Innovation Management – An Overview and some Best Practices

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Das C-LAB - Cooperative Computing & Communication Laboratory - leistet Forschungs- und Entwicklungsarbeiten und gewährleistet deren Transfer an den Markt. Es wurde 1985 von den Partnern Nixdorf Computer AG (nun Siemens Business Services GmbH & Co OHG) und der Universität Paderborn im Einvernehmen mit dem Land Nordrhein-Westfalen gegründet.
Die Vision, die dem C-LAB zugrunde liegt, geht davon aus, dass die gewaltigen Herausforderungen beim Übergang in die kommende Informationsgesellschaft nur durch globale Kooperation und in tiefer Verzahnung von Theorie und Praxis gelöst werden können. Im C-LAB arbeiten deshalb Mitarbeiter von Hochschule und Industrie unter einem Dach in einer gemeinsamen Organisation an gemeinsamen Projekten mit internationalen Partnern eng zusammen.

C-LAB - the Cooperative Computing & Cooperation Laboratory - works in the area of research and development and safeguards its transfer into the market. It was founded in 1985 by Nixdorf Computer AG (now Siemens Business Services GmbH & Co OHG) and the University of Paderborn under the auspices of the State of North-Rhine Westphalia.
C-LAB's vision is based on the fundamental premise that the gargantuan challenges thrown up by the transition to a future information society can only be met through global cooperation and deep interworking of theory and practice. This is why, under one roof, staff from the university and from industry cooperates closely on joint projects within a common research and development organization together with international partners. In doing so, C-LAB concentrates on those innovative subject areas in which cooperation is expected to bear particular fruit for the partners and their general well-being.

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Abstract

Innovation is being turned to by business and political leaders as a miracle cure, allowing companies and economies to stay competitive in ever changing world markets. For all of the talk about the importance of innovation, innovation management and creativity in business, the topics are hardly generally well understood. This paper seeks to provide a broad view of innovation, innovation management, creativity, and best practices.

There are two major types of innovation – product and process innovation. As a third type hybrids combine product and process innovation. Product innovation is concerned with bringing new or greatly improved goods or services to market. Process innovation concerns itself with improving the business functions required to profit from providing goods or services. This includes (but is not limited to) strategic planning, inventory control, logistics, personnel training, communicating, financing and marketing. Much of the focus and hype around innovation is focused on product innovation – particularly radical innovation. This has the largest potential payoffs, but carries the most risk (Vahs; Burmester 2005).

Innovation management is the economic implementation and exploitation of new ideas and discoveries, and the implementation of an innovation culture in an organization, to promote and make possible the development of new ideas and business opportunities. Innovation management consists of innovation strategy, culture, idea management and implementation of innovation processes. This C-LAB report ends with a brief outlook on further areas of research.

1 Introduction

The exact definition of innovation varies from person to person. Generally, innovation is the economic application of ideas, technology or processes in new ways to gain a competitive advantage. Innovation is not invention. The process of technological invention is only concerned with creating new technical ways or devices to solve existing problems. Beside inventions which are generated in a purposeful manner, there are serendipity inventions (Vahs; Burmester 2005).

The goal of this C-LAB Report is to give a brief overview of the field of innovation management and to highlight some best practices. Although there is an extensive body of scientific literature on innovation management, only a few of these papers are cited in this C-LAB Report. The intention of this report is to give some early hands-on advice, rather than be a scientific paper.

Innovation management is an extremely broad topic. This report will cover some general aspects of innovation, innovation strategies and innovation processes. A special emphasis is placed on the process of generating new ideas and their potential sources. This report also addresses how creativity techniques can help collect new ideas and what types of methods are suitable to evaluate them. It will be shown that there are factors that prove to be helpful and some aspects that may hamper a “successful” culture of innovation.

A further section on innovation management is about measuring innovation. By definition, technological invention and innovation are inherently concerned with generating something new. Thus, any measurement of the innovation process can only happen in an approximate manner.

The final section of the white paper is a best practices study. The organizations selected were of various sizes and from various industries. Included were W.L. Gore & Associates, 3M, Nokia and Siemens Medical Services. At the end this C-LAB Report concludes with an outlook on promising avenues of future scientific research.

2 Innovation Management

2.1 Different Types of Innovation

Innovation Management is the economic implementation and exploitation of new ideas and discoveries. Innovation management also covers the implementation of an innovation culture in an organization and helps to promote the development of new ideas and business opportunities. The management of innovation should be treated as a part of business strategy (Turrell; Lindow 2003). In addition to the improvement of and development of new products and processes, innovation management is also concerned with the structure of an organization, the internal processes and the management techniques used (Deloitte 2005).

“In general, technological innovation involves the solution of problems” (Dosi 1988). There are many different ways to classify and categorize innovation, and many definitions. It is important to establish what innovation is not. While innovations are concerned with the launch or introduction of new products, services and processes, inventions are not necessarily introduced into the market. The majority of patented inventions are never used in a way that brings economic value.

Thomas Edison is an outstanding example of the difference between invention and innovation. While he was arguably one of the greatest inventors of all time, Edison was among the worst innovators. He was so incompetent at innovating – successfully commercializing his developments, that his financial backers were forced to remove him from every business venture he started. In contrast, a McDonald’s Hamburger is an innovation. Ray Kroc, the company founder, certainly did not invent the hamburger, French fries or even the drive through pickup window. Kroc’s innovations were in standardizing his products - giving customers a meal made with consistent quality, in hygienic conditions, delivered just-in-time at very low prices (Valery 1999).

Product innovations and process innovation have to be distinguished. However, some research also allows for hybrid innovation, which combines the two types (Accenture 2005). Furthermore recent research has pointed out that the relevance of product-related after sales services is constantly growing. As the distinction between products and services is becoming unclear (Hipp; Grupp 2005), new fields of research concerning this kind of “hybrid innovations” are just about to evolve (BMBF 2005).

There are also two major categories of innovation: sustaining and disruptive (Deloitte 2004). These can occur under both types of innovation (product and process). Sustaining innovations are those which improve an already existing product or process. Disruptive innovations are those which are radically different from any previously existing process or product or service on the market. Examples of sustaining innovations include: improved versions of software products, more efficient auto motors, and waste reduction measures in the manufacturing process. Examples of disruptive innovations include: interchangeable parts, assembly line production, container shipping, the

affordable automobile, personal computers, mobile phones, CNC machining, and genetically engineered crops.

Four different types of **product innovation** can be best shown in a matrix (Fig. 1). (1) Incremental innovation is a form of sustaining innovation, in which existing technology is used to improve products or services that are already established in the marketplace. This can include altering the packaging, offering the product in different flavors, sizes or colors, or improving the quality of the customers' experience. (2) Technological substitution involves using new technology developments to create new products that fill existing market categories. Examples include power tools or cordless telephones (which perform the same functions as a normal corded telephone).

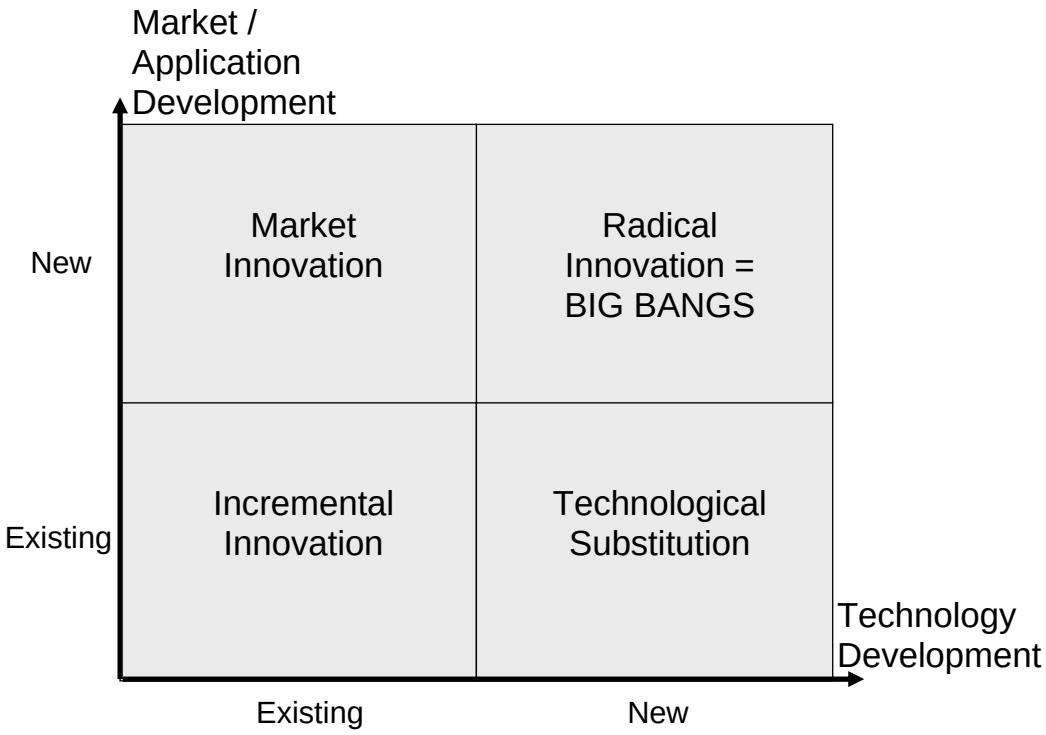

Figure 1: Different types of product innovation (Adapted from Kroy 1995)

(3) Market innovation is combining and presenting existing technologies in a way that is new to the market, thus creating a new market segment. The classic example of this is the Sony Walkman. It was a combination of two existing technologies (head phones and a portable cassette player) that created a completely new market segment. The original Walkman is a market innovation because the "portable personal music device" segment did not previously exist. (4) Radical innovation is a type of disruptive innovation. It is a technologically advanced product or service that creates an entirely new market segment. Radical innovations are the most rare type of product innovation with the highest risks, but due to temporary monopolies they also offer the highest potential rewards (Vahs; Burmester 2005). Very few products or services fit easily into this category, because technologies generally build

upon existing technologies. Examples could include: mobile phones with text messaging, the personal computer and the automobile.

Another common classification is to differentiate between „technology push-“and „demand pull-“innovations. In the first case, technological innovations emerge from technological inventions as it is described in Schumpeter's theory of economic development on “creative destruction” (Schumpeter 1912). Challenging the Schumpeterian approach, Schmookler (1966) modeled an innovation process in which demand forces from within the market pull inventions and innovations. Ever since then, there have been numerous efforts by researchers to provide evidence for the predominance of either theory (e.g. Mowery; Rosenberg 1979). Presumably, one of the most famous theories that is in line with Schmookler's theory is the “lead-user-concept” by Eric v. Hippel. Here the users of products initiate new ideas for better or new applications. Due to the close cooperation with the customer, the innovation process can become more market-orientated and thus more successful. However, evidence is restricted to specific industries (Hippel 1988, 2005).

Yet there is a tendency for technology push- innovations in the realm of complex and challenging technologies and a tendency for demand pull-innovations when radical innovations (see Fig.1) have been implemented and allow for a successive adaption in the consumer's context (Meffert 2000; Vahs; Burmester 2005).

According to the Oslo Manual, which are proposed guidelines for collecting and interpreting technological innovation data, **technological process innovations** can be defined as: “the adoption of technologically new or significantly improved production methods, including methods of product delivery. These methods may involve changes in equipment, or production organization or a combination of these changes …” (OECD 1997). A broader definition of process innovation states that it “involves not only the manufacturing process of products, but also the planning, steering, and support processes in the organization.” Process innovation also includes improving the following functions that are found in most organizations: strategic planning and implementation, customer use optimization, market communications processes, product and service allocation, logistics and maintenance, quality assurance, order processing, underwriting and auditing, capacity planning, risk management, and personnel training and motivation (Imhausen 2005).

Examples of successful process innovations include: the development of cost-based accounting to improve managerial decision making, JIT (Just In Time) manufacturing to reduce costs, e-stores such as Amazon to make new products quickly available to more customers, flexible manufacturing that quickly adapts to changing demands, Supply Chain Management that reduces stock-outs for retailers, and Lean Manufacturing techniques to reduce waste and increase the efficiency of production.

Due to the growing importance of the service sector (Miles 2005), there have been efforts to classify service innovations according to the distinction of product- and process innovations. In the banking sector for example, the

introduction of telephone-banking can be defined as a process innovation. Offering multi-purpose cards can be described as a product innovation, which might enable new services. In offering new services there are probably new processes involved. Therefore it is often difficult to differentiate between product and process service innovations (OECD 1997). This is attributed to the special characteristics of services. To deliver a service, processes are necessary. As services are provided from one person to another, they normally involve relationships between producers and consumers. Services are not entities that can exist independently of its producer or consumer (Hill 1999). This is closely linked to the aspect of non-storability of service outputs, i.e. services are intangible (Gallouj; Weinstein 1997).

2.2 Innovation Strategy

The first step to successful innovation management is for the top managers of an organization to choose a strategy. In order to develop an innovation strategy it is to determine if a need to innovate exists, to what degree and in what areas. Successful innovation requires a strategy that is clearly understood by all in an organization – from the CEO to the Receptionist.

As previously described, there are two basic strategies, product innovation and process innovation, and infinite hybrid combinations. Deloitte surveyed 650 top executives of North American and European firms, for a study published in March 2004. The executives, on average, expected that 37% of their firms' annual revenues in 2007 would come from new product sales. In 1998, just 21% of the revenues came from new products. The executives surveyed also expected that within six years, 70% of their products currently on the market will be rendered obsolete by competition or customer demands. However, at the same time it was found that "Time-to-market" and "Product innovation" is near the bottom of most manufactures' priorities for supply chain strategy (Deloitte 2004).

In 2002, Accenture surveyed consumers in North America and Europe to produce a study titled "Mind the Gap!" The study concluded that consumers saw little innovation of value in many industries (Table 1). The study further concluded that despite a weak economy, consumers were willing to spend more on products and services that were innovative. For instance in Germany 61.4% of consumers agreed with the statement "there are many categories in which I would be willing to spend more for my purchases if I could find better products and services" (Accenture 2002). Therefore the strategy of pursuing product innovation is critical for business, especially during economic downturns.

Products	US	UK	France	Germany	Spain
Housing	57.2%	68.8%	41.2%	55.2%	46.9%
Home Furnishings	51.8%	53.0%	29.8%	40.4%	33.3%
Clothing/Apparel	46.1%	50.2%	33.8%	38.4%	26.4%
Household Appliances	38.9%	37.6%	18.4%	24.2%	22.3%
Personal Care	33.5%	40.0%	22.8%	28.4%	27.7%
Pharmaceuticals	32.2%	40.9%	22.1%	32.3%	28.1%
Automotive	33.5%	51.0%	9.8%	22.2%	25.4%
Consumer Goods	31.0%	31.0%	16.5%	23.1%	19.0%
Packaged Foods	30.8%	34.3%	19.0%	28.7%	22.7%
Household Electronics	9.5%	6.4%	2.1%	6.8%	3.4%
Service					
Insurance	72.3%	70.4%	55.8%	61.0%	62.4%
Government	69.2%	76.6%	59.7%	68.0%	66.4%
Investing	65.5%	65.3%	49.8%	50.9%	61.3%
Hospitals/Nursing Care	63.4%	70.0%	46.5%	63.9%	45.6%
Education	58.4%	70.0%	49.2%	52.2%	54.5%
Restaurants	57.2%	63.9%	55.6%	54.2%	37.0%
Entertainment	52.6%	51.9%	33.1%	38.8%	18.4%
Banking	38.3%	26.3%	29.0%	25.3%	36.1%

Table 1: Categories in which customers saw no innovation of value within the past two years (Accenture 2002)

Successful innovators use innovation management as a core of the competitive strategy. IBM, The Economist and Nikkei Research performed one-on-one interviews with 456 CEOs of global corporations in 2004. 80% of the CEOs interviewed said that their primary goal has shifted from cost-cutting to revenue growth. Two-thirds expect growth from new products and services that would be developed within five years. To achieve the new growth objectives, 90% of CEOs expected to transform their organizations within five years, to become more responsive, particularly to customer demands. Over half expected the transformation to happen within two years (IBM 2004).

