"Insightful Encounters - Regional Development and Practice–Based Learning"
Conference on Regional Development and Innovation Processes
March 5th-7th, 2008, Porvoo - Borgå, Finland

[Theme 3.]

The nature of innovation and implications on innovation management

Schulz, Klaus-Peter
Department of Innovation Research and Sustainable Resource Management,
Chemmitz University of Technology, Germany
schulzkp@wirtschaft.tu-chemnitz.de

Abstract

In this paper the complexity of the object innovation will be considered through discussing different definitions and characteristics from a technological, process and social perspective. It is argued that the outcome of innovation cannot be planned and the management of innovation is a process of mastering uncertainty. Examples in the text shall illustrate that these characteristics are phenomenon that can be found in work practice. The paper concludes with implications for the management of innovation.

Introduction

What is an innovation? Who decides about the ascription of the label innovation? How can innovation be distinguished? When asking these questions to one of the common search machines a vast number of definitions and explanations is shown (see also Schumpeter 1934; West/Farr 1990; Utterback 1994; Pleschak/Sabisch 1996; Fagerberg 2004; Rogers 2005). These descriptions are followed by a variety of characteristics - of types, degrees, facets, etc. of innovation. On one hand this discussion about definitions can be seen as an academic one. On the other hand however, considering the object "innovation" more carefully can help researchers and practitioners to estimate novel processes, products and the resources that are needed, in the right way. Such assessment facilitates an adequate management and decision-making process related to the development of innovation.

Quite often the concept of "innovation" is reduced to new products and technologies. Either from a business management or from a scientific view such generalization completely underestimates the meaning of innovation for work, business and society. Therefore if discussing the issue innovation, the first distinction should be between "innovation" as the result of a creative development process and "innovation" as the process itself starting from the emergence of a new idea until a new "product"[i] is introduced on the market.

In this paper I will therefore suggest a conceptual structuring of the nature and characteristics of the concept of innovation. Based on this pattern I will describe the diffusion process of innovation (see Rogers 2003) and further derive implications for its management.

Defining "Innovation"

The fact that no universal innovation theory exists (see Reichert 1994) finally leads to a vast number of definitions of the concept of innovation. Most of the approaches however refer to the idea "novelty" and "change". Among the uncountable definitions of innovation the following

selection may represent correspondence about the nature of innovation although they stress different emphases of the object innovation.

One of the initial definitions of innovation is attributed to the economist Joseph Schumpeter. He used the concept of "creative destruction" and "new combinations" (1934), which he saw related to:

- Production of a new good or new quality of a good.
- Invention of a new production method.
- Development of a new market.
- Conquest of new access to raw materials and semi finished goods.
- Organizational change.

The German innovation researchers Jürgen Hauschildt and Klaus Brockhoff both describe the process of how to bring about innovation (see Hauschildt 1997; Brockhoff 1997). Brockhoff especially distinguishes between the emergence of ideas, the invention itself and the development of a product ready for "sale". These steps he describes as concept of innovation in a broader sense whilst the invention and product/production development should be seen as core understanding of innovation. Each step includes decision-making processes that are based on a general acceptance or rejection of the idea, technological feasibility and proposed economic success. Further he distinguishes between planned and unplanned invention, a view that basically sees innovation as a result of successful planning or of chance (see figure 1).

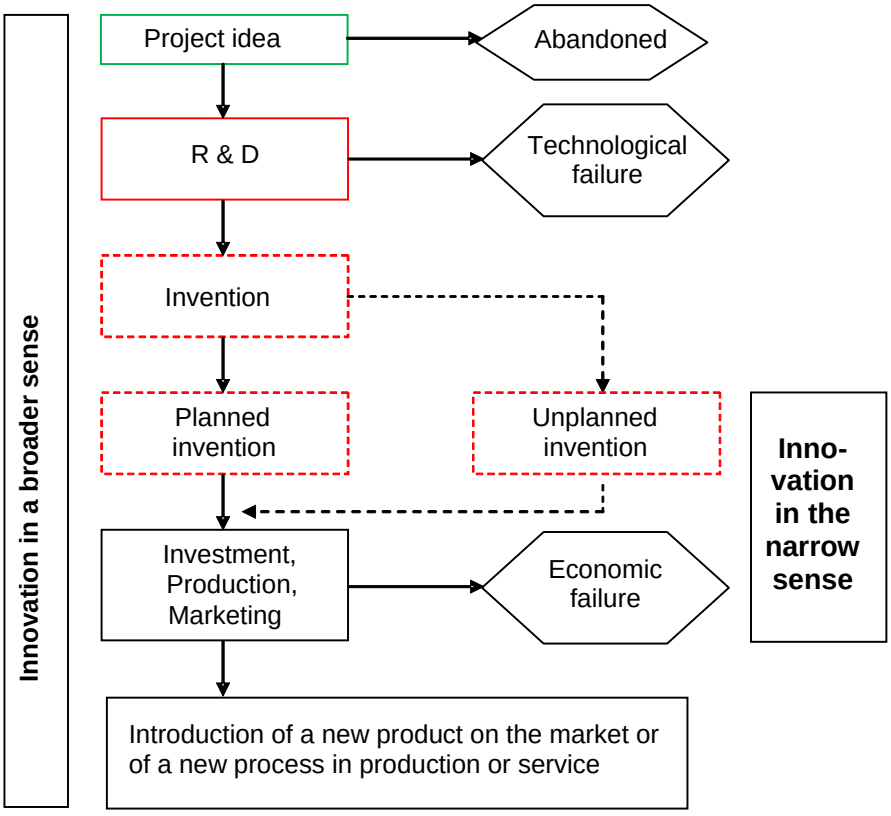

Figure 1: Correlation between invention and innovation (see Brockhoff 1997: 36; Strebel 2003: 21)

This understanding of a gradual process from the idea towards a new "product" [ii] implies that innovations are the result of professional creativity and R&D management. Furthermore it indicates more or less linear procedures that can be followed, an understanding gratefully adopted by practitioners. Examples from pharmaceutical industry where e.g. new antibiotics are desperately needed and rarely come out of the research pipeline however show that intensive research and management effort not necessarily leads to the outcome of innovation.

