In: Bekavac, Bernard; Herget, Josef; Rittberger, Marc (Hg.): Informationen zwischen Kultur und Marktwirtschaft. Proceedings des 9. InternationalenSymposiums fur Informationswissenschaft (ISI 2004), Chur, 6.-8.Oktober2004. Konstanz: UVK Verlagsgesellschaft mbH, 2004. S. 373 – 394

The significance of tacit knowledge on company's innovation capability

Ragna Seidler-de Alwis[1], *Evi Hartmann*[2]

[1]Fachhochschule Köln
Fakultät für Informations und Kommunikationswissenschaften
Institut für Informationswissenschaft
Claudiusstr. 1
D-50678 Köln
ragna.seidler@fh-koeln.de

[2]A.T. Kearney GmbH
Management Consultants
Platz der Einheit 1
D-60327 Frankfurt am Main
evi.hartmann@atkearney.com

1 Introduction

Nowadays innovation success is becoming even more important. After months and years of restructuring and cost cutting to regain profitability, many firms are forced to renew their product portfolio. Only with new products can they sustain their competitive position by increasing revenues and profit, leading to an improved company value. But do the firms have the right conditions and environment to lead them to maximum innovation success? Do they understand the appropriate triggers and levers for optimising their innovation success? The authors stress the role of tacit knowledge as one key lever for achieving this innovation success. They analysed the existing published works on tacit knowledge and innovation management, by reflecting the relevant dimensions leading to a smooth interplay between tacit knowledge and innovation management with the aim of innovation success.

The paper is organized as follows: Firstly, we provide an overview of the literature on tacit knowledge management and innovation management, thereby developing a conceptual framework. Then, based on these classifications and by synthesizing all aspects, an integrated model is proposed. We close with an outlook of further research opportunities and some managerial implications.

Dieses Dokument wird unter folgender creative commons Lizenz veröffentlicht:
http://creativecommons.org/licenses/by-nc-nd/2.0/de/

2 Knowledge management in organizations

The ever increasing importance of knowledge in contemporary society calls for a shift in our thinking concerning innovation in business organisations – be it technical innovation, product or process innovation, or strategic or organizational innovation. It raises questions about how organizations process knowledge and, more importantly, how they create new knowledge. Innovation, which is a key form of organisational knowledge creation, cannot be explained sufficiently in terms of information processing or problem solving. Innovation can be better understood as a process in which the organisation creates and defines problems and then actively develops new knowledge to solve them (Nonaka 1994, p. 14).

Davenport and Marchand suggest that: "whilst knowledge management does involve information management, beyond that it has two distinctive tasks: to facilitate the creation of new knowledge and to manage the way people share and apply it" (Davenport & Marchard 1999, p. 2).

In Nonaka's et al. (2000) unified model of dynamic knowledge creation, knowledge is described as dynamic, since it is created in social interactions amongst individuals and organisations. Knowledge is context specific, as it depends on a particular time and space. Without being put into context, it is just information, not knowledge. Information becomes knowledge when it is interpreted by individuals and given a context and anchored in the beliefs and commitments of individuals (Nonaka et al. 2000). Also Davenport, de Long and Beers (1998, p. 43) come up with similar definitions of knowledge. Knowledge which is new to an organisation has to either be invented internally, or acquired from external sources. There are two types of knowledge: explicit knowledge and tacit knowledge. Nonaka et al. (2000) and other authors such as Hall and Andriani (2002) describe explicit knowledge as what can be embodied in a code or a language and as a consequence it can be communicated, processed, transmitted and stored relatively easily. It can be shared in the form of data, scientific formulae, manuals and such like. In contrast, tacit knowledge is personal and hard to formalise – it is rooted in action, procedures, commitment, values and emotions etc.. Tacit knowledge is not codified, it is not communicated in a 'language', it is acquired by sharing experiences, by observation and imitation (Hall & Andriani 2002). Tacit and explicit knowledge are complementary, which means both types of knowledge are essential to knowledge creation. Explicit knowledge without tacit insight quickly looses its meaning. Knowledge is created through interactions between tacit and

explicit knowledge and not from either tacit or explicit knowledge alone (Nonaka et al. 2000).

3 Tacit knowledge management

Many definitions of tacit knowledge exist but Polanyi (1969) is widely accepted as the founding father who identified the significance of the concept of tacit knowledge. Polanyi encapsulates the essence of tacit knowledge in the phrase 'we know more than we can tell', and provides further clarification in such commonplace examples as the ability to recognize faces, ride a bicycle or swim, without the slightest idea to explain how these things are done (Polanyi 1966, p.4). The whole discussion on tacit knowledge management including definitions was brought forward by several authors such as Rosenberg (1982, p. 143) who describes tacit knowledge as "the knowledge of techniques, methods and designs that work in certain ways and with certain consequences, even when one cannot explain exactly why". Nonaka (1991, p. 98) explores the term further: "tacit knowledge is highly personal and hard to formalize and ,therefore, difficult to communicate to others", and details his description that there are two dimensions of tacit knowledge: the first is the technical dimension which encompasses the 'know-how', the second is the cognitive dimension which consists of beliefs, ideas and values which we often take for granted (Nonaka & Konno 1998, p. 42). Howells (1996, p. 92) defines " it as follows: "tacit knowledge is non-codified, disembodied know-how that is acquired via the informal take-up of learned behaviour and procedures". Grant (1997, p. 451) explores the term relating to its applicability: "tacit knowledge which is manifest only in its application and is not amenable to transfer". Rüdiger and Vanini (1998, p. 469) say that tacit knowledge is represented through non articulated knowledge. The different attributes focus on particular parts of tacit knowledge management and ,therefore, highlight somewhat different aspects of tacit knowledge. The authors focus here is based on the definitions of Nonaka et al. (2000) and Hall and Andriani (2002) mentioned above and in Chapter 2. The authors of this paper want to concentrate on the role and impact of tacit knowledge in the innovation process, and the tied-in achievement of innovation success in organisations. In their opinion this can be anticipated through three key dimensions of tacit knowledge: the Evolution of tacit knowledge in organisations, the vitalisation of tacit knowledge, and the transfer of tacit knowledge in organisations all of which will be discussed in the following chapters.