One of the functions of an innovation strategy is choosing what type of innovations to pursue. The pursuit of sustaining innovations - making small improvements, minor adaptations, developing new uses for products, using less expensive materials or processes in manufacture, delivering higher quality faster, etc., is generally more profitable and safer in the long term than pursuing disruptive or radical innovation (Deloitte 2005). The irony is that officials, academics and entrepreneurs usually give more attention to the riskiest form of innovation (trying to exploit a science based discovery or invention) than they do to the easiest, fastest and cheapest type of innovation – sustaining innovations. There is a blinding appeal of disruptive innovation that comes from the glamour of research and development (and the opportunities for large grants, tax credits and investor clout). There is evidence to show that if a new product or service comes to market as a result of some proprietary breakthrough in the company's own R&D laboratories, it

often yields high returns: just think of DuPont's pay-off from Nylon or Pfizer's profits from the drug Viagra. The downside of this, is that such big breakthroughs usually happen only once or twice in a company's lifetime (Bergmann 2005; Valery 1999).

In January 2005, Accenture released a study on innovation strategy, as a part of their "Marke Deutschland" initiative. 107 of the top 300 (by revenue) firms in Germany, in six branches (manufacturing, electronics, telecommunications/IT, chemicals and raw materials, consumer goods, and retail) were analyzed, and 121 top managers were interviewed about the goals, strategies and results of their attempts at innovation. The study found that 94% of these top firms had clearly formulated goals for process innovation, and 85% had clearly formulated goals for product innovation. 55% of the firms analyzed had a competitive strategy of cost reduction; while 43% used the strategy of process innovation (2% of firms did not have a clear competitive strategy.). When researchers analyzed the revenue and cost data of the firms, the 43% of firms that used a competitive strategy of process innovation had average revenue growth of 15%, and their cost of goods sold was reduced by an average of 13%. A positive side effect of the process innovation strategy is that unlike product innovations, which are placed on the market and easily copied, the competitive advantages gained through process innovation remain within the firm and are difficult for competitors to replicate (Deloitte 2005).

There is no universal perfect innovation strategy. The strategy of innovation must be chosen in the same manner than any strategic management decision is made. After careful analysis of the organization's assets, competition, marketplace opportunities and the culture of the firm, senior leadership must agree to a long term strategy that every member of the organization will be a part of. It is important that companies recognize the limits of innovation, and avoid overextending their brands and straying too far from their core competencies to be successful. Zyman describes the tendency of companies to invoke "innovation" as an escape from difficult times, "at its core, this approach to business growth is simply lazy… actually it's worse than that… it's dangerous." He points out in his book that companies who stray too far from their core competencies are rarely successful (Powers 2004).

Another important point in regard to innovation strategy is the timing of market entrance. To be a successful innovator requires not only developing new products and services, but to know when to entry and exist the specific market. Among the most common strategies are the "first-to-market"-strategy ("leader"),"second-to-market"-strategy ("early follower") and the "later-to-market-strategy" ("late follower)". To strive for a "leader"-position usually needs enormous resources like R&D, market research, etc. But once the product has been launched (successfully), it affords the opportunity to skim the market segment of "lead users" and to gain a competitive advantage due to temporary monopoly rents. Even though the "leader" is eager to set up barriers to market entry for competitors, there are several examples showing that the "early follower"-strategy can be successful as well. Though *Apple Macintosh* was the first graphical user interface on the market, it was *Microsoft* who set the "Windows-standard" with the help of aggressive

marketing and cooperations with manufacturers of hardware devices (Vahs; Burmester 2005). Finally, the strategy of the “late follower” is to imitate the technology, use the standards already implemented and to offer products at a lower price. However, this strategy is not very innovative and critical in terms of market entry barriers. Gerpott (1999) for example states that the probability of success for a follower is low when the product under consideration is technically complex, closely linked to after-sales services and costly to switch to.

2.3 Innovation Processes

In order to achieve revenue growth through new products and services, and improve their response to customer demands, organizations must innovate. To innovate successfully and efficiently, the process of innovation must be managed (Deloitte 2005).

The process of innovation begins with the initialization of innovation, with the overall strategy of how the organization will pursue innovation. This includes selecting the core competency of the organization and determining the direction the company should innovate in, as well as the boundaries. As a general principle, it can be stated that the learning process of an organization is cumulative and local (Cimoli; Dosi 1996). In other words, the organization’s innovation process is heavily affected by experiences with past innovations and based on technologies the organization is, at least to some extent, already familiar with.

Ideas for innovative products or services are thus needed to follow the innovation strategy. Innovative companies often employ an idea management system. Idea management is the practice of handling ideas in a structured fashion. It is the aim to select the best ideas with the most potential for further development and implementation. If ideas are the raw material for innovation, then idea management is the core of innovation management. The idea management process is not merely the generation of new ideas. The process encompasses the generation, collection, development, evaluation and selection of business ideas (Turrell; Lindow 2003).

Obviously the innovation process comprises more than just the creation and management of new ideas. As it is depicted in Fig. 2, the process starts with the generation of new ideas and results in a critical assessment of the total project. This “Stage Gate Model” is based on empirical findings of numerous “NewProd-Studies” conducted by Cooper (e.g.1985, 1992, 1994). Comparing new product successes with failures, a standardized procedure concerning innovative projects was identified as a critical success factor.

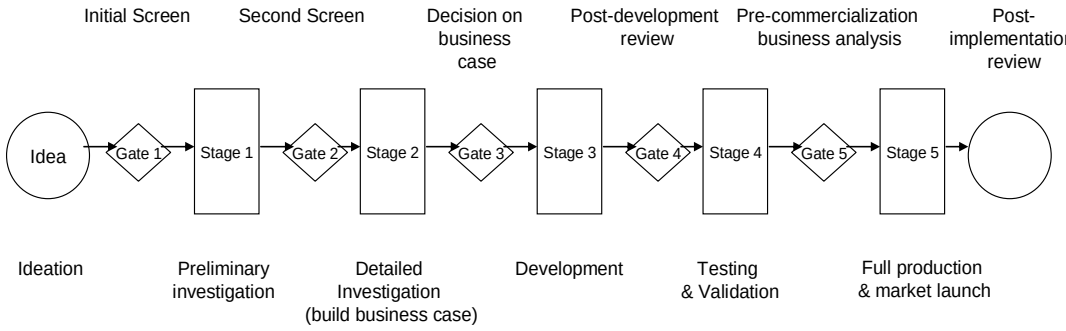

Figure 2: Typical "Stage-Gate" new product process (Adapted from Cooper; Kleinschmidt 1993)

At each “gate”, the project has to be evaluated in terms of a “go/no-go”-decision. Precisely, there are several pre-defined “must-meet”-criteria and some “should-meet” characteristics (see table 2).

Stage-Gate	Activities & Decisions
Gate 1	Idea screening and commitment of resources
Stage 1	Preliminary market and technical assessment of the project
Gate 2	More rigorous screening concerning market attractiveness, technical advantages of the product, competitive situation
Stage 2	Development of the business case (incl. legal & financial analysis)
Gate 3	Yield a "sign-off" on the product definition
Stage 3	Technical development; deliverable: lab-tested prototype of the product
Gate 4	Check attractiveness and quality of the product
Stage 4	Testing & validation of the entire project concerning all dimensions (marketing, engineering, accounting)
Gate 5	Appropriateness of production, launch and finance plans
Stage 5	Market launch
Review	Evaluation of the project 6-18 after commercialization

Table 2: Important Activities throughout the Stage Gate Process (compiled from Cooper; Kleinschmidt 1993)

As several departments (e.g. Marketing, R&D and Engineering) are involved in the evaluation process, this model is able to dispel a major drawback of previous approaches. Even though Fig. 2 gives the impression of a linear sequencing of phases, the “stage gate process” allows – to a certain degree – for an overlapping of the phases (Cooper; Kleinschmidt 1993). However, Verworn and Herstatt (2003) suggest using this standardized method only for incremental innovations with a low degree of technological and economic uncertainty.

It has to be pointed out that the “stage gate process” only applies for new *product* development. Due to the specific characteristics of services and the lack of standardization, the modeling of innovation processes of *services* has just become a matter of research (De Jong et al. 2003).

2.4 Culture of Innovation in Organizations

According to Valery (1999) two things set apart all organizations with a good record of innovation. First, they foster individuals who are internally driven; they are either motivated by money, power and fame, or simply by curiosity and the need for personal achievement. Second, successful organizations are able to master inherent complexity and pursue innovation systematically. They actively search for change (the root of all innovation), and then carefully evaluate its potential for an economic or social return (Deloitte 2004; Valery 1999).

The organizations that are the most successful innovators have many common traits. These traits can be defined as a culture of innovation. Culture is defined in the American Heritage Dictionary as “the predominating attitudes and behavior that characterize the functioning of a group or organization”. There is no definitive recipe for creating a culture of innovation within an organization. Analyzing some best practice companies yields the following aspects to be important.

Leadership: Innovation starts at the top. As organizations grow, hierarchies tend to develop, imposing artificial barriers on the flow of ideas and innovation. It is the role of leaders to establish the right psychological conditions in a company. The top management of an organization with an innovation culture is responsible for setting the innovation strategy. In addition, the leadership at all levels is responsible for steering the organization’s attitudes toward innovation, creativity and new ideas. If the directors of a company fail to recognize new ideas, recognize and reward both incremental and radical innovations, and provide support (with both resources and personal encouragement), the possibilities for innovation to occur are limited (Karlsberg; Adler 2005; see also A.T. Kearney 2005b; Deloitte 2005; Sherman 2005).

Employees are recognized and valued as individuals: It is not a coincidence that employees in innovative firms feel that they are treated fairly and given adequate compensation for their work. Creativity is strongly linked to intrinsic

motivation. Organizations with a culture of innovation recognize and value people. They acknowledge the importance of people and their ideas, experience and know-how within innovative organizations (Deloitte 2005). Amabile et al. (2002) put forth that employees placed the most worth on a workplace where their achievements and ideas were recognized and valued. Furthermore, innovations often result from non-traditional thinking. Organizations that are flexible, tolerant, and allow for individual eccentricities within a supportive structure have good innovation climates (Sherman 2005).

Cross-functional teams: Many of the most innovative companies in the world have found that a small cross-functional team composed of employees from different backgrounds is the most effective organizational structure. The more diverse an organization is, in cultural, professional and personal terms, is directly linked to the number of perspectives that ideas and solutions can be generated from (Amabile 1998; Schlicksupp 2004).

Open Communication and Collaboration: Wilbert L. Gore, who left DuPont in 1958 to start W.L. Gore & Associates, liked to say that “communication really happens in the car pool.” He felt that in most hierarchical organizations, the only place where people would talk to one another freely, without regard for the chain of command was in the car pool during their commute. Innovative organizations have a general culture that encourage employees to share ideas, information and development, and also encourage collaboration to solve problems and generate ideas. Many larger innovative organizations make use of internal forums where the latest developments in each division are put on display for all in the organization. The sharing of ideas and information between different divisions results in new ideas for applications of technologies and new approaches to problem solving (Breen 2005; Deloitte 2004; Sherman 2005).

Trust and Autonomy: There are numerous examples of innovative firms allowing employees to use a portion of their work time (usually between 10 and 20%) to pursue creative ideas, research and projects of their own interest. This strategy is credited with turning Nokia into the mobile communications giant it is today, and the development of many products, processes and technologies at firms such as W.L. Gore & Associates, 3M, Clariant GmbH, and Toyota. The key to the strategies success is trusting employees to manage their own time effectively and work without constant supervision. 3M has a time-honored practice they call “bootlegging”, which places employees on an honor system when it comes to working hours, and where employees are free to pursue their own ideas without receiving approval. Part of this practice is the so-called 15% rule, where employees are expected to use that amount of their work time on creative new ideas and research of their own interest. A retired vice president of R&D at 3M said “Most of the inventions that 3M depends on today came out of … individual initiative. You don’t make a difference by just following orders” (3M 2002). Organizations with a strong innovation culture encourage and support employees to take ownership of their work and provide resources for the pursuit of ideas and innovation, while trusting employees to make good decisions and be responsible. Amabile identified “surveillance – being watched while you are working” and “expected

evaluation – focusing on how work is going to be evaluated" as "creativity killers" in early controlled laboratory environment research on creativity (Amabile et al. 2002; Secretan 2005).

Tolerance of Risk Taking and Failure: One of the traits of a company with a climate of innovation is the tolerance of risk taking. There is a tendency of established companies to continually invest nearly their entire R&D budget into only improving existing products. While this is a fairly safe and possibly profitable strategy, it precludes any major breakthrough innovations. However employees that are encouraged to take risks to a certain extend are more likely to come up with innovative solutions. A good corporate culture minimizes the negative consequences of failure, and even celebrates it. Employees of W.L. Gore & Associates are known to celebrate the conclusion of failed projects the same way they would celebrate a success. By minimizing the fear of failure, the employees are encouraged to explore new ideas and perform experiments that lead to innovations, without the fear of failure (Deutschman 2004b; see also A.T. Kearney 2005b).

Patient and far-sighted: One of the keys to successful innovation is patience. Before he began marketing the electric light bulb, Thomas Edison tested over 6,000 different filament materials before finding one suitable for production (Ament 2005). Organizations with good innovation cultures understand and accept that the development of an idea or technology into a successful innovation (either a marketable product or an improved process) can be a lengthy process, and that results and profits may not be immediate. Many organizations have missed out on profiting from innovations because they were so focused on immediate profits that they canceled projects or sold them off cheaply. The 3M Company uses the term "patient money" to describe the policy of allocating support and resources to innovations that are seen as having the potential to ultimately change the basis of competition in a category. Scotchlite reflective technology, which is used in hundreds of applications, including as a durable striping material for highways, took eight years to earn a small profit. Ron Baukol, former Vice President of International Operations for 3M said "you don't throw too much money into the investigation, but you keep one to five people working on it, for 20 years if you have to. Because you know that, once you crack the code, it's going to be big" (3M 2002).

Customer Oriented: In a Booze-Allen survey of European top executives, completed in October 2004, nearly half of those surveyed were unhappy with their company's innovation performance. These same executives ranked understanding customers better as the most important way to increase the value of innovations created in their company's product development process (Booze Allen Hamilton 2005). Over half of small and medium sized businesses surveyed in a study even credited customers as being the source of their best ideas for innovation (Verworn et al. 2000). In many organizations, there exist institutional barriers that prevent good understanding. Engineers are buried so deep within the company that they do not see first-hand what customer needs are. The culture of the company causes them to become so focused on technical problems that they do no appreciate the emotional

reactions and attachments customers have toward products (Verworn et al. 2000; see also Deloitte 2004).

The Harley Davidson firm is notable for its culture, in which employees are nearly all motorcycle enthusiasts, and the company sends it development teams to motorcycle rallies and conventions around the world, to meet and understand their customers. In many firms with good innovation cultures, employees and especially managers are also customers, who truly believe in the product that they produce and sell. Observing and interacting with customers (and observing the interaction of customers with products or technologies) can lead to innovation (Booze Allen Hamilton 2005). The Whirlpool Company, a large home appliance manufacturer in North America began focusing on design and used customer observation to develop products that were distinct and easy to use. Despite of high prices their new products are selling extremely well (Salter 2005).

Ideas are given value, whatever the source: A culture of innovation is able to recognize and accept ideas, and give them value. Many organizations have missed opportunities because of a “not invented here” attitude, which causes management to ignore or reject ideas, technologies or processes because they were not fully developed in-house. Successful innovators work closely with customers, partner with other organizations and take measures to educate their employees in fields outside of their specialties. Innovation is not limited to the Research and Development department. Nearly everyone in an organization has ideas on how to improve the processes they work closely with, or to improve the product they produce or the environment they work in. Organizations with a good innovation culture are able to tap into this wealth of ideas and knowledge, and encourage and recognize employees for submitting their ideas (Vahs; Burmester 2005).

