The “Fuzzy Front End” of Innovation

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ABSTRACT

The fast transformation of technologies into new products or processes is one of the core challenges for any technology-based enterprise. Within the innovation process, we believe, the early phases (“fuzzy front end”) to have the highest impact on the whole process and the result (Input-Output Process), since it will influence the design and total costs of the innovation extremely. However the “Fuzzy Front End” is unfortunately the least-well structured part of the innovation process, both in theory and in practice.

The focus of the present chapter is on methods and tools to manage the “fuzzy front end” of the innovation process. Firstly, the activities, characteristics, and challenges of the front end are described. Secondly, a framework of the application fields for different methods and tools is presented: Since a product upgrade requires a different approach compared to radical innovation, where the market is unknown and a new technology is applied, we believe such a framework to be useful for practitioners. Thirdly, a selection of methods and tools that can be applied to the “fuzzy front end” are presented and allocated within the framework. The methods selected here address process improvements, concept generation, and concept testing.

1. INTRODUCTION

Successfully launching new products, processes or services in the marketplace is vital for the long-term survival of any enterprise. As life cycles shorten and the technological and competitive environment are changing fast, technology-based enterprises have to convert new technologies into innovative products and processes as quickly as possible. In parallel, they have to make sure that customer needs are met.

To cope with these challenges, the “fuzzy front end” of the innovation process has a key role. It determines to a great extent which projects will be executed. Quality, costs, and timings are mostly defined during the front end. At this early stage, the effort to optimize is low and effects on the whole innovation process may be extremely high. But Managers describe the front end as the greatest weakness in product innovation (Khurana and Rosenthal 1997).

Consistently, an extensive empirical study (Cooper and Kleinschmidt 1994) showed, that “the greatest differences between winners and losers were found in the quality of execution of pre-development activities”. Two factors were identified to play a major role in product success: the quality of executing the pre-development activities, and a well defined product and project prior to the development phase (Cooper and Kleinschmidt 1990). A study of Koen et al. (1999) identified the front end as the key-contributing factor for large numbers of really new products introduced each year.

Yet, Cooper and Kleinschmidt (1988) found out that pre-development activities received the least amount of attention (only 6 % of dollars and 16 % of man-days of the total) compared to product development and commercialization stages. When product innovation success was observed, about twice as much money and time was spent on the front end stages compared with non-performing projects. Consequently, high failure rates have often been related to insufficiencies, low management attention and poor financial support during the “fuzzy front end”.

In this chapter, we describe the “fuzzy front end” of innovation in more detail. To systematize the application fields of different methods and tools for the “fuzzy front end”, a framework is presented in section 3. This framework differentiates innovation projects with regard to the market and technical uncertainty implied. Based on this differentiation, section 4 presents a selection of methods and tools suitable for the “fuzzy front end” and the respective application fields. This selection does not claim to cover the whole range of methods applicable to the front end. Instead, it focuses on on the one hand basic and on the other hand relatively new methods to deliver an insight into basics and into current discussions. The methods selected address concept generation and concept testing. Conclusions and a brief summary are presented in section 5.

2. CHARACTERISTICS OF THE "FUZZY FRONT END" OF INNOVATION

In the innovation management literature, several terms are used for the description of the front end of innovation, e. g. "pre-development" (Cooper and Kleinschmidt 1994), "pre-project activities" (Verganti 1997), "fuzzy front end" or "pre-phase 0" (Khurana and Rosenthal 1997/1998). In general, the front end ranges from the generation of an idea to either its approval for development or its termination (Murphy and Kumar 1997). *Figure 1* describes a model of the innovation process, highlighting the front end and it´s activities.

