Chapter 20
Knowledge Exchange in Production Networks: Operational Excellence Multiplied

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Introduction: Importance of Knowledge Management in Manufacturing Networks

Ikujiro Nonaka, one of the most influential researchers in knowledge management, once stated that "[i]n an economy where the only certainty is uncertainty, the one sure source of lasting competitive advantage is knowledge. When markets shift, technologies proliferate, competitors multiply, and products become obsolete almost overnight, successful companies are those that consistently create new knowledge, disseminate it widely throughout the organization, and quickly embody it in new technologies and products." (Nonaka 1991, p. 96) Thus, manufacturing network managers have to focus their attention not only on the management of the physical flow of goods but also on the management of the intangible flow of knowledge (Chew et al. 1990). This applies to all kinds of industries: The strength of an international manufacturing company today is to a large degree dependent on its ability to exploit the knowledge that is available somewhere within its network or in its boundaries. To achieve this, network management has to be aware of the knowledge available at each site, generated, e.g., through Operational Excellence programs. It further has to trigger the distribution of process innovations and successful practices within the network (De Meyer and Vereecke 2009). However, many attempts to foster the exchange of knowledge in the network fall short of expectations. Popular examples are idle databases or lacking exchange of successful practices. Competition between manufacturing sites adds further barriers to the sharing of knowledge.

To overcome existing shortcomings and obstacles, a structured approach is needed which takes the network's structure and the specificity of knowledge into

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account and thus enables the OPEX organization to actively steer the flow of knowledge in the production network.

In the following sections, we first address how knowledge is created in an organization. We then proceed with a discussion of the aspired exchange structure and degree of transparency which together form the basis of knowledge management within the network. Afterwards, we introduce different exchange mechanisms. The chapter concludes with a summary of incentive systems, which reinforce the knowledge management efforts. Practical examples enrich the theoretical framework.

Creating Knowledge Within a Global Manufacturing Network

The creation of new knowledge always starts with individual learning (Nonaka 1991). Only when this individual knowledge is shared and accumulated within the company, it becomes organizational knowledge (Foss et al. 2010). In this endeavor, the ease of knowledge sharing mainly depends on the type of knowledge: Whereas explicit knowledge is highly codified and thus may be easily shared (e.g., the knowledge of how to use a DVD player is easily shared by means of a user manual), tacit knowledge is highly personal, context-specific, mainly embedded in actions and thus difficult to communicate (e.g., the ability to ride a bicycle cannot easily be communicated) (Nonaka 1991). Thus, with tacit knowledge individuals seem to know more than they can tell (Polanyi 1966). That is, individuals learn on the job, acquire practical expertise, but are unable "to describe [the tacit knowledge] in a way that is helpful" (Szulanski and Winter 2002, p. 64). According to Nonaka and Takeuchi (1995), knowledge is created through a conversion of tacit into explicit knowledge while proceeding in a spiraling process from the individual to the organizational level (Nonaka and Takeuchi 1995; Fig. 20.1). The authors distinguish four modes of knowledge conversion: (1) from tacit to tacit knowledge, i.e. socialization, (2) from tacit to explicit knowledge, i.e. externalization, (3) from explicit to explicit knowledge, i.e. combination, and (4) from explicit to implicit knowledge, i.e. internalization (Nonaka and Takeuchi 1995).

First, socialization describes the process of knowledge creation through shared experiences between individuals (Nonaka 1994). This involves primarily learning through observation, imitation, and practice (Nonaka 1994). A common principle used in companies to spread tacit knowledge is on-the-job training. Second, the process of externalization comprises the conversion of tacit knowledge into explicit knowledge. It usually takes place within the context of concept development. As tacit knowledge cannot directly be grasped, it needs room for interpretation. This is realized by use of metaphors or analogies, e.g., within the scope of product development. Third, knowledge creation through combination covers the creation of new (explicit) knowledge through a reconfiguration of existing explicit