The British psychologist Michael West follows an approach that takes into account creative potentials of individuals or groups. He considers innovation mainly as non- linear process. He distinguishes between the creative process of bringing about ideas and the procedure of developing such ideas towards "products". Innovation therefore can be seen as consequence of creativity however the emergence of ideas cannot be controlled from outside.

> "Creativity is thinking about new things, innovation implementation is about doing new things" (West/Rickards, 1999).

> "Innovation can then be defined as encompassing both stages— the development of ideas—creativity; followed by their application—the introduction of new and improved products, services, and ways of doing things at work. Innovation, I shall argue, is therefore a two-component, but essentially non-linear process, encompassing both creativity and innovation implementation. At the outset of the process, creativity dominates, to be superseded later by innovation implementation processes." (West 2002: 357)

One of the most recognized researchers in the field of innovation, Everett Rogers, considers innovation as idea, practice or object. He therefore expands the traditional view of innovation as new product towards a more open view that also considers processes and social change. Rogers's initial empirical research on innovation in the late 1950s and 1960s focussed especially social change through the adoption of new technologies in developing countries (see Rogers 1962). It follows from that that Rogers brought in the idea of subjective novelty. For him the attribute innovation is assigned if an object is new in the individual perception of people or groups.

> "An innovation is an idea, practice or object that is perceived as new by an individual or other unit of adoption. It matters little, so far as human behaviour is concerned, whether or not an idea is "objectively" new as measured by the lapse of time since its first use or discovery. The perceived newness of the idea for the individual determines his or her reaction to it. If an idea seems new to the individual, it is an innovation." (Rogers, 2003: 5)

The Swiss organizational psychologist Christof Baitsch refers to innovation as radical change in various fields. As criteria of labelling a novelty innovation he suggests social and collective acceptance of a "product" as being really new. This retrospective approach includes a change of perspective: It is no longer the innovation generating system that decides about the attribute novelty but the environment that is affected by the invention. Baitsch further outlines system change as a consequence of innovations on both side at the innovators and the customers. If considering e.g. innovations in the field of mobile communication and its consequences for a company like Nokia, the firms' local environments and the customers this aspect becomes obvious.

> "Innovations are radical technological or social novelties, characterized through social acceptance or collective attributing of the label "novelty" and therefore are able to create success for the system that emerged the novelty.

This indicates:

- The attribute "innovation" is awarded posterior, after a new product, process or change is accepted.
- Success on the market or social acceptance decide whether an object is considered as innovation.
- The award "innovation" is connected to monetary profit or non-monetary gain.
- Innovation brings about change (structural, procedural, social) in both systems, the attributing system (customer, environment, community) and in the innovation creating system."
  (Baitsch et. al. 1999)

Innovation in the understanding of Baitsch is not the result of stringent planning and controlling procedures but a possible consequence of supportive framework conditions. Therefore innovations are not developed they rather emerge out of work processes. The challenge for innovation managers is how to create such framework conditions, a question which will be discussed under the headline "innovation management".

Fields of innovation – a general distinction

Taking up the above conclusion that innovation can hardly be planned but emerge as a possible result of creative processes, it should also be taken into account that innovation often does not appear in the field as expected. As a reminder: Viagra was designed as heart medication. Therefore innovations are not limited to new products they can also appear in other fields such as work processes, infrastructure or social life. According to a number of authors it may be useful to follow a basic distinction between fields of innovation such as:

Product Innovation
Development and realization of new products or services
Example: MP3 Player

Process Innovation
New procedures on how to produce products and services
Example: Kanban-production, situated learning

System Innovation
Novelties that combine institution, technology and infrastructure
Example: fuel cell

Social Innovation
Novelty and change in the characteristics of social relationship in production, service, administration, education and social life.
Example: emission trade, workers benefit systems

The distinction between these fields of innovation can be seen as important since novelties and significant changes concerning social aspects are often not considered as innovation, although they can provide sustainable impact in social life and work. Furthermore the importance of process innovation is often underestimated, it can however provide a competitive advantage if products can be produced faster, cheaper, requiring less workforce, less energy etc… However it is sometimes not so easy to assign an innovation to a different field. A posterior assignation should not be seen as the important aspect, moreover it is the question of how aware an organization is that searching for innovation should not be reduced to the output of new products but also to the question of how processes can be improved and workers can be qualified or of how

the organization can be embedded in its social environment. Especially in the case of radical innovation, one should be aware that innovation in one field might require change and novelty in a different field or triggers innovation in another field. Hence the fields of innovation are intertwined and do not follow a linear logic.

The developments in the "Renewable Energy Valley" Freiberg, Germany:

For the people in East Germany the radical political change in 1989 and 1990 can be seen as social innovation. The change in the political system highly affected the economic systems, especially production companies. Since the traditional markets broke away manufacturers had to cope with the bifold situation that their products were not required anymore and their production technology was no longer competitive compared to western technology. Although workers, engineers and scientists had a high level of experience and knowledge, they lacked specific knowledge of how to act in a competitive situation in a free market system. This led to tremendous bankruptcies and a high percentage of unemployment. A significant amount of companies and people adopted the challenge of social change and developed new products and processes. Two examples are the photovoltaic producer Solar World and the bio fuel producer Choren in Freiberg Saxony. At Solar World a group of researchers from Freiberg University, experienced in the development of silicon wafers started to manufacture silicon blocks, solar cells and solar modules under one roof. They further developed solar cell production technology together with a spin-off of a former research institution from Dresden and a Swiss company. Also at Choren scientists from Freiberg University developed a process on how to produce high quality fuel out of organic waste. The technology was so promising that after a few years a pilot installation could be built with the help of investors and a test fleet of vehicles could be equipped. Currently Solar World is an independent plc, and the second largest producer of solar cells worldwide. Choren is growing rapidly with a second pilot installation dimensioned ten times bigger then the first one. The company was integrated into a joint venture between Volkswagen, Shell and Daimler. The region around Freiberg is in the meantime recognized as "the renewable energy valley" in central Europe. These developments, brought about through radical social change, demand advancements in terms of workforce and qualification. The existing potential of workers has to be educated and qualified, and additionally people have to be motivated to move to Freiberg. Both aspects require further innovation from the firms in terms of qualification and benefit systems and from the social environment: the university has to cope with this growing specific demand, the city of Freiberg has to adopt these requirements through housing programs, social, cultural and education facilities that are adequate for the demands of the population.

