

Workshop

Geschäftsprozessorientiertes Wissensmanagement - Von der Strategie zum Content -

WM 2001 Baden-Baden

Applied knowledge management in innovation processes

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“For DuPont, accelerating innovation is the main objective of their Knowledge Management program.”¹

1 Introduction

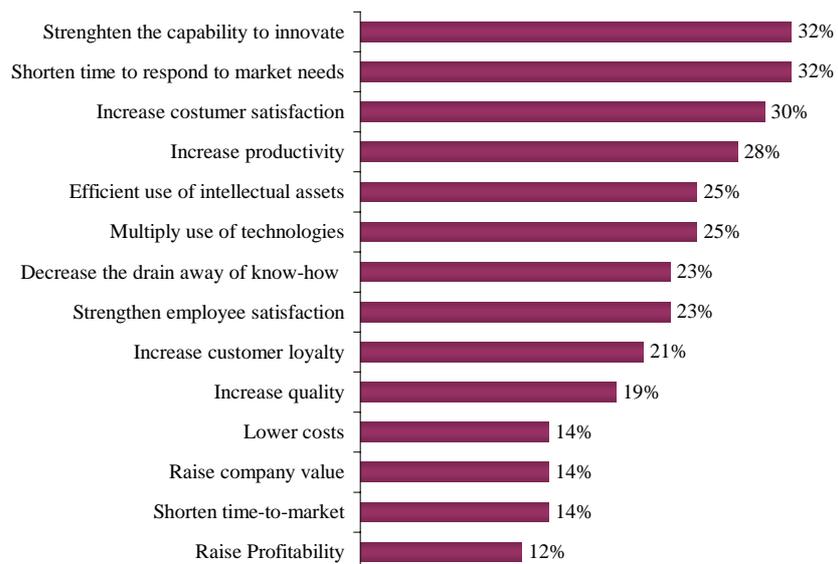
Currently, most companies are conscious of the constant need to innovate. Company operations must change to be in tune with a new economic landscape.² Education increases³ and technology – think only of the increasing computer capacity, the internet or the seemingly endless emerging wireless networks – triggers growing networks, increasing exchange of information and the resulting explosion of knowledge one has access to. Subsequently, the importance of knowledge and its management has grown significantly and the task of every company is to build an organization that will meet the demands of the postindustrial knowledge economy.

One trigger of introducing Knowledge Management (KM) to Innovation Processes is the increasing complexity of products and services, in which ever more different technologies are combined and embedded. Therefore, the essentially different competencies must be available and used efficiently and effectively. This requires the Innovation process to increase its capabilities of combining and integrating the large numbers of participants and stakeholders and their knowledge.

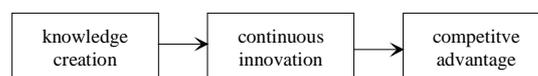
Emerging technologies and intelligent systems⁴ combined with KM actions do provide an enormous potential to match that challenge. Yet, in order to have these technologies supporting knowledge creation and therewith innovation processes, one has to know how to use and apply these tools most efficiently. But recommendations for that issue are answered sufficiently neither by practice nor by research. In analyzing the fundamental and underlying processes of KM and Innovation this paper will take one step further to lay a reasonable foundation for an answer.

In a recently conducted survey, companies were asked what they expected from the efficient management of knowledge. The expectation to ‘Strengthen their capability to innovate’ was named most along with ‘Shorten time to respond to market needs’.

Source: Knowledge Bridge Consulting (2000)⁵



The overall necessity of implementing knowledge management, with regard to innovation, is has been stated by Nonaka/Takeuchi as well as other authors in the field⁶. The sketch below shows, that today knowledge management is needed to create continuous innovation in order to gain competitive advantages with respect to competitive advantages similarly to other business processes.



Source: Nonaka, Takeuchi (1995)⁷

¹ White Paper by Extreme Innovation, Inc. (July, 1999)

² See Quinn, et al. (1997; p. 20)

³ E.g. professional corps of engineers, scientists are constantly growing. See von Krogh and Nonaka (2000; p. 3)

⁴ These new technologies range from databases, internet and intranet technologies, to mobile communication technologies using satellites, to Bluetooth technologies etc.

⁵ The survey was conducted among 1070 firms, while 143 firms answered the questions. See Wienröder (2000; p. 24)

⁶ See Nonaka and Takeuchi (1995; p. 5 f.)