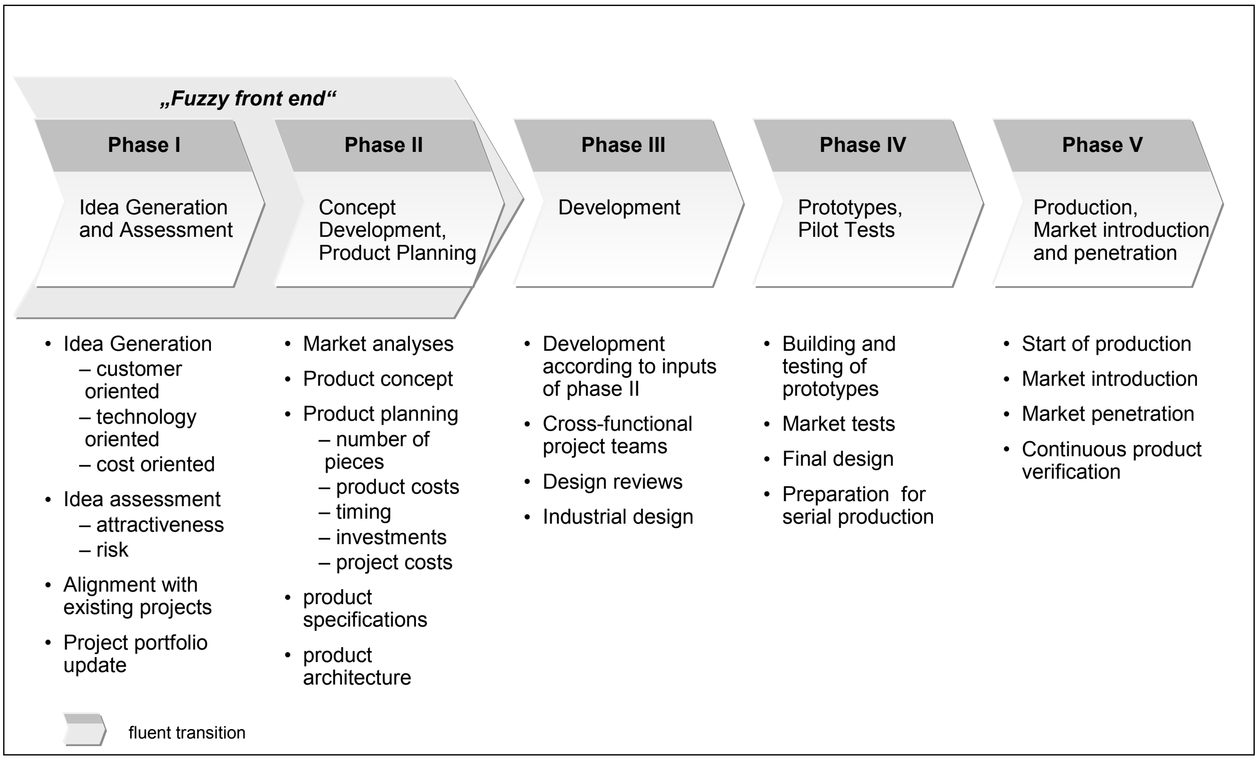

Figure 1: The innovation process (own depiction)

As idea generation and concept development are typical tasks of the front end, besides the need to systematize activities to enhance the efficiency, there has to be sufficient room for creativity. *Figure 2* shows a typical characteristic of the "fuzzy front end": At the beginning of the innovation process, the degree of freedom in design and influence on project outcomes are high, whereas costs for changes are low. This front end advantage is limited by the fact that the amount and certainty of information is low compared to later stages of the innovation process. Hence, sound decisions cannot be made unless necessary information is gathered during the course of the innovation process.

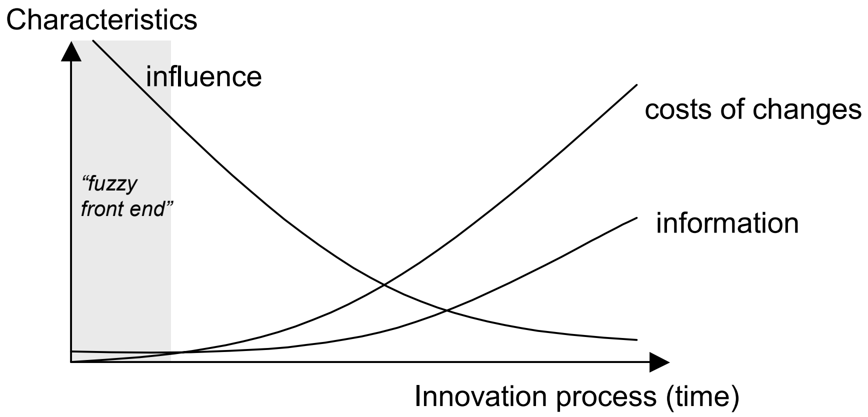

Figure 2: Influence, cost of changes, and information during the innovation process (according to von Hippel 1993/ modified by the authors)

In the next section we will show in more detail, what kind of information has typically to be gathered during the front end, depending on the kind of innovation targeted at. This determines the application fields of methods and tools.