In addition to this collection of common traits of innovative organizations a model of five environmental elements that affect creativity (Amabile et al.1996) is mentioned in Chapter 4.3. Furthermore aspects that hinder creativity are discussed as myths.

2.5 Sources of Ideas for Organizations

2.5.1 The Importance of Different Sources

The use of creativity techniques is generally appropriate for generating new ideas within project teams or groups within an organization. However, in a study of 350 “great ideas”, it is reported that less than 2% of the 350 great ideas came out of scheduled meetings. 23% resulted from informal discussion and 43% came while the person was alone (Baroudi 2002).

Interviews with top level managers of 21 small and medium sized German businesses (SMB) in six industries revealed that internal sources for ideas are not limited to the employees of the R&D or marketing departments (Verworn et al. 2000). Every employee of a company has ideas on how to improve their

workplace, speed up their work or improve a function of their job. In addition to gathering ideas from current personnel, old ideas, research and concepts that were developed during an organizations history can be used as a source of innovative ideas, if a company has appropriate knowledge and idea management systems in place.

But other sources and methods for collecting ideas should not be ignored (see Fig. 3). According to the results of the above mentioned study customers are the most important source for innovations. The study concluded that due to a lack of personnel and resources (for instance for R&D activities), SMBs were more likely to pursue external ideas than large companies (Verworn et al. 2000).

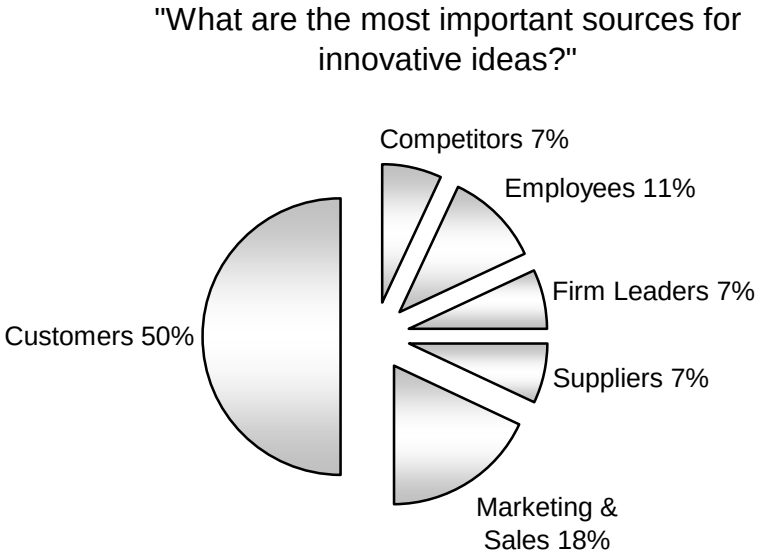

Figure 3: Most Important Sources for Innovative Ideas (Verworn et al. 2000)

Old ideas from outside a company are excellent sources for innovation ideas as well. Old patents are rich with ideas that may not have been fully developed enough to succeed on the market. The telephone answering machine was patented in 1935. It was about three feet (approx. 1 meter) tall, and used very primitive recording technology. Casio introduced the first commercially successful telephone answering device in 1971. The idea had been in the United States Patent Office for over 35 years before making it to market (Bellis 2005).

Furthermore, the Internet is a very fertile source for ideas. The United States Patent and Trademark office and the European Patent office have made patents available for viewing online. In addition, there are many free patent search services, including for instance freepatentsonline.com, which offers over 100 Gigabytes of patent data. There are many inventors' networks on the

Internet as well. These formal and informal networks provide individual inventors with resources to develop, patent and market their ideas. Businesses seeking ideas for innovation can view and opt to purchase ideas and inventions for prices that are often below comparable corporate development costs (InventNet 2005).

Other external sources for innovative ideas and technological spillovers in general include business partners, such as financial institutions, service providers and firms offering complementary products or services. Many large innovative businesses have close ties with academic institutions. Thereby, academic research is not limited to basic research but extends to applied research (Afuah 1998).

However, it should be kept in mind that besides the relevance of the different sources for innovative ideas, the difficulties of transferring innovation across functional and organizational boundaries have to be accounted for. Among the factors that determine the effectiveness of innovation transfer are the nature of the innovation, i.e. its degree of complexity and tacitness, the timing (when does the window of opportunity close?) as well as the absorptive and transmission capacity of the organization under consideration. In this sense, all agents within and at the gateways of a company can be interpreted as receiving and transmitting units. To reduce the impedance mismatch between transmitter and receiver due to complex and implicit knowledge underlying the innovation process is one of the main tasks to perform (Afuah 1998).

2.5.2 Harvesting Employee Ideas

In 1999, 1.1 million suggestions for improvements were submitted by the employees of 438 German businesses. The realization of these suggestions saved companies 1.9 billion DM (about 0.95 billion €) in costs. The additional revenues generated by suggestions were estimated to be worth an additional 330 million DM (about 165 million €) (4Managers 2005). However, a study of innovation management in small and medium sized businesses found that the overwhelming majority of SMBs lacked systematic approaches to collecting ideas from employees. Most of the ideas were collected in informal ways, and evaluated without any type of system or criteria in place (Verworn et al. 2000).

The suggestion box is one of the most common methods of collecting employee ideas. The first such box in an industrial setting was set up in 1886, by Scottish ship builder William Denny (Robinson; Schroeder 2004). But the suggestion box might have several weaknesses as an idea submission system. The majority of organizations do not have evaluation criteria for ideas, or a system for routing the ideas to company decision makers for implementation. In addition, it is often not possible for the ideas to be viewed by anyone besides the reviewer.

Web-based Idea Management systems overcome many of these weaknesses. The ideal system should be easily accessible from the Internet for all employees, including those working at satellite locations and traveling.

The software should be designed so that from the employee perspective it is intuitive, interactive, has a clear procedural flow and a reliable feedback mechanism. The system should provide information on what areas the company is seeking ideas in, the status of ideas, and especially a way to view a broad repository of ideas from others. Mechanisms for developing and refining the ideas submitted by others are a key component. Systems should also include an option for anonymity, allowing ideas to be submitted in confidence. From the reviewer's or manager's perspective, an ideal idea management software system should include opportunities to seek expert opinions, analysis tools for examining the idea pools to identify trends, and most importantly, a clear evaluation process. Scoring methods which use defined criteria ensure greater consistency of evaluations from multiple reviewers and reduce source biased evaluation. Tools for results tracking are important for administrators. From their perspective, an ideas management system should also be integrated with other enterprise systems and include a way to logically hand off ideas to the next phase management system for implementation (Baroudi 2002).

Many larger organizations have developed their own proprietary tools for the internal management of ideas, with varied degrees of success. Furthermore idea management systems software is currently marketed by a wide variety of companies. Some of the commercially available software systems on the market offer industry or organizational type specific packages and modules. JPB Inc. offers their "Jeni" ideas management software in multiple forms, including "JeniLITE" for small businesses, "JeniGov" for public and government agencies and "SylviaWeb Brainstorm" for idea generation in multinational organizations (http://www.jpb.com/jenni/index.php). Daimler-Chrysler uses a web-based ideas management system. In 2001, the system received over 69,000 suggestions. The implementation of some of these suggestions is credited with saving the company 62 million Euro that fiscal year (Baumgartner 2004).

The ideas that should be pursued by ideas management are not the 'big bang' radical innovation ideas. Small ideas are most easily implemented, and collectively the most profitable risk to pursue. The competitive advantage they provide is often not easily copied by competitors, and the implementation risks are generally low. Robinson and Schroeder published a study of the power of small ideas (Robinson; Schroeder 2004). Included in the study are numerous examples of organizations worldwide that have cut costs and generated profits from seemingly small ideas.

Robinson and Schroeder also establish links between the number of ideas submitted per employee, the implementation rate for ideas, and the sales growth and profitability of a company. They cite numerous companies around the world with high submission rates and extraordinary profits. Those companies have average annual idea submissions per employee ranging from 25 to 110 ideas a year (Robinson; Schroeder 2004).

Toyota is an example of a corporation that gathers and implements employee suggestions. As a part of the companies innovation strategy, *oobeya* (trans:

big open office) meetings are conducted at least twice annually, during which employees and managers reexamine the processes and methods of their functional areas. These meetings have produced major cost savings based on simple suggestions (Warner 2002). Furthermore, every employee of the company is empowered and obligated by the strategy of *Kaizen*, to continually improve their work and workplace. Toyota has received over one million improvement suggestions per year since the 1970s. An employee idea is submitted through a formal process for evaluation, and if feasible, implemented. The company has an 80% implementation rate for employee ideas. Employees who submit ideas receive recognition such as a certificate or story in the company newsletter and small non-monetary rewards (Baumgartner 2004; Das, Puri 2003).

2.5.3 Ideas from Suppliers and Partners

Among the keys to successful innovation is collaboration. Companies that have undertaken TQM (total quality management) programs have found partnerships developed with suppliers and other business partners to be valuable sources of ideas for innovation. Verworn et al. found that suppliers were a relatively untapped source of innovation ideas for German small and medium businesses (Verworn et al. 2000). Among large businesses, suppliers and partners are more highly valued. A survey of international business leaders found that 40% of CEOs believe suppliers to be an important source of innovation, and about 35% feel the same way about alliances (partnerships) (Kambil 2002).

What is critical to gathering ideas and suggestions from partners and suppliers is structure. Networks to connect partner companies require both a common strategy and an established framework. Online document and information sharing portals, with mechanisms for access by partners and suppliers are a major step toward this goal. In addition, some companies have found that establishing joint ventures and joint work facilities to enhance face-to-face collaboration on problems to be helpful. What is required for this to happen is communication between company leaders, to develop a shared innovation strategy, and establish the ground rules and process framework for collaboration.

2.5.4 Ideas from Customers

By far, the most important source for ideas in surveys of small and large businesses is customers. The importance of customers and users is stressed especially in the research conducted by von Hippel (1986, 1988, 2005). Von Hippel coined the term “lead-user”, i.e. users who face new needs months or years before they become general in the marketplace. Lead-users do not only serve as a “need-forecasting laboratory for marketing research” (Hippel 1986), but also develop products and services themselves (Hippel 1988, 2005). The latter applies for example to cases where lead-users identify a drawback in

the construction of technical devices. Since they anticipate a relatively high benefit from obtaining a solution to their problem (Hippel 1986), lead-users may innovate. Several works in this field were able to provide empirical evidence for the “lead-user”-theory. Franke and Shah (2003) for example studied several sports enthusiastic communities, finding that almost 38% of the group members surveyed developed and built products for their own use. Ranging from incremental innovations to more “radical” innovations, there were still 23 % among these user-developed innovations that had commercial potential (Franke; Shah 2003; Hippel 2005).

The challenge in business lies in collecting ideas from customers and users. The methods for doing so are highly dependent on the industry and type of company. Companies that sell products or services to other companies have perhaps the least complicated methods of generating feedback and ideas. Many companies are seeking to develop innovation partnerships with their suppliers. Suppliers are no longer only responsible for several parts to deliver, but for whole systems that have to fulfill certain functions. These functions are essential in the further production process or even in the later usage of the product. In this respect often the supplier’s role has changed from just being a supplier to become an important, market-orientated partner in the innovation process (Vahs; Burmester 2005).

The companies selling in the B2C (Business to Consumer) industries tend to have greater challenges. Methods for gathering ideas are highly dependent on the nature of the product or service. Some companies, such as Harley Davidson motorcycles, are able to tap into consumer ideas by becoming customers. Every executive of that company attends motorcycle rallies around the world, and is a regular rider of the company’s products. By seeing the company’s products from the customer perspective, the executives develop an empathy with the customer, and are able to listen to and understand feedback.

Apart from this there are many more methods of researching customer use in the consumer products industry. Feedback surveys, customer focus groups and blind preference testing have value, but can lead to skewed results.

The Coca Cola Corporation found itself losing shares in the North American market to Pepsi in the 1980s and became increasingly concerned over the “Pepsi Challenge,” where consumers sipping small cups of the beverage in blind taste tests greatly favored Pepsi. Relying on focus groups and blind taste testing, the company developed “New Coke,” also known as “Coke II.” The formula was much sweeter than original Coca Cola, and tasted almost like Pepsi. When New Coke debuted on the North American market in 1985, the customer feedback the company received was almost universal – they hated it. Coca Cola made several mistakes, the most important of which was putting too much faith in blind taste tests. Because the consumers performing the tests were only taking small sips, the sweeter beverage was nearly always more popular. The 200,000 customer interviews that Coke performed were skewed, because, as the researchers had tried to point out, the questions were wrong and the methods used were not appropriate for trying to

reformulate a flavor. Had Coca Cola performed real life user testing, such as sending cases of the sample product home with the customer and recording their reactions after a few weeks, the results would have been different. Coca Cola reintroduced its original formula to the North American market as Coca Cola Classic. The decision to tamper with a 99 year old formula that was loved around the world is regarded as one of the largest business blunders in history. One thing that the Coca Cola Corporation did right during the fiasco was not to fire, demote or reprimand the managers who made the decisions that led to “New Coke.” "They had the courage to put their jobs on the line, and that's rarely done today at major American companies," said Herbert A. Allen, President of the Compensation Committee at Coca Cola. Roger Enrico, then President of Pepsi USA, has argued that mass firings would have put everyone on notice that risk-taking was discouraged at Coca Cola, and would have caused a major drop in work performance (Bastedo; Davis 1993).

Whirlpool, a North American manufacturer of home appliances, makes customer observation research a major part of the design process for new products. By observing customers as they interact with appliances – loading a dishwasher, washing and drying laundry, changing the filter for the water dispenser system of a refrigerator, cross-functional teams of engineers, designers and anthropologists are able to make products more intuitive to use (Salter 2005).

Another way for companies to gather ideas from their customers is through contests and idea suggestion sites. Church & Dwight, manufacturers of Arm & Hammer, the leading brand of baking soda in North America, have kept a 170 year old brand fresh by holding contests for alternative uses and having feedback forums. The alternative uses that resulted have earned Arm & Hammer a place in 95% of American homes. The company’s marketing team promotes the customer ideas of using the bicarbonate of soda (baking soda) as a deodorizer, cleaning product, antacid, etc. The customer submitted ideas have even been used to extend the Arm & Hammer brand to include toothpaste, deodorant and laundry soap, all based on bicarbonate of soda (Makely 1999).

3 Generating Ideas through Creative Processes

3.1 Creativity

Given the definition that “technological innovation involves the solution of problems” (Dosi 1988), it is obvious that this kind of problem-solving is usually far from being solved in a purely logical and routinized manner. Thus, problems that have to be solved by an innovative solution are initially ill-defined problems (Schlicksupp 2004). To solve them requires creativity. Internally generated ideas may have the highest potential for innovation in an organization. To best generate and preserve ideas in a transferable state, creativity techniques are necessary. In order to understand and use creative thinking techniques effectively, background knowledge of the creative process and thought processes is necessary.

The most widely used model of the creative process was developed by Henri Poincaré (1921). The model of the creative process consists of four phases (Schlicksupp 2004):

1. preparation,
2. incubation,
3. illumination and
4. verification.

The *preparation* phase begins with the recognition, analysis and understanding of the problem. This involves gathering and analyzing available knowledge and background material relating to the problem, to build a solid general working knowledge of the subject. The phase also includes working intensively with the problem; attempting to break the problem into components, attempting to solve sub-problems, and to understand the interdependencies of the problems components (Schlicksupp 2004).