3.1 Evolution of tacit knowledge

Basic conditions should exist for the Evolution of tacit knowledge and tacit knowledge creation. Nonaka et al. (2000) come up with the spiral model of knowledge: new knowledge always begins with the individual, e.g. a brilliant researcher has an insight that leads to a new patent or a shop-floor worker draws on years of experience to come up with a new process innovation. In each case, an individual's personal knowledge is transformed into organizational knowledge, which expands through the organisation and is valuable to the company as a whole. Making personal knowledge available to others should be the central activity of the knowledge and innovation creating company. It takes place continuously and at all levels of the organisation. Through these interactions an organisation creates a knowledge process, called knowledge conversion. By Nonaka et al. (2000) there are four modes of knowledge conversion: (1) **S**ocialisation (from tacit knowledge to tacit knowledge); (2) **E**xternalisation (from tacit knowledge to explicit knowledge); (3) **C**ombination (from explicit knowledge to explicit knowledge); and (4) **I**nternalisation (from explicit knowledge to tacit knowledge). These four modes of knowledge conversion form a spiral, the SECI process.

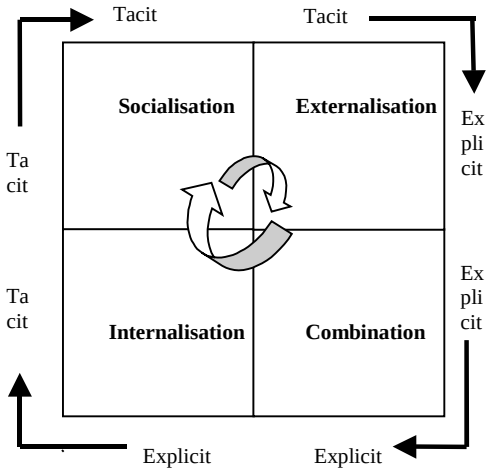

Figure 3.1: The SECI Process (Nonaka et al. 2000, p. 12)

Knowledge created through this spiral process can trigger a new spiral of knowledge creation, expanding horizontally and vertically across organisations. This interactive spiral process takes place both intra- and inter organisationally. One example is the articulation of tacit knowledge possessed by customers that they themselves have not been able to articulate. A product works as the trigger to elicit tacit knowledge when customers give meaning to the product by purchasing, adapting, using, or even not purchasing it. Their actions are then reflected in the innovation process of the organisation and a new spiral of organisational knowledge creation starts

again (Nonaka 1991, Nonaka et al. 2000). Senker (1993) notes that substantial codification of knowledge in the 20th century has not diminished the contribution of tacit knowledge to innovation, and argues that the tacit component of innovation can only evolve through practical experience (learning by doing), or personal interaction with experts who possess the relevant experience or knowledge, in or outside the organisation and social networks, meaning the 'know-who'. A prerequisite for the Evolution of tacit knowledge is an open culture in an organisation which supports innovation, by e.g. installing pilot plants or design and testing prototypes (Madeuf 1984, p. 127). Interaction with others, as opposed to isolation is important if knowledge conversion is to take place (Stover 2004, p. 167). Rüdiger and Vanini (1998, p. 473) express the only way to recognize the subject of tacit knowledge is via personal contacts with external organisations or inside organisation, and, therefore, it is the duty of the management to support and afford these contacts. Baumard found common characteristics among successful tacit knowledge conversion companies: "resolution of ambiguity through communities of practice; tacit complicity among employees; informal matrices of relationships among employees and reliance on collective knowledge" (Stover 2004, p. 167). We follow these arguments and conclude that, the basic conditions for tacit knowledge to be created and shared and used for in the innovation process, is trust amongst organisation members. Sharing tacit knowledge will be more successful in informal settings than in formal ones. Therefore, it is important for the management of organisations to cultivate commitment to motivate the creation of tacit knowledge, and to create an atmosphere in which organisation members in an organisation feel safe sharing their knowledge.

3.2 Vitalisation of tacit knowledge

A precondition to activate tacit knowledge in the innovation process is to make sure that one is able to identify the relevant tacit knowledge in the organisation. Rüdiger and Vanini (1998) note that tacit knowledge enables an increased perception of ideas. Therefore, it stimulates creativity and has a positive effect on business activities. The identification of tacit knowledge is often heavily hindered, but is made possible through the scope of personal contacts (Rüdiger & Vanini 1998, p. 475) where ideas are sharply critiqued but individuals are respected. A group of diverse individuals addresses a common problem, each skilled person frames both the problem and its solution by applying mental schemata and patterns. In a well-managed process, these varying perspectives foster creativity, (which includes tacit knowledge), and this intellectual conflict between diverse viewpoints

produces energy that is channelled into new ideas and products (Leonhard & Sensiper 1998). A popular technique for capitalizing on the respective insights and intuitions (tacit knowledge) of a group of individuals is to conduct brainstorming sessions. Brainstorming sessions should occur at crucial stages in the innovation process and have been shown to lead to important consequences for the organization as a whole (Sutton & Hargadon 1996). Tacit knowledge exists randomly in society and relates to the context of a specific problem. Access is mainly through social networks, or know-how (Imai 1991). The tacit dimensions of individual knowledge are not publicly available except as embodied in people to be hired, and the tacit dimensions of collective knowledge are woven into the very fabric of an organisation and can therefore not easily be imitated. Tacit knowledge is made visible through its application and can then be utilized in the innovation process (Leonhard & Sensiper 1998). Howells (1996) emphazises that learning is particularly crucial in relation to difficult-to-acquire tacit knowledge, which may explain why tacit knowledge is often identified as being derived primarily from in-house capability and efforts. Tacit knowledge can be activated by generating new scientific knowledge, (learning-to-learn), by incorporating new knowledge in the design of a new product, when learning new production methods and improving existing technology through minor improvements based on learning-by-doing, and based on learning-by-using once the new product or process is being used internally in the organisation or by external consumers (Senker 1993). Tacit knowledge is gained throughout the innovation and production chain of a company, and Howells (1996) adds further, that the stage at which tacit knowledge is gained and utilized in the innovation and production process is an important strategy and policy issue. The authors conclude that tacit knowledge is a source of competitive advantage. The creativity necessary for innovation derives not only from obvious and visible expertise, but from invisible reservoirs of experience which need to get vitalised first, before using these in the innovation process. Tacit knowledge can be gained both in and outside the organisation: Inside the organisation, by deciding what existing tacit knowledge capabilities the members in the organisation carry themselves and what improvement could be made to build up the accumulated learning of the individuals and, therefore, enhance the tacit know-how competence. Outside the organisation, by trying to gain tacit knowledge and skills from other firms, through recruiting the right individuals with the requisite education or work experience, or by acquiring parts of or whole new companies, or by engaging appropriate consultants or by building networks with other companies. It is made clear that tacit

knowledge is gained and vitalised throughout all functions and stages of a company's operations.