3. A FRAMEWORK OF APPLICATION FIELDS FOR DIFFERENT METHODS AND TOOLS FOR THE “FUZZY FRONT END”

As already outlined, the lack of information is a limiting factor for the front end. Therefore, a differentiation for the management of the front end should be made with regard to the *newness* of key activities for the enterprise. Typical questions an enterprise has to ask itself at the beginning of an innovation project are summarized in *figure 3*.

Figure 3: Questions determining the degree of newness of an innovation project (own depiction)

Methods and tools might help to fill the gap between the amount of information needed and already available. Different methods and tools require different kinds of input information to gather results. Hence, the difference between the amount of information required to perform a particular task and the amount of information already possessed is a suitable variable for the systematization of application fields. This difference is defined as uncertainty (Galbraith 1973).

As the multidimensional approach in *figure 3* is too complex to assign methods and tools to the respective application field characterized by a combination of these factors, a two-dimensional framework is chosen and presented in *figure 4*. It focuses on two key factors an enterprise has to consider, namely the market and the technical uncertainty of an innovation project.

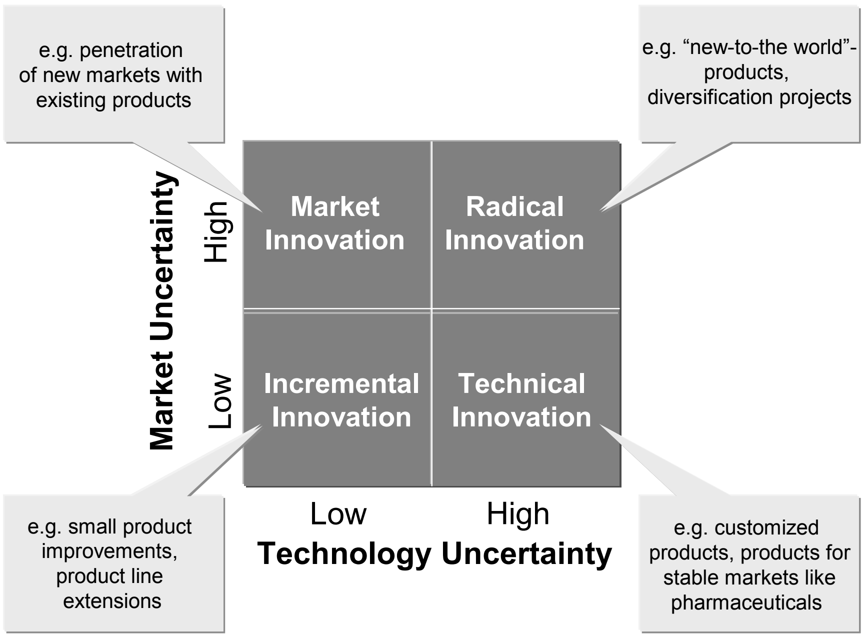

Figure 4: A framework of application fields of methods and tools for the “fuzzy front end” (according to Lynn and Akgun 1998/ modified by the authors)

The highest level of newness to a firm is implied in *radical innovation* with a high market as well as technical uncertainty (upper right quadrant of *figure 4*). In literature, differentiations are made between incremental and radical, “breakthrough” innovation or continuous and discontinuous innovation (Lynn et al. 1996). There are several definitions of “breakthrough” innovations (e. g. Rice 1999, Song and Montoya-Weiss 1998, for a detailed review see Veryzer 1998). However, a common understanding of these terms has not emerged yet. Here, the term radical innovation is used as it is suitable to explain that the firm has to acquire new marketing and technological skills and cannot build on former experiences. Technology-driven innovations are the core business of technology-based enterprises. These need not to be radical innovations only. For instance, for pharmaceutical enterprises, the market for a new drug are the number of people with the respective disease. The market uncertainty is low. These “technical innovations” are shown in the lower right quadrant of *figure 4*.

Although the focus of the technology-based enterprise is on technical and radical innovations, innovations which incorporate an existing technology should not be neglected. E.g. *incremental* innovations (lower left quadrant of *figure 4*) with a low market and technical uncertainty like product improvements or product line extensions could result in a considerable competitive advantage. If a technology-based enterprise solely concentrates on the development of new technologies, it could be leapfrogged by competitors, e.g. fast followers which add additional product features which may be preferred highly by customers. Likewise, *market innovations* with a low technological and a high market uncertainty as shown in the upper left quadrant of *figure 4* should be taken into consideration by enterprises. Turnover could be increased significantly by finding new application fields for existing technologies and the penetration of new markets. Examples for market innovations are “personal copiers” or food processors for home use.