The *incubation* phase involves doing nothing. The preparation phase worked with the problem in the conscious mind and prepared the subconscious to produce new ideas. During this phase, the creative thinker should push the problem out of his or her mind, and occupy him or herself with something else. Working on a parallel problem may be helpful during this stage (Konnerth 2005).[1]

[1] The Japanese inventor Dr. Yoshira Nakamatsu holds more patents than any other individual. His inventions include the floppy disk, the CD, CD player, digital watch, and a host of others. He described his methods for coming up with innovative ideas in an interview. He spends time in what he called his “static” room, a calm, peaceful room filled with only natural things, such as flowing water and rock gardens. Then he moves to a “dynamic” room, where he listens to different types of music, before moving to his swimming pool, where he claims his ideas come to him underwater. In addition, he is a frequent napper. At the time he was interviewed in 1990, he held over 2300 patents (Nakamatsu 1990)

What all of these practices do, is free the subconscious mind and allow it to work with the problem. This will lead into the third phase, the *illumination*. This phase has also been referred to as the enlightenment, the lightning strike, and the mind blitz. The creative thinker will be hit with a creative insight, a sudden idea, or a vision. These lightning bolt ideas can strike unexpectedly, and often go unrecognized or are forgotten in a short time. Many creative thinkers report that ideas come to them during dreams. It is therefore important for the creative thinker to have resources available and train him or herself to recognize and express these ideas. Illuminating ideas can sometimes be triggered by various experiences, using metaphors, observing nature, listening to music, etc.

The fourth phase of the creative process is *verification*, also known as validation. The ideas developed during the third phase are presented and analyzed. During this phase the focus is on the solution to the problem. Ideas are looked over to determine if they make sense, and then analyzed to determine if the workable ideas are practical. Solutions are then developed and implemented, and the creative process cycles to the next problem.

The creative process involves purposeful problem and information analysis, imaginative idea generation and critical evaluation of the ideas. The creative process is a balance between analysis and imagination. Early creative process models credited (or implied credit to) subconscious processes as the source for ideas, largely out of the direct control of the thinker. More modern models generally imply that creative ideas are generated purposefully, under the direct control of the thinker (Plsek 1996; Simon 1986).

3.2 Foundations of Creativity Techniques and Limitations

Creative process models generally involve moving ideas and information from the conscious, cognitive mind to the subconscious mind, and vice versa. This process is hindered by internal censors, or barriers, which prevent the free flow of ideas. Creativity techniques are tools to present problems and stimulate individuals or groups to generate a flow of ideas, while overcoming internal barriers (Schlicksupp 2004).

Creativity techniques provide structure and separation between the thought processes. The thought processes of the mind can work in two directions; convergent and divergent. Convergent thinking serves to restructure problems and to arrange possible solutions into existing contexts. Divergent thinking is about mental flexibility and originality. According to Guilford; Hoepfner, the last trait necessary for creativity is cognitive capability, i.e. the capability to identify and to understand problems (Guilford; Hoepfner 1976).

In Fig. 4 it is depicted how the different patterns of thinking are used and how the creativity process is influenced. First of all, the problem to be solved has to be defined. Therefore convergent thinking is needed in a logical phase to collect information about the problem and about potential solution approaches.

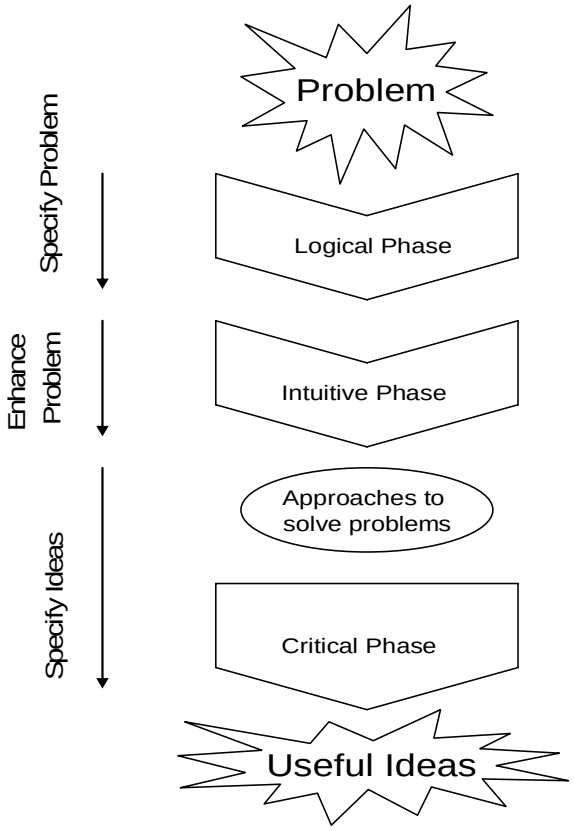

Figure 4: Typical Course of Creativity Processes
(Adapted from Vahs; Burmester 2005)

Then, in an intuitive phase, the problem must be transferred to the subconscious mind in order to identify new ideas which might solve the problem. During this idea finding stage (i.e. incubation and illumination) the problem is enhanced. In this respect the thought processes are primarily divergent (see chapter 3.1). Finally, in the critical phase, the potential solutions to the problem are evaluated and prioritized for example in terms of technical feasibility, efficiency and other pre-defined criteria. It is obvious that the step of evaluation is necessary to identify the most promising ideas and rests upon convergent thinking patterns.

It is absolutely critical that the thought processes be separated. In particular, idea finding must be separate from evaluation. This prevents the barriers to ideas that internal censors erect, which prevent the flow of creative ideas (Schlicksupp 2004). There are several techniques that support individuals or groups in generating new ideas and solving complex problems. Among them are methods with an analytical approach like the Morphological Chart, Progressive Abstraction, Attribute Listing etc. as well as methods with a more creative, intuitive approach (e.g. Brainstorming, Method 635, Synectics). The

suitability of a specific method depends on the problem that needs to be solved. Brainstorming and Method 635 are usually chosen when a list of existing solutions has to be compiled. A typical example may be the question: “What kinds of sources are appropriate to produce light?” Attribute Listing is a suitable method for problems that ask for relations and structure; i.e. “What kind of functions would the light have to fulfill?” The Morphological Chart-method is able to exchange, restructure, and rearrange existing attributes, devices or ideas. In the above context the task would be to develop a concept for a device that allows for a flexible positioning of the light (Schlicksupp 2004).

The creative process is often hindered by psychological and sociological barriers (Schlicksupp 2004). Psychological barriers comprise internal and mental barriers. Internal censors and rigid thought patterns, e.g. a dominating focus on material worth like “…and what is this going to bring me?” have been identified as a blocker of creative thought. Mental barriers to creativity include seeking absolute answers (such as in the field of mathematics), perfectionism, complacency with the present situation, and failure to trust ones own abilities. Being non-confrontational and seeking to avoid conflict is also a hindrance, as it prevents the expression of ideas that run contrary to established norms. Being overly quick to formulate and give opinions is also a barrier to creativity, because it does not allow the incubation and formulation of new ideas (Schlicksupp 2004).

Within organizations and society there are barriers to creativity. In addition to those mentioned in the research of Amabile, such as time pressure, barriers to communication, fear and distractions (Amabile 1998; Amabile et al. 2002), there are more basic social blockers of creativity. Lack of objectivity, due to rivalries or conflicts of interest is harmful to creativity, particularly in the analysis and evaluation processes. Organizational structures with large numbers of committees, review boards, and bureaucracy discourage and stifle the development of creative ideas (Schlicksupp 2004). Strict chains of command and feelings of anonymity are barriers as well. Goals that are not challenging do not encourage creativity, but poorly developed goals that are out of reach are barriers that shut down creative processes (Stevens 1995).

The sociological barriers to creativity that are possibly the most prevalent in organizations are tradition and criticism. Traditions, taboos and sacred cows are creativity killers. They prevent creativity and innovation. Generally, taboos and sacred cows are based on assumptions. By their nature, these assumptions are not allowed to be questioned or examined, preventing creativity from flowing in such directions. Negative criticism is a strong social barrier to creativity. It exists in many forms in organizations. These include blatant and subtle verbal criticism, poor evaluations of creative employees deemed ‘eccentrics,’ and body language and non-verbal cues during presentations, meetings and conversation. In order to support and encourage creativity within an organization, it is important that managers understand the effects, both intended and unintended, of their communications (Schlicksupp 2004).

3.3 Creativity in Organizations and Popular Myths

Individual creativity and organizational creativity are two interdependent aspects. As mentioned above, there may be organizational barriers that hamper creativity, no matter how creative the individuals are.

This is why it is important not only to concentrate on the creativity of the individual, but to stimulate the creativity in an organizational context. Schlicksupp (2004) mentions three factors: information flow, integration, and cooperation. To achieve a better flow of information requires open communication by means of a minimum of regulated work-flow, project-oriented teams, and "job-rotation". Integration serves to minimize rivalry within an organization and can be achieved if clear goals are communicated, human resources development and their promotion are done in a systematic way and innovative ideas are generally appreciated. Finally, cooperation is needed to make the process of problem-solving more efficient and to strive for a synergetic surplus (Schlicksupp 2004).

Empirical evidence for the factors that promote or hamper creativity was provided by the research conducted by Amabile (e.g. 1996, 1998, 2002). Beginning in 1996, Amabile et al. began a ten year study of creativity in the modern business environment, outside of controlled laboratory conditions. The research was described as the first study of "creativity in the wild". Amabile developed a model of creativity based on her earlier research of creativity under controlled conditions. The model identifies five environmental elements that affect creativity (Amabile et al.1996):

Encouragement – organizational, supervisory and work group encouragement. They all foster creativity as for example a risk-taking mentality, goal clarity and diversity in team member background encourage employees to generate and appreciate new ideas.

Autonomy – the freedom to organize the work and responsibility to make decisions foster intrinsic motivation and thus creativity.

Resources – extreme resource restrictions impede creativity, because they give the impression that the project is less valuable.

Pressure – to a certain degree it is perceived as challenging; i.e. this kind of pressure has a positive effect on creativity. It turns out to be negative when it is perceived as excessive work load pressure.

Organizational barriers – conservative thinking and rigid management structures impede creativity. It is argued that these factors are perceived as controlling and thus intrinsic motivation necessary for creativity decreases.

Amabile states that she advocates "smart management." Open communication is essential between and within all levels of an organization. Intrinsic motivation is also key. The aim of managers should be to facilitate creativity in their employees. To help achieve this goal, employees should be given autonomy and allowed (and encouraged) to take ownership of their work. Managers should work to eliminate barriers in communication, and to make sure that employees understand why their work (and deadlines) is

meaningful. Managers should also act to shield employees from distractions when they are under pressure. Another key role of the lower level managers is to shield the creative employees from criticism of their ideas. Simply put, the key to smart management is to value and recognize the employee (Amabile 1998; Amabile et al. 2002).

Although there are models that aim to describe creativity and creative processes it is difficult or almost impossible to enforce creativity. Nevertheless organizations can try to provide conditions that support creativity. As discussed earlier an innovation culture supports the occurrence of innovations and promotes creativity at the same time. Apart from measures that advance creativity there are also aspects that hinder creativity. These are discussed as myths of creativity (Amabile 1998; Amabile et al. 2002; see also Breen 2004).

Creativity Comes From Creative Types

During interviews with senior managers, Amabile asked “where in your organization do you want to see creativity?” The responses were almost invariably “R&D, Marketing and Advertising.” When asked where they did not want to see creativity, the most frequent reply was “Accounting”. What the managers failed to understand was that any person with normal intelligence can be creative. Creativity is not limited to certain occupations. As an example, there have been (completely ethical) creative innovations in the financial field, such as activity based accounting, which are major assets for companies. Creativity is dependant on experience (including knowledge and technical skills), talent, the ability to think in new ways and intrinsic motivation.

Money Is a Creativity Motivator

The research that Amabile cites to disprove this myth shows that employees do not actively think about their salary on a daily basis. Pay for performance plans have been shown to have a negative effect on creativity. The reason for this is that employees become risk-shy, and are afraid of trying out new ideas, because every move they make affects their compensation. Employees need to feel that they are compensated fairly, but the research that Amabile’s team conducted shows that employees place more value to a work environment where creativity is supported, valued and recognized, than on monetary compensation.

Time Pressure Fuels Creativity

The diary study found that many employees believed that they worked most creatively under the pressure of extreme deadlines. Analysis of their journals actually showed the opposite to be true. Employees were least creative under the stress of extreme time pressure. In addition, they often had a “time pressure hangover” for two days afterwards, in which creative thought was impossible. Workers facing impending deadlines do not have adequate time for the incubation of creative ideas. Amabile states that the reason many employees feel they work better under time pressure is focus. For many

employees, the only time they can eliminate or reduce the distractions in their work environment and focus is when faced with urgent deadlines. Of vital importance, is that employees understand the reasons for urgent deadlines – not just that an assignment needs to be done by a certain time. Amabile has published several articles on this topic and developed a time pressure creativity matrix (see Tab.3).

		Time Pressure	
		low	**high**
Likelihood of Creativity	**high**	Creative thinking under low time pressure is more likely when people feel as if they are **on an expedition**. They: • show creative thinking that is more oriented toward generating or exploring ideas than identifying problems • tend to collaborate with one person rather than with a group	Creative thinking under extreme time pressure is more likely when people feel as if they are **on a mission**. They: • Can focus on one activity for a significant part of the day because they are undisturbed or protected. • believe that they are doing important work and report feeling positively challenged by and involved in the work. • show creative thinking that is equally oriented toward identifying problems and generating or exploring ideas.
	low	Creative thinking under low time pressure is unlikely when people feel as if they are **on autopilot**. They: • receive little encouragement from senior management to be creative. • tend to have more meetings and discussions with groups rather than with individuals. • engage in less collaborative work overall.	Creative thinking under extreme time pressure is unlikely when people feel as if they are **on a treadmill**. They: • fell distracted • experience a highly fragmented workday, with many different activities. • don´t get the sense that the work they are doing is important. • feel more pressed for time than when they are „on a mission“ even though they work the same number of hours. • tend to have more meetings and discussions with groups rather than with individuals. • experience lots of last-minute changes in their plans and schedules.

Table 3: Time Pressure/Creativity Matrix (Amabile et al. 2002)

Fear Forces Breakthroughs

The myth of the creative artist with a tortured soul does not have any factual basis in Amabile's research. The analysis of journal entries that were coded for emotions found that creativity is positively associated with feelings of joy and love, and negatively associated with anger, fear and anxiety. The journal entries showed that employees were happiest when they had a creative idea, and that creative ideas were more likely to occur if the employee had been happy the previous day.

Competition Beats Collaboration

In several industries (especially high-tech), there is a belief among managers that internal competition fosters innovation. Amabile forwards that creativity and innovation are more likely to result from collaboration between individuals and teams within an organization. When faced with internal competition, information and idea sharing ceases and this is particularly destructive because "nobody in an organization has all off the information to put all the pieces of the puzzle together".

A Stream-Lined Organization Is a Creative Organization

This myth is largely the result of Public Relations spin and consultants attempting to justify layoffs. The exact opposite is true. Amabile's team studied a 6,000 employee division of a global firm during the entire 18 month course of laying off 25% of the workforce. Every single stimulant of creativity dropped, and was down five months after the layoffs were completed. The anticipation of the layoffs had a greater negative effect on creativity than the actual downsizing did. Insecurity and fear of the unknown led employees to disengage from their work, and stifled the intrinsic motivation that generates creativity.

4 Evaluation, Implementation, and Measurement

4.1 Evaluation of Innovative Ideas

All of the ideas and problem solution proposals generated by creativity techniques are by no means equal in quality or necessarily feasible. The techniques briefly discussed in this chapter can be used to evaluate and make decisions about proposed ideas and to examine alternatives in a decision making process respectively. As a reminder to what was said above, it is the convergent thinking process which is primarily needed for this kind of task. Divergent thinking serves the purpose for collecting and developing ideas from various sources (Rangaswamy; Lilien 1997). Concerning the evaluation process, collecting ideas is generally the easier part of innovation and idea management. Turning the lists of hundreds of ideas of varying quality into a short list of actionable alternatives is the challenge of the evaluation and selection processes of idea management. This difficulty also tends to be reflected in the procedure of idea evaluation in business. Up to now the evaluation process in many companies is rather intuitive and “ad-hoc” (Vahs; Burmester 2005).