Degrees of innovation – from radical to incremental

For the innovating organization it is of high strategic importance to assess the potential of an idea in terms of its degree of technological novelty and possible markets. Both aspects should be considered in relation to each other. The degree of novelty gives an idea of resources needed to develop an invention to a product ready for the market. The estimation of possible markets for the new product conveys aspects of competition and potentials. Figure 2 represents a variety from the use of basis technology over the development of key technology towards setting a new trend. On the other hand, each of these technological steps can serve existing markets, extend present markets or create new ones. In terms of a trend setting technology or the conquest of new markets one may talk of basic or radical innovation whilst the other steps represent incremental innovations (e.g. Kroy 1995).

At first sight the decision whether an innovation can be described as radical or incremental may be of minor relevance. Consequences especially at the cutting edge of technology and market,

however, may be far reaching: Trend setting technologies need to be produced in sustainable quality and sufficient quantity. New technology in new markets may change customer behaviour and can therefore be succeeded by social change. Diffusion of e-mail made low price and high-speed data exchange and communication possible throughout the world. On the other hand access technology in terms of PCs and data line is necessary. If on the other hand innovation is more in the field of basically known technology that serves existing markets, competition is of high relevance. In that case an important question is the production of the new technology to a competitive price and the flexibility to adapt to market change.

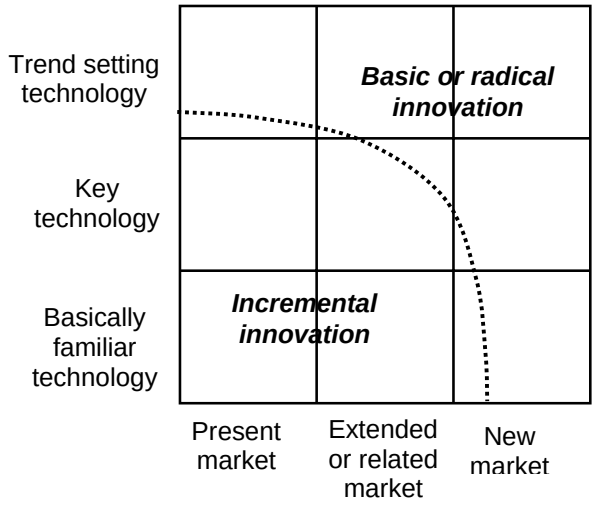

Figure 2: Correlation between radical and incremental innovation (see Kroy 1995: 59)

Other authors distinguish between further steps of novelty. Pleschak and Sabisch differentiate five types of innovation: basic innovation, improvement innovation, adaptation, imitation, and sham innovation (1996). Compared to figure 2 only the first two steps can be seen as innovation, the others are instead optimizations. Especially in the pharmaceutical field a big discussion about sham innovation has been established: Producers bring new products to the market labelled as innovation, health insurances and independent evaluators however declare the lack of added value of such products compared to known alternatives. Following Baitsch, who defines innovation after its market acceptance, question appears who the market in terms of medicals is and what reasons of market acceptance are finally.

The discussion about pharmaceutical sham-innovation:

The Anglo-Swedish pharmaceutical company AstraZeneca developed the proton pump inhibitor Nexium® for reduction of gastric acid production. Following the German 'Independent Research Institute for Quality and Efficiency in Health Care', there is hardly any added value identifiable compared to the proven alternative product Omeprazol®. However, the 'innovation' costs around 35% more then the predecessor. Despite this fact Nexium® could gain a considerable market share in the last three years. One support instrument was a socalled application-observation carried out by medical practitioners who get an expense allowance for each patient participating in the study. Around one third of all regular Nexium® prescriptions were part of the study. Despite significant doubt in the added value of the medication AstraZeneca could increase

turn over with Nexium® in 2006 of 23% in Germany. Additional costs for health care were around 100 Million € p.a.

The patients are neither in a position to decide what medication is suitable nor are they aware of costs. For doctors the decision about the 'innovation' is also difficult since they have to rely on studies and product information. However they are motivated to prescribe the novelty. Health insurances and independent research institutions represent the opinion that the innovation is only an analogue product with no added value, however they have to accept doctors' decisions. The market diffusion of the new product can therefore hardly be seen as a result of the innovativeness of the product but as the result of intensive marketing. (Source: Grill 2007)

A further common distinction in terms of innovation is the question of objective (generally new) or subjective (new to a certain community) novelty. Following Rogers and Baitsch this differentiation is not relevant since the ascription novelty is always related to a certain community that can be smaller or larger. However, in some cases it may be useful to take into account the degree of novelty of a "product" for its potential users. If they are not familiar with an object brought in their life it is likely to cause social change, although it is generally known and not considered as innovation anymore. Inventors should respond adequately to such reaction and should anticipate possible consequences related to the social context of the users (see Rogers 2003).

Considering complex products or processes in terms of their innovativeness it is possible that they include several single innovations but that the user can only perceive marginal improvements. In such a case, detail innovations lead to an optimized but not innovative product. This aspect often appears in car developments where innovation can hardly be found in the finished product but in supplied parts. On the other hand the combination of known technologies may lead in sum to an innovative product. The hybrid drive for cars can be seen as an example.