⁷ See Nonaka and Takeuchi (1995; p. 6) or as Pérez-Bustamante (1999; p. 6) state “... innovation and knowledge management are tightly linked.” Also Madhavan and Grover (1998; p. 1) “From the idea-generation phase to the launch phase, the creation of new knowledge can be viewed as the central theme of the NPD process.” (NPD = New Product Development)

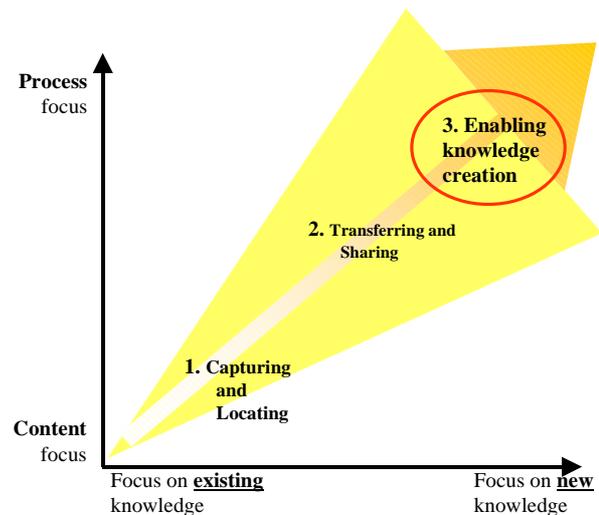
Yet, effective knowledge management will have different profiles in different business processes, depending on process complexity, knowledge intensity.

Source: Eppler, Seifried and Röpneck (2000)



While the efficiency of business processes that are less knowledge intensive⁸ like order fulfillment or customer service relies mainly on the exploitation of existing knowledge or the dissemination of new knowledge, product innovation and development have to focus on the process of efficiently creating new knowledge. Based on a model of von Krogh and Nonaka, the “company development in knowledge creation” follows three steps. (1) Firms begin their knowledge initiatives by trying to locate and capture valuable company knowledge. (2) The second step is characterized by the objective to make the company knowledge easily accessible to the organization and to find new applications for existing knowledge. (3) In order to be able to take the third step – enabling knowledge creation - the first two have to be inherited respective performed in an organizations business process. While the efficiency of the first and second step relies on the exploitation of existing knowledge or the dissemination of new knowledge, innovation has to focus on the process of efficiently creating new knowledge. Neither theory nor practice have investigated or even used stage three sufficiently.

Source: von Krogh, Nonaka (2000, p. 259ff.)