3.3 Transfer of tacit knowledge

The third dimension regarding the impact of tacit knowledge in the innovation process is the transfer of tacit knowledge. Howells (1996) notes that intuition based on tacit qualities plays an important role in the innovation process which shows that a great deal of the knowledge that is important to the operation or improvement of a given process or product technology is tacit. Tacit knowledge, which "cannot be wholly formalized, nor transmitted solely through written documents" (Madeuf 1984, p. 127), a kind of knowledge which is difficult to codify and embody in a blueprint or operating manual. Tacit knowledge is usually part of a long-term, accumulated learning process that often starts a more systematic scientific understanding of a technology or process (Senker 1993, p.211). The strength and importance of tacit knowledge is that it is often very difficult for competitors to imitate it and, therefore, to be transferred. On the other hand tacit knowledge is often an important element in industrial collaboration, both as a factor initiating collaboration and in its success. Tacit knowledge is a key factor in the competitive advantage of a collaboration and this is the only way that tacit know-how can be transferred and shared (Howells 1996). Hall and Adriani (2002) argue that the major challenge of an organisation should be the achievement of balance between the tacit knowledge developed by individuals and the explicit knowledge needed for effective communication and integration, which means to make the bulk of an organisation's knowledge explicit and to render the company safe from employees walking away with their personal knowledge (Hall & Andriani 2002). Leonhard and Sensiper (1998) argue against that although it is much easier to stimulate, combine and communicate explicit dimensions of knowledge than the tacit, there are many situations in which tacit knowledge cannot or will not be wholly converted into explicit. Furthermore a certain level of personal intimacy is necessary to establish comfortable communication of tacit knowledge. This involves recognizing networks of relationships as Scarbrough (2003) highlighted as a critical resource for the combination and exchange of knowledge required to promote innovation and create intellectual capital (Nahapiet & Ghoshal 1998). Transfer of tacit knowledge strongly depends on the distinction between face-to-face and arm's length relationships (Spring 2003). The closeness of the two partners is key to the degree of tacit knowledge transfer (Cavusgil et al. 2003). Much tacit knowledge is generated and transferred through body language or

physical demonstrations of skills and, therefore, the use of information and communication technology is only partly possible (Leonhard & Sensiper 1998). Nonaka et al. (2000) claim that as tacit knowledge cannot fully be transferred into formal language, electronic storage of tacit knowledge can hardly take place, and if so, will lead to loss of knowledge. Barriers to generating, sharing and transferring tacit knowledge occur if individuals who possess tacit knowledge important to innovation are either actively discouraged from participating in the innovation process, or are not involved. To support the knowledge transfer process Xerox initiated the "Transition Alliance" to deal effectively with innovations (Cavusgil et al. 2003). Individuals rewarded for hoarding their tacit knowledge will do so. In organisations where expertise is highly regarded, but mentoring and assisting others is not, people will want the power they gain from being an important knowledge source, especially since sharing tacit knowledge requires time devoted to personal contact (Leonhard & Sensiper 1998).

The authors of this paper summarize that tacit knowledge transfer to a major part requires personal and informal interaction. To support and encourage the application and transfer of tacit knowledge in organisations, and to underline the impact in the innovation process, management of organisations should create a working environment which supports respect for different thinking styles without penalties for failure, which discourage experimentation. Management can calibrate the level of divergent thinking by encouraging an open culture and having less hierarchies in organisations.

4 Innovation management

To be able to analyse the impact of tacit knowledge on innovation we need a uniform understanding about the definition of innovation. The growing interest in innovation and its relationship to economic growth has resulted in a body of specialised literature on various facets of the process of innovation starting with simple linear "technology push" (e.g. Carter & Williams 1957), and "need pull" models in the 1960s and 1970s (e.g. Myers & Marquis 1969), through the "coupling model" of the late 1970s (Rothwell et al. 1974; Mowery & Rosenberg 1978) to early 1980s to the integrated model of Rothwell (1992). The complex nature of the innovation process has been analysed by several authors. Tornatsky et al. (1983) described the process of innovation as a "process of many discrete decisions and behaviours that unfold slowly over time". Forrest (1991) reviews and structures a number of models of the innovation process and identifies the important elements involved. For the authors three dimensions are especially of major

importance, and they will be discussed in the following chapters: types of innovation, type of industry and organizational structure of an innovative firm.

4.1 Types of innovation

In the literature different methods exist to define innovation. One research direction underlines the novelty of an idea (e.g. Barnett 1953, Becker & Whisler 1967, Aregger 1976). "An innovation is … any thought, behavior or thing that is new because it is qualitatively different from existing forms" (Barnett 1953, p. 7). Others stress the subjective recognition of novelty (Rogers 1983, Zaltman et al. 1984). A third direction emphasized the first introduction of the novelty (e.g. Schmookler 1966, Knight 1967, Kieser 1969, Vedin 1980). Another research direction focused on the new combination of needs and solutions (Pfeiffer & Staudt 1975, Moore & Tushman 1982, Rickards 1985). Some academics analyze innovation as a combination of invention and exploitation (e.g. Roberts 1987, Brockhoff 1992). Another research direction is focused on the process aspect (e.g. Uhlmann 1978, Goldhar 1980) in the sense of "a sequence of organizational and individual behavior patterns" (Goldhar 1980, p. 284).

But all these approaches are stand-alone, and do not cover the integrated aspect of novelty on the one hand, and economic benefits on the other hand. Therefore, the authors go along with the definition of Hauschildt (1993), who defined four dimensions for describing the types of innovation:

1. What is new? - Content dimension
2. New for whom? - Subjectivity dimension
3. Where does the novelty start, where does it end? - Process dimension
4. Does new means successful? - Normative dimension

As for *content dimension* innovations can be differentiated, depending on whether they help to solve an existing problem but in a new way, or they help to solve a new problem with existing tools, or they help to solve new problems with new tools, or they solve existing problems with traditional tools, but in a more efficient and effective way. The critical characteristic is the degree of novelty, which leads to product or process innovations.