Diffusion process

One of the central questions in innovation research is why some innovations become success stories and others fail. The renowned innovation researcher Everett Rogers identified the diffusion and adoption process as central steps that decide of success or failure of an innovation. He systematically researched the diffusion aspects of innovations since the 1960s through numerous empirical studies (Rogers 2003; Singhal/Dearing 2006). He identified four main elements appearing in every innovation process: (1) the existence of a novel *idea, practice or object*; (2) *communication channels* that provide information about the novelty and its possible benefits throughout a system; (3) *time* horizon within an innovation is adopted by a certain amount of people; (4) a *social system* that adopts the innovation.

Within the social systems Rogers describes different characters of adopters – the adopter categories. Following his research they can be identified in each social system that has to cope with innovation (see figure 3). The adopters are characterized differently (Rogers 2003: 282 ff.). *Innovators*, who are a small group to take over an innovation and can be seen as open minded, participate in an extended interpersonal network. They are able to cope with high degree of uncertainty that is important since they cannot count on the experience of others in application of the innovation. Financial resources of innovators are high. *Early adopters* can be characterized in a similar way, however they are more integrated in the social system than innovators are. They help trigger the critical mass since they are not as far ahead from the majority as innovators are. The *early majority* adopts new ideas just before the average member of the system. They can rarely be seen as opinion leaders, however provide an important link between the very early and the late. *Late majority* is skeptical in terms of novelties also because of limited resources. They

only adopt an innovation if its added value is clear and free of risks. The laggards finally can be seen as traditionalists and peripheral members of a social system. Since their resources are limited they must be sure that a new idea will not fail before they adopt it.

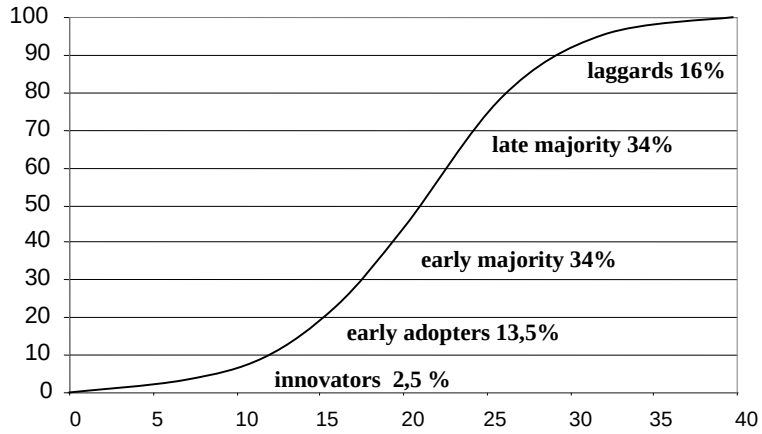

Figure 3: Adopter categories in innovation diffusion processes (see Rogers 2003: 281)

Further Rogers defined the critical mass, "the point after which further diffusion becomes self sustaining" (ibid: 343). Although the critical mass differs from innovation process to innovation process one may summarize that it can be identified in an adoption rate range between 20 and 30%. If adoptions remain below this level for a longer period of time the innovation is likely to fail since it does not reach the demands of the majority of a social system.

For an innovation creating body the awareness of such differentiation of characters within an innovation process is important, for instance if the communication of novelty should at first address opinion leaders. Considering the diffusion, it should however be asked whether an innovation can meet the requirements and concerns of the majority within a social system.

Whether or not the members of a social system adopt an innovation depends mainly on following variables (Moore/Benbasat 1991).

Variables determining the adoption rate:	Adoption criteria:
1. Perceived attributes of the innovation:	- Relative advantage compared to existing technologies, structures, understandings. - Compatibility to existing technologies, structures, understandings. - Complexity: Can the innovation be understood and handled? - Trialability: Can the innovation be tested and its benefits assessed? - Observability: Are effects of applying the innovation visible?
2. Type of innovation decision:	- Optional: Each individual has its own opportunity to

	adopt or reject the innovation. - Collective: It is more or less a collectively shared decision whether an innovation is adopted or not. - Authority: Innovation has to be adopted by order.
3. Communication channels:	- Mass media or interpersonal.
4. Nature of the social system:	- Norms, network structures, degree of interconnection.
5. Promotion efforts:	- Change agents, marketing campaigns.

However the different adopter categories assess the criteria below differently: Innovators e.g. rarely care about observability. They are interested in the relative advantage, an optional decision process and rely on an interpersonal communication network. The early majority is more interested in compatibility and trialability. Central communication channels for them are mass media. The decision process is more collective then optional.

With his research on diffusion of innovation Rogers made a significant contribution on how to understand the process from the idea towards penetration of social systems. The model, however, implies a more or less linear process, where only one trajectory of a novelty entering the social world is described. Considering the overwhelming amount of innovations (mainly incremental) nowadays people are confronted with strong competition between novelties. Sometimes it is an authoritarian decision of innovation leaders between technologies (e.g. competition between Blue Ray and HD-DVD) often it is also a decision between competing paradigms that influence adoption. The ascription innovation is also a question of basic understandings. Innovation for one community can be a step backwards in the opinion of another group. This ascription often crosses borders between the fields of innovation: A step forward in technology may be seen as a step backwards from social views. In recent years competition between innovations has especially become more and more obvious.

Use of pesticide in corn cultivation in Iowa:

The example of Iowan farmers that used pesticides to improve corn yield in the 1950s is often cited by Rogers. He researched the diffusion of the use of pesticides in a specific region. The diffusion time was about six years until most of the farmers used pesticides and therefore significantly improved their yields. More than 50 years later the dangers of extensive use of pesticides become obvious, as well as the disappearance of robust corn types. Several food scandals later a growing community follows organic cultivation; others specialized in genetically manipulated corn. These two paradigms are currently competing and it is not only a question of acceptance of the farmers but also of the public opinion as to which way seems more promising. In recent years a third stream has come up since corn is especially used for the production of bio-fuel. All of these streams follow different objectives and therefore require different ideas and developments. However, they interfere with each other and the assessment of novelties cannot be made independent from other influence factors and strongly depends on values and basic understandings of its supposed users.