To summarize, the framework of application fields for methods and tools of the “fuzzy front end” has to consider market and technological uncertainty. The four combinations of these uncertainties are designated as incremental, market, technical, and radical innovation.

In the following section we will present methods and tools supporting these types of innovations.

4. METHODS AND TOOLS FOR THE “FUZZY FRONT END” AND THE RESPECTIVE APPLICATION FIELDS

4.1 Process-related aspects

4.1.1 The “stage-gate” approach

One of the major advantages of a process-oriented approach is the systematization of an often ad-hoc-development. The process is transparent for all departments, and a common understanding can be developed. This eases communication within teams as well as with top management.

A vast number of models to structure and systematize the innovation process is available. These models typically divide the innovation process into distinct phases and assign tasks and responsibilities to each of these phases.

Process models vary with regard to the degree of detailing tasks, priorities and perspectives, e.g. market or technological. *Figure 5* shows one of the most well known models, the so called “stage-gate-process”. The “fuzzy front end” (“predevelopment activities”) is here divided into four sub-phases from idea generation to concept evaluation. After every stage a gate exists, deciding on continuing or terminating the project (go or no-go).

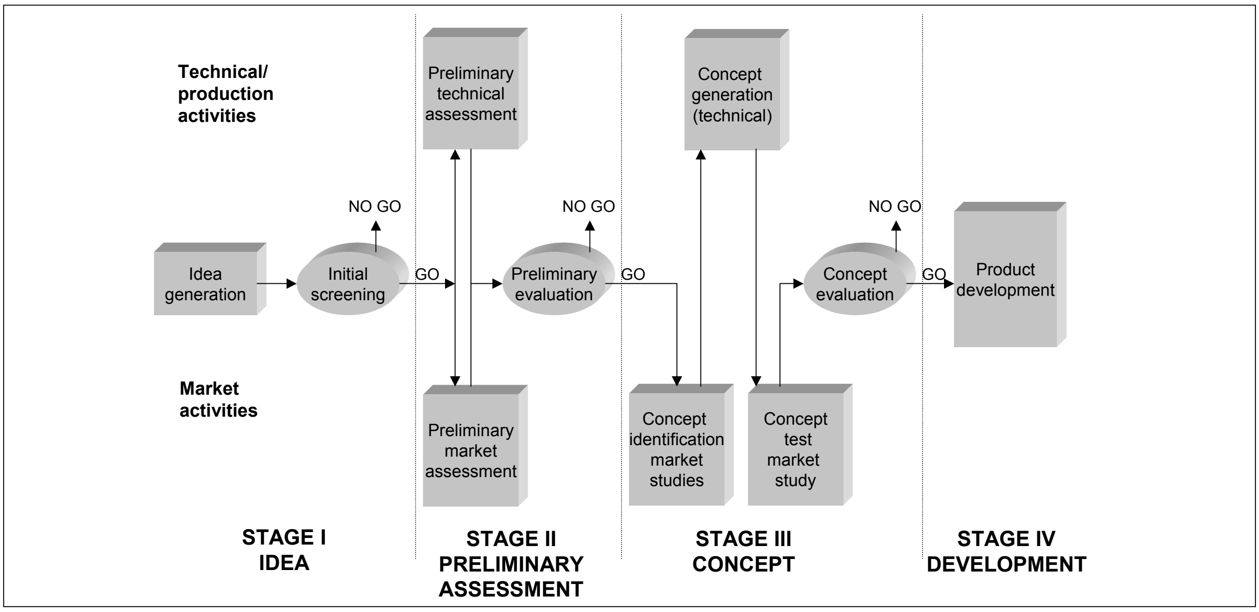

Figure 5: The “stage-gate”-process (Cooper 1988)

The “stage-gate”-process integrates a market and technological perspective, since activities are performed in parallel and decisions at the gates are made within cross-functional teams.

Besides this “stage-gate”-driven process several attempts have been made to structure the “fuzzy front end” (e.g. Murphy and Kumar 1997). The probably most sophisticated process model is illustrated in *figure 6*. Khurana and Rosenthal (1998) define the front end “to include product strategy formulation and communication, opportunity identification and assessment, idea generation, product definition, project planning, and executive reviews”.

