a result of negotiations in which both Bosch and the focal manufacturers compromise on their IPR strategies. Increasingly adopting the role of knowledge broker, Bosch's interest in such negotiations is twofold. First, Bosch aims to keep a "freedom to operate" that allows it to leverage the jointly developed knowledge in other customer relationships. Second, Bosch tries to

maintain a monopoly status on the jointly developed knowledge with respect to horizontal competition with other suppliers. In contrast, lead car manufacturers have a strategic interest in enjoying exclusive control over the jointly developed technology and in sharing this knowledge with other car suppliers in order to become less dependent on Bosch.

Due to those conflicting interests, agreements between Bosch and lead car manufacturers typically cover two types of exclusivity for defined time intervals. First, there is a certain time period (usually one year) of abstract exclusivity in which Bosch is not allowed to reuse the jointly developed technological principles in any other customer relationship. Second, there is a certain time period (also usually one year) of product exclusivity in which Bosch is allowed to develop products based on the jointly developed technology but not to deliver them to other customers.

Besides convincing potential partners to engage in a learning collaboration, strategic suppliers as knowledge brokers face another internal dilemma. Those partners that may be best suited for learning may not be the most attractive commercially. The traditional business rationale for having strategic suppliers is to gain access to those partners that can contribute most to the revenue stream. In this respect, knowledge brokerage needs to be regarded as an investment, as strategic suppliers must be willing to sacrifice short-term profits for learning opportunities. The top management of strategic suppliers must be aware of this dilemma. Like the innovator's dilemma as described by Christensen (1997), being too attached to the voice and revenue stream of current mainstream customers may ultimately lead to the failure of strategic suppliers in a rapidly changing business environment.

An example of the dangers involved in building on existing value streams is that of Helioprint, a strategic supplier that in the 1990s was among the world's leading suppliers of prepress printing technology. This technology was later replaced by digital technology. However, Helioprint, which basically had one large multinational customer (Agfa) to which it provided most of the optical equipment used, did not anticipate this fundamental technological change. In 1999, Agfa decided to

withdraw from the business relationship over a three-year period corresponding to its service obligations to customers. Helioprint realized too late that their dependence on this customer had made them overlook and sacrifice the development opportunities needed to meet the technological disruption of digital imaging.

Another aspect related to the identification and accessing of learning problems is the notion of interfirm relationship-specific investments. It has been argued that the specific investments of a supplier in a relationship and collaboration with a particular buyer are positively associated with relational rents (Dyer & Singh, 1998). Strategic suppliers as knowledge brokers, however, need to view relationship-specific investments not just as a means to realize relational rents with a particular buyer but also as a means to learn tacit knowledge that can be reused in other relationships.

Post-project learning from bilateral collaboration with producers

It is crucial that strategic suppliers as knowledge brokers have the ability to capture knowledge generated from single projects with producers for reuse. In this respect, strategic suppliers must be capable of applying “double loop” learning by reflecting on the insights that can be extracted from a particular project in one context and made productive in yet other contexts. This “double loop” learning can be facilitated via post-project reviews (von Zedtwitz, 2002). Despite their value and importance, however, few companies have systematically applied post-project reviews to date (Koners & Goffin, 2007). This resistance to learning from post-project reviews may be due to psychological barriers (e.g., inability to reflect, memory bias, and ambivalent experiences), team-based shortcomings (e.g., reluctance to blame or poor internal communication), epistemological constraints (e.g., difficulties generalizing or the tacitness of procedural knowledge), and managerial problems (e.g., time constraints or bureaucratic overhead) (von Zedtwitz, 2002). The role shift of strategic suppliers from being project executors for manufacturer clients to being knowledge brokers requires that they overcome those barriers and realize a high maturity level with respect to learning from post-project reviews. Von Zedtwitz (2002) identifies five process-maturity levels. At level one,

organizations characterize post-project reviews as ad hoc or even chaotic. The review process is seldom planned and poorly defined. Most organizations are still at this level. At level two, the organization has established post-project review guidelines and sound review practices. This ensures that a given review process is comparable to previous ones. Level three organizations have established a standardized review process as well as sound and consistent review criteria. The responsibility for post-project reviews is assigned to a unit. At level four, the review process goals are quantified and can be measured across different review outcomes. Corrective action in the review process can be taken based on process controls. At level five, the final level of process maturity, post-project reviews are established organization wide to ensure consistent cross-project learning. The review process itself is under ongoing scrutiny to foster continuous improvement. In a case-based study of five leading German companies, Koners and Goffin (2007) identified metaphors as an effective tool for capturing tacit knowledge acquired in prior projects.