Implications for the management of innovation

A question arises about the implications of the above characteristics and estimations on the object innovation on its management process. How can the emergence of innovation be influenced in a positive way? Based on the general assumption that innovations emerge as a result of suitable framework conditions it is obvious that the outcome of novelty cannot be planned as a project

path to be followed. Therefore innovation management differentiates very much from traditional project management: it is rather a balancing act between uncertainty, capabilities, resources and demands. The tasks can be summarized in two central aspects:

(a) Providing framework conditions that make the emergence of innovation more likely.

(b) Reacting on actual requirements of the work context and environmental developments, which can also be called 'situated action' (see Suchman 2007).

Although the outcome of innovation can hardly be planned it would be inadequate strategy to consider an innovation management process needless and leave the object innovation to chance. It is more a question of how to make resources available, to react onto potentials and to push promising ideas forward. Coming back to the definition from Rogers and West and also from Brockhoff, uncertainty lies not only in the process of creativity but also in the invention and in the diffusion process. With radical novelties problems may occur in serial production or in market acceptance. An example for such failed innovation is the Wankel rotary engine, an ingenious idea however, problematic in mass production and through the oil crisis in the early 1970s caught at its weak point, the extensive fuel consumption. Another example for an innovation between success and failure is the maglev (magnetically levitated vehicle). Despite convincing technology there is some uncertainty about the influence of the magnetic field on the environment, further investment in infrastructure is extremely high since its realization require a system change in public transportation, and finally railway technology using existing infrastructure is catching up. Bearing additionally in mind that 'innovation' is a posterior ascription to novelty (Baitsch et al. 2000), innovation's managers should be aware that the outcome of a creative process can also be an optimization or an incremental innovation or even in case of a radical novelty it can fail in the judgment of customers.

Considering the management of innovation more closely it may be useful to distinguish between different perspectives on the innovation persons and their environment. For an innovation manager it is useful to take up a multi-level perspective as depicted in figure 6. Based on the individual the outcome of innovation is related to capabilities, knowledge and knowing in the field of perception, modes of thinking and problem solving. Analayzation of the narratives of inventors of groundbreaking innovations shows the process of innovation creation can often be described as development from something unclear intuitively, towards an explicable idea or concept. Therefore, the sentence "it came to me under the shower" is only half of the truth, since people discovering or developing something new have usually dealt with the problem for a longer period of time. When the German physicist Werner Heisenberg was asked how he discovered the uncertainty principle he answered that he "knew" it all the time but he was unable to describe until a certain moment.

Usually people work together in groups; even most of the inventor personalities are connected to groups. It is however an important question of which group constellations foster innovation processes and which ones inhibit them. An important aspect is the critical reflection of reality. Following group research external demands, threat, and uncertainty motivate groups to innovate at work (West 2002). Further groups should be heterogeneous, with members representing different perspectives and knowledge. However, there is a border of beneficial heterogeneity: groups should have a collectively shared understanding of the context of work and an intrinsic motivation to improve their work and its results. Empirical studies about the reflection and improvement capabilities of groups show that homogeneous groups of high cohesion have little interests in change and development. Heterogeneous groups with low cohesion and relation to a shared context produce many ideas, but these remain on an abstract level (Schulz 2006).

Working groups are embedded in firms or other organizations. Decision processes within depend on implicit and explicit structures and rules. Often tasks are more or less strictly allocated to specific functions, e.g. the development of innovation is part of R&D. In such cases the organization can only benefit from the creative potential within in a very limited way. Therefore innovation management requires a switch from this prescriptive, towards a more research based view: Innovation may emerge in any parts of the organization. It is the task of the innovation management to provide resources that make the emergence of new ideas more likely and to search carefully about ideas being discussed within the organization.

Creativity and ideas are not limited to organizational borders. Or organizations only have restricted capabilities and resources to solve problems within the innovation process. Therefore it may be useful to connect with additional resources and knowledge from outside the organization. Such innovation networks concentrate on joint problem solving and developments. Motivations for collaborating in networks can be resources to be needed for innovation development or specific capabilities located at certain network partners.

The Saxonian automotive supplier initiative AMZ:

The state of Saxony has a long tradition in automotive industry, which is nowadays characterized through production plants of car manufacturers and a high amount of medium sized enterprises. To connect these firms and to support those with management and marketing know how, the automotive supplier initiative AMZ was founded. Some years ago a car supplier developed a functional body part with improved performance using regenerative material. The component was offered to the Volkswagen company, who became very interested in the component. They communicated a price level and the amount needed. Both were far beyond the opportunities of the car manufacturer. As a consequence the company addressed the AMZ who searched for possible manufacturers of production devices experienced in the field. Finally a group of three firms developed a system solution of a new product and production device. The result at least met the requirements of Volkswagen.

In terms of networks one should however bear in mind that they are always a balancing act between cooperation and competition. An important indicator in this context is how they fit in the interests of their parent organizations.

On a political and administrative level the development of regions towards innovation clusters is often discussed. Although this question goes beyond the operational question of how to manage innovation it should be recognized to some extent. Innovation capabilities build on human capabilities, financial resources and networks. Therefore it should be taken into account what resources are available in a certain region and what opportunities exist for further expansion to reasonable investment. This question can however not be answered simply since these correlations are – as the example AMZ shows – not directly related to specific products or even not to specific business areas. The following chapter gives a short impression how such regional and societal innovation capabilities are measured.

Politics carry a high responsibility in terms of innovation. Although the emergence of new ideas cannot be enforced, the allocation of financial resources provides a high influence on innovation activity. Further, especially in publicly subsidized areas the acceptance of innovations depends on the decision of public reimbursement. In health care especially, promising products could not be realized due to political rejection of cost refund of its use. Alternative decisions in other countries finally proved that the products were in fact innovative.