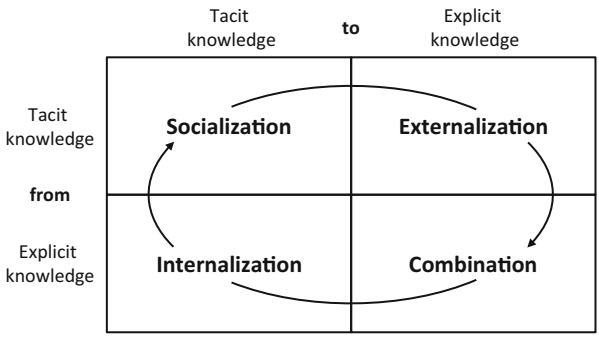

Fig. 20.1 The knowledge spiral (Adapted from Nonaka and Takeuchi 1995)

knowledge. It is based on an exchange of knowledge through documents, meetings, telephone calls or data bases and involves sorting, reorganizing, and adding of existing knowledge. Finally, internalization depicts the conversion of explicit knowledge into tacit knowledge. It is similar to the practice of learning-by-doing. Documentation may provide a useful basis for the process of internalization. (Nonaka and Takeuchi 1995)

Summarizing, knowledge creation is achieved in different ways with different underlying conditions and the application of different exchange mechanisms. To advance knowledge creation within a global manufacturing network, the conditions should be set appropriately to support the different modes of knowledge conversion.

Determining the Exchange Structure and the Degree of Transparency

The two main dimensions that describe the basic conditions for knowledge creation and dissemination in a network are the structure and the transparency of knowledge exchange (Mundt 2012). The exchange structure defines the degree of centralization of knowledge exchange (Mundt 2012). It range from complete decentralization, focused on a direct exchange between sites with little or only indirect central guidance, to full centralization, with knowledge being centrally provided from the headquarters to the plants (Chew et al. 1990). Additionally, a mixture between a decentralized and a centralized structure may occur which allows a certain degree of direct exchange between sites while still having a central steering in place. Progressing towards a more centralized structure, knowledge exchange may also be centrally coordinated by a hub that collects and distributes knowledge within the network (Mundt 2012). The prevalent exchange structure strongly influences the channels, through which knowledge is collected, processed, and distributed (Mundt 2012).

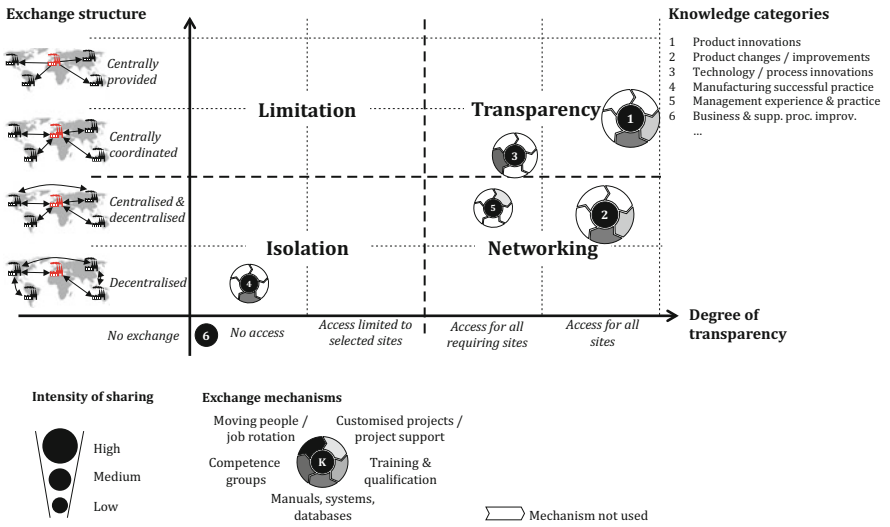

Fig. 20.2 Knowledge sharing framework (Adapted from Mundt 2012)

The second dimension comprises the degree of transparency, i.e. the sites' accessibility to the available knowledge (Mundt 2012). It ranges from fully accessible to fully restricted. In case of the latter, managers with network-wide responsibilities have the opportunity to control the exchange of knowledge and steer the sites by granting or restricting the access to knowledge. This may either involve certain sites or certain pieces of knowledge (Mundt 2012).

Figure 20.2 visualizes the two dimensions in the knowledge sharing framework.