Identification of target applications

Once knowledge from a particular project is extracted and stored, strategic suppliers as knowledge brokers must be capable of identifying potential and relevant application fields for such knowledge. This identification process resembles, though in reverse, analogical reasoning processes. In analogical reasoning it is assumed that a novel problem (i.e., target problem) can be solved with the help of an existing solution to an analogous problem (i.e., base analogue). The three basic stages in the process of building analogies are: 1) formulating the target problem in a more abstract form, 2) identifying base analogues, and 3) mapping knowledge from the base domain into the target domain (Blanchette & Dunbar, 2000; Gentner & Markham, 1997; Holyoak & Thaggard, 1995). The identification of base domains is the systematic exploration of areas in which the target problem is experienced in a similar or even more extreme fashion (Lilien et al., 2002). For example, when looking for ways to improve hygiene conditions in hospitals, one could search for existing approaches used in “clean room” conditions in chip production.

Strategic suppliers as knowledge brokers need to apply a similar identification and matching process. They acquire procedural, technical, and/or market-related knowledge in a specific base domain by collaborating with a specific producer. Once this knowledge has been developed and captured, strategic suppliers as knowledge brokers must identify potential target domains or applications in which there is a strong need for such knowledge. This is a non-trivial and highly creative process. It requires that strategic suppliers be able to describe the knowledge they have acquired in bilateral collaboration in more abstract terms. It also requires that they then systematically identify and explore the other sectors and applications (i.e., target domains) in which such knowledge may be critical. The target domains for the strategic suppliers' knowledge can be more or less distant from the base domain. The more distant the target domain, the more likely it is that strategic suppliers will be able to facilitate breakthrough innovations on the sites of their customers (Dahl & Moreau, 2002). In this respect, strategic suppliers face an important trade-off: the more distant the target domain is from the base domain, the greater the likelihood of creating breakthroughs but the more difficult it becomes to transfer knowledge from the base domain to the target domain.

One example of applying a developed technological solution in a new domain is the transfer of oil filtering and oil maintenance technology, developed to prolong the operating life of vessel machinery, to offshore wind turbines. By filtering oil to remove microscopic metal particles, operating life can be prolonged. Moreover, given the extreme environmental conditions in which ship motors operate, the overall oiling systems must be adapted as well. CC Jensen, a supplier of these systems, has actively sought other applications for their technological insights (originally intended for mechanical systems operating at sea). It found that manufacturers of wind turbines for installation in offshore parks were facing problems similar to those associated with motors in ships. Consequently, CC Jensen now develops oil maintenance systems for Vestas offshore wind turbines.

Organizing processes of interfirm knowledge exchange and development

The second strategic challenge facing brokers relates to aligning the interests, timing, etc., of the involved actors in a complementary fashion as well as ensuring and monitoring the progress of knowledge development in these firms. The structure of the actors' network plays an important role in the accessibility and combination of actors with complementary knowledge development needs (Burt, 1992). Working with firms from different industries may enhance the brokers' ability to develop novel innovations, as there is a greater scope for technological synergies across complementary rather than identical knowledge-sharing interfaces. According to this view on social networking, developing links between firms may be conceived as a process of accumulating social capital, which can be optimized by avoiding redundancy in network connections, as multiple links to the same knowledge area do not provide the focal actor with any novel information. Brokers face a classical problem of organizing stakeholders: they must develop an organizational form that both efficiently coordinates bilateral knowledge flows (i.e., avoiding problems of both shirking and opportunism) while providing the necessary incentives for participants to continue collaborating. Social relationships that provide participants the incentives to collaborate are crucial in a specialized division of labor aiming to achieve mutual learning gains. Both problems relate to the selection of members. First, members must have complementary interests in a specific area (i.e., process technology). At the same time, they should not have conflicting interests, for example, being rivals in specific technologies or markets. Second, brokers must ensure that the learning contribution is relevant to all partners and that learning can be transmitted between partners at little additional cost—meaning that each partner's dedication of resources to this area can be well administered by the broker. This raises the important problem of economizing on decision-makers' limited cognitive capabilities for attention and absorption (Cohen & Levinthal, 1990). Therefore, buffering participants from superfluous information is a related and important intermediation task of the broker.