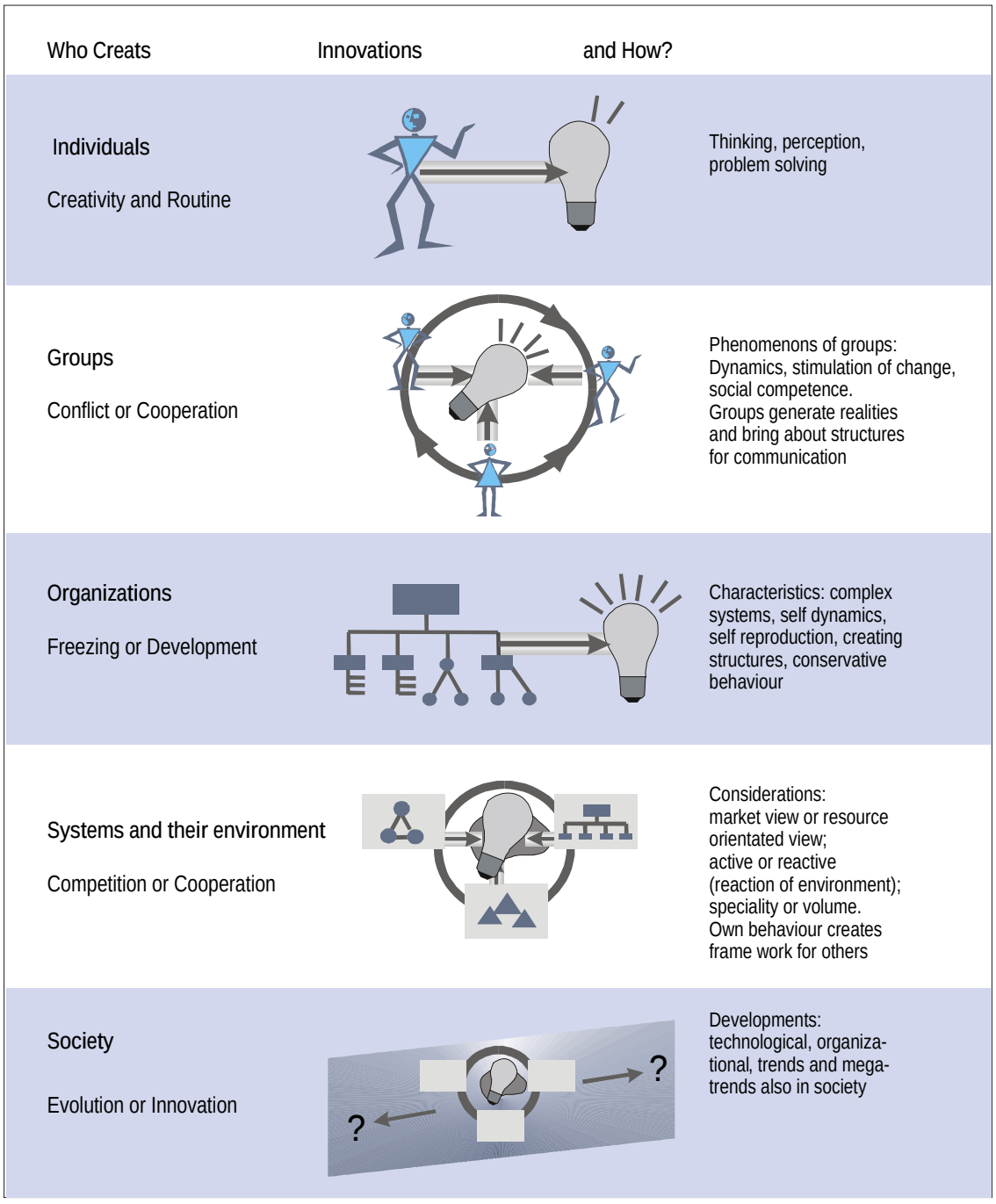

Figure 6: Contents of a multi-perspective approach to innovation management (Schulz/Baitsch 2000)

The distinction in the different perspectives described above leads to a multidisciplinary approach in innovation processes that an innovation manager should be aware of. Discussing innovation usually people from different functions and disciplines gather around the table. Basic research often is related to natural scientists, the product development process often lies in the hands of engineers, whilst the business people care about market invention and economic benefit. The skill

lies in integrating these people to parallel communication and cooperation. Very often project reality is more a sequential process where results of one step are passed over to the succeeding one. If innovation management is, however, a reflexive and discursive process integrating the different functions and disciplines related, it is likely that problem solving within the 'product' development process is in terms of problem solving and improvement an innovation itself.

Innovation key figures

Apart from the assessment factor "social acceptance" organizations and economies are interested in measuring innovation capabilities and output in new products (see e.g. Arthur D. Little Innovation Excellence Study 2004; EU EUROSTAT study 2004). Most of these measurements however have a more or less narrow view on new products and leave behind the fields of process and social innovation, which have a high impact on the development of companies, regions or an economy as a whole. It may be argued that the interrelation between these fields in terms of sustainable development is not sufficiently taken into account although the EUROSTAT[iii] statistics bears in mind social, educational and knowledge aspects as evaluation factors. The list below shows relevant criteria to be taken into account from the EU commission to measure and compare innovation capabilities of the EU- and other countries.

I. Human resources
- S&E graduates (‰ of 20 – 29 years age class)
- Population with tertiary education (% of 25 – 64 years age class)
- Participation in life-long learning (% of 25 – 64 years age class)
- Employment in medium-high and high-tech manufacturing (% of total workforce)
- Employment in high-tech services (% of total workforce)

II. Knowledge creation
- Public R&D expenditures (% of GDP)
- Business expenditures on R&D (% of GDP)
- High-tech patent applications (per million population)
- High-tech patents granted (per million population)
- Patent applications (per million population)
- Patents granted (per million population)

III. Transmission and application of knowledge
- SMEs innovating in-house (% of all SMEs)
- SMEs involved in innovation co-operation (% of all SMEs)
- Innovation expenditures (% of total turnover)
- SMEs using non-technological change (% of all SMEs)

IV. Innovation finance, output and markets
- Share of high-tech venture capital investment
- Share of early stage venture capital in GDP
- Sales of 'new to market' products (% of total turnover)
- Sales of 'new to the firm but not new to the market' products (% of total turnover)
- Internet access
- ICT expenditures (% of GDP)
- Share of manufacturing value-added in high-tech sectors

Figure 4 compares the innovation index, which is based on the above criteria. It shows that the leaders in innovation capabilities are Japan, Sweden, Finland and with some distance the US and Switzerland.