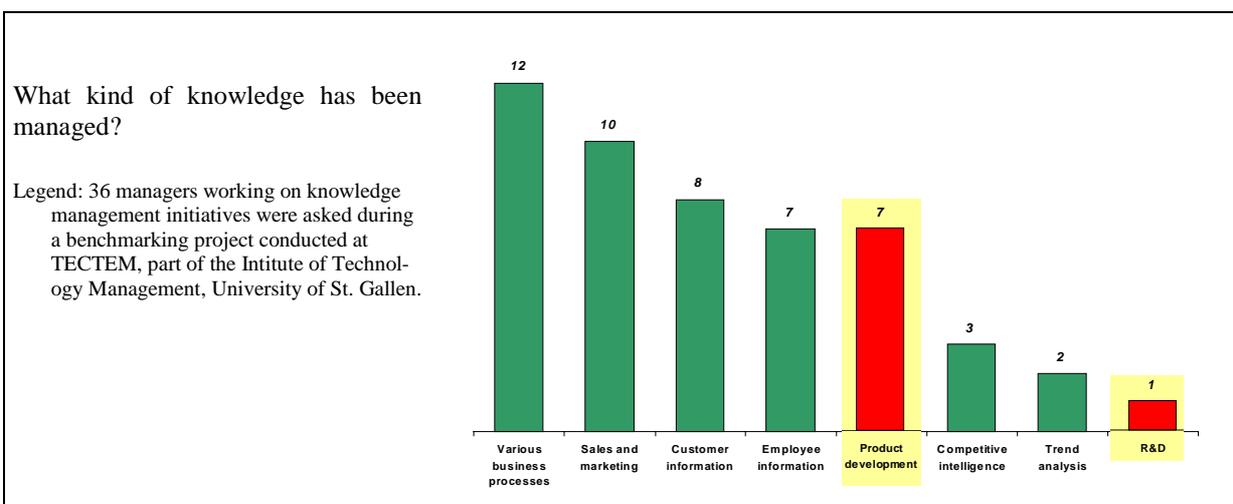
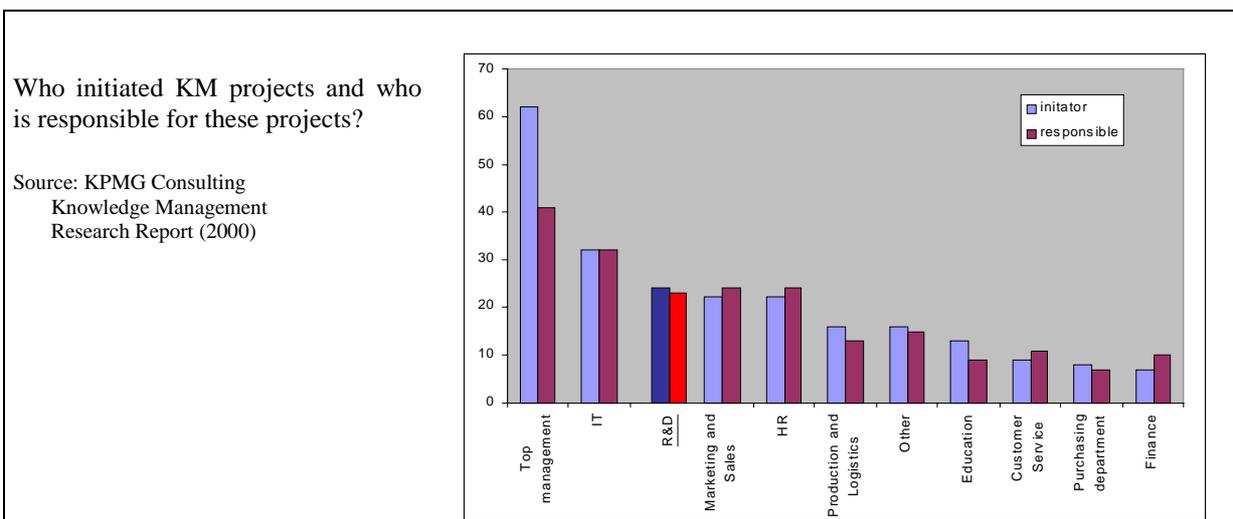
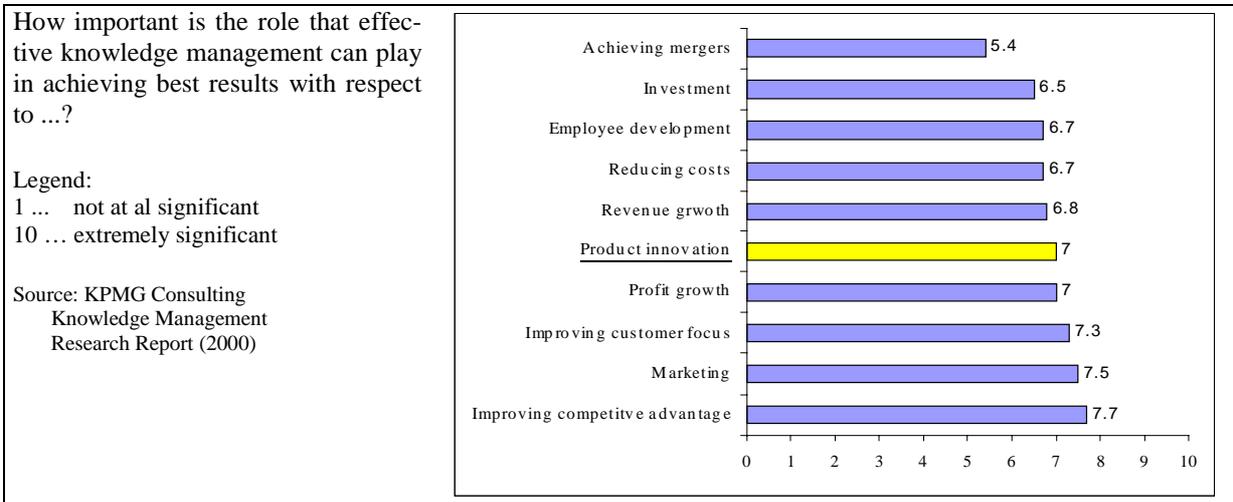
This paper is guided by an analysis of the knowledge creation process, the innovation process, and their interrelationship. The results of that analysis will serve as a base for further examinations of the implication of knowledge management on innovation management, answering questions like: To what extent can knowledge management support and improve a company’s ability to innovate and if so, what circumstances have to be provided by a firm to do so effectively? Moreover, the paper will concentrate on product innovations that are driven by technology, especially in the industry of the production of communication, telecommunication, and data transfer devices.

⁸ Eppler, et al. (2000; p.) define “... knowledge intensive processes as business processes that have a high need for innovation of the single agent who affects the results of a process directly.” Whereas agents can be humans, communities or information processing machines. See Eppler, et al. (2000; p.)

2 The research context

2.1 State of the art in practice

Taking an interest in what companies expect from knowledge management as well as what they have been doing so far, several studies were analyzed. Three diagrams of different studies are shown below, complementing the very first chart of this paper on page 1.



Even though some companies are convinced, that the role which effective knowledge management can play in achieving best results with respect to product innovation is very significant and even though R&D was named third in answering the question who initiated Knowledge Management projects, the knowledge that has been managed is mainly to find in other areas respective departments.

2.2 Theoretical approaches to date

Theoretical approaches to date concerning the interrelation of KM and innovation have been studied by the author in detail.⁹ So far, none of these researchers and practitioners have focused on the steps of innovation process and investigated how KM could contribute to these steps. Subsequently selected theoretical approaches to date concerning the interrelation of knowledge management and innovation processes are presented.