Critical factors affecting the transition from strategic supplier to knowledge broker

Having established which activities are critical to knowledge brokering, we now focus on the particular challenges for effective knowledge brokerage across multiple business networks and technological contexts. Derived from a strategic supplier's position in a business network, we suggest that the identified challenges for knowledge brokerage are contingent on four principal factors: a) the supplying firm, b) the buying company and its network position, c) the nature of the relationship and project, and d) the supplier's network portfolio. These are portrayed in Figure 2 and will be further discussed below.

*** Insert Figure 2 about here ***

Supplier factors

To begin with, strategic suppliers, the management systems, organizational structures, and process and employee skills of which were molded before the globalization and digitalization of manufacturing activities, are now faced with a strong transformation imperative. In the terminology of Stabell and Fjeldstad (1998), this can be compared to transforming an organization established according to a value chain logic into one that combines characteristics of a value network and a value shop. In a value chain logic of organizing, production is the defining key to arranging flows of production activities and to assigning internal roles and responsibilities in an organization. In a value shop, the ability to learn and relearn from activities implies the matching of customer problems with current sets of technologies. This calls for more cyclical and project-oriented organizational forms. Moreover, a business model based on creating a value network calls for organizations to act as club managers, prioritizing the complementarities of relationships in the network rather than the nurturing of single relationships as such. In this manner, the value creation logic arising from relationship building differs from that of strategic suppliers, which seek to base their strategic advantage on the ability to form long-standing relationships with single buyers. Leading organizational transformation is always challenging, as it involves no small measure of strategic and operational risk as well as resistance from the existing organization (Argyris & Schon, 1978). Moreover, it is a complex process

from a managerial perspective (Kotter, 2007). Resistance to change may emanate from both inside and outside the organization. Given the availability of slack resources, organizations may be more or less able to adapt to changing external circumstances (Hayes, 2002). Moreover, as pointed out by Schumpeter (1934/1961), relationships with customers and suppliers and the broader context may fetter an organization. A similar point has been made about network contexts by Håkansson (1992): any activity performed by an actor is part of several activity cycles, which depend on each constituent activity being performed in a particular way. Given the breadth and depth of this dependency, actors in a network structure also attempt to limit changes, as these will affect their ability to produce value. Organizational environments may, however, be more or less tightly coupled, depending on task specialization and actor flexibility (K. E. Weick, 1976). Hence, we can propose that:

Proposition: 1a: The ability of a strategic supplier to transform itself into a knowledge broker is contingent on the availability of slack resources in the supplier organization.

Proposition 1b: The ability of a strategic supplier to transform itself into a knowledge broker is contingent on the degree to which the use of internal resources is structured by external collaborators.

Making the supplier organization effective at identifying and solving customer problems calls for changes at both the individual and organizational levels. As direct involvement in manufacturing diminishes in importance and the need for employers with abilities to absorb and process information into knowledge increases, suppliers must reduce their blue-collar workforce and increase the number of white-collar workers. The transformation process involved is well described in the words of Ole Jørgensen, manager of Ribe Maskinfabrik (Ribe Machine Shop):

Before we had 40 welding operators. Now there are only three left. We used to have 14 apprentices, now we can hardly get any. Earlier, my father and I were the only engineers. Now there are eight. To survive we have to sell additional value and not just weld. Today we have a turnover of DKK 2.5 million/employee and make money. The future prospects for us are practically unlimited. But it has been a huge readjustment process.