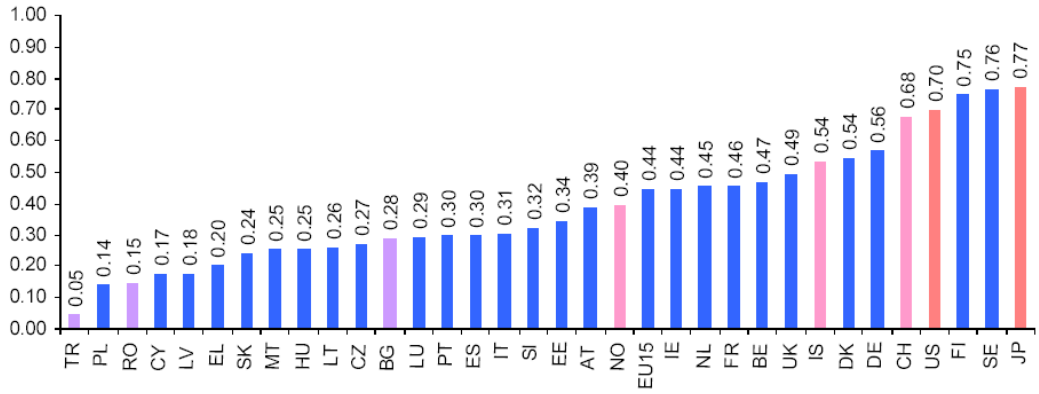

Figure 4: Innovation index of EU and other selected countries (Source: European Innovation Scoreboard 2004 – Methodology Report, p. 15)

A second measurement from the European trend portal compares the innovation index of European states with current innovation dynamics (see figure 5). The trend indicators represent a summary of the innovation indicators of the last years. It shows that main innovators losing dynamics on a high level and other countries that started from a low level are catching up. Two exceptions are Denmark and especially Iceland that started from a high level and still have high dynamic in terms of improving innovation capabilities.

Taking into account the conclusion from the beginning that innovation is not a result of stringent planning and project management but a consequence of appropriate framework conditions, the significance of considering process and social transformation in parallel to product developments becomes obvious. Considering current assessments of innovation capabilities through the EU, it is not a single company or institute at any location that provides sustainable innovation developments but the embedding of possible innovators in regional networks of profitable exchange. Although this aspect is not explicitly measured in the EU statistics it can clearly be concluded from statistic data. Key success factors are related to political framework conditions, workers availabilities, technology access, infrastructure, education opportunities and social life. One of the recent EU studies on technology and innovation marked the following five regional clusters as the ones with the highest innovation development potential (in any order): Paris – Isle de France, Dublin, Copenhagen – Malmö, Helsinki – Tampere and Stuttgart – Ulm.

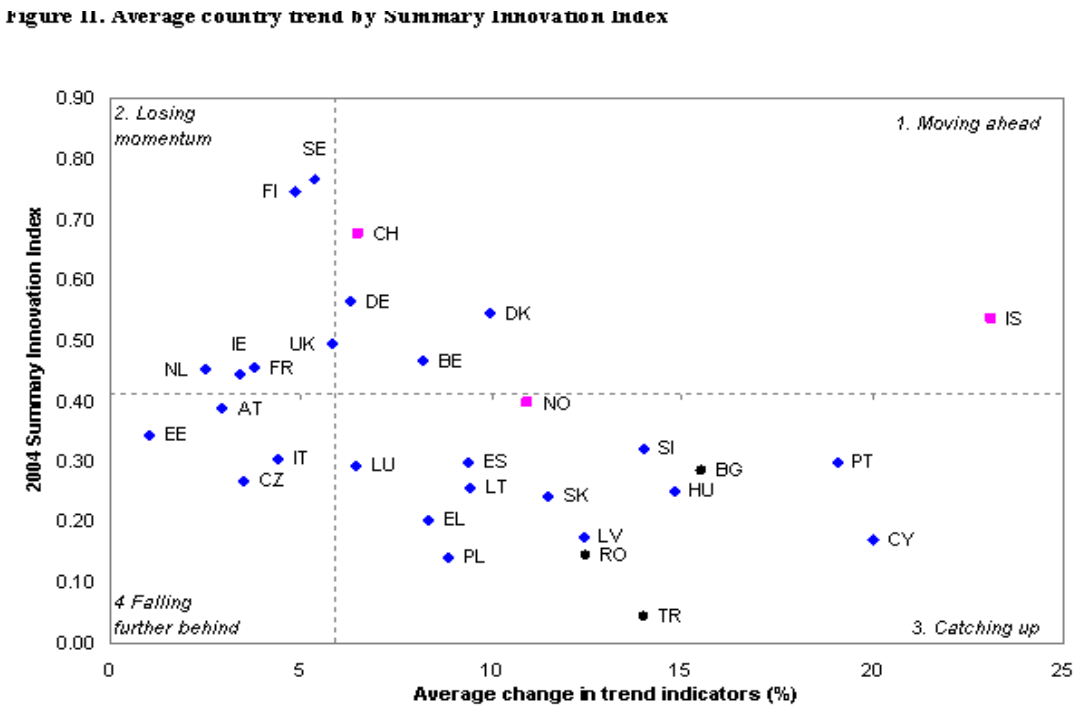

Figure 5: Innovation capability vs. innovation dynamics (source: http://trendchart.cordis.lu/scoreboards/scoreboard2004)

Summary and challenges

Discussing innovation requires grasping the 'multivoicedness' of the object: Innovation as result is more then a novel product. Innovation as process goes far beyond a linear project from idea generation towards market introduction.