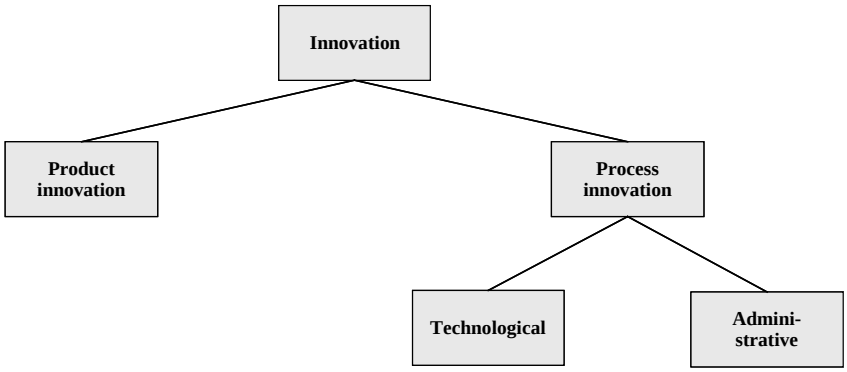

Figure 4.1: Degree of novelty (Hauschildt 1993, p. 11)

As regards to the *subjectivity dimension* the focus rests on awareness. Not changes in technology are key, but the awareness to recognize them. Along with Hauschildt (1993) the authors emphasize not individual, personal awareness, but the entrepreneurial perspective. Companies can talk about innovations, when they use novelty the first time, independent of whether companies have already used it before (Witte 1973, p. 3).

Referring to the *process dimension* a clear definition of where does an innovation start and end is necessary. For Hauschildt (1993, p. 18) this process is divided into seven subsequent steps starting with the idea and ending with the successful ongoing utilization.

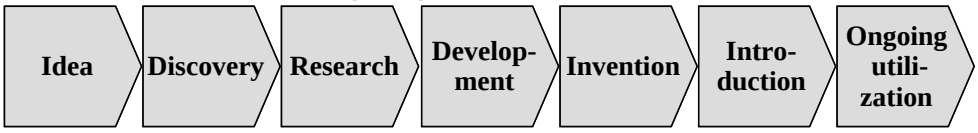

Figure 4.2: Process of innovation

For Leonard and Sensiper (1998) this process is only divided into six steps, but starting as well with the idea and ending with after sales service. For them the innovation process is a rhythm of search and selection, exploration and synthesis, i.e. cycles of divergent thinking followed by convergence.

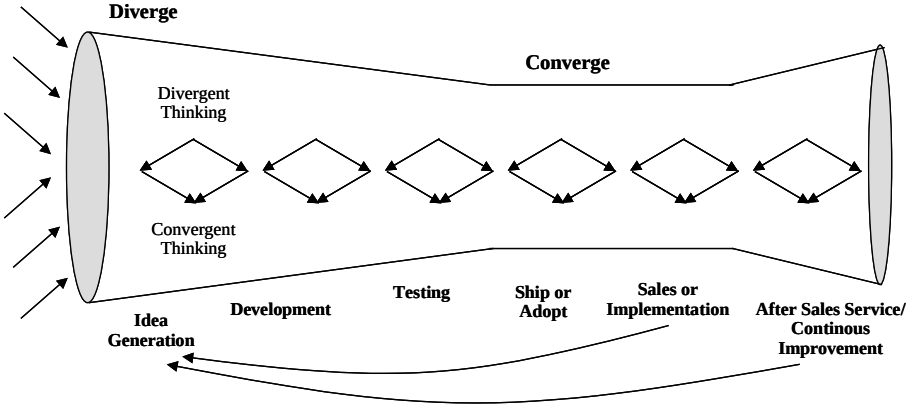

Figure 4.3: The innovation funnel (Leonard & Sensiper 1998, p. 117)

For Bohinc and Erichsen (2002) the innovation process consists of five main steps. They underline the fact that in most cases this process is not linear but many iterations and steps backwards leading to many parallel process steps. This iterative process is also underlined by Corso (2002), who differentiates new product development and innovation during manufacturing and consumption with iterative loops. Utterback (1971) even simplifies this innovation process down to only three stages: idea generation subprocess, problem-solving subprocess and implementation and diffusion subprocess. But he differentiates his approach from the sequenced 'naive' models by describing three stages where different activities are involved.

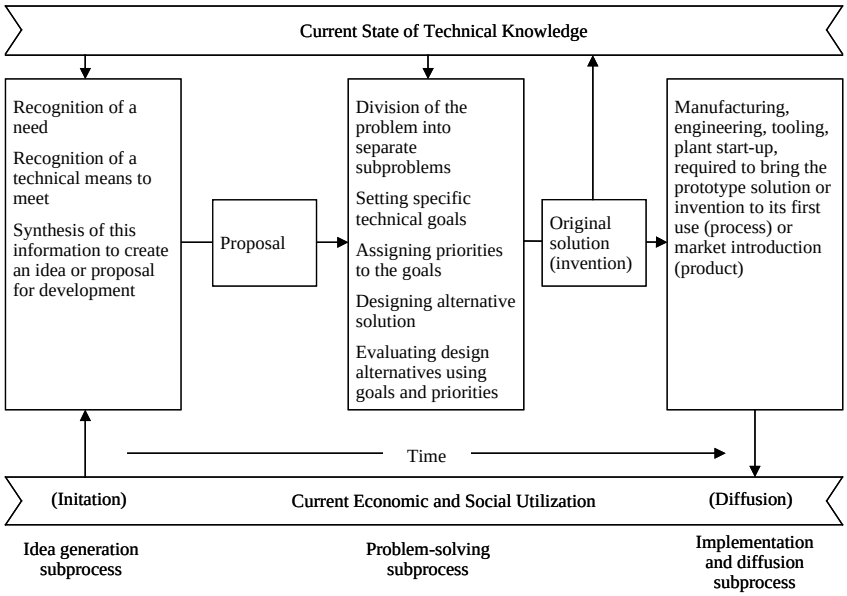

Figure 4.4: Stage models (Utterback 1971, p. 78)