Empirical evidence for this drawback was provided by researchers of the TU Hamburg-Harburg. They discovered that of the 21 small and medium sized business leaders surveyed, 16 stated that their company had no method for evaluating innovation ideas. Five said their companies conducted market analysis of potential ideas, four conducted traditional cost estimates and two conducted investment appraisals. Only one respondent said that his or her company used scoring techniques in evaluating ideas (Verworn et al. 2000).

Far too often, idea evaluations are made by a single manager based on gut feelings, without using a list of relevant criteria. However, nearly all of the innovation management best practices companies have a policy of evaluating new ideas in a committee composed of members from various backgrounds. The most critical factor in their idea evaluation process is having a set of clearly defined criteria that new ideas must meet to be accepted (Cooper; Kleinschmidt 1993). By establishing a framework for the idea evaluation process, the need for gut feelings is removed, along with (at least some of the) potential bias of individuals. Clear criteria allow an idea evaluation committee to examine a suggestion or concept logically, and score it in a consistent manner.

In the above mentioned study fifteen managers and decision makers said that *market demands* were the most important factor in their decision making process. Twelve used *technical feasibility* criteria, eleven looked at *development costs* and ten analyzed the *profit potential*. Eight decision makers used *development time* in their decision criteria. If the getting new products to market faster and increasing the profitability (while decreasing the time to profit) are goals of innovation management, the small and medium sized business leaders surveyed are not evaluating ideas with the right criteria. Furthermore it is important to note that the majority of respondents

had stated earlier that their company did not have a clearly defined idea evaluation process at all (Verworn et al. 2000).

Criteria for evaluating ideas and decision making are different for each company, based on the industry, size, resources, competition, markets, risk tolerance, culture and most importantly the innovation strategy of the business. If a strategy is well developed, the criteria for idea evaluation should be apparent. For example, if decreasing the time to market is an important component of the innovation strategy, the time required to develop an idea should be a decisive evaluation and decision criterion. What is most important is that evaluation criteria be used consistently, so that ideas and decision alternatives can be compared objectively.

To assist in the evaluation of ideas, idea management software systems generally include decision making and evaluation tools. An overview of software tools for new product development is provided by Rangaswamy and Lilien (1997). According to the development stage under consideration (e.g. *idea evaluation*), they present the specific software (e.g. "*Expert Choice*") and the theory underlying (*Analytical Hierarchy Process by Saaty 1980*). One of the core concepts which is to be found in many (software) evaluation tools is a decision matrix based on user selected weighted criteria. Evaluators determine – usually on a scale from one to five – the degrees to which an alternative fulfills each criterion out of a list of selected criteria. These scores are in turn to be multiplied with pre-defined criterion weights yielding weighted ratings for each criterion. Aggregation over each criterion finally produces an overall score for each idea, which can be used to decide which ideas to act on. It is the alternative with the highest overall to be the best course of action.

Beside this „Scoring Method", there are a number of other, less formal techniques. Among them is the "PMI Method", the "SWOT Analysis" or the "Six Thinking Hats". The PMI method of evaluating ideas is simple and quick to use. Each idea or possible solution is examined in three different ways. First, the Plus Points (P), or positive aspects of the ideas are collected and written into a column. Then the Minus Points (M) or negative aspects are recorded. Finally, the Interesting Points (I) are noted. Interesting points are neither positive nor negative, or require clarification (further research, expert consultation, etc.). The SWOT method examines potential decisions in a way similar to the PMI method. SWOT stands for Strengths, Weaknesses, Opportunities, and Threats. The technique user should examine the problem or decision, and then record their ideas under the appropriate categories. Finally the Six Thinking Hats method (De Bono 1985) allows to examine and to solve a problem from different emotional aspects by using different types of thinking. Each member of the evaluation group has to examine the problem from a specific perspective (e.g. take the red hat and analyze the problem through emotional, intuitive thinking). Each of the six colors stands for a different kind of thinking. The hats are then exchanged, until each member has examined the idea from all different perspectives.

4.2 Further Development of Ideas and Implementation

Ideas for innovation are rarely perfect. Generally, all but the simplest suggestions require further development before they can be implemented. Once methods for evaluating ideas have been used, there should generally be a short list of prioritized projects to invest effort, knowledge and resources into. This is generally the weakest link in the innovation process.

In a survey of business leaders conducted by Accenture and Chief Executive Magazine, only one in eight executives felt their company excelled at implementing innovative ideas. Nearly 60% of survey respondents stated that their company was limited in its ability to implement innovative ideas by lack of personnel who could be freed up. About 45% believed their company was limited in implementing innovative ideas by lack of sufficient skilled people, and just below 40% agreed that project management skills to execute implementation were to blame. Just below 30% of executives agreed or strongly agreed that lack of “knowledge sharing and management systems”, “ability to develop the necessary new skills”, and “information technology” were hindering their companies’ ability to implement innovative ideas (Kambil 2002).

The ability to overcome these barriers to implementation is one of the ways that the most innovative organizations stand out. Effective time and personnel management are decisive innovation factors. Establishing cross-functional teams to further develop ideas into innovations is only possible when the team members are freed from other commitments and daily tasks, such as mundane paper work, status reports and other job functions that send workers scattering in a thousand directions daily. To allow personnel the time to work on innovative projects, responsibilities for their jobs need to be reevaluated, and some tasks possibly reassigned to others or eliminated.

Innovative companies have found a number of workable solutions to the problem of freeing up personnel for teams to develop and implement ideas. These solutions include adapting the corporate structure, such as at W.L. Gore & Associates, where the cross functional team is the key to the lattice work structure of the company. Other solutions include adopting a corporate culture that prioritizes innovation in the work day, such as the 3M “15% rule”, which encourages employees to spend about 15% of their working time on innovative projects and research. Among the alternatives available for freeing up personnel for innovative project development and idea implementation is outsourcing. By determining tasks that can be contracted out to third parties, skilled personnel are able to focus on implementing new ideas. This option should be undertaken with great care, as outsourcing is very commonly associated with layoffs. Layoffs and especially the expectations of layoffs have been shown to have major negative impacts on employee morale and creativity (Amabile et al. 2002).

Implementation difficulties stemming from a lack of adequately skilled personnel can be dealt with in several ways. Human Resource management is the key to the issue. Hiring personnel from a wide variety of academic and experience backgrounds is an option for some organizations. Consultants

offer an option to organizations lacking specific know-how, as does creating joint ventures, partnerships and alliances with other organizations, which allow for cross-functional teams composed of experts from various organizations. Continued education and training of personnel is another way to reduce the limitations caused by lack of skills and know-how.

4.3 Measurement of the Innovation Process

Innovation is an abstract concept that is not easily quantified. Nevertheless, there are researchers, analysts and consultants who have sought to do so. The methods employed to measure innovation are less than precise.

The most common method of measuring innovation is through the use of indicators. In this respect researchers usually differentiate input-, byput- and output-indicators (Grupp 1997).

The spending on research and development is a commonly used indicator to measure a part of the input, i.e. the resources that were spent. This has major flaws as a method of measurement. The first being that money spent on R&D does not always equal successful innovation. Microsoft is the world leader in R&D spending, with over $6 billion annually. This is roughly equal to Oracle, Hewlett-Packard, Dell, Apple, and Sun Microsystems combined. Only IBM, with $5 billion annually is anywhere close. However, the majority of successful Microsoft products were developed by others and acquired by the firm. Microsoft's co-chief technology officer, Craig Mundie estimates that 90% of R&D dollars go toward fixing and improving existing products, with only the remaining 10% being spent on pure research or new product development. Some new products that Microsoft has invested fortunes of R&D resources into have not had many successes. The company spent ten years and much money on developing the tablet PC, which was a consumer flop, as was the SPOT watch, a PDA-wristwatch released in 2003 that used old technology and was dismissed by consumers (Hawn 2004).

Among the most common byput-indicators measuring the output of R&D activities are patents. The equivalent scientific indicator comprises bibliometric data. Both patents and scientific publications do generate R&D output, but do not necessarily lead to successful innovations.[2] They rather measure some kind of inventive activity. Unfortunately, using patents as a measure has numerous flaws. The first, being that many innovations, especially process innovations, do not use new technologies that are patentable. Moreover, patents can only be granted for new technological inventions. Dell, the computer manufacturer has less than half the patents of its rival Apple. Dell’s innovations are in its business model, which is not patentable. Amazon, Google, eBay, and Yahoo are arguably among the most creative and innovative companies of the Internet era; however, they each have only a handful of patents. IBM, with over 3,400 patents a year, would be considered

[2] Though, it is common to refer to patents as innovation output indicators (Smith 2005).

the world's most innovative company by this measure, a judgment that would be widely criticized outside of IBM (Deutschman 2004a).

Innovation measurements through patents fail to capture the new innovations that are not patented by the developer. Furthermore, patents are awarded to either the first to invent or the first to file, depending on the country (Grupp 1997). But the inventor of a process or technology is not necessarily the innovator. In a recent legal decision, Apple was denied a patent for its iPod mp3 player, because the technology was patented by Microsoft. Innovation measurement by patents would wrongly credit Microsoft for Apple's industry changing innovation (Morgenstern 2005).

Output indicators do not refer to single R&D activities, but measure the overall innovation output. One of the most common ways is to measure the share of a company's turnover that was realized with new products. Another way is to measure the technological gap: The market shares are differentiated by the age of their products. Products launched within the last period are more valuable than "older" products. This is reflected by gradually assigning weights to older products and a weight of zero for "brand new" products. Small values indicate a small technological gap. This type of measurement is derived from the well-known concept of product life-cycles. However, both indicators are critical as the definition of novelty in both cases is left up to subjectivity. Besides this, the definition of novelty is only valid for a specified period (Grupp 1997). The indicators will be misleading if not updated regularly and carefully.

Scorecard methods are the tool of choice for the majority of the innovation raters, such as business magazines. Fast Company uses an innovation scorecard to assess businesses against others in a particular industry each quarter. Their scoring method uses three factors. The first is five year performance – expenditures on R&D, new products and processes, return on R&D spending, revenues, percentage of revenues (and profits) from new products, failed product and process innovations, and missed opportunities. The second factor is a five-year forecast of the same factors. The final category is innovation capacity, focusing on corporate structure, innovation climate, leadership, personnel training, and resources (Prospero 2004). The consulting firm A.T. Kearney, in partnership with the German business weekly, Wirtschaftswoche, administers the Best Innovator prize, awarded to European top innovators annually since 2003. They also use the scorecard method to compare innovative companies. They base their judgements on five categories. These are: Innovation strategy, innovation culture, innovation processes, supporting factors and continuity of the generation and successful implementation of innovation.

While the aspects of measuring the innovation process stated above are mainly related to the business level, there are several points worth mentioning in terms of innovation indicators on an industry or nation-wide level. There has been a long tradition of refining measurement principles and indicators as apparent in numerous editions of the "Frascati Manual" and "Oslo Manual" (OECD 1997, 2002). While the "Frascati Manual" comprises proposed standard practices and definitions for surveys on research and experimental

development, the “Oslo Manual” covers proposed guidelines and definitions for collecting and interpreting technological innovation data. The theoretical grounding of the “Frascati Manual” goes back to the view of the innovation process as a linear process. Since it primarily gives an advice how to measure expenditures for basic research, applied research and development on different levels (e.g. classification according to sectors, sources of finance, etc.) the underlying assumption is that R&D expenditures is a necessary input for innovation activities. However, the “Oslo Manual” takes a more holistic approach in terms of the innovation process. Much of the theoretical grounding of the “Oslo Manual” goes back to the works of Kline and Rosenberg (1986), who state that

- innovation is a learning process involving multiple inputs,
- innovation does not depend on the invention process, and
- innovation does not follow a linear process, but allows for feedbacks.

Recently, two approaches have come to the fore which incorporate the innovation process itself and explore aspects of the sources of innovative ideas, external inputs and users of innovation (Smith 2005).

One approach is called the “object approach”, because it focuses on important technological innovations. The most common example for a survey that is in line with this approach is the SPRU (Science Policy Research Unit at the University of Sussex) database, which identifies major technological innovations in the British industry from 1945 through 1983. One of the most important results using the SPRU database was to show that innovation activities of firms vary according to the type of industry they belong to. Pavitt (1984) classified firms into “science based”, “scale intensive”, “specialized suppliers” and “supplier dominated” and showed that these groups differ in regard to firm size, sources of technology, types of users and means of appropriation.

The other approach, the “subject approach” focuses on the innovating agent, i.e. on innovation activities at firm-level, asking about the innovation inputs (R&D and Non-R&D) and outputs of the firm. This approach is reflected in the Community Innovation Survey (CIS) conducted by the European Commission. The third survey in 2002 covered approximately 140.000 European firms and collected data at a highly disaggregated level, asking for example for

- sources of information relevant to innovation,
- expenditures on activities related to the innovation of new products (i.e. R&D; training, market exploration, equipment acquisition, etc.), and
- forms of technological collaborations.

Speaking of technological collaboration and new products already hints that the “subject approach” primarily comprises technologically changed products and not processes. This is in line with the concept of the “Oslo Manual”. Besides this, in following the “Oslo Manual” with respect to the concepts of change, novelty and commensurability a high degree of consistency among

the survey methods can be achieved (Smith 2005). Consistent methods are vital in the field of measurement, especially when it comes to compare the development of technologies and processes. This is said to be the dilemma of measurement and at the same time the reason why the field of innovation measurement has not expanded to aspects like service innovation yet. To find consistent methods and instruments in the field of measuring service innovations will thus be one of the greatest tasks to perform (Hipp; Grupp 2005).

One of the newer analysis concepts being used in the field of innovation management research is ROI: Return on Innovation. In the 2005 study, “Was macht Innovationen erfolgreich?” Accenture determined that the return on innovation, the ratio of capital investments in product and process innovation to profits from the sales of new goods and services was variable by industry for successful innovators. In the chemical and raw materials industry, the ROI was the highest, at 169%, while the electronics industry had the lowest return on innovation, with negative 5% (Accenture 2005). But it is arguable whether the return on innovation measurement is a workable tool for measuring innovation. There are studies that found almost no correlation between increased R&D spending and improvement in profitability (Kandybin; Kihn 2003).

5 Innovation Management: Best Practices Organizations

In studies of innovation and innovation management, there are organizations that are frequently cited when it comes to innovation. The companies represented in this section are notable for their strategies, structures, management tools, and corporate cultures.

5.1 3M

The 3M company describes itself as a “diversified technology company with a worldwide presence in the following markets: consumer and office; display and graphics; electro and communications; health care; industrial; safety, security and protection services; and transportation”. The company had worldwide sales in 2004 of over $20 billion. 40% of sales are of products less than four years old. 10% are from products that have been on the market less than twelve months. 3M employs over 67,000 workers in more than 60 countries. Twenty-nine manufacturing companies and 35 research facilities are operated outside of the company’s home country, the United States. In 2004, 3M was awarded 585 U.S. patents.

The company was founded in 1902 by five businessmen in Two Harbors, Minnesota, USA, as the Minnesota Mining and Manufacturing Co. The intent of the founders, to mine the mineral corundum, which was used for industrial grinding wheels, failed when the minerals produced from their mine proved to be of low quality. The company closed down the mine and moved to manufacturing sand paper and industrial abrasives from purchased materials.

The companies experience in manufacturing sandpaper eventually led to the development of adhesives, the first major product being masking tape for painters in the auto industry. Other technologies developed by the company include reflective materials, non-woven materials, magnetic tapes for data storage, stain-resistant fabric treatments, Post-it® notes, and the overhead transparency projector. The company has an innovation strategy of developing a core technology and then developing products based on the technology in many different industries.