Especially more recent approaches to the issue innovation, and innovations' management, emphasize the emergent character of bringing about novelty, and the uncertainty of the innovation management process. Further the label innovation is not in anticipation of the generating institution but a posterior ascription by the social system making use of the novelty.

Taking into account the definitions and differentiations above, following implications can be summarized:

- Innovations are rarely the result of an optimized management process but rather emerge within work processes through discursive processes from multiple perspectives.

- The uncertainty of the innovation processes is not limited to the "creative step" at the beginning but includes the procedures from the idea emergence up to the product on the market. This process is not linear and unclear. It depends on the object itself but also on internal and external framework conditions.

- Since the emergence of innovation can hardly be planned, the focus of innovation management should be on awareness of framework conditions and resources that make it more probable that innovation will be produced.

- The innovation management process is not only a question how novelty emerges in work processes but also how its diffusion takes place throughout society (Rogers 2003). This diffusion process, however, can be seen as a competition between the innovation, alternatives, legal acts and public opinion.

- As mentioned above it is an aspect of social acceptance whether a new product or process is regarded as innovation or not.

Based on the discussion above, following challenges in terms of innovation management can be surmised:

- Global and regional innovation networks: Especially the development of radical or system innovation is becoming an issue that exceeds potentials of one partner. Therefore local, structural and human resources have to be identified which can be included in the process.

- Organizational learning and sharing of knowledge: The emergence of innovation is not a singular process of the solitary thinker but a discursive one. However results may differ from existing practice and lead to change in an organization.

- Cultural embedding and innovation styles: Since innovation is a question of social acceptance, local and cultural backgrounds have to taken into account in terms of discussing market potentials or proposed acceptance.

- Focus on tacit knowing and creativity: potentials inside and beyond organizational borders have to be identified. It can be taken for sure that these potentials in terms of creative people exist, however they are not easily accessible since the people are themselves often not aware of it.

- Considering contextual practice: although creativity cannot be planned, the emergence of innovation is not a result of chance but of dealing with a specific problem embedded in a context related to the problem.

- Replacing of "stage models" by "recursive process models": Since the whole process of bringing about innovation is characterized through uncertainty and unexpected results, it may require change of direction, further developments, cancellations or reworked schedules. A permanent reflection in order to learn from recent developments is important.

- Technology genesis as social process: Especially radical technological innovation is often followed by changes of social behaviour or the social system.

- Thinking in dilemma, analysis of paradoxes: Radical innovation processes are some kind of learning activity. It can be taken for sure that existing social habits or structures are questioned and contradictions in existing life structures occur.

To conclude: Innovation management should be considered as the discovery of potentials. This task goes more and more beyond organizational borders or a simple "bringing people together" towards new forms of transdisciplinary cooperation and communication.

References:

Brockhoff, K (1997) *Forschung und Entwicklung. Planung und Kontrolle.* München: Oldenbourg.

Baitsch, C., Aderhold, J., Beelitz, N., Heideloff, F. & K.-P. Schulz (1999) Innovationsmanagement – ein praktisches Studium. Bericht von einer Innovation in Sachsen. *Handbuch Hochschullehre*. Berlin: Raabe.

Fagerberg, J. (2004) 'Innovation: A Guide to the Literature', in Fagerberg, Jan, David C. Mowery and Richard R. Nelson: *The Oxford Handbook of Innovations*. Oxford University Press, 1-26.

Gill, M. (2007) 'Die Scheinforscher'. http://www.stern.de/wirtschaft/unternehmen/maerkte/581173.html?p=2&nv=ct_cb (retrieved: 02-2008).

Moore & Benbasat (1991) 'Development of an Instrument to Measure Perceptions of Adopting an Information Technology Innovation' *Information Systems Research*, 2 (3), 192-222.

Pleschak, F. & H. Sabisch (1996) *Innovationsmanagement*. Stuttgart: UTB.

Reichert L. (1994) Evolution und Innovation. Prolegomenon einer interdisziplinären Theorie betriebswirtschaftlicher Innovation. Berlin: Springer.

Rogers, E.M. (2003) *Diffusion of innovation (fifth edition).* New York: Free Press.

Schulz K.-P. & C. Baitsch (2000) 'Study to work – an interdisciplinary approach to the field of innovation management in university education'. In: Häberli, Scholz, Bill, Welti (eds.): *Transdisciplinarity. Joint problem-solving among science, technology and society.* Zurich: Haffmanns, 248-253

Schumpeter, J. (1934). *The Theory of Economic Development*. Cambridge, MA: Harvard University Press.

Singhal, A. & J. W. Dearing (eds.) (2006) *Communication of Innovations: A Journey with Ev Rogers,* Sage, New Delhi.

Strebel, H. (ed.) (2003) *Innovations- und Technologiemanagement*. Wien: WUV.

Suchman, L. (2007) *Human-Machine Reconfigurations*, New York: Cambridge University Press.

Utterback J. (1994) 'Radical Innovation and Corporate Regeneration' *Research Technology Management,* 37(4): 10.

West, M. (2002) Sparkling Fountains or Stagnant Ponds: An Integrative Model of Creativity and Innovation Implementation in Work Groups, *Applied Psychology: An International Review,* 2002, *51* (3), 355–424

West, M. & J. Farr (1990) *Innovation and creativity at work: Psychological and organizational strategies.* Chichester: Wiley.

West, M. & T. Rickards (1999). Innovation. In M.A. Runco & S.R. Pritzker (Eds.), *Encyclopedia of creativity*, Vol. 2 (pp. 45–55). London: Academic Press.

[i] Product in a broad sense can be new service, new process, new good, etc. This distinction will be discussed further in the following.
[ii] Terms like product, or market are put into quotes since they should be seen in a broader then a commercial sense. Products include for instance new procedures as well as markets include e.g. public acceptance.
[iii] EUROSTAT is an administrative institution of the EU and provides statistical data on EU level.