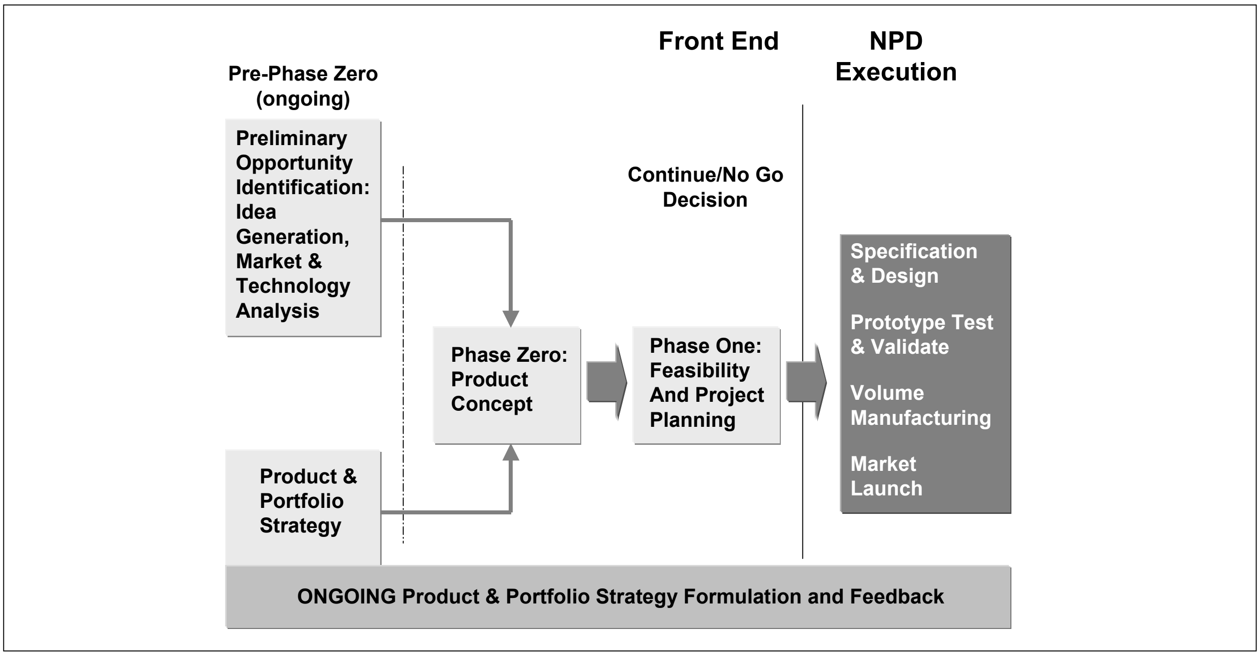

Figure 6: A model of the front end of the innovation process (Khurana and Rosenthal 1998)

The Khurana and Rosenthal approach starts with an input-stream from two different sources within the corporation into the product concept development. The first input stream containing the steps from opportunity identification through to idea generation and market research activities is similar to Cooper´s model. The second input stream includes activities like product and portfolio strategy formulation, which are typically assigned to strategic management. Khurana and Rosenthal emphasize the meaning of foundation elements, e.g. the formulation and communication of a strategic vision, a well-planned portfolio of new products, cross-functional sharing of responsibilities, and an information system. A typical result of a first qualitative screening is an idea portfolio, which has to be aligned with existing projects and the overall project portfolio.

Phase zero delivers the product concept, which includes a preliminary identification of customer needs, market segments, competitive situations, business prospects, and an alignment with existing plans. In phase one, the business and technical feasibility are assessed, the product is defined, and the project is planned. Primary front-end deliverables are a clear product concept and product definition, and a detailed project plan. If a product concept is approved, the NPD (New Product Development) execution starts.

As Cooper’s stage-gate process model, Khurana and Rosenthal’s front end model is a useful approach to visualize and structure front end activities, reduce the fuzziness, and ease communication. Nevertheless, a lack of flexibility due to the sequential approach of the process models has often criticized.