The Knowledge-Creating Company

Nonaka, I.; Takeuchi, H., Oxford, 1995

The book discusses the process of knowledge creation theoretically in depth but not specifically for applications. It has been written with respect to the general process of knowledge creation and the authors use very often the product development, R&D, and innovation processes as an example. Yet, the book does not take the perspective of the innovation process itself stating if certain knowledge modes¹⁰ are dominating in certain stages of the innovation process. In order to take action for improving innovation processes using knowledge management an analysis of that would be necessary.

How does knowledge management influence innovation and competitiveness?

Carneiro, A., in: Journal of Knowledge Management Vol. 4, No. 2, 2000, p. 87-98

This article attempts to provide insights on the linkages between innovation and competitiveness. These considerations point out the importance of knowledge development and the role of knowledge management in order to assure competitiveness. Their suggestions for further research are to examine factors that affect knowledge development.

Knowledge Management and Innovations: networks and networking

Swan, J., Newell S., Scarbrough, H.; Hislop, D.,

in: Journal of Knowledge Management Vol. 3, No. 4, 1999, p. 262-275

The article focuses on knowledge sharing and knowledge transfer of tacit as well as explicit knowledge with regard to innovation. In their findings Swan et. al. propose to apply a cognitive model¹¹ to share explicit knowledge for innovation, while the knowledge for innovation which is socially constructed and based on experience is more efficiently shared by applying community networking.¹²

Knowledge Management and Innovation – An Initial Exploration

Ruggles, R.; Little, R., Ernst & Young Center for Business Innovation,

http://www.businessinnovation.ey.com/mko/html/inoov.htm on Oct. 6th 2000

Objective of the paper is to lay the groundwork for further discussion about the links between knowledge management and innovation. A dynamic model with the major stages of innovation is presented and it is discussed how knowledge management can create value in this evolution process. Further research still needs to be done on the specifics of the innovation – knowledge management interaction, especially around factors of causality.

Wellsprings of Knowledge – Building and sustaining the sources of innovation

Leonard-Barton, D., Boston 1995

Leonard-Barton's model is oriented by location and time of knowledge creation. She focuses on sustaining core capabilities, corresponding with internal and external (location) and present and future (time) knowledge building activities. Regarding the topic of integrating knowledge management in business processes – particularly in innovation processes, using the process perspective as foundation will provide the desired insight.

That the presented literature – that has open question to further research is supported by the following quote:

“The contribution of the knowledge management literature to date in terms of understanding innovation has been limited by a rather narrow focus on IT-based tools and systems.”

Source: Swan et. al.¹³

⁹ Carneiro (2000; p.), Dougherty (1992; p.), Galunic and Rodan (1998; p.), Johannessen, et al. (1999; p.), Kanter (1988; p.), Kogut and Zander (1992; p.), Leonard-Barton (1995; p.), Madhavan and Grover (1998; p.), Nonaka and Takeuchi (1995; p.), Pérez-Bustamante (1999; p.), Pitt and Clarke (1999; p.), Ruggles and Little (1997; p.), Swan, et al. (1999; p.), etc.

¹⁰ In Ch. 4.2 the modes are socialization, externalization, combination, and internalization are explained.

¹¹ The cognitive model emphasizes linear information flows through static IT-based networks.

¹² Community networking stresses dialogue and sense making occurring through active networking.

¹³ Swan, et al. (1999; p. 264)

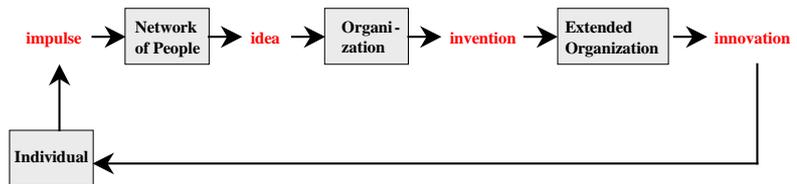
3 Innovation, innovation processes and innovation management

3.1 Innovation

Here, innovation is understood as a new product or service of a company, which has been introduced to the market. The process of innovating starts out of a certain problem perspective or creative spark with the idea generation and will end with the commercialization or market introduction. A successful innovation is determined by economic market success.¹⁴

3.2 The innovation process

Innovation processes can be found in a broad variety throughout the literature.¹⁵ They also differ significantly in different industries and companies. Yet, all of them have certain characteristic steps in common. Subsequently, these steps will be explained briefly.



(1) Creating an idea

The process start is triggered by an impulse. This impulse could be a creative spark as well as the awareness of a problem or a new perspective on a topic. This phase can often be low-key simmering for years without well defined structures. It is strongly dependent on individuals communicating face to face.¹⁶ Usually an informal network of people from inside and also outside the company¹⁷ is involved. Brainstorming, discussing their thoughts, thinking about cause and effect, experimenting they come up with ideas¹⁸.