This is in line with the arguments of Cohen and Levinthal (1990) that the absorptive capacity of organizations is contingent on the skill base of their individual employees. At the same time, suppliers must build on existing knowledge of customers' technological needs. Retaining manufacturing and with it technological competence is therefore crucial to the strategic supplier's ability to collaborate with both customers and other suppliers. Much of this knowledge is not codified, but embodied in blue-collar occupational communities on the factory floor (Kristensen & Zeitlin, 2005). Moreover, knowledge liaisons with key people in the customer organization may very well reside in people involved in manufacturing in both supplier and buyer organizations (Kristensen & Zeitlin, 2005). This suggests that key manufacturing employees provide important support to the knowledge broker. With respect to new product development, these employees are "champions" (Howell & Higgins, 1990; Shane, 2000) or—as phrased in the German school of thought—"promoters" of innovation. This school distinguishes between *power promoters* who have hierarchical power (Witte, 1977), *expert promoters* (Witte, 1977) who possess expert knowledge, *process promoters* who are familiar with organizational processes (Hauschildt & Charkrabati, 1989), and *relationship promoters* who are boundary spanners to firm-external stakeholders such as suppliers and customers (Walter & Gemuenden, 1998). Using this resource of skilled personnel effectively in providing new responsibilities and organizational roles for key manufacturing personnel may be the key to the knowledge broker's ability to maintain its ability to identify and solve customer problems. Thus, we can propose that:

Proposition 2: Effective knowledge brokerage depends on the ability to develop the skill base of existing employees.

As well, structural aspects of the supplier organization affect its ability to capture knowledge from collaboration and subsequently reuse it in relationship with other customers. The structure of an organization has an impact on its ability to acquire and disseminate knowledge in innovation processes, and this ability depends on whether the organization displays organic or mechanistic structural characteristics (Burns & Stalker, 1961). Organic organizational forms are characterized by informal and decentralized decision-making procedures, lateral interaction, and fluent employee task boundaries. They display a stronger ability to adapt to constant change and are therefore more flexible than static forms, all of which reinforces lateral information processing, learning, and organizational commitment. A similar point has been made by Cohen and Levinthal (1990), who state that the ability to gain insight at an organizational level depends not only on the skills of individuals but also on the level and intensity of communication among subunits of an organization and on the degree to which these subunits communicate with the environment of the organization. The negative example of the Bosch Rexroth Corporation illustrates this point. This company offers its customers a full range of drive and control technologies. It is currently active in 44 different industries ranging from medical equipment to agricultural and forestry machines. The firm calls itself proudly the “Drive and Control Company.” While the “drive and control” branding suggests a systemic approach to integrated technology areas, Bosch Rexroth still resembles a silo organization, according to company officials. The company is organized according to four technology areas (i.e., electric drives and controls, hydraulics, linear motion and assembly technologies, and pneumatics) and a service area. Company officials report that these five areas still function and work almost like independent departments: there is a considerable lack of cross-area coordination and communication, which significantly reduces Bosch Rexroth’s ability to act as a system provider or knowledge broker for “drive and control.” Accordingly, we may also propose that:

Proposition 3: Effective knowledge brokerage is positively related to having an organic organizational form.

Processual aspects concern the ability to establish and maintain procedures for gaining access to and developing relationships with collaboration partners as well as practices for rationalizing knowledge exchange and development. According to Hargadon (2002), the organizational process of knowledge brokering may be described as comprising five generic steps: access, bridging, learning, linking, and building. *Access* concerns the structural preconditions for knowledge brokerage: the distributive nature of knowledge, which makes brokerages possible in the first place. Knowledge resides in social contexts that are densely connected internally, but less so externally. The social network literature refers to these contexts as “small worlds,” separated by structural holes (Burt, 1992). The second step concerns the process of *bridging* the gaps between these knowledge areas. This relates to gaining access to the resources and problems residing in these multiple domains. This is a precondition for the next step, *learning*, which is the process of gaining knowledge of existing resources and problems to be able to extract and use this knowledge. This reflects the same concerns that Von Hippel (1994) discussed in relation to accessing “sticky knowledge.” The fourth step, *linking*, concerns the process by which new learning is combined with existing knowledge within the knowledge broker, and used to address existing problems in novel ways. This prepares the knowledge broker for the final step in the knowledge brokerage model, *building*, in which these new insights are funneled into social contexts where they can foster innovative breakthroughs. This process and its constituent steps form an explicitly acknowledged part of any organization in which the strategic access to and codification of knowledge are seen as central.