The company has a practice they call “fuzzy front-end innovation.” Researchers are given a very broad area to work in, and told to “have at it”. Bill Coyne, a retired senior vice-president of Research and Development said of fuzzy front-end innovation, “the most important innovations respond to an unarticulated need – not as a response to an identified customer need”. This practice, in addition to what the company calls “patient money”, has led to many important developments and products. “Patient money” is the company name for the practice of funding research and development with an eye on long term technology gains, rather than short term profits. The development of a technology or product that shows promise will be funded and supported for years if necessary, before it is expected to yield profitable results. Many of 3M’s important innovations, such as the early developments in reflective

materials, took years or even decades before being successfully brought to market.

An example of “fuzzy front-end innovation” is the development of non-woven materials technology. In 1938, a young chemist, Al Boeses, heard his boss mention a requirement for electrical tape, which required an inexpensive, non-corrosive backing material that was fibrous but not woven. Boeses spent a summer researching fibers production, and the rest of the year conducting experiments on his own. When he developed a way of binding fibers together without weaving, the company began working to develop products out of the new technology. The first product using non-woven materials technology was decorative ribbon for packages. The product was only modestly successful, due to dull appearance and low breaking strength. The management gave Boeses three years to improve the product and technology. The success of the improved ribbon created a brand new market, decorative gift wrapping products, and lead to numerous other products.

Following technology where it leads has proven highly successful. Non-woven Halloween masks lead to surgical masks, which lead to industrial respirators and furnace filters. Combining non-woven technology with abrasives technologies led to products including Scotch-Brite scrubbing and floor buffer pads. Combining non-woven materials with adhesives led to the development of products like non-woven surgical tape. Today non-woven materials represent 10% of 3M’s business, or about $1 billion in sales across twenty divisions.

Apart from the “patient money“ 3M has a practice, in place since the 1940s, of allowing researchers to spend about 15% of their working time on research and projects of their own interest. Many of the company’s important technologies and products, including Post-it® notes, have come from this practice. Columnist Dale Dauton wrote “The beauty of 3M’s 15% rule is that it’s not a rule at all; it’s permission. Most big businesses are run like grade schools. 3M is college”.

The 3M Company spent $1.44 billion on research and development in 2002. This equals nearly 14% of the company’s sales. In addition to funding R&D through traditional budgeting, 3M has internal grants, known as “Genesis Grants” to provide employees with ideas the funding and resources needed to develop their projects.

3M is also very successful when it comes to Lead-User innovations (see chapter 2.5.4). A recent project conducted at 3M compared Lead-User innovations with conventional methods of innovation in terms of their market share, expected turnover and degree of newness of innovation. It was shown that all these aspects were significantly higher in to Lead-User innovations.

The practice of conducting internal “technology audits” has been in place since 1960. Teams of ten to fifteen technical and business managers visit each of the major research labs and appraise the projects being developed. They analyze each projects strengths, weaknesses and probability of success, both technical and commercial. The audit team then makes non-

binding recommendations to management. In addition to providing management with recommendations on which projects are in need of further funding, technology audits keep management informed of developments and inspire project groups that receive less than desirable ratings to work harder and push the limits of their developments, or aid in the decision to cut a project gone astray.

In addition to technology audits, the 3M legal department conducts regular Intellectual Property (IP) audits. During the 1990s, 3M received 4,853 U.S. patents, and in 1995, ranked 14th among international companies for patents received worldwide. IP audits are performed any time a new product or technology is developed that has market potential. Firm lawyers ensure that all of the patents and trademark protections are in place, worldwide, and search for gaps in patent coverage before competitors can exploit them. These audits also help find gaps in the market, where no products or competitors exist.

When firm lawyers analyzed over 1,700 patents for fasteners – from clips and buttons to Velcro type hook and loop combinations, they found gaps in the market. From this analysis, it was determined that no type of high-temperature hook and loop fastener existed on the market. 3M quickly developed and patented such a fastener. The same analysis pointed out that 3M manufactured a unique type of fastener for disposable diapers, which lacked any type of patent protection. The gap was quickly closed. In addition to performing regular intellectual property audits, the firm's legal department closely monitors competitors around the world, and aggressively defends the 3M's intellectual property rights. Intellectual property rights are emphasized throughout the company, and training is available to employees throughout the organization.

The company's innovation culture includes several non-typical practices. Since the early days of the company, flexible work schedules and allowing individual eccentricities have been company policy. There are two separate career paths at 3M; a managerial track and a technical track. Each path has equal opportunities for advancement, prestige and compensation. 3M has a leadership development program in place that was recognized by the Human Resource Planning Society as being the best among 350 top US companies. The program includes having employees take on the roles of mentoring, sponsorship and champions. Much of the mentoring occurs informally, requiring personal contact and rapport.

Today's management of 3M follows the principles laid out by William L. McKnight, an early employee of the company who became company president in 1929, and served as chairman of the board from 1949 to 1966. He believed in creating a culture of trust that encouraged employee initiative and innovation. McKnight's principles were laid out in 1948 as follows:

"As our business grows, it becomes increasingly necessary to delegate responsibility and to encourage men and women to exercise their initiative. This requires considerable tolerance. Those men and women, to whom we

delegate authority and responsibility, if they are good people, are going to want to do their jobs in their own way."

"Mistakes will be made. But if a person is essentially right, the mistakes he or she makes are not as serious in the long run as the mistakes management will make if it undertakes to tell those in authority exactly how they must do their jobs."

"Management that is destructively critical when mistakes are made kills initiative. And it's essential that we have many people with initiative if we are to continue to grow."

Employees are encouraged to voice their ideas and ideas are given equal value, without regard to position or title. There is a high level of trust placed in the individual employee, allowing decisions to be made at low levels, so long as they are made within the ethical framework that is universal for all employees in each of the 60 countries where 3M operates.

To facilitate better communication within the organization and promote the sharing of ideas and developments, 3M has regular exhibitions of technologies and products. The company also holds technology fairs for students and community members. The company also showcases new technologies in the company magazine. Idea management systems have been in place for much of the company's history.

"At 3M, we are a bunch of ideas. We never throw an idea away, because you never know when someone else may need it" said Art Frey, inventor of the Post-it® note. One of the best known 3M products, Post-it® notes, were developed from an adhesive that was regarded as a failure. The unique glue had been in the company for five years, before Frey came up with the idea to make removable self-adhesive note pads.

Close relationships with customers is another best practice of 3M. Since the early days of the company, 3M has involved end-users and customers in product development. McKnight called the philosophy "looking beyond the smokestacks". The practice began in the company's first decade, when traveling salesmen were urged to push beyond the front office and the purchasing agent, and speak directly to the workers in auto body shops, who were the main users of sand paper, 3M's main product at the time. Working with the auto mechanics opened the door to the development of masking tape.

When Art Frey's Post-it® notes were developed, test batches were sent directly to the head executive assistants of major corporations and the feedback was used to perfect the product and develop a marketing strategy. When 3M entered the medical products market in the 1960s, researchers were sent to observe surgeons performing operations. Partnerships with hospitals resulted in the development of products including medical tape, butterfly wound closure strips and surgical shields, in addition to the pharmaceuticals division of the company.

Source: 3M 2002; Lilien et al.2002, Studt 2003.

5.2 Clariant GmbH

Clariant GmbH is a leading manufacturer of specialty chemicals. Established in 1995 as a spin-off of Sandoz Chemical, the group is now represented on five continents by over 100 group companies. Worldwide, Clariant employs over 27,000 people. The company's sales total over CHF 5 billion (Swiss Francs) annually. In 2004, the consulting firm A.T. Kearney named the Pigments & Additives and Life Science & Electronic Chemicals divisions of Clariant as having the "Best Supporting Factors" for innovation in its "Best Innovator" competition.

In 2004, Clariant spent CHF 274 million on research and development. This is equal to 3.2% of annual sales. The amount spent on R&D is significantly higher than the industry average. The company regularly sets aside between ten and 20% of the annual R&D budget for high risk projects. The number of patents that Clariant receives annually is much higher than industry averages. Approximately 20% of sales come from new products, a number extremely high in the chemical industry. The current innovation strategy is for Clariant to expand into new markets for its existing products, develop new formulations, applications and processes for existing markets, and develop new markets for the new formulations, applications and processes.

Clariant is composed of five divisions: textile, leather and paper chemicals; pigments & additives; functional chemicals; life science chemicals; and master batches. Research and development are decentralized, and carried out within the different businesses, which prioritize projects based on local market requirements and chances of success (Fig. 5). A high degree of entrepreneurship is encouraged by the company management, and is found throughout all levels of the organization

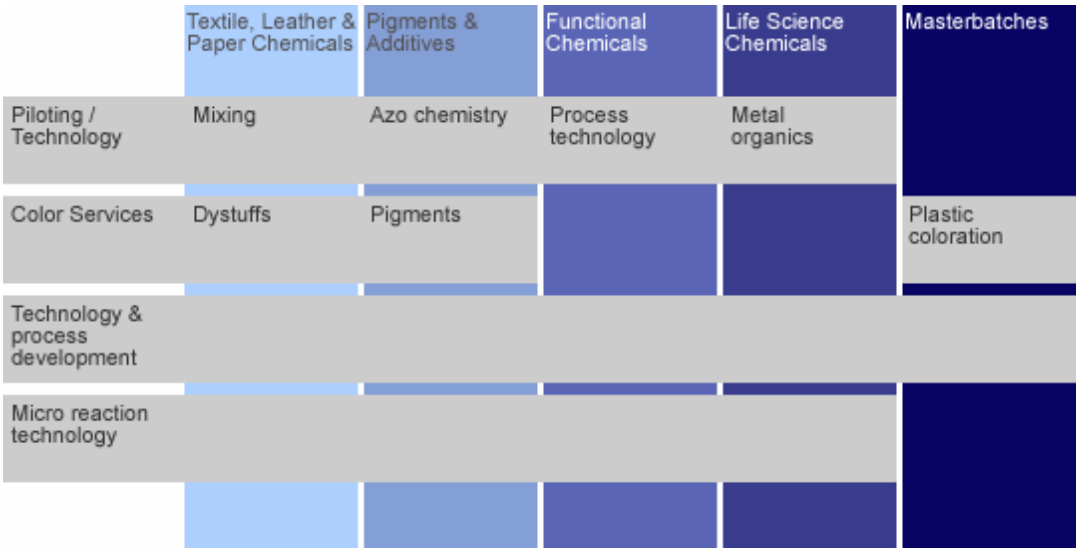

Figure 5: Network of interdivisional technology teams (Source: Clariant 2005)

The company is notable for its high use of cross-functional teams, made up of experts with varied backgrounds from many fields. These “excellence teams” are tasked with developing new processes and applications for chemicals, in addition to developing new products and services.

Interdivisional networks are responsible for the efficient development of technologies. Competence centers, in fields such as micro reaction technology, use cross-functional teams to perform research and development across divisional barriers in the company. Through the use of efficient inter-divisional knowledge sharing, new developments are turned into new products, applications and processes across multiple divisions. The cross functional teams are given great degrees of freedom to perform their work. Additionally, researchers at Clariant are allowed to use as much as 20% of their work time on projects and research of their own interest.

Sources: A.T. Kearney 2005a; A.T. Kearney 2005b; Clariant 2005.

5.3 CoreMedia

Innovation management best practices are not limited to large companies. CoreMedia is a medium-sized provider of software licensing, consulting and services, based in Hamburg, Germany, with further offices in London and Oslo. The firm has about 120 employees, and annual sales exceeding €10 million.

In the realm of consulting and services, CoreMedia has developed an extensive network of software providers, systems vendors and business consultants. The company is the developer and provider of Smart Content Technology modular content management standard software for rapidly growing portals and enterprises. The other major product offered is software for digital rights management. All product sales include personalized service to tailor the software to fit customer needs and systems. This innovative business model gives CoreMedia a value-adding role in content and business processes in media, industry, service and administration.

The company services over 150 customers in twenty countries. Customers include: the Deutsche-Presse Agentur (dpa), O², Vodafone, Wincor Nixdorf, SEAT, Deutsche Bahn, and the Deutscher Bundesrat. Over 1,000 software licenses have been sold since the firm was founded in 1997. The main investor in the company is Deutsche Telecom.

CoreMedia has received numerous awards for innovation, management, leadership, strategy, service, and technology. The company was named “Best Innovator” in June 2004 by the German business magazine Wirtschaftswoche, and was named to the Red Herring 100 Europe in 2005. The annual award distinguishes the top 100 technology firms in Europe and Israel. In 2003, the company was named one of the 50 top workplaces in Germany. 94% of surveyed employees reported that they were satisfied or extremely satisfied with their employer.

The stated innovation strategy of the firm is to bring ideas quickly and effectively to market as high quality, innovative products. The company culture of CoreMedia is highly supportive of innovation. Employees are encouraged to be creative and a high value is placed on the development of new ideas. All ideas that are submitted by employees are evaluated using concrete decision criteria in a clearly laid out process. Additionally, there are two career tracks available to employees. The management track and the expert track. The expert track allows talented developers to continue working with the actual development of products and software rather than supervising others and offers the same opportunities for advancement and equal pay and prestige like the management track.

Close relationships with research institutes, universities, customers and partners play a major role in CoreMedia's success. Partners are classified under three categories: implementation partners, technology partners, and ASP and hosting partners. The partners include large companies, such as Oracle, Siemens Business Services, Hewlett-Packard, IBM Business Consulting Services, and smaller specialty companies. To better manage relationships with its partners, CoreMedia has a partner certification process and uses a web portal called Partnerweb to promote information and technology sharing.

Sources: A.T. Kearney 2005a; CoreMedia2005.

5.4 Nokia

The Nokia Corporation is an example of how innovation management makes a company successful. The company is responsible for much of Finland's economic success during the past two decades. However, the Nokia Corporation was not always a telecommunications powerhouse.

The company origins date back to 1865, when the company was established in South-West Finland to harvest timber and produce wood products. The company expanded into various other industries, including metal cables, paper, rubber, and electricity. Nokia's most successful product in the early 1960s was rubber boots, which were offered in a rainbow of colors. By the early 1980s, the company found itself facing intense pressure on all sides from competitors in its traditional industries.

Nokia's saving grace came when the director of research made the decision to allow the large numbers of developers and engineers already in the company to pursue their own ideas during company time. The company also began encouraging and supporting researchers to work on dissertations and improve their technical backgrounds. The researchers, developers and engineers embraced the freedom and Nokia embraced their ideas. Within a short time of setting the policy in place, researchers and engineers at Nokia developed the product ideas, patents, business models and promotions that became the basis for Nokia's entry into and eventual success in the mobile phone and telecommunications industry.

Nokia currently employs over 55,000 people around the world. 42% work in Finland and the remainders are spread across Asia, North and South America and Europe. In 2003, net sales for the Nokia Group were over €29 billion, with a gross profit margin of 41.5%. Research and development expenditures were €3.76 billion, or 12.76% of net sales (30.77% of gross profits). Of the 51,359 employees of the company in 2003, 19,800 worked in research and development, representing 39% of the company's workforce.

The high amount spent on (and high percentage of profits reinvested into) R&D is not the only reason Nokia continues to be an innovator. The corporate hierarchy, despite the huge mass of the concern, is intentionally kept as flat as possible. The company stresses personal growth and values, as well as teamwork skills when hiring and promoting employees. The work team is the basis for Nokia's structure. The corporate culture is very tolerant and encourages entrepreneurship and risk taking. Mistakes are tolerated, so long as they are recognized and acknowledged early and used as learning experiences.

Nokia was among the first Finnish company to aggressively recruit foreigners. The company strongly believes in the benefits of a diverse multi-cultural workforce. In addition, the firm names collaboration as a critical component of its growth strategy. Partnerships with other companies have led Nokia into many new directions and fields. Nokia has successfully established numerous joint ventures in Finland, China, the United Kingdom, and Malaysia. The company is also active in numerous organizations and groups to create, recommend and promote standards for the IT and telecommunications industries. Customer involvement plays a key role in product development, where Finland is regarded as the world test-bed for mobile technologies and in the services field.