Empirical studies (e.g. Cooper 1996) show that firms using a well executed “stage-gate” process are more successful than firms without a systematic approach and a gate-driven system. But closer observation shows that the “stage-gate” approach has (only) proven helpful in the case of incremental innovation. And for innovations with a high market and/or technical uncertainty a sequential and formalized approach might be even counterproductive. Several empirical studies confirm that in such cases a learning-based approach is more adequate (Lynn and Akgun 1998, Lynn and Green 1998, Rice et al. 1998). Why? In the case of radical innovation, all corporate areas and functions have to go through extensive learning-processes and sometimes years of trial-and-errors. Example: The General Electrics’ CT scanner (Lynn and Akgun 1998). After years of learning from the development of unsuccessful breast, head, and full body scanners, GE introduced a further full body scanner and became the dominant CT supplier. In many cases, the first experiences with prototypes are negative like in the CT scanner example. The emphasis is on gaining maximum information and not on “getting it right” the first time. As radical innovations sometimes cause high costs for years with no guarantee of success due to high uncertainties, a short term, cost-oriented evaluation at sequential gates would not allow for any “breakthroughs”.

To summarize, a process-oriented sequential approach with evaluation gates enhances the effectiveness and efficiency of incremental innovation processes leading to minor improvements (products and /or processes). For innovation projects characterised by high uncertainty in both dimensions (market and technology), a flexible, learning-based approach should be applied. Unfortunately, only little experience has been documented and reported how to manage such processes.

4.1.2 “Front-loading” problem-solving

Besides structuring the innovation process, recent research in innovation management has concentrated on various approaches to shorten development times, e.g. cross-project management (McGrath et al. 1992) or overlapping activities, or adequate staffing (Smith and Reinertsen 1991). In this section, we discuss the “front-loading” problem-solving approach and it´s impact on structuring and enhancing the performance of the “fuzzy front end”.

“Front-loading” problem-solving is defined as “a strategy that seeks to improve development performance by shifting the identification and solving of problems to earlier phases of a product development process” (Thomke and Fujimoto 2000). The focus is on lead time reduction in order to enhance the efficiency of the development process.

To achieve this enhancement, two approaches are described by Thomke/Fujimoto:

- project-to-project knowledge transfer and
- rapid problem-solving.

Figure 7 illustrates the two approaches for car crash tests.

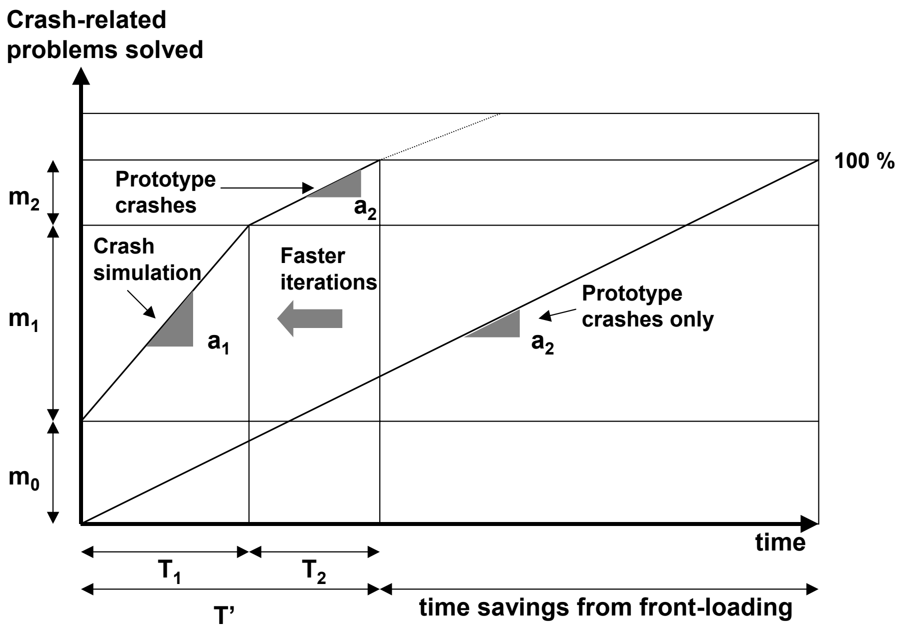

Figure 7: “Front-loading” problem solving for car crash tests (according to Thomke and Fujimoto 2000/ modified by the authors)

Firstly, the total number of problems to be solved is reduced by transferring problem-specific information from former projects (m_0). An example are postmortem reports which provide software developers with information on problems that occurred during former projects. The importance of systematic learning from past experience is supported by several studies (e. g. Verganti 1997).