Cotas Computer Technology (CCT) provides an example of how this practice may be embodied in organizational processes. Based on their consultancy experience of serving customers in the machine industry, CCT engineers had realized that, from a technical consulting point of view, customers even in diverse industries often faced similar processor control problems. As its customer portfolio

enlarged, CCT gradually became a transmitter of knowledge of electronic control systems between firms with adjoining and complementary learning interests. Its customer account represents diverse industrial branches such as packaging, wind turbine production, textile processing, and industrial cleaning machinery. CCT has developed standard procedures for managing its role in the product planning process, and has now routinized its procedures with respect to engagement in product development. For example, CCT has built large meeting facilities to take over some of the product development meetings from their clients and hold them in-house.

To cope with the growing array of technological knowledge and to make access to company knowledge easier, CCT very quickly introduced a policy of documentation according to standard modules. Thus, for each new project, any new developments had to be documented and related to existing modules. For example, program components from systems for sensing possible wind turbine overload due to high wind speeds may be used to acquire environmental information on overload from sorting systems in the cold storage facilities of retail chain warehouses. Developing a library and constantly adding to it by following simple formulas for documentation and possible applications made this form of knowledge sharing much easier, and may be seen as a strategy of codification. Moreover, all client meetings are always attended by at least two engineers from CCT. This practice was implemented to ensure some continuity and flexibility in terms of collective organizational memory, should one engineer decide to leave CCT. Other organizational memory bins include written memos, customer files, and even videotaped meetings. Moreover, these memory bins are in some cases even shared with customers, using web hotels and other devices to facilitate smooth knowledge sharing and virtual teamworking.

Using and sharing knowledge embodied in existing designs to solve new problems follows from the modularization and codification scheme addressed in the previous section. CCT has no patents or forms of legal protection for its developed components; it deems this unnecessary, as knowledge is constantly reformed and renewed through ongoing customer interaction. CCT sees its core capability

as mastering the storage, inflow, and outflow of knowledge through network relationships rather than as protecting core knowledge via patent rights and the like. This also means that customers have access to most of CCT's component library through extranet.

Organizations differ in how they learn from the R&D activities in which they have been involved. Most have not established a structured learning process and are therefore incapable of deriving systematic experience from previous development activities (Koners & Goffin, 2007; von Zedtwitz, 2002). However, the ability to learn from involvement in previous projects and transfer this knowledge to future collaborative projects is crucial to a knowledge broker. Accordingly, we propose that:

Proposition 4: Effective knowledge brokerage is positively associated with enacting organizational processes for accessing and exchanging knowledge in collaboration with customers.

Buyer factors

Buyers differ with respect to their willingness and ability to involve suppliers (Nieto & Santamaria, 2007). Organizational resistance to supplier involvement in product development can stem from internal R&D envy or from other departments' anxiety about becoming redundant. Competence issues concern the lack of ability to manage supplier relationships, i.e., including employees with technical, commercial, and social skills in an organizational unit and giving it both the authority and responsibility to interact efficiently with suppliers. In a similar vein, Croom (2001) discusses the process of realizing the strategic importance of supplier relationships for product development and of integrating such concerns in the strategic agenda-forming process of the manufacturer. According to the strategic importance of supplier involvement, manufacturers may vary their organizational setup and commitment during the involvement process. An important issue here concerns the local

adaptation and flexibility of the buyer's business unit involved in the collaboration. We propose the following:

Proposition 5: Effective knowledge brokerage is positively associated with the manufacturer's collaborative abilities.

A related issue concerns the critical role of the supplier's innovative inputs for the buyer. Buyer–seller relationships vary in the degree to which buyers depend on inputs from a single supplier versus multiple suppliers. In the first case, the buyer–supplier relationship clearly favors the supplier, who is in a relatively better position to dictate the terms on which the collaboration should proceed. This means that the supplier will have fewer access problems and is more likely to take ownership of knowledge developed in collaboration with the buyer. In the case of multiple suppliers, however, buyers are in a position where they can organize knowledge exchange regimes in their favor, which means that suppliers may also compete to access buyers by discounting their knowledge services. In these cases, buyers may be more prone to appropriate the rights to knowledge developed. In the case of the wind turbine industry, Vestas, the world's leading manufacturer of wind turbines, needed inputs for cooling systems for a new generation of wind turbines. Given the fast growth of this industry, several strategic suppliers were rivals in seeking to become the lead knowledge provider for this subcomponent. Consequently, suppliers allocated development resources and provided knowledge input to the buyer in jockeying for position. These knowledge inflows were adopted and used by Vestas in clarifying and narrowing the bidding process. Hence, in a rivalry situation, providing knowledge inputs that the customer decides to use only ensures access to the further bidding process; it does not guarantee the order (Andersen & Drejer, forthcoming). From this, we can propose that:

Proposition 6: The extent and intensity of supplier rivalry is negatively associated with effective knowledge brokerage.

Another dimension concerns the manufacturer's strategic risk regarding a given component's importance to the development (and production) of the finished product. This may be seen in relation to issues of both output (i.e., product performance) and process (i.e., interaction with other component development tasks).

Project and relationship factors

In the relationship between the buyer and the strategic supplier seeking to transform into a knowledge broker, issues such as previous experience (and with it, trust issues) and matters regarding the task boundaries of the project may influence the ability to conduct knowledge brokerage as well. Mutual trust developed through previous exchange episodes is important in sharing knowledge among partners. Trust affects openness in collaborative activities, which in turn again affects the knowledge broker's opportunities for learning and knowledge dissemination. When communication in the relationship is unclear, the actors may experience significant problems in determining what is expected and needed from them (Wynstra, van Weele, et al., 2001). Moreover, distrust may lead to a negative relationship among actors, which again impairs knowledge exchange.

We may therefore propose that:

Proposition 7: Mutual trust in buyer–strategic supplier relationships is positively associated with knowledge brokerage.

Project factors particularly relate to the degree of newness and specificity involved in the knowledge developed. Exploration activities must be balanced with exploitation activities for organizations to assimilate and combine new learning with what is already known, in order to maintain their capabilities (March, 1991). Balancing the newness of tasks becomes important to the knowledge broker, so it can maintain its effectiveness as a learning organization. New development tasks may vary in terms of goal and means uncertainty (Sobrero & Roberts, 2002; Thompson, 1967), so tasks

may involve greater or lesser degrees of means uncertainty, greater or lesser degrees of goal uncertainty, or both. In cases where both task and means uncertainties are low, tasks are primarily exploitative in nature: knowledge templates are simply transferred from one context to another with few or no adaptations, so there are limited possibilities for the knowledge broker to be exposed to new learning opportunities. In some cases, goals may be well known, but there are multiple potential means to reach a particular goal. Knowledge brokers face both exploitation and exploration opportunities, as the unknown context allow both experimentation and adaptation. For example, Hydro-X, a supplier of chemical additives for reducing the corrosive elements in feed water in process plants, frequently collaborates with intermediaries and customers around the world to find optimal ways to develop additives suitable to particular combinations of process plant and water treatment. In other cases, the means may be certain, but the goals less so: the literature on strategic alliances documents collaborative R&D projects where the partners initiate a relationship for strategic reasons but lacks an operational objective (Sobrero & Roberts, 2002). These projects also offer the knowledge broker opportunities for both explorative and exploitative learning. Finally, projects where both means and goals are unknown in the collaborative relationship are theoretically possible, though rare if existing at all in practice. Based on the above, we propose that:

Proposition 8: Effective knowledge brokerage is positively associated with engaging in development tasks that mix explorative and exploitative elements.

Supplier network portfolio factors

The innovative value related to knowledge exchange depends on how and to what extent it is deemed relevant by those forming part of the knowledge broker's network portfolio. By portfolio we mean a mix of customers who may be more or less complementary in their needs, as seen from the perspective of the knowledge broker. Diversity is a core issue, since it is from divergent learning contexts that the knowledge broker develops possibilities for transferring knowledge across structural information holes (Burt, 1992). If buyers are well connected in advance or have similar experience of

using a particular technology, the knowledge broker will likely have limited opportunities to add to its existing knowledge. From a network portfolio perspective, the knowledge broker's involvement of lead users—highly innovative customers at the forefront of technological development—may strengthen learning opportunities and increase the value of belonging to the network for other actors (Von Hippel, 1978).