(2) Develop an invention

Since there are no unlimited resources for developing ideas, they have to be evaluated. Evaluations can be performed in cross-functional teams,¹⁹ thus involving many parts of the organization. Subsequently resources are dedicated to building prototypes or conduction pilot projects. In the successful case, the following trial and error procedures will result in an invention.²⁰ At this point, however there is no certainty of a commercial application.

(3) Launching an innovation

After relating the invention to market studies and aligning potential product strategies to the company strategy a systemized production concept will be worked out, involving suppliers and sales channels. The new process/product has to be sourced for supplies. Marketing and sales channels have to be ramped up to foster demand. In the end, the customer's acceptance (money) will decide, if it is a viable product/process innovation or not.

(4) Generate impulses

The experience that was built up during the innovation process grows the intellectual property of the organization and its partners. Specifically, the involved individuals do learn and enrich their basis for deriving creative sparks, identify problems and determine new perspectives, and therewith create impulses for new innovation processes.

3.3 Innovation management

"Innovation management has the objective to launch new technical solutions systematically and constructive."²¹ Aiming at that objective it can be characterized by the following tasks:²²

- Define innovation strategies (e.g. choose between the first or follower strategy)
- Set targets ("By the end of the year x % of products must not be older than x years.")
- Make decisions ("Shall the expensive development of a chemical process with unknown outcome be pursued further or not?")

¹⁴ The definition is based on Hauschildts characteristics of innovation definitions. Hauschildt (1993; p. 3f.)

¹⁵ See Pérez-Bustamante (1999; p. 7)

¹⁶ See Boutellier, et al. (2000; p. 165)

¹⁷ This can be a customer, suppliers, interns etc.

¹⁸ An idea in this sense is a constructive alternative with the objective to apply to a certain technical question.

¹⁹ These teams usually consist of employees from operations, marketing, accounting and finance, R&D etc.

²⁰ Here, an invention is understood as a technical solution. With experiments or simulations it can be shown, if the solution is functioning. The general objective is to create a tangible manifestation of the idea.

²¹ Schröder (2000; p.

²² See Hauschildt (1993; p. 23)

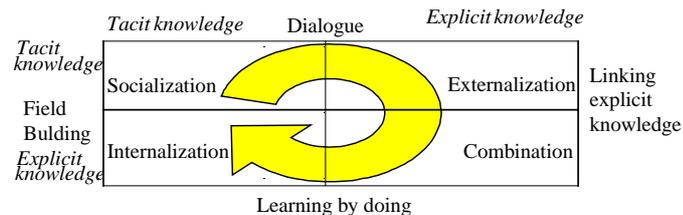
4 Knowledge, knowledge processes, and knowledge management

4.1 Knowledge

For this paper knowledge shall be defined as "... reasoning about information and data to actively enable performance problem solving, decision-making, learning and teaching."²³ In other words: "Knowledge is a capacity to act."²⁴

4.2 The knowledge (creation) process

Keeping in mind the relation to innovation processes and knowing that innovation is tied to the development of new knowledge, the discussion of knowledge processes and knowledge management will focus on the creation of new (!!) knowledge. How the process of knowledge creation occurs can be well described with the model of Nonaka and Takeuchi²⁵. Firstly, they distinguish between tacit knowledge and explicit knowledge. Moreover, they argue, that knowledge is created by converting tacit to explicit knowledge and vice versa. The process scheme is shown in the following table and can be understood as a spiral, which can be repeated endlessly, creating new knowledge.



Source: Nonaka, Takeuchi (1995, p. 71)

(1) Socialization: from tacit to tacit

Exchange of tacit knowledge creates common mental models and abilities.²⁶ In order to exchange tacit knowledge, people do not necessarily need to use language. For instance crafts-work can be learned by observation, imitation and praxis. The key is experience.

(2) Externalization: from tacit to explicit

This phase includes the process of articulating tacit knowledge. The tacit knowledge will be transformed to models, pictures, and so on. Externalization is induced by dialog and collective reflection.

(3) Combination: from explicit to explicit

Combination is a process of connecting different areas of explicit knowledge. The exchange of knowledge is done with media like documents, meetings, phone, or computer networks. Sorting, adding, or combining develops the new combination of existing information. The classification of explicit knowledge can lead to new knowledge.

(4) Internalization: from explicit to tacit

The incorporation of explicit knowledge in tacit knowledge is the main process of internalization. Through that process new knowledge is generated which becomes greater than the sums of both inputs. This knowledge capital enhances the participant's own knowledge.

4.3 Knowledge management

The following definition of Knowledge Management will be applied in this paper: "Knowledge Management applies systematic approaches to find, understand, and use knowledge to create value."²⁷ The creation of value can be: enhance customer value, enable superior performance, create new capabilities, and encourage innovation.²⁸

²³ Beckmann in: Liebowitz (1999; p. 1f)

²⁴ Sveiby (1997; p. and <http://www.knowledgecreators.com/km/kes/glossary.htm>.