Secondly, technologies and methods shall be applied to increase the speed of problem-identification and -solving. For car crash tests, the time-consuming building of physical prototypes limits the rate of crash-tests and therefore problems solved (a_2). Computer-aided engineering tools enable a simulation of the crash tests with a higher rate of problems solved (a_1) at even lower costs compared to physical prototypes. As some problems can only be solved via physical prototype crash tests (e.g. roll-over crashes), after a time T_1 of virtual crash tests, further physical prototype crash tests are performed (T_2). *Figure 7* shows potential time savings from “front-loading” compared to physical prototype crash tests only.

To summarize, “front-loading” problem-solving may enhance the efficiency of the innovation process by transferring knowledge from one project to another and rapid problem solving, e.g. by computer simulation. The principle of front-loading can theoretically be applied to all kind of innovation projects. But it requires information to be available early in the process and this is more likely to be the case for incremental innovations. In addition, project-to-project knowledge transfer assumes that projects are not completely new to a firm, which limits at least this aspect of “front-loading” to incremental, market or technical innovation.

4.1.3 Project planning

Another success factor identified in numerous studies is the thorough planning of a project (e.g. Maidique and Zirger 1984, Pinto and Slevin 1988, Rubenstein et al. 1976). As most innovations are developed in the form of a project, accurate project planning can significantly increase the effectiveness and efficiency of an innovation project. In the following, a short summary of the key elements of project planning is given.

Project goals and project definition:

Different Studies identify a well-defined product and project prior to the development phase as one of the success factors for new product development (e. g. Cooper and Kleinschmidt 1990).

Goals should be complete, unequivocal, and neutral towards solutions. They should be aligned between all parties, in particular with the client. In addition, they should be ranked according to their importance.

Goals are part of the project definition. The project definition is a short description of the project and basis for go/no-go-decisions. Further elements of a project definition are listed in *figure 8*:

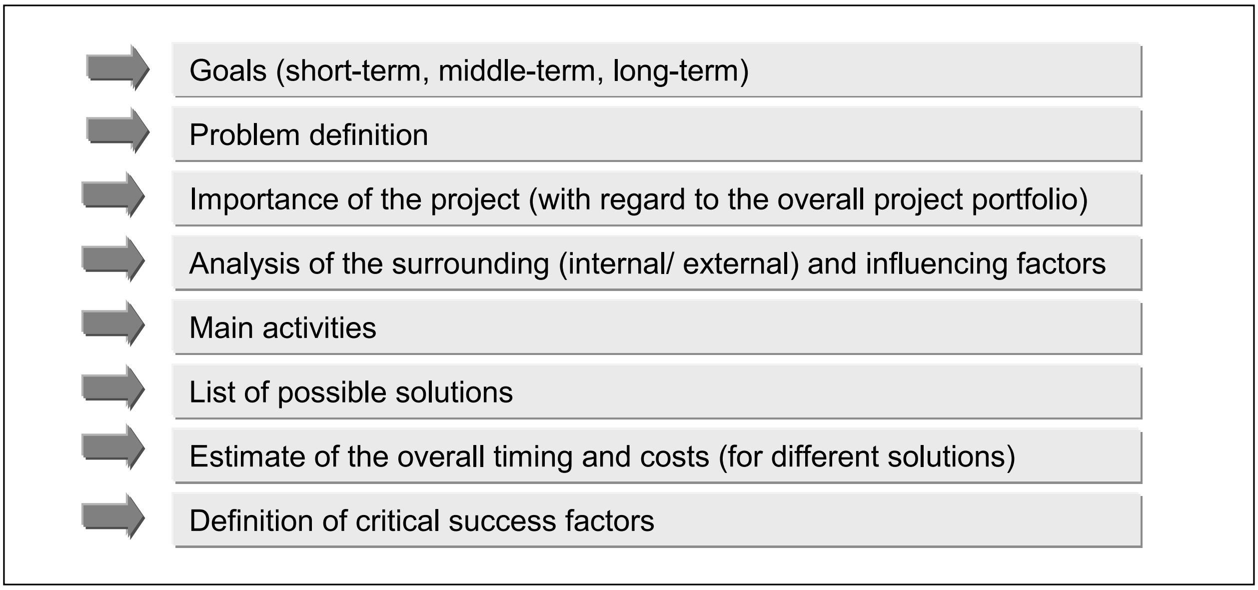

Figure 8: Elements of a project definition (own depection)

Work breakdown structure:

A work breakdown structure identifies all work packages required on a project. It ensures that all tasks required to satisfy the overall projects goals are done. The main activity is hierarchically broken down into partial activities. The smallest activities are called work packages. Work packages should be tangible, deliverable items. They should be sufficiently small so that each is understandable. The work breakdown structure is the basis for time, cost and resources estimates. *Figure 9* shows a work breakdown structure for a photovoltaic solar power system.