The framework reveals four generic positions for knowledge sharing (Mundt 2012):

1. The isolation position is based on a decentralized structure with restricted access to knowledge. This position is usually owed to highly autonomous sites acting independently and lacking a platform for knowledge exchange.
2. The networking position is also built on a decentralized structure, but involves a high degree of transparency. This position occurs when sites are actively engaged in knowledge exchange, thus perceiving themselves as "team members" within the network.
3. The transparency position is characterized by a central exchange structure and a high degree of transparency. Typically, headquarters or a leading site in the network are steering the knowledge exchange, being responsible either for the creation and provision, or the collection, processing, and transfer of knowledge.
4. The limitation position is also based on a centralized structure, but characterized by a low degree of transparency. The sites are hence restricted in their access to knowledge. This may either be due to strategic targets of the central steering unit, e.g., conscious limiting of the sites' access to knowledge, or due to a selective allocation of knowledge.

The cases of two global non-pharma manufacturing companies illustrate the implications of the knowledge sharing framework. In the case of a mechanical seals manufacturer, the network management was struggling with knowledge sharing. It found itself locked in the isolation position with the autonomous sites being reluctant to share their knowledge with each other. Only financial information "which was collected centrally" and knowledge on product innovations from the central R&D function were exchanged throughout the whole network. Local product adaptions as well as local innovations in technologies and processes remained undisclosed from network management. This in turn hindered the achievement of a common global product quality standard and process standardization. In order to counteract the adverse effects, network management had to actively engage in knowledge management. Measures inducing a change and a move towards the transparency position included a centralization of product- and process-related knowledge sharing. This again demanded a harmonization of the various existing product data management systems to create a platform for a transparent knowledge exchange.

The second case of a chemical engineering company in the dental industry illustrates how the company succeeded in reaching the networking position. The first step to get the manufacturing sites working closer together was achieved by a comprehensive overhaul of the organizational structure, which led to the creation of a central production function. This reduced the existing organizational barriers and competition between the manufacturing sites. However, one of the main success factors was the personal commitment of the network manager who not only created dense ties to each of the sites but also between them. He did so by establishing a structured exchange which included regular meetings on different hierarchical levels, within functions, as well as cross-functional.

In the next section we will concentrate on the different types of knowledge exchange mechanisms and their application in the network.

Examining the Different Types of Knowledge and Deriving Appropriate Exchange Mechanisms

Choosing the appropriate mechanisms to generate and distribute knowledge within the network is another prerequisite for successful knowledge management. The right mechanism for the transfer of knowledge depends on the type of knowledge that has to be transferred. Ferdows (2006) provides a framework that builds upon the distinction between tacit and explicit knowledge and the speed with which the knowledge changes (Fig. 20.3). For explicit knowledge, codification is a key mechanism to transfer knowledge (Ferdows 2006). New knowledge is mainly collected centrally and then codified in operations manuals or systems (Ferdows 2006). Requiring employees or units may then be taught how to apply the new knowledge. When, however, production knowledge is tacit, it has to be transferred

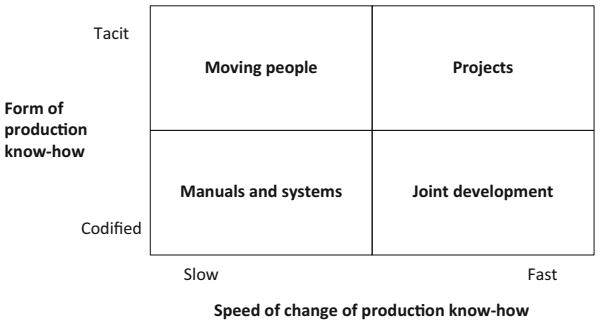

Fig. 20.3 Exchange mechanisms (Adapted from Ferdows 2006)

face-to-face (Ferdows 2006). In this case, network management should consider moving people to spread the new knowledge within the network (Ferdows 2006). Furthermore, regardless of whether the knowledge is explicit or tacit in its nature, if it is changing quickly, a critical mass of experts is needed to participate in the creation of new knowledge (Ferdows 2006). The use of experts also allows for a fast implementation of new production methods and transfer of the knowledge in time to other employees or units (Ferdows 2006). In the case of quickly changing tacit knowledge, the experts should participate in projects to directly contribute their knowledge and expertise. In the case of quickly changing production knowledge that can be codified, joint development between the central unit and the manufacturing sites is an appropriate mechanism to generate and distribute new knowledge.