²⁵ Nonaka, Takeuchi (1995, p. 71)

²⁶ Nonaka and Takeuchi defines shared mental models based on Canon-Bowers, Salas, and Converse (1995, p.228) as knowledge structures held by members of a team that enable them to form accurate explanations and expectations for the task, and in turn, to coordinate their actions and adapt their behavior to demands of the task and other team members. See Nonaka, Takeuchi (1995, p. 91)

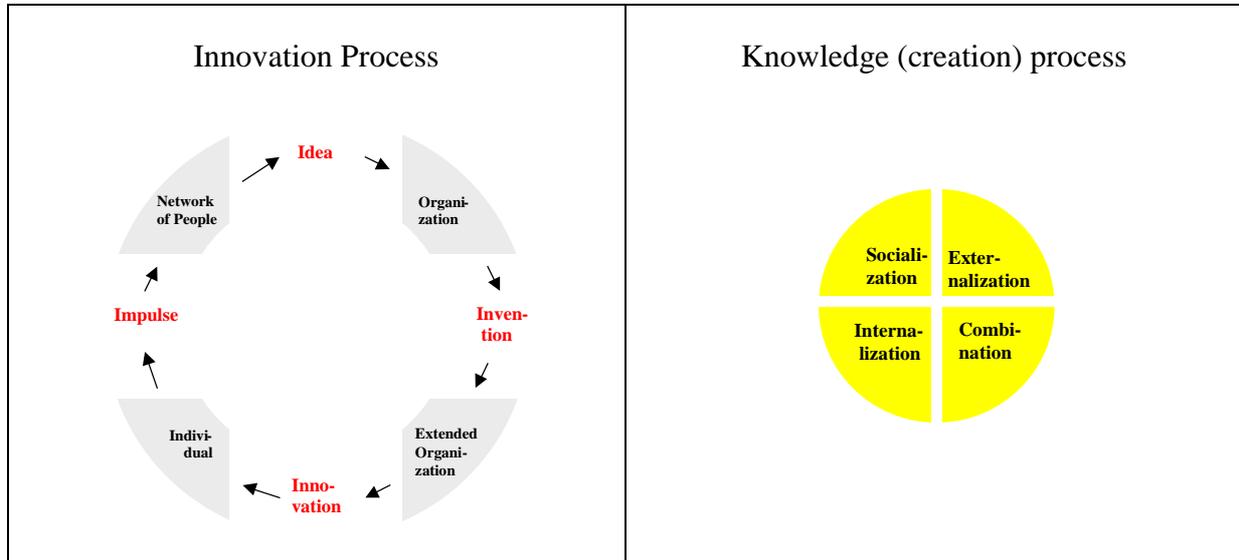
²⁷ O'Dell in: Liebowitz (1999, p. 1f)

²⁸ Beckmann in: Liebowitz (1999, p.1) For a further series of definitions on Knowledge Management see <http://knowinc.com/definitions/index.htm>.

5 Knowledge creation in innovation processes

5.1 Integrating processes

In this chapter the innovation process will be discussed from a knowledge creation perspective. The processes were graphically adjusted.



(1) Creating an idea



Independent of the type of impulse, the creative spark or the awareness of a problem, people will discuss it with others. This is necessary due to today’s knowledge explosion. Individuals are very specialized and new product ideas can barely be developed by a single person anymore. Depending on the field of innovation, there might be discussions, simulations or even experiments to develop a creative spark to an idea. Now, even though there were several persons involved, the knowledge the shared and developed is not explicit yet. Employees who are interacting in that phase have common experiences, shared mental models and similar mind sets. Since mainly tacit knowledge is exchanged and acquired, socialization is the dominating knowledge mode here. Key aspects are trust and informal networking. Key aspects in that stage are trust and informal networking. If people would not trust each other, such an experiment would not be possible.

(2) Develop an invention



In order to be able to decide which idea should be pursued further, other employees e.g. a technology management board needs to understand the principles and solution that an idea claims to provide. Therefore members of that informal created group or personal network will have to articulate their (hidden) tacit knowledge. Otherwise it could not be communicated to people outside that personal network, who have a different mind set and speak a different ‘language’. In other words, the ideas need to be externalized into concepts. These concepts might be written descriptions, prototypes, pilot projects etc. in doing so the idea will be brought further, will be sharpened and finally refined to an invention. In Nonaka/ Takeuchi’s terms conceptualized knowledge has been created.

(3) Launching an innovation



The commercialization of a new product has to be carefully prepared. Involved are suppliers, distributors, advertising etc. In order to be successful, a holistic approach is necessary. The existing company knowledge and the knowledge of partners needs to be combined. A combination of already existing explicit knowledge takes place. If different aspects have to be combined for that and a project is initiated, than it is a systematic, planned and methodological process of knowledge generation.²⁹ Systemic knowledge is created.