Nokia maintains that the keys to maintaining the company's innovative edge are speed and flexibility in decision making. A high degree of trust is placed in employees. The company tries to push decision making as close to the "frontline" as possible, allowing decisions to be made by those most knowledgeable of the situation. Nokia describes itself as "believing in equal opportunity and openness towards people and new ideas". Additionally, the company strongly encourages the practice of job rotation, even at very senior levels.

Sources: Hadenius 2004, IG Metall 2003, Nokia 2004; Nokia 2005a, Nokia 2005b.

5.5 Siemens Medical Solutions

Siemens Medical Solutions is one of the largest providers of medical devices and technologies in the world and a leading innovator in the field. Siemens is renowned for its innovative products, services and solution systems. These range from imaging systems for diagnosis and therapy equipment for treatment, to IT solutions which increase efficiency and optimize workflow in

hospitals, clinics and doctors' offices. Worldwide, Siemens Medical's annual sales were €7.1 billion in 2004.

The company traces its origins back to 1877, when Erwin Moritz Reiniger founded a workshop in Erlangen, Germany, to produce electro-medical devices. Siemens AG became the major shareholder in the company in 1925, and in 2002 the firm name was altered to its present designation. Throughout its history, Siemens Medical has been a major innovator. Innovations include: the first industrial manufacture of x-ray tubes in 1896, the first electrical hearing aid in 1913, manufacturing the first implantable cardiac pacemaker in 1958, the first ultra-sound device with real time display in 1966, installing the first Magnetic Resonance Imaging (MRI) system in North America in 1982, and several firsts in the development of networking and IT solutions for medical institutions.

Currently, the firm produces medical equipment in various branches, including nuclear medicine, patient monitoring, anesthesia, and medical imaging. Other offerings include advanced IT systems for clinical management, patient data management, and a wide variety of fields. Siemens Medical also offers consulting services in the areas of strategic consulting, financial-administrative consulting, IT consulting, and clinical consulting. In addition, the company now offers what they call UPTIME services. This is a sub-unit of Siemens Medical with 5,200 employees in 128 countries, offering technical servicing of medical systems.

Innovation strategy is treated as a part of the overall business strategy. The Siemens web site calls the excellence strategy "P^3 - People, Processes and Products". It is described in the statement, "We bring together innovations and process optimization to help our customers provide higher-quality, patient-centered healthcare services more efficiently and at lower cost". Siemens Medical has a clearly defined project management process and uses innovative financial models. Currently two-thirds of products are less than three years old.

The corporate culture allows for a degree of personal responsibility for employees in a challenging work environment and rewards creativity and initiative. Cross-functional teams are frequently used to develop new solutions and products. Team members come from a wide variety of technical, administrative and medical backgrounds and are able to bring different perspectives to the development teams. Researchers are given a high degree of latitude to pursue research and perform experiments of their own interest. Additionally, the company is accommodating to individual work habits and allows researchers round-the-clock access to lab facilities to perform their own projects and research.

One of the deciding factors for successful innovation at Siemens Medical Solutions is the close relationship of innovation management with patent management. Researchers have a clearly defined process to follow, without any major internal hurdles, to submit their ideas and inventions to an internal patent review committee. This committee uses clearly defined criteria to decide if the idea is worthy of applying for patent protection. If a patent is

accepted and used by the company, the researchers receive a portion of the profit from sales and license rights. Siemens Medical Solutions currently averages about one patent per day.

Siemens Medical maintains close relationships with its customers and closely involves healthcare administrators, doctors, nurses, and especially patients in the development process. The company publishes a customer magazine in English and German to keep clinics and doctors informed on the latest advancements. In addition, Siemens Medical hosts workshops, symposiums, fellowships, and provides advanced training for customers worldwide. The close relationships these actions build provide a source of new ideas and continuous feedback for the improvement of products and services and the development of new innovations.

Sources: A.T. Kearney 2005a; Braun 2002; Siemens AG 2005a; Siemens AG 2005b.

5.6 W.L. Gore & Associates

W.L. Gore & Associates is a privately owned company, based in Newark, Delaware in the United States. It was founded by Wilbert L. Gore, a former chemist for DuPont, in 1958, to pursue new ways to use polytetra-fluoroethylene (PTFE), better known as Teflon, which DuPont was not pursuing. The company's first products were improved plastic coatings for electrical wires and cables. In 1969, Gore developed a new way to stretch the polymer, resulting in expanded PTFE or ePTFE, which the company trademarked as GoreTex™. While the waterproof but breathable fabric is still the company's best selling product, the experience with polymers led to the development of hundreds of products across a diverse range of fields. Nearly every product the company has brought to market has been profitable. Tent fabric, vascular grafts for heart surgery, dental floss, guitar strings, gaskets for the aerospace industry, filters for vacuum cleaners and clean room suits are just a few examples of Gore's offerings.

There are currently over 6,000 associates employed by Gore in 45 countries. The company had sales in 2004 of $1.35 billion. In 2005, Fortune magazine listed Gore as on its annual "Top 100 Companies to Work for" for the eighth consecutive year. Gore ranked number 2 overall, and was the top medium sized company. The company has earned similar distinctions in the UK, Germany and Italy.

The culture of W.L. Gore & Associates is unique. The company founder, W.L. Gore, had an intense dislike of hierarchies, and so sought to eliminate them in his own company. There are few ranks or titles. The company has a lattice structure, with a CEO and designated leaders for each of the four major divisions and certain companywide support functions. There are, however, no codified ranks or positions, or set career paths in the company. The terms "employee" and "manager" are not used. Everyone working for the company has the title of "associate," and there is no boss. New associates are advised

by “sponsors”. Gore also championed one-to-one communication. Memos and e-mail are discouraged. Any associate at Gore can, and is encouraged to, speak directly to anyone in the organization.

Gore is organized like small task forces with small, cross functional teams. Associates are hired for general work areas, and under the guidance of sponsors, they commit themselves to projects based on their skills, knowledge and experience as their understanding of opportunities and the team objectives grows. Eventually associates develop a niche in the organization.

Research and development technologists and salespeople work in the same buildings and are encouraged to share ideas and work together. Manufacturing facilities are limited to 150-200 associates, in order to maintain a small team atmosphere and allow associates to get to know each other and share ideas. The associates at Gore are encouraged to make everyday decisions independently, as long as they abide by the company founder’s principle of “not drilling below the waterline” (deciding if the decision may materially affect others or the company). Major decisions, such as hiring, budgeting, and strategy are made by committees of experienced associates, whose membership frequently changes.

An essential element of Gore’s culture is the high degree of investment that associates have in the company. The company is run like a startup. After one year at the company, employees receive the equivalent of 15% of their salary in stock in the private company, which can be cashed out when they leave or retire, after they are fully vested. The stock value is determined by independent auditors, and depends on continued growth and new products to appreciate. In addition, teams determine compensation by voting, based on the contributions of each member, similar to law firms.

One of the ways that employees grow the company is through pursuing ideas of their own interest, and starting projects independently. Research Associates are encouraged to spend about 10% of their workday pursuing ideas and projects of their own interest in what the company calls “dabble time”. Any associate can start a new project group, but to do so, they must practice what the company calls “natural leadership” or “leading by leading”. The associate must convince other associates of their idea’s potential, and persuade them to use their time and knowledge on the project. With the open communication and organization structure, the resulting project groups can draw on expertise and experience from many different areas of the organization.

It is also important to note that the culture of Gore tolerates, and actually celebrates failure. When an unsuccessful project is canceled, the team celebrates with champagne or beer, just like they’d do if it was a success. By tolerating failure, the culture of Gore encourages risk taking and motivates associates to try new ideas.

Elixer Guitar strings were developed by Dave Myers, an engineer working at one of Gore’s medical product plants to invent new types of heart implants. In his free time he was an avid mountain biker, and used his “dabble time” to

develop a brake cable coated with PTFE that would be smoother and more durable. This development led to improved cables for large puppets (such as at Disney World). In 1993, he was using guitar strings as a substitute for thin cables during his experiments, when he came up with the idea for guitar strings with a plastic coating, which would prevent finger oils from deteriorating the sound quality of the strings and leading to premature breakage. To develop his idea, he recruited another engineer, who was an amateur musician. After two years of experimenting without success, they were joined by John Spencer, who had previous experience working on the Glide dental floss project (shred resistant Teflon coated dental floss that is number two on the North American market). He used spare time from his main commitment (developing inventory management systems for hospitals) to work on the guitar strings. Eventually the trio recruited six others, and the group worked independently, without supervision, for three years to develop a marketable product. Only when they needed support to enter the market did the team inform the larger organization. The marketing strategy used for Elixer was also innovative. To get around the objections of music store owners who objected to the price of the strings ($15 a set, three to five times higher than average), Gore took a financial risk by sending 20,000 free samples to subscribers of guitar magazines. These users began requesting the strings from their local shops. Elixer Guitar strings, developed by Gore, a company with no previous experience in the music industry, have the largest market share (35%) of the acoustic guitar string market.

Many of Gore's other innovations come as a result of working closely with customers, and especially potential customers, to understand their needs. Gore is successful at innovation because of its strategy. The company uses its core competences – expanded PTEF and polymers – and is continually finding new uses and ways to adapt the substance and technology to fit the needs of potential customers. Another part of Gore's strategy is to only pursue innovations that are new. The company does not field "me too" products.

Sources: Deutschman 2004a; Deutschman 2004b; Harrington 2003; Harrison 2002; Secretan 2005; Gore 2005.

6 Conclusions

Innovation is being continually looked to as a means for businesses to stay successful and increasingly, to simply survive in competitive market driven economies. The terms innovation, innovation management and creativity are being used throughout business and politics.

The companies that are able to build and manage their innovation potential are the most likely to succeed and profit in the ever faster moving economy of the future. To do so, they must develop a solid innovation strategy, create an innovation culture and develop and implement the best ideas captured through idea management processes. All of this must be supported by solid leadership at all levels and support functions.

There is a great deal of research and information available that was not able to be included in this report. However, there are still topics which demand further study. One of the most promising fields of research seems to be the process of idea evaluation and selection. This stage in the development process is said to be critical in terms of an efficient and effective innovation management, both for product and service innovations. Concerning product innovations, a number of methodologies like AHP or NewProd have proven to be helpful in screening ideas for new products (Calantone et al. 1999). However, as the development of new services and new products differ, efforts to screen and evaluate new service ideas in a systematic way have been rather scarce (Kelly; Storey 2000). Finally, the authors would like to suggest a second promising aspect of research, which is closely linked to the process of idea generation and idea evaluation. It is the role that customers play in the service innovation process, especially in a business-to-business context. Questions of how this relationship differs from conventional business-to-consumer industries and to what extent customers should be integrated in the service development process are aspects worthy to address in further research.

Literature

(3M 2002) 3M (Ed.): A Century of Innovation: the 3M story, URL: http://www.3m.com/about3M/century/index.jhtml (Status: 30.11.2005).

(4Managers 2005) 4Managers (Ed.): Ideenmanagement, 2005, URL: http://www.4managers.de/01-Themen/..%5C10-Inhalte%5Casp%5C Ideenmanagement.asp?hm=1&um=I (Status: 20.11.2005).

(Accenture 2002) Accenture (Ed.): Mind the Gap! – Consumer Attitudes to Innovation, 2002.

(Accenture 2005) Accenture (Ed.): Was macht Innovationen erfolgreich?, URL: http://www.accenture.com/xdoc/de/locations/germany/aboutus/ newsroom/2005/innovationen_erfolgreich.pdf (Status: 30.11.2005).

(Afuah 1998) Afuah, Allan: Innovation Management, Chapter 4, Oxford University Press, New York, 1998.

(Amabile et al. 1996) Amabile, Teresa M.; Conti, Regina; Coon, Heather; Lazenby, Jeffrey; Herron, Michael: Assessing the Work Environment For Creativity, in: Academy of Management Journal, 1996, Vol. 39, pp. 1154-1184.

(Amabile 1998) Amabile, Teresa M.: How to kill creativity, in: Harvard Business Review, 1998, Vol. 76, pp. 77-87.

(Amabile et al. 2002) Amabile, Teresa M.; Hadley, Constance N.; Kramer, Steven J.: Creativity Under the Gun, in: Harvard Business Review, 2002, Vol. 80 (8), pp. 52-61.

(Ament 2005) Ament, Phil: Light Bulb – Fascinating facts about the invention of the light bulb by Thomas Alva Edison in 1879, URL: http://www.ideafinder.com/history/inventions/story074.htm (Status: 21.11.2005).

(A.T. Kearney 2005a) A.T. Kearney (Ed.): Best Innovator 2004, URL: http://www.atkearney.de/content/veranstaltungen/bestinnovator/sieger.php (Status: 30.11.2005).

(A.T. Kearney 2005b) A.T. Kearney (Ed.): European Best Innovators – The New Frontiers, 2005, URL: www.atkearney.com/shared_res/pdf/ European_Best_Innovator.pdf (Status: 05.12.2005).

(Baroudi 2002) Baroudi Group (Ed.): Ideas Management - Capturing the spark that ignites innovation, 2002, URL: http://www.thinksmart.com/inmembership/ articles/baroudi_ideas_management.pdf (Status: 25.11.2005).

(Bastedo; Davis 1993) Bastedo, Michael; Davis, Angela: God What a Blunder: The New Coke Story, Cola Fountain, 17. Dec. 1993, URL: http://members.lycos.co.uk/thomassheils/newcoke.htm (Status: 02.12.2005).

(Baumgartner 2004) Baumgartner, Jeffery: Big and Little Innovation, Report 103, 27. Apr. 2004, URL: http://www.jpb.com/report103/archive.php?issue_no =20040427 (Status: 02.12.2005).

(Bellis 2005) Bellis, Mary: About The History of Answering Machines, URL: http://inventors.about.com/library/inventors/blansweringmachines.htm (Status: 25.11.2005).

(Bergmann 2005) Bergmann, Jens: Ein und Alles, in: Brand Eins, 2005, Vol. 9, pp. 94-99.

(BMBF 2005) Bundesministerium für Bildung und Forschung (Ed.): Förder-richtlinien zum Thema „Integration von Produktion und Dienstleistung“, „Rahmenkonzept Forschung für die Produktion von morgen“, Mai 2005, URL: http://www.bmbf.de/foerderungen/4453.php (Status: 28.11.2005).

(Booze Allen Hamilton 2005) Booze Allen Hamilton: How Companies Turn Customers’ Big Ideas into Innovations, in: Strategy + Business, 2005, URL: http://www.strategy-business.com/sbkwarticle/sbkw050112?pg=3&tid=230 (Status: 06.12.2005).

(Braun 2002) Braun, Bianca: 125 Years of Siemens Medical Solutions – Providing the Future in Healthcare, Siemens AG, Medical Solutions, URL: http://www.medical.siemens.com/siemens/en_INT/rg_marcom_FBAs/files/brochures/about_us/125yearsSiemensMed_eng.pdf (Status: 30.11.2005).

(Breen 2004) Breen, Bill: The 6 Myths of Creativity, in: Fast Company, December 2004, No. 89 p. 75, URL: http://www.fastcompany.com/magazine/89/ creativity.html (Status: 22.11.2005).

(Calantone et al.1999) Calantone, Roger J.; Di Benedetto, Anthony C.; Schmidt, Jeffrey B.: Using the Analytic Hierarchy Process in New Product Screening, in: Journal of Product Innovation Management, 1999, Vol. 16, pp. 65-76.

(Cimoli; Dosi 1996) Cimoli, Mario; Dosi, Giovanni: Technological paradigms, patterns of learning and development: an introductory raodmap, in: Dopfer, K. (Ed.): The Global Dimension of Economic Evolution, Physika, Heidelberg 1996.