Besides Utterback, Mansfield et al. (1971) have also developed a stage model but incorporating the cost and time dimension resulting in a five-stage model. Then Twiss (1980) derived a real innovative step forward with his activity stage model where alternative pathways have been identified leading to successful and unsuccessful innovations. Different factors can lead to successful or unsuccessful innovations. Twiss has further detailed his model with the result of a conversion process model and a market-pull model. Several authors have derived models based on technology-push or market pull, but theses models are viewed as extremes of innovation models (Rothwell & Zegveld 1985). Therefore Rothwell and Zegveld (1985) developed an integrated model, including both technology-push and market-pull in the same model to achieve balanced innovations with long-term success stories in the market. In their model "innovation is regarded as a logically sequential, though not necessarily continuous, process, that can be

subdivided into a series of functionally separate but interacting and interdependent stages" (Rothwell & Zegveld 1985, p.50). After many iterations when the product is repeatedly redesigned, a product with improved performance and lower costs results. Depending on the stage in the invention-to-innovation stage the involvement of the user differs, with especially increasing importance in the redesign process. For the modern high tech industry this model has been even further adapted by Utterback & Abernathy (1981), who attempted to develop an integrative model of process and product innovation with changing characteristics depending on the product life cylce. Schmidt-Tiedemann (1982) then further built on this model by incorporating research functions, technical functions as well as commercial functions. But even this complex model lacks flexibility of any specific inputs and outputs and any criteria by which to measure the effectiveness of the innovation process. Along with Forrest (1991) the authors draw the conclusion that all these models have to be combined in their aspects to receive an integrated picture on the status in the innovation process. All different stages benefit from different stages and types of knowledge, so that the process dimension is key for delivering and transferring the appropriate knowledge to achieve a successful innovation.

With the fourth dimension, the *normative dimension*, the economic success of an innovation is evaluated. Target setting is key. An innovation is only valuable to a company, if measurable benefits can be achieved either in terms of revenues, profits or cost reductions (Hauschildt 1993). The authors emphasize this integrative approach not only evaluating the novelty from the R&D perspective and market perspective but also incorporating the economic benefit. Similar to Takeuchi and Nonaka (1986) they see a change in the emphasis companies are placing on new products as a source of new sales and profits. In today's fast-paced and highly competitive world of commercial new product development, speed and flexibility are essential but only if they lead to economic benefits.

With these four dimensions the authors have defined a clear structure how to characterize the type of innovation by incorporating all necessary aspects starting with the innovation content leading to the economic benefits of an innovation.

4.2 Type of industry

Apart from the type of innovation different industries react to the impact of tacit knowledge on innovation success in different ways. In the history of

innovations, every 50 years we had such innovation waves. Different industries have experienced major basic innovations, which pushed the development of a whole set of new product generations on a differentiated level.

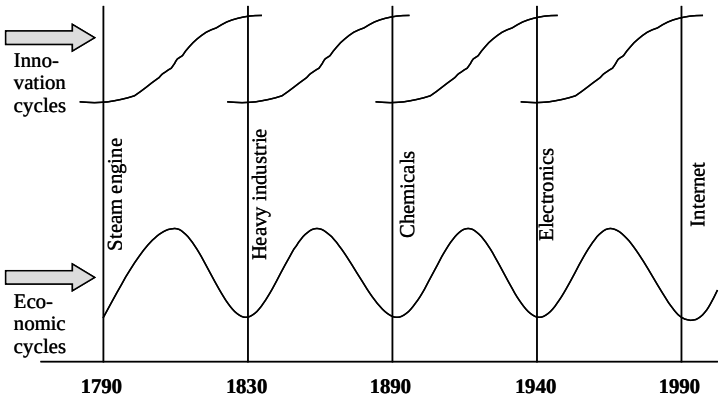

Fig. 4.5: Interplay between economic and innovation cycles (Bohinc, Erichsen 2002, p. 7)

First a series of smaller product innovations took place in the same industry as the basic innovation. In a next step the innovations were transferred to other industries. Referring to Bohinc and Erichson (2002) innovation has different effects on an industry. If the innovation achieves improvement either a single organization/company can be changed step by step or the entire market of a traditional industry. If it is a "radical innovation" (Hauschildt 1993, p. 9) a new generation can be developed either as a paradigm change within one organization or by replacing an entire industry. The different industry effects of innovations are triggered by the economical environment. The interplay of adaptations to the economical environment and the industry leads itself to changes and adaptations in the environment. This interplay generates new impulses for developing innovations with different effects on the various industries.

For further analysis of the effect of tacit knowledge on innovation in high-technology companies (e.g. biotechnology industry) and in traditional industries, such as ceramics industry, Senker (1995a) has executed an empirical study. It seems to be that firms have different ways to receive specific knowhow. In the ceramics industry, firms maintain supplier relationships to ensure a continuous inflow of knowledge via the expertise of the suppliers. However, the high tech industry focuses on intra-company knowledge only, without incorporating the suppliers and outside expertise (Blümm 2002, p. 68). Depending on the industry the type of innovation differs. In traditional industries we have process improvements or product improvements, whereas in new industries radical innovations are the trendsetter. Therefore, the technology base of a company plays a dominant

role. Depending on the assets the necessity of tacit knowledge increases (Howells 1996, p.92).

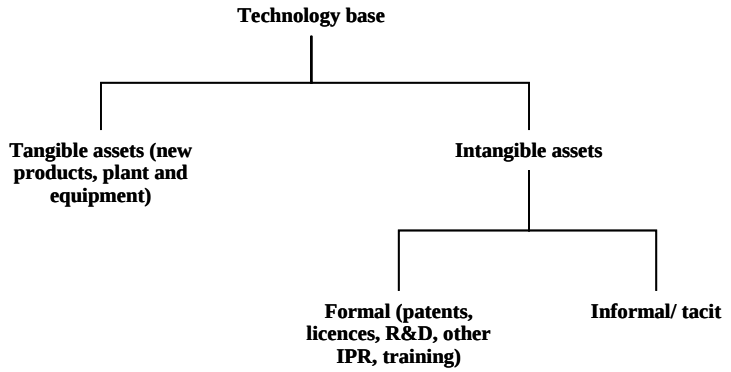

Figure 4.6: The technology profile of a firm (Howells 1996, p. 92)

Especially in the case of existing intangible informal assets the necessity of implicit know-how increases.

4.3 Organizational structure of an innovative firm

In our increasingly competitive environment most firms have, besides profit, revenue generation, quality, on-time delivery and reliability as target of innovativeness. But to be successful in this dimension the organization needs to be aligned accordingly. We define six dimensions to characterize an innovative organization along with Hauschildt (1993, p. 78):

1. Openness
2. Level of organization
3. Information management
4. Awareness of conflicts
5. Recruiting requirements
6. Competences and responsibilities.

Only firms with these six characteristics are able to optimise their innovation process leading to innovation success. They have the appropriate organizational structure to ensure a fully integrated innovation process.