(4) Generate innovative impulses



What generates innovative impulses? The awareness of certain problems or creative sparks are built on existing knowledge and experiences. Hence, the process of internalization has to have happened sometime before. At certain moments knowledge and information components fit like a jigsaw and make sense all of a sudden. This will be experienced more likely by someone with a large knowledge base than by someone with a smaller knowledge base. In addition to that, creativity theory applies. A creative individual is able to combine knowledge pieces in unconventional ways. He or she is able to think out of the box instead of repeatedly using proven patterns and schemes.³⁰ However, creativity itself is not given to every individual. Therefore internalization of explicit (organizational) knowledge is key.³¹

²⁹ Brockhoff (1994; p. 37)

³⁰ “A company is creative when its employees do something new and potentially useful without being directly shown or taught.” Robinson, Stern (1997, p. 17)

³¹ Experienced-based operational knowledge often triggers a new cycle of innovation. See Nonaka, Takeuchi (1995, p. 72)

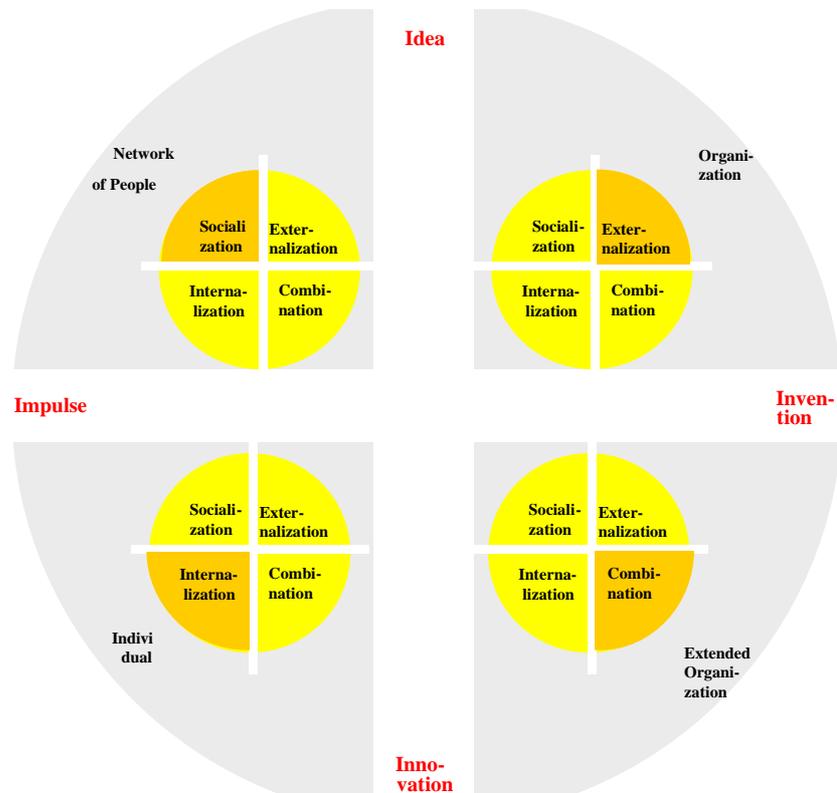
5.2 An integrated model

The findings from the previous paragraphs have been combined and are pictured in the figure to the right. Interviews with practitioners confirmed the integration of these two processes as shown in the model.

5.3 Propositions

Also based on these findings, propositions can be formulated:

- Different knowledge modes are dominating in the different stages of a successful innovation process.*
- Yet, they do not occur exclusively.*
- Therefore, the different stages of the innovation process do require different knowledge management activities in order to be efficient.*



If we know the dominating knowledge modes in each step of the innovation process, we can develop management actions specifically supporting the development of innovations.³² It is also important to note, that KM actions that are useful in one stage of the innovation process might be useless or even harmful in other stages of the process. Possible managerial implications will be discussed in the succeeding chapter.

6 Managerial implications – knowledge management applied in innovation processes

6.1 Creating promising ideas

In understanding, that the effective creation of promising ideas takes place where socialization is supported, specifically where people trust each other, and where they have common mental models etc. innovation management should apply the according means. In this phase it would be effective to support informal networking by encouraging frequent face-to-face as well as virtual meetings. One example for face-to-face meetings are “brainstorming camps”.³³ Based on sociological perceptions trust can be increased if sanctions of supervisors are limited, not only individual but also team work is rewarded etc.³⁴ Thinking of tools supporting virtual team meetings are „Community Generators“ which enable almost everybody who is familiar with technologies of the New Economy to set up a web based platform for community members to meet.

³² Awareness of the different characteristics of the knowledge modes is essential to manage adequately the creation of knowledge. Pérez-Bustamante (1999; p. 14)

³³ These are informal meetings for detailed discussions to solve difficult problems. The concept has been applied at Honda in development projects. See Nonaka, Takeuchi (1995, p. 63)

³⁴ The author will have to investigate that topic in more detail.