(Clariant 2005) Clariant: R&D and Innovation at Clariant, URL: http://www.clariant.com/corporate/internet.nsf/vwWebPagesByID/08D66A9DB4545F56C12568C7004F64AA (Status: 30.11.2005).

(Cooper 1985) Cooper, Robert G.: Selecting winning new product projects: Using the NewProd System, in: Journal of Product Innovation Management, 1985, Vol. 2, pp. 34-44.

(Cooper 1992) Cooper, Robert G.: The NewProd System: The Industry Experience, in: Journal of Product Innovation Management, 1992, Vol. 9, pp. 113-127.

(Cooper 1994) Cooper, Robert G.: New Products: The Factors that Drive Success, in: International Marketing Review, 1994, Vol. 11, pp. 60-76.

(Cooper; Kleinschmidt 1993) Cooper, Robert G.; Kleinschmidt, Elko J.: Stage Gate Systems for New Product Success, in: Marketing Management, 1993, Vol. 1, pp. 20-29.

(CoreMedia 2005) CoreMedia: Homepage, URL: http://www.coremedia.com/ (Status: 30.11.2005).

(Das; Puri 2003) Das, Monish; Puri, Rajiv: Using Innovation Management for Cost Reduction in the Auto Industry, September 2003, URL: http://www.infosys.com/Technology/cutting_edge_CE-07-03.pdf (Status: 25.11.2005).

(De Bono 1985) De Bono, Edward: Six Thinking Hats, Little Brown Company, Boston, 1985.

(Deloitte 2004) Koudal, Peter: Mastering Innovation – Exploiting Ideas for Profitable Growth, March 2004.

(Deloitte 2005) Gentle, Chris; Contri, Bob: Glittering Prize – How financial institutions can drive growth through process and service innovation, 2005.

(Deutschman 2004a) Deutschman, Alan: The Fabric of Creativity, in: Fast Company, December 2004, No. 89, p. 54, URL: http://www.fastcompany.com/magazine/89/open_gore.html (Status: 20.11.2005).

(Deutschman 2004b) Deutschman, Alan: Gore's Text for Innovation, in: Fast Company, December 2004, No. 89, p. 59, URL: http://www.fastcompany.com/magazine/89/open_gore-fasttake.html (Status: 20.11.2005).

(De Jong et al. 2003) De Jong, Jeroen P.J.; Bruins, Anne; Dolfsma, Wilfred; Meijaard, Joris: Innovation in service firms explored: what, how and why?, EIM Business & Policy Research, Zoetermeer, 2003, URL: http://www.eim.net/pdf-ez/B200205.pdf (Status: 29.11.2005).

(Dosi 1988) Dosi, Giovanni: Sources, Procedures, and Microeconomic Effects of Innovation, in: Journal of Economic Literature, 1988, Vol. 26, pp. 1120-1171.

(Franke; Shah 2003) Franke, Nikolaus; Shah, Sonali: How Communities Support Innovative Activities: An Exploration of Assistance and Sharing Among End-Users, in: Research Policy, 2003, Vol. 32, pp. 1199-1215.

(Gallouj; Weinstein 1997) Galouj, FaÏz; Weinstein, Olivier: Innovation in services, in: Research Policy, 1997, Vol. 26, pp. 537-556.

(Gerpott 1999) Gerpott, Torsten: Strategisches Technologie- und Innovations-management, 1.Auflage, Schaeffer-Poeschel, Stuttgart, 1999.

(Gore 2005) W.L. Gore & Associates: Homepage, URL: http://www.gore.com (Status: 22.11.2005).

(Grupp 1997) Grupp, Hariolf: Messung und Erklärung des technischen Wandels, Springer, Berlin, 1997.

(Guilford; Hoepfner 1976) Guilford, Joy Paul; Hoepfner, Ralph: Analyse der Intelligenz. Beltz, Weinheim/Basel, 1976.

(Hadenius 2004) Hadenius, Patric: Peer-to-Peer Phones, Technology Review, 2004, Vol.107, pp. 60-67.

(Harrington 2003) Harrington, Ann: Who's Afraid of a New Product?, Fortune, 2003, Vol. 148 (10), pp. 189-192.

(Harrison 2002) Harrison, Laird: We're All the Boss, Time Magazine, April 2002.

(Hawn 2004) Hawn, Carleen: What Money Can't Buy, Fast Company, 2004, Vol. 89, URL: http://www.fastcompany.com/magazine/89/microsoft.html (Status: 30.11.2005).

(Hill 1999) Hill, Peter: Tangibles, intangibles and services: a new taxonomy for the classification of output, in: Canadian Journal of Economics, 1999, Vol. 32, pp. 426-446.

(Hipp; Grupp 2005) Hipp, Christiane; Grupp, Hariolf: Innovation in the service sector: The demand for service-specific innovation measurement concepts and typologies, in: Research Policy, 2005, Vol. 34, pp. 517-535.

(Hippel 1986) Hippel, Eric von: Lead User: A source of novel product concepts, in: Management Science, 1986, Vol. 32, No. 7, pp. 791-805.

(Hippel 1988) Hippel, Eric von: The Sources of Innovation, Oxford University Press, Oxford, New York, 1988.

(Hippel 2005) Hippel, Eric von: Democratizing Innovation, The MIT Press, Cambridge, Massachusetts, 2005.

(IBM 2004) IBM Business Consulting Services, The Global CEO Study 2004, URL: http://www-1.ibm.com/services/ondemand/business/global_ceo_study_2004.html (Status: 06.12.2005).

(IG Metall 2003) IG Metall: Die Innovation der Innovationspolitik, Frankfurt a.Main, 2003, URL: http://www.dgb.de/themen/innovation/dokumente/innovation_igmetall.pdf (Status: 05.12.2005).

(Imhausen 2005) Imhausen, Hans-Peter: Herausforderung und Ziel, PFIF, 2005, URL: http://www.pfif.de/html/herausforderung.html (Status: 05.12.2005).

(Kambil 2002) Kambil, Ajit: Good Ideas are Not Enough, Accenture, URL: http://www.accenture.com/Global/Research_and_Insights/By_Subject/Innovation/GoodEngines.htm (Status: 02.12.2005).

(Kandybin; Kihn 2003) Kandybin, Alexander; Kihn, Martin: Raising Your Return on Innovation Investment, in: Strategy+Business, 2003, URL: http://www.strategy-business.com/resilience/rr00007?pg=all (Status: 05.12.2005).

(Karlsberg; Adler 2005) Karlsberg, Robert; Adler, Jane: 7 Strategies for Sustained Innovation, June 2005, URL: http://www.innovationtools.com/Search/recommended_details.asp?a=185 (Status: 25.11.2005).

(Kelly; Storey 2000) Kelly, David; Storey, Chris: New Service Development: Initiation Strategies, in: International Journal of Service Industry Management, 2000, Vol. 11, pp. 45-62.

(Kline; Rosenberg 1986) Kline, Stephen J.; Rosenberg, Nathan: An Overview of Innovation, in: Landau, R. (Ed.): The Positive Sum Strategy: Harnessing Technology for Economic Growth, National Academy Press, Washington, 1986, pp. 275-306.

(Konnerth 2005) Konnerth, Tania: Der kreative Prozess nach Graham Wallas, URL: http://www.zeitzuleben.de/inhalte/ge/kreativitaet/kreativitaet_2_prozess.html (Status: 20.11.2005).

(Kroy 1995) Kroy, Walter: Technologiemanagement für grundlegende Innovationen, in: Zahn, E. (Ed.): Handbuch Technologiemanagement, Stuttgart, 1995.

(Lilien et al. 2002) Lilien, Gary, L.; Morrison, Pamela D., Searls, Kathleen; Sonnack, Mary; Hippel, Eric von: Performance Assessment of the Lead User Idea-Generation Process for New Product Development, Management Science, Vol.48, pp. 1042-1059.

(Makely 1999) Makely, William: Arm & Hammer refreshes baking soda sales with its new Fridge-n-Freezer box, in: Food & Drug Packaging, August 1999, URL: http://www.findarticles.com/p/articles/mi_m0UQX/is_8_63/ai_55587843#continue (Status: 20.11.2005).

(Meffert 2000) Meffert, Heribert: Marketing. Grundlagen marktorientierter Unternehmensführung, 9.Auflage, Gabler, Wiesbaden, 2000.

(Miles 2005) Miles, Ian: Innovation in Services, in: Fagerberg, J.; Mowery, D. C.; Nelson, R. N. (Ed.): The Oxford Handbook of Innovation, Oxford University Press, 2005.

(Morgenstern 2005) Morgenstern, David: Apple, Microsoft Tussle over iPod Interface Patents, PC Magazine 12. Aug. 2005, URL: http://www.pcmag.com/article2/0,1895,1847959,00.asp (Status: 02.12.2005).

(Mowery; Rosenberg 1979) Mowery, David C.; Rosenberg, Nathan: The influence of market demand upon innovation: a critical review of some recent studies, in: Research Policy, 1979, Vol. 8, pp. 103-153.

(Nakamatsu 1990) Nakamatsu, Yoshiro: Interview with Chic Thompson – What a Great Idea, 29. Apr. 1990, URL: http://www.whatagreatidea.com/nakamatsu.htm (Status: 01.12.2005).

(Nokia 2004) Nokia Group (Ed.): Regrouping of 2003 Financials, URL: http://www.nokia.com/BaseProject/Sites/NOKIA_MAIN_18022/CDA/Categories/AboutNokia/_Content/_Static_Files/regroup.pdf (Status: 30.11.2005).

(Nokia 2005a) Nokia Group (Ed.): Nokia in Brief, URL: http://www.nokia.com/BaseProject/Sites/NOKIA_MAIN_18022/CDA/Categories/AboutNokia/Company/_Content/_Static_Files/nokiainbrief.pdf (Status: 30.11.2005).

(Nokia 2005b) Nokia Group (Ed.): About Nokia, Company, URL: http://www.nokia.com/link?cid=EDITORIAL_1769 (Status: 02.12.2005).

(OECD 1997) OECD (Ed.): Oslo Manual, Proposed Guidelines For Collecting and Interpreting Technological Innovation Data, 2. Revision, Paris, 1997.

(OECD 2002) OECD (Ed.): Frascati Manual, Proposed Standard Practice for Surveys on Research and Experimental Development, 7, Revision, Paris, 2002.

(Osborn 1957) Osborn, Alex F.: Applied imagination: principles and procedures of creative problem-solving, Scribner, New York, 1957, see also URL: http://www.betterproductdesign.net/tools/concept/osborne.htm (Status: 09.12.2005).

(Pavitt 1984) Pavitt, Keith: Sectoral Patterns of Technological Change: Towards a Taxonomy and a Theory, in: Research Policy, 1984, Vol. 13, pp. 343-373.

(Plsek 1996) Plsek, Paul E.: Models for the Creative Process, URL: http://www.directedcreativity.com/pages/WPModels.html (Status: 22.11.2005).

(Poincaré 1921) Poincaré, Henri: The Foundations of Science, The Science Press, New York, 1921.

(Powers 2004) Powers, Steve: What Innovation Can't Do, in: Business 2.0, 18. Aug. 2004, URL: http://www.business2.com/b2/web/articles/ 0,17863,683123,00.html (Status: 22.11.2005).

(Prospero 2004) Prospero, Michael A.: Innovation Awards, Fast Company, Dec. 2004, Vol. 89, URL: http://www.fastcompany.com/magazine/89/ monitor.html (Status: 02.12.2005).

(Rangaswamy; Lilien 1997) Rangaswamy, Arvind; Lilien, Gary L.: Software Tools for New Product Development, Journal of Marketing Research, 1997, Vol. 34, pp. 177-184.

(Robinson; Schroeder 2004) Robinson, Alan G.; Schroeder, Dean M.: Ideas are Free, 2004, URL: http://www.ideasarefree.com/iaf.pdf (Status: 02.12.2005).

(Saaty 1980) Saaty, Thomas L.: The Analytic Hierarchy Process, McGraw-Hill, New York, 1980.

(Salter 2005) Salter, Chuck: Whirlpool Finds Its Cool, in: Fast Company, No. 95, June 2005, p. 73, URL: http://www.fastcompany.com/magazine/95/ open_design-jones.html (Status: 22.11.2005).

(Saviotti 1996) Saviotti, Pier Paolo: Technological Evolution, Variety and the Economy, Elgar, Cheltenham, 1996.

(Schlicksupp 2004) Schlicksupp, Helmut: Innovation, Kreativität und Ideenfindung, 6. Auflage, Vogel Buchverlag, Würzburg, 2004.

(Schmookler 1966) Schmookler, Jacob: Invention and Economic Growth, Harvard University Press, Cambridge, Massachusetts, 1966.

(Schumpeter 1912) Schumpeter, Josef Alois: Theorie der wirtschaftlichen Entwicklung, August Rabe, Berlin, 1952.

(Secretan 2005) Secretan, Lance: Case Study: W.L. Gore and Associates, URL: http://www.secretan.com/case_gore.html (Status: 22.11.2005).

(Sherman 2005) Sherman, Dawn: The Innovative Organization: Lessons Learned from Most Admired Companies, Hay Insight Selections, April 2005, URL: http://www.haygroup.com/mediafiles/downloads/Hay_Insight_ Selections_April_2005.pdf (Status: 20.11.2005).

(Siemens AG 2005a) Siemens AG (Ed.): Medical, URL: http://www.siemens.com/index.jsp?sdc_p=t55ls7o1165736i1032521cd1032445fmun1031325pz3&sdc_sid=20906765068& (Status: 30.11.2005).

(Siemens AG 2005b) Siemens AG (Ed.): Annual Report 2004 Medical, URL: http://www.siemens.com/index.jsp?sdc_p=t4cz3s4u20o1228140pGB04flmi1227397 (Status: 30.11.2005).

(Simon 1986) Simon, Herbert A.: Decision Making and Problem Solving, National Academy Press, Washington, 1986.

(Smith 2005) Smith, Keith: Measuring Innovation, in: Fagerberg, J.; Mowery, D.C.; Nelson; R.N. (Ed.): The Oxford Handbook of Innovation; Oxford University Press, 2005.

(Stevens 1995) Stevens, Tim: Creativity Killers: Management Practices that Affect Creativity, Industry Week, 1995, Vol. 244 (2), p. 63.

(Studt 2003) Studt, Tim: 3M-Where Innovation Rules, R&D Magazine, 2003, Vol. 45, pp. 20-24.

(Turrell; Lindow 2003) Turrell, Mark; Lindow, Yvonne: The Innovation Pipeline, Imaginatik Research White Paper, March 2003, URL: http://www.imaginatik.com/web.nsf/docs/idea_reports_imaginatik (Status: 25.11.2005).

(Vahs; Burmester 2005) Vahs, Dietmar; Burmester, Ralf: Innovations-management: Von der Produktidee zur erfolgreichen Vermarktung, 3. Auflage, Schäffer-Poeschel, Stuttgart, 2005.

(Valery 1999) Valery, Nicholas: Innovation in industry: Industry gets religion, in: The Economist, 1999, Vol. 350 (8107).

(Verworn et al. 2000) Verworn, Birgit; Lüthje, Christian; Herstatt, Cornelius: Innovationsmanagement in kleinen und mittleren Unternehmen, Arbeitspapier Nr. 7, TU Hamburg-Harburg, Oktober 2000, URL: http://www.tu-harburg.de/tim/de/forschung/arbeitspapiere/Arbeitspapier_7.pdf (Status: 21.11.2005).

(Verworn; Herstatt 2003) Verworn, Birgit; Herstatt, Cornelius: Prozess-gestaltung der frühen Phasen, in: Herstatt, C.; Verworn, B. (Ed.): Management der frühen Innovationsphasen, Grundlagen, Methoden, Neue Ansätze, Wiesbaden, 2003.

(Warner 2002) Warner, Fara: In a Word – Toyota Drives for Innovation, in: Fast Company, No. 61, August 2002, p. 36, URL: http://www.fastcompany.com/magazine/61/toyota.html (Status: 22.11.2005).