As the value of knowledge brokerage depends on the knowledge broker's ability to find complementary interests in knowledge exchange, the technological complementarities of actors in the network portfolio of the supplier intending to become a knowledge broker are crucial. At the same time, technological complementarities must be balanced with respect to the business (and thereby the competitive scope) of those involved with the supplier. Buyers in the network will be less inclined to share knowledge with a knowledge broker if they suspect this knowledge will be integrated into services offered to competing firms. This may lead to distrust and thus reduce the rationale for knowledge sharing. Hence, we propose that

Proposition 9: A strategic supplier's ability to be an effective knowledge broker depends on the technological complementarities of the actors in its network portfolio.

Parallel to the concept of asset specificity (Williamson, 1975), specificity here concerns the extent to which the knowledge derived from engaging in a specific project has intrinsic economic value or whether this value only exists in the specific relationship. This concept has been discussed in the supplier literature as relationship-specific skills (Asanuma, 1989). For the knowledge broker, there is a trade-off between the depth of relationship-specific skills and the breadth of dissemination of what has been learned. On one hand, mutual adaptations breed trust and lead to depth of knowledge exchange, which in turn may lead to insights that are valuable throughout the network portfolio (Imai & Baba, 1991). On the other hand, the higher the relationship specificity of the projects, the more

idiosyncratic the findings and the more difficult it is to generalize and combine them with existing knowledge and conduct knowledge brokerage across relationships. Hence, we propose that:

Proposition 10: Since there is a curvilinear relationship between relationship specificity and the value of knowledge for the focal network of the knowledge broker, effective knowledge brokerage is contingent on intermediate adaptation to customer development needs.

Discussion and concluding remarks

Throughout this paper we have discussed generic challenges we envisage for strategic suppliers trying to reinvent themselves as knowledge brokers, as the sources of value generation in production networks are shifting from tangible to intangible assets. For many years now, the business models for profiting from the value generated from intangible assets such as knowledge have been seen as primarily found in the so-called creative industries, such as the film and entertainment industry. Increasingly, however, industrial suppliers must build their value-creation and not least value-capturing activities around knowledge services. As we have pointed out, in an economy increasingly driven by innovation abilities and supply-side learning, new organizational forms will arise. These will make room for knowledge brokerage by service-oriented knowledge suppliers, which are able to repackage their technical competencies and provide co-innovation services separate from production activities. Hence, the number of strategic suppliers turning into knowledge brokers is expected to increase in coming years. However, as the new global division of work continues unfolding, the overall number of suppliers in the manufacturing sector in western countries will probably decrease. Maintaining manufacturing competencies for the development and monitoring as well as the buffering of production activities unfolding elsewhere in the world will be less resource demanding than conducting these activities themselves.

We have focused on four generic challenges linked to the supplier organization itself and to its surrounding business network in transforming itself into a knowledge broker. These factors have here been categorized as supplier-related, relationship-related, project-related, and network portfolio related. Our categorization of these factors and how they impact is not presented as the only existing one. Moreover, each of the identified factors can be further explored. We have provided a first step, which we will operationalize and test empirically and which we hope can inspire other researchers to build their knowledge of the transitional challenges faced by strategic suppliers.

Another critical issue for strategic suppliers transforming themselves into knowledge brokers concerns the role of intellectual property rights in managing value capture. As company output becomes increasingly intangible, the appropriation of value from knowledge assets becomes increasingly crucial (Teece, 2000). However, given space limitations, we have not addressed this issue or how the strategic management of property rights affects both internal skills impacts on the organization and division of work with client companies (Reitzig, 2004).

Implications for management and academia (avenues for further research)