6.2 Developing powerful inventions

One measure in the stage of developing inventions could be employing experts to support the expression of their ideas and thoughts, to promote the externalization. The reason for that is, that employees do not always have the time or the skill for externalizing the ideas they have in mind. Different “functional” languages as well as different spoken languages (in transnational firms) are barriers in the knowledge creation process. Experts, formal structures, methods or tools could be implemented to support externalization of tacit knowledge. There are more and more technologies emerging that are able to provide effective support: Having a tiny video camera sitting on the top of someone’s computer screen, only a button to push (or some words to say) in order to activate it induces people to use it, e.g. recording important knowledge which can be translated of written down from an expert where ever he or she is located and at any time the expert will find the time to do so.

6.3 Launching successful innovations

An effective combination of knowledge is essential in order to lead to a victorious launch of a new product. Not just single employees, but throughout the whole organization people must be assured of the fastest access to the broadest variety of necessary knowledge, going through the fewest steps.³⁵ Formal networks and structured knowledge flows are means to promote that. Since also knowledge has to be combined that is located outside the organization, the knowledge exchange between suppliers, sales channels, distributors, advertisement agencies etc. is important to take into consideration. The introduction of software tools, intranet and internet solutions are management means which could provide the required fast and easy access to the named knowledge.³⁶ And even though the technology for desk top video conferencing (with the purpose of fostering informal networks) would not explicitly harm the knowledge creation process and therewith the innovation process. Yet, according to the integrated model of that paper, that technology is not the strongest means to apply in the phase of launching innovations. Knowledge Managers should take that into consideration when promoting KM tools.

6.4 Generating innovative impulses

The objective here is to internalize the experience of previous innovation processes as well as other experiences. In order to enhance the process of learning, knowledge could be disseminated well directed, whereas an information and knowledge overflow will hinder to enlarge individuals knowledge base. In order to do so, the process of learning has to be understood and incorporated regarding technological concepts and organizational structures. One managerial question to answer would be: What are the most efficient dynamic and interactive learning tools? Besides technology, accompanying measures must not be disregarded! How much time shall employees use actively to provide their knowledge and especially learn and internalize organizational experience? Is there dedicated time for that at all? If so, is it communicated to them? What approaches of KM in the New Economy support that most efficiently, keeping in mind, that internalization is key in that phase?

7 Further research process

An empirical valuation will be conducted verifying or falsifying the integrated model as well as the named propositions. The methodology suggests a qualitative approach using case studies. The author will cooperate with companies, asking for at least one successful and one failed innovation project, investigating:

- if at the successful one socialization played the major role in the first process step of innovating
- if at the failed one socialization did not play that role.

Beforehand, indicators have to be determined, operationalizing

- successful, medium, and failed innovation projects on the one hand³⁷ as well as
- the four knowledge modes (e.g. socialization via frequency of face to face meetings, intensity/duration of communication an so on) on the other hand.

³⁵ See Nonaka, Takeuchi (1995, p. 82)

³⁶ For an evaluation of leading Knowledge Management Suites see: Seifried, Eppler (2000). Knowledge Management Suites are different technology based Knowledge Management Tools integrated in a software package that software companies offer.

³⁷ Sometimes commercial success may be an appropriate dependent variable. At other times, the amount of knowledge created may be the best indicator. See Madhavan and Grover (1998; p. 10)

In case the integrative model and the hypotheses are valid, the following table would appear:

| | Socialization | Externalization | Combination | Internalization |
|-----------------------|---------------|-----------------|-------------|-----------------|
| Idea Creation | X | O | O | O |
| Invention Development | O | X | O | O |
| Innovation Launch | O | O | X | O |
| Impulse Generation | O | O | O | X |

x ... indicating that the knowledge mode would dominate in the according phase of the innovation process
 0 ... indicating that the knowledge mode plays a secondarily role in the according phase of the innovation process

In order to make cases comparable, the research will concentrate on product innovations that are driven by technology. The applicability for other types of innovations and other industries will be examined subsequently.

8 Concluding remarks

„All innovation is a learning process through which people create the relevant new tacit and explicit knowledge that will enable them to coax ideas to maturity.“³⁸

The presented approach strives to understand certain knowledge processes and flows in certain stages of the innovation process. Once that interdependence is comprehended, KM approaches and supporting technologies can be evaluated. Moreover, specific and clearly aimed organizational measures can be developed to enhance a companies ability to innovate efficiently. Therewith companies will strengthen their ability to compete in the postindustrial knowledge economy.

Transferring the findings to other knowledge (management) processes, the introduced integrated approach might be used for other theories in KM. Other business processes consist - like innovation processes - of a series of steps. The research question to answer would be: Are KM methods and technologies of to be used equally throughout in all the steps of the investigated business process? Or does management has to differentiate the application of them depending on the process stage of the investigated business process in order to have an efficient KM in place for not only facing but shaping the 'New Economy'.

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³⁸ Miller and Morris (1998; p. 90)

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