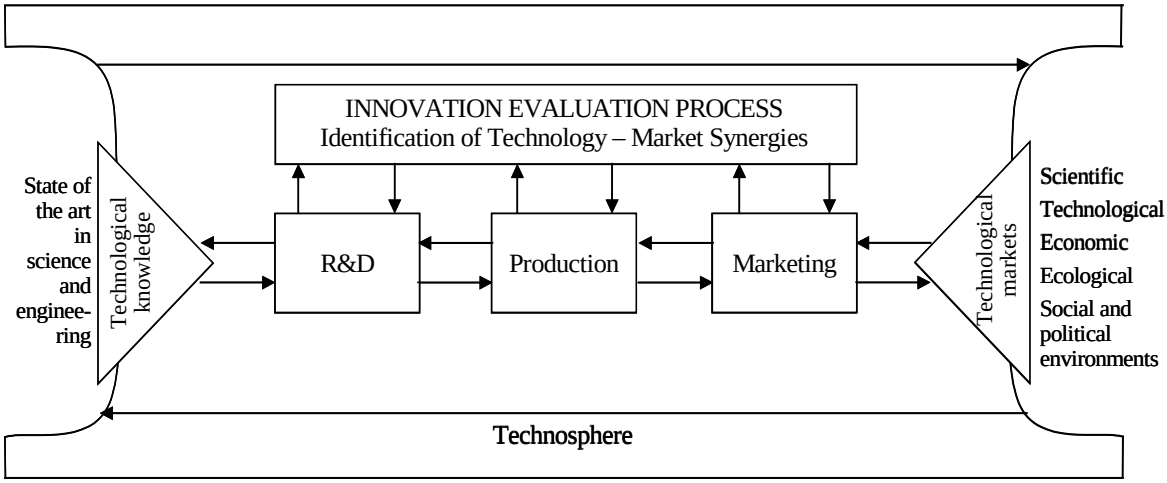

Figure 4.7: Innovation evaluation process (Martin 1984, p. 34)

Therefore the authors stress the necessity of the above mentioned six characteristics for an innovation affined firm. The *openness* emphasizes the ability of information absorption and transfer. Innovative companies focus on relationships with opinion leaders. They are open to any kind of discussion. Employees tend to be intellectually curious, willing and free to explore knowledge creation and use (Davenport et al. 1998). As Senker (1995a, p. 432) postulates "innovation derives largely from accumulated knowledge about a firm's existing technology, as well as that gained from undertaking research, design and development activities, and from interacting with the external environment." A minimum *level of organization* is typical for innovative organizations. People have to have the freedom to manage their roles and responsibilities. Only a limited number of rules define the joint working process. This openness is also reflected in the *information management*. Only little communication is organized by rules. People are not inhibited in sharing knowledge, they are not alienated or resentful of the company and do not fear that sharing knowledge will cost them their jobs. *Conflicts* are the seeds for innovation. Innovative companies support cultures, where conflicts arise and are discussed. With conflicts the employees are trained how to handle new situations. Innovative companies have accordingly adapted *recruiting requirements*. These firms attract and hire people who reinforce the positive orientation towards creativity and innovation. People need to have the ability to create conflicts and find ways how to solve them. *Competence and responsibility* for innovation is shared within the entire workforce. Everybody within the organization is responsible to develop and push innovation. All employees have the one joint overall target to support the development of innovation. A culture with a positive orientation to innovation is one that highly values learning on and off the job, and one in which experience, expertise and rapid innovation supersede hierarchy.

5 The significance of tacit knowledge in innovation management

The authors see the need to combine all different dimensions discussed above within one classification model. This model enables companies to adapt tacit knowledge management to their specific innovation process by optimising their innovation success. Such an approach offers a meaningful tool for both academics and practitioners. We have to stress that due to the specific situational circumstances a contingency approach is recommended to be able to adapt the importance and weight of the various factors. In the tacit knowledge management dimension we summarize the three key levels discussed above: Evolution of tacit knowledge, vitalization of tacit knowledge and transfer of tacit knowledge which are the most relevant (relating to the tacit knowledge lever) to receive high benefit through its usage and application in the innovation process. As for the dimension of innovation management the authors combine all relevant criteria to characterize the innovation process of a company: type of innovation, type of industry and organizational structure of an innovative firm.

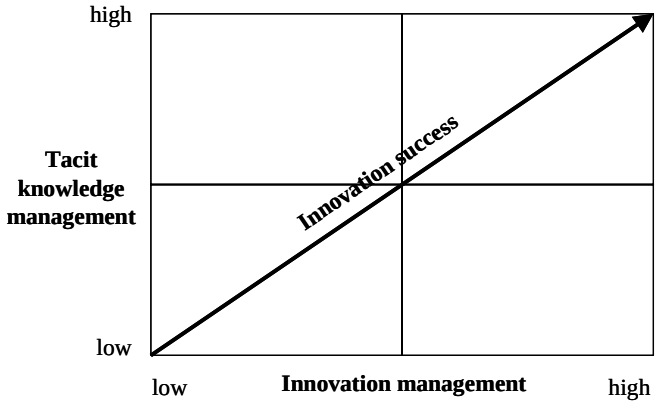

Figure 5.1: The role of tacit knowledge on innovation management

It is made clear that innovation management corresponding to its type of industry, type of innovation, and its organizational structure, has to employ different mechanisms and structures to be able to utilize the existing tacit knowledge assets for each company's innovation success. Problems which occur within the scope of the innovation process are often too complex to be solved only on an analytical basis. Making decisions within an innovation process rely heavily on tacit knowledge 'know-how'. Consequently tacit knowledge plays an important role in all stages of the innovation process. It is obvious that in the early phases of the innovation process, (idea discovery and generation), the degree of intangibility is high, so the assumption is close that the significance of tacit knowledge in the early phases of the innovation

process plays a more important role. Blümm (2002), however, has disclosed in his case studies that also in later phases of the innovation process tacit knowledge tremendously contributes to speeding-up of the innovation process and thus results in innovation success. As regards to innovation success, the authors refer to Ritter (1998), who has defined innovation success by two components: product innovation success and process innovation success. These two dimensions reflect the market recognition compared to the competitive environment. Along with König et al. (1994, p. 19) successful innovations lead to increased revenues and profits. At the four companies Blümm examined, the transformation and implementation phase of ideas in the innovation process was shortened substantially through the application of appropriate tacit knowledge (Blümm 2002, p.184). Also the intuitive containment of the different alternatives before the real test phase starts, leads to a process-acceleration effect in the innovation process. A success in innovation is gained every time a crisis is overcome in any phase of the innovation process, either through the acceleration of the process or through the prevention of an interruption. It shows that with appropriate tacit knowledge management, upcoming problems are solved in a flexible manner and that in all phases of the innovation process, (from idea discovery up to market entry and ongoing utilization), tacit knowledge is of great significance for the innovation success.