The changing role of strategic suppliers as knowledge brokers has implications for both research and corporate practice. The addressed role change of strategic suppliers shifts our attention from dyadic supplier–buyer relationships to suppliers’ network portfolios. In this respect, the focal supplier firm embedded in a specific network becomes the relevant unit of analysis. This implies that the instruments of social network analysis become increasingly relevant in this area of research, too. This calls for longitudinal research designs, as networks of strategic suppliers are by definition dynamically evolving, which in turn influences the degree to which they can effectively fulfill the knowledge brokerage role. Furthermore, research needs to develop a valid and reliable measure of the construct “knowledge brokerage of strategic suppliers.” In this regard, we suggest starting with explorative research designs to determine the different and crucial dimensions of knowledge brokerage in the context of strategic suppliers. This explorative research may result in a formative

measurement model for deductive, quantitative work. This changing knowledge brokerage role itself induces business model innovation. While prior work in the innovation field has primarily focused on product innovation, more research is needed into the broader concept of business model innovation. This need is confirmed by the findings of the Global CEO Study, conducted by IBM in 2006. The study reveals that CEOs perceive business model innovation as crucial in helping their companies stay competitive. Finally, our study has shown that a multidisciplinary research approach including disciplines such as business-to-business marketing, innovation management, and entrepreneurship is necessary to fully capture the phenomenon of knowledge brokerage by strategic suppliers.

From a managerial point of view, our study emphasizes the need for fundamental changes within strategic supplier firms. The business model of knowledge brokerage requires changes in strategic focus, internal capabilities, organizational structures, and networks. All the core processes of strategic suppliers are affected by this change, including selecting collaboration partners and determining relationship-specific investments. In this respect, the management of strategic suppliers needs to rethink the current practice of selecting and investing in a specific buyer relationship based on the sales volume of buyers (ABC customer approach). Instead, the role of knowledge brokerage shifts the focus to the criterion of potential learning that can be derived from collaboration with a particular buyer.

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	Strategic supplier	Knowledge broker
Business model	Developing network position through control of scarce resources. Tangible assets dominate	Developing network position through superior knowledge of integrating, reconfiguring, accessing, and releasing unique resource combinations. Intangible assets dominate
Value chain position	Bridge-building and integrating	Mediating and reconfiguring
Competence base	Focus on “above market” manufacturing skills	Focus on orchestrating dynamic networks
Role of production activities in the value proposition	Focus on production volume	Focus on problem solving and new learning possibilities
Purpose of knowledge development in relationships	To create commitment and capitalize on information richness in prioritized relationships	To create innovation possibilities through information reach across relationships with complementary knowledge needs
Organizational characteristics	Customer-centric organization: Focus on organizational skills and managerial task structures that support the development and management of dyadic relationships	Network-centric organization: Focus on organizational skills and managerial task structures that support the integration and combination of activities across relationships
Relationships with customers	Collaborative and hierarchical	Dynamic and reconfigurable

Figure 1: Differences between a strategic supplier and a knowledge brokers

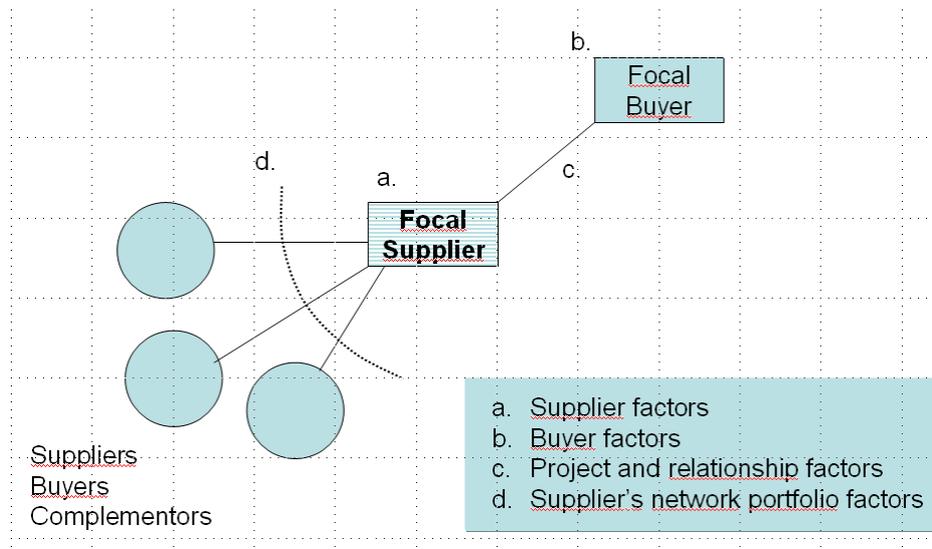


Figure 2: Factors influencing knowledge brokerage efficiency (capture and reuse of knowledge from collaboration)