The relation between the type of knowledge and the use of exchange mechanisms is illustrated by several practical examples. A leading producer of private label pet food, for example, has implemented so-called centers of expertise (CoE), which support the company's strategic target of being a quick follower. The CoEs consist of experts in a certain field of operations, e.g., they are related to a specific production technology or to product development for a particular product group. All experts belonging to a CoE are centrally assigned and their role is clearly communicated in the network to achieve a high degree of transparency. Main tasks of the CoEs comprise support for the producing plants and further development of the CoE's specific field of expertise within the whole network. Thereby, the experts are both engaged in documentation of existing knowledge and sharing of their expertise in joint development projects. Thus, the CoEs are the basis for the company's ability to quickly launch new products and expand production to several sites of the network within a short period of time.

In the network of a polymer processing company, a central unit steers the exchange of knowledge. It is primarily responsible to ensure global adherence to the standardized production process. Consequently, it is not only engaged in the process control system but also in the documentation of the target process, and accomplishment of process audits. Where applicable, information and knowledge are codified and stored in a database. The sites may access the information, but are not able to make any changes to the standard process. Requests for changes always have to be directed to the central unit which then checks if a modification of the

standardized process is necessary. If modifications are made, the central unit sends its experts to the sites to introduce the changes. Usually, the experts support the modification of one production line; modifications of the other lines are done by the site itself. Thus, the experts transfer their knowledge to the dispersed sites but, due to supporting the modification of the different sites' production lines, also acquire new knowledge.

In the case of a producer of domestic appliances, the choice of appropriate exchange mechanisms was crucial to the establishment of cooperation between China and Europe. Cultural differences represented major barriers to an exchange of knowledge, which could not be overcome by conventional communication channels such as e-mail and telephone calls. Hence, in a first step network management introduced regular video-conference meetings which were less and allowed for a more personal communication. In a second step, an exchange of employees was initialized to strengthen the tenuous ties. Thereby, the exchange not only involved the management level but was enlarged to comprise also functional layers. By this means, the network management succeeded in creating a mutual understanding and could identify ties between the European and the Chinese sites. Today, the plants work closely together and knowledge is exchanged frequently. The mechanisms used today also comprise e-mail and telephone calls, as the employees now draw on a closer relationship based on common projects, discussions, and meetings (Mundt 2012).

Incentive System: Reinforcing Knowledge Management

After having defined the basic structure of knowledge exchange, the degree of transparency, and the appropriate exchange mechanisms, another crucial task of network management is to embed the sharing of knowledge in the network. This must of course involve the dispersed sites. Thereby, the targets of the sites, e.g., increasing their own knowledge base to strengthen their position in the network, may be contrary to the targets of network management, e.g., sharing of successful practices to enhance product and process quality throughout the network. Thus, it is important to set the right incentives. According to Mundt, "[i]ncentive systems provide mechanisms to motivate an intended behavior by facilitating desirable or restricting unwanted actions." (Mundt 2012, p. 91) The definition of network- or site-specific targets and the related allocation of rewards provide network managers with a means to steer the sites along the network's goals. If targets are set for individual sites, this may foster competition, whereas setting targets for the whole network may intensify collaboration between sites (Bartol and Srivastava 2002). The allocation of rewards further affects the interaction between sites: If rewards are solely based on each site's individual contribution, e.g., connecting the site manager's bonus payment to the site's performance, this is likely to fuel competition. On the other hand, if rewards are equally allocated between sites, this may strengthen cooperation between them (Mundt 2012).

Conclusion

In this chapter we provided an overview of our structured approach to foster the exchange of knowledge in a global network. We illustrated how knowledge is created within an organization, i.e. with individual learning always standing at the beginning of knowledge creation. It then comes to determine an appropriate structure for knowledge exchange. On the one hand, strong centralization gives headquarters a comprehensive overview of existing knowledge and might, in combination with a limited access to knowledge, be used as a means to control the flow of knowledge. On the other hand, a centralized structure together with free access to knowledge may foster networking within the organization. Knowledge exchange may further be supported by applying suitable exchange mechanisms. These are dependent on the type of knowledge. Especially for organizations which have to keep up with fast-changing production know how, mere documentation will not suffice to spread knowledge between sites. Finally, we claim that the implemented knowledge exchange system should be supported by an appropriate incentive system.

The structured approach to knowledge management allows the network function to actively steer the exchange of knowledge in the production network. The OPEX organization with network-wide responsibilities is thus in the pole position to drive knowledge exchange in the network and multiply the benefits achieved at the single sites.

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