The authors draw the assumption that tacit knowledge management needs to be adapted quite closely to the innovation management of a firm for being able to achieve maximum innovation success, focussing most on the three different levels of tacit knowledge: Evolution, vitalization and transfer of tacit knowledge as mentioned above. The more 'relevant tacit knowledge' is involved in the different phases of the innovation process, the more effective and efficient innovation management is carried out which leads to an increase in innovation success.

6 Managerial impact and further research

For the authors it can be derived that tacit knowledge is an important driver in the innovation process, and its application has significant impact on innovation success, and therefore, plays a prominent role as company resource and success factor. It displays in detail, the most significant tacit knowledge levels for the management of tacit knowledge and the corresponding underlying dimensions for innovation management. The role of tacit knowledge in innovation management is explored by generating a model which enables companies to adapt tacit knowledge management to

their specific type of innovation, type of industry and specific organizational structure, within their innovation process and, therefore, to enhance the possibility to optimise their innovation success. The model reflected is somewhat idealised, as generally in the innovation process tacit and explicit knowledge components merge into each other and are quite difficult to separate from each other. On the other hand this one-sided emphasis serves to underline the need for straight analysis, to gain the right consequences for tacit knowledge management in the innovation process. Researchers and managers in the field of interaction and networks should show high interest in this subject as tacit knowledge seems to be an outflow of personal interaction processes. The transfer of intuitions, or what you "feel in your guts" seem to work best in an informal atmosphere and from face-to-face to successfully generate new ideas, products or processes or to solve problems in a flexible manner. So far there has not been a lot of empirical research on the question of the role and significance of tacit knowledge in the innovation process, which as such could be generalised. Faulkner and Senker (1995b) interviewed research & development employees out of the biotechnology and ceramics industry, regarding the knowledge components in their new product development innovation process, focussing on the the tacit knowledge component and Blümm (2002) has come up with four detailed explorative based case studies out of the biotechnology and medical engineering industry. Further research should go towards the direction of empirical approximation using quantitative and qualitative analysis methods to explore the relevant tacit knowledge in companies, to build-up and sustain their competitive advantage. Here Cavusgil et al. (2003) should be mentioned, who surveyed a broad spectrum of manufacturer and service firms to examine the effect of tacit knowledge transfer on firm innovation capability, but focusing on US. This study should certainly be enlarged to other parts of the world incl. Europe and Asia. It is reasonable to assume that the importance of different tacit knowledge levels varies between types of innovation and between types of industries as well as different countries and cultures. Therefore, it will be challenging to do further empirical research especially on the field of the transfer of tacit knowledge, to include both the transfer of tacit knowledge within the organisation, and to only the relevant locations and individuals within the organisation and transfer of tacit knowledge to only appropriate locations and individuals outside the organisation. Here the work of Spring (2003) with an empirical analysis of three illustrative cases (International car assemblers in Brazil, ERP implementation of a large consumer goods manufacturer and a case on design and production of products with strong national and regional identities) builds a platform for additional research. A further field of research should

have a close look on how organization structures have to be modified in different industries so that the organizational structure of a company or a department supports transfer and transmission of tacit knowledge in the best way. Li and Gao (2003) recommended to identify knowledge hierarchies to efficiently and effectively explore the tacit knowledge within an organization. This study shows one opportunity, which can be further explored and deepened.

Overall, our findings regarding the impact of tacit knowledge on successful innovation management and the development of an integrated model, provides us with a solid starting point for further analysis on tacit knowledge in innovation management. This starting point character comes on top of the fact that our model can be used as a tool for managerial decision making.

7 References

Aregger, K. (1976): Innovation in sozialen Systemen – Einführung in die Innovationstheorie der Organisation, Bern/Stuttgart

Barnett, H.G. (1953): Innovation: The Basis of Cultural Change, New York

Becker, S. W., Whisler, T. L. (1967): The Innovative Organization. A Selective View of Current Theory and Research, in: Journal of Business, 40, 462-469

Blümm, C. (2002): Die Bedeutung impliziten Wissens im Innovationsprozess, Gabler, Wiesbaden

Bohinc, T., Erichson, J. (2002): Innovationsmanagement, in: Telekommunikation, 56(7+8), 1-59

Brockhoff, K. (1992): Forschung und Entwicklung – Planung und Kontrolle, München/Wien

Carter, C., Williams, B. (1957): Industry and Technical Progress, Oxford University Press

Cavusgil, S.T., Calantone, R.J., Zhao, Y. (2003): Tacit knowledge transfer and firm innovation capability, in: Journal of Business & Industrial Marketing, 18 (1), 6-21

Corso, M. (2002): From product development to Continuous Product Innovation: mapping the routes of corporate knowledge, in: International Journal of Technology Management, 23(4), 322-340

Davenport, T. H., De Long, D. W., Beers, M. C. (1998): Successful knowledge management projects, in: Sloan Management Review, 39(2), 41-56

Davenport, T. H., Marchard, D. (1999): Is KM just good information management, in: Financial Times Mastering Information Management Supplement, Financial Times, London March 8th, 2-3

Faulkner, W., Senker, J. (1995): Knowledge frontiers: Public sector research and Industrial innovation in biotechnology, engineering ceramics and parallel computing, Oxford University Press, Oxford

Forrest, J. E. (1991): Models of the Process of Technological Innovation, in: Technology Analysis & Strategic Management, 3(4), p. 439-453

Franke, N., von Braun, C. F. (1998): Innovationsforschung und Technologiemanagement: Konzepte, Strategien, Fallbeispiele, Berlin

Goldhar, J. D. (1980): Some modest Conclusions, in: Management of Research and Innovation, Amsterdam/New York/Oxford, 283-284

Grant, R. M. (1997): The knowledge-based view of the firm: implications for Management Practice, in: Long Range Planning, 30(3), 450-454

Hall, R., Andriani, P. (2002): Managing knowledge for innovation, in: Long Range Planning, 35, 29-48

Hauschildt, J. (1993): Innovationsmanagement, Vahlen, München

Howells, J. (1996): Tacit Knowledge, Innovation and Technology Transfer, in: Technology Analysis & Strategic Management, 8(2), 91-106

Imai, K. (1991): Globalization and Cross-border Networks of Japanese Firms, Paper presented to Japan in a Global Economy Conference, Stockholm School of Economics, 5-6 September

Kieser, A. (1969): Innovationen, in: HWO (1), Grochla, v. E. (1969), 741-750

Knight, K. E. (1967): A Descriptive Model of the Intra-Firm Innovation-Process, in: The Journal of Business, 40, 478-496

König, H., Licht, G., Staat, M. (1994): F&E Kooperationen und Innovationsaktivität, in: Gahlen, B., Hesse, H., Ramser, H.J. (1994), Europäische Integrationsprobleme aus wirtschaftswissenschaftlicher Sicht, Tübingen, 219-244

Leonard, D., Sensiper, S. (1998): The Role of Tacit Knowledge in Group Innovation, in: California Management Review, 40(3), 112-125

Li, M., Gao, F. (2003): Why Nonaka highlights tacit knowledge: a critical review, in: Journal of Knowledge Management, 7 (4), 6-14

Madeuf, B. (1984): International technology transfers and international technology payments, Definitions, measurements and firm's behaviour, in: Research Policy, 13, 125-140

Mansfield, E., Rapoport, J., Schnee, J., Wagner, S., Hamburger, M. (1971): Research and Innovation in the Modern Corporation, W. W. Norton & Co., London

Martin, M. J. C. (1984): Managing Technological Innovation and Entrepreneurship, Prentice Hall, Englewood Cliffs

Moore, W. L., Tushman, M. L. (1982): Managing Innovation over the Product Life Cycle, in: Readings in the Management of Innovation, Boston/London/Melbourne/Toronto, 131-150

Mowery, D. C., Rosenberg, N. (1978): The Influence of Market Demand upon Innovation: A Critical Review of Some Recent Empirical Studies, in: Research Policy, 8(4)

Myers, S., Marquis, D. G. (1969): Succssful Industrial Innovation, National Science Foundation, Washington

Nahapiet, J., Ghoshal, S. (1998): Social capital, intellectual capital and the organizational advantage, in: Academy of Management Review, 23, 242- 266

Nonaka, I. (1991): The knowledge-creating company, in: Harvard Business Review, November – December, 96-104

Nonaka, I. (1994): A dynamic theory of organizational knowledge creation, in: Organization Science, 5(1), 14-37

Nonaka, I., Konno, N. (1998): The Concept of "Ba", in: California Management Review, 40(3), 40-54

Nonaka, I., Toyama, R., Konno, N. (2000): SECI, Ba and Leadership: a unified model of dynamic knowledge creation, in: Long Range Planning, 33(4), 4-34

Pfeiffer, W. Staudt, E. (1975): Innovation, in: HWB (4), Grochla, v. E., Wittmann, W. (1975), 1943-1953

Polanyi, M. (1966): The Tacit Dimension, Routledge & Keagan Paul, London

Polanyi, M. (1969): The Logic of Tacit Inference. Knowing and Being, Routledge & Keagan Paul, London

Rickards, T. (1985): Stimulating Innovation – A Systems Approach, London

Ritter, T. (1998): Innovationserfolg durch Netzwerkkompetenz, Gabler, Wiesbaden

Roberts E. B. (1987): Introduction: Managing Technological Innovation Technology-Based Organization, in: Sloan Management Review, 22, 19-34

Rogers, E. M. (1983): Diffusion of Innovations, New York

Rosenberg, N. (1982): Inside the black box. Technology and Economics, University Press, Cambridge, 143

Rothwell (1974): Innovation in Textile Machinery: Some Significant Factors in Success and Failure, Science Policy Research Unit, 2(6)

Rothwell, R. (1992): Successful industrial innovation: critical factors for the 1990s, in: R&D Management, 22 (3), p. 221- 239

Rothwell, R., Zegveld, W. (1985): Reindustrialization and Technology, Longman, Harlow

Rüdiger, M., Vanini, S. (1998): Das Tacit knowledge Phänomen und seine Implikationen für das Innovationsmanagement, in: DBW, 58(4), 467-480

Scarbrough, H. (2003): Knowledge management, HRM and the innovation process, in: International Journal of Manpower, 24 (5), 501-516

Schmidt-Tiedmann, K. J. (1982): A new model of the innovation process, in: Research Management, 25, 18-21

Schmookler, J. (1966): Invention and Economic Growth, Cambridge

Senker, J. (1993): The Contribution of Tacit Knowledge to Innovation, in: AI & Society, 7, 208-224

Senker, J. (1995a): Tacit knowledge and models of innovation, in: Industrial and Corporate Change, 4(2), 425-447

Senker,J. (1995b): Networks and Tacit Knowledge in Innovation, in: Economies et Sociétés, 29 (9), 99-118

Spring, M. (2003): Knowledge management in extended operations networks, in: Journal of Knowledge Management, 7 (4), 29-37

Stover, M. (2004): Making Tacit Knowledge explicit, in: Reference Services Review, 32 (2), 164-173

Sutton, R. I., Hargadon, A (1996).: Brainstorming groups in context, in: Administrative Science Quarterly, 41 (4), 685-718

Takeuchi, H., Nonaka, I. (1986): The new new product development game, in: Harvard Business Review, January-February, 137-146

Tornatsky, L. G., Eveland, J. D., Myles, G. B., Hetzner, W. A., Johnson, E. C., Roitman, D., Schneider, J. (1983): The Process of Technological Innovation: Reviewing the Literature, in: National Science Foundation, Washington, p. 17

Twiss, B. (1980): Managing Technological Innovation, Longman, London

Uhlmann, L. (1978): Der Innovationsprozess in westeuropäischen Industrieländern, Berlin/München

Utterback (1971): The process of technological innovation with the firm, in: Academy of Management Journal, 14, pp. 78

Utterback, J. M., Abernathy, W. J. (1981): Multivariate models for innovation, in: Omega, 9, p. 429-436

Vedin, B.-A. (1980): Large Company Organization and Radical Product Innovation, Lund/Goch/Bromley

Witte, E. (1973): Organisation für Innovationsentscheidungen, Göttingen

Zaltman, G., Duncan, R., Holbeck, J. (1984): Innovations & Organizations, Malabar