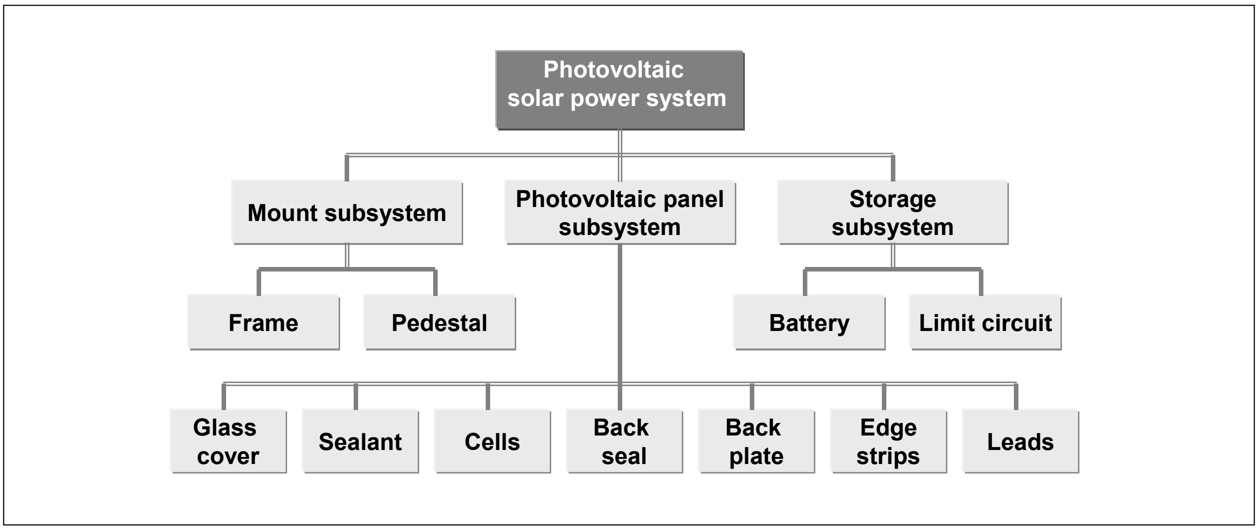

Figure 9: Work breakdown structure (Rosenau 1998)

Project schedule and time estimate:

The project schedule contains the durations and sometimes the sequence of single work packages defined in the work breakdown structure. Scheduling methods are milestone charts, which portray selected events, bar charts, which visualize activities as bars, and network diagrams which depict activities and their sequence and interdependencies.

Milestone charts:
Milestones are critical events, which require approval before proceeding further or a verification. These critical activities are depicted in a calendar bar chart.

Bar charts:
Bar charts *(figure 10)*, sometimes called Gantt charts after H. L. Gantt, consist of bars which represent the single activities, with their length being proportional to the time period required to fulfill that activity.

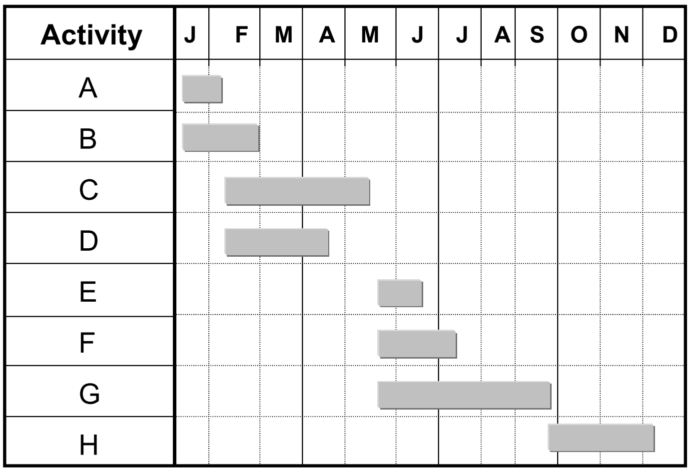

Figure 10: Bar chart (own depiction)

Network diagrams:
A network diagram links single activities with one another to portray interdependencies. Many different forms of networks diagrams are used, e.g. program evaluation and review techniques (PERT), or precedence diagramming method (PDM). *Figure 11* shows an example of a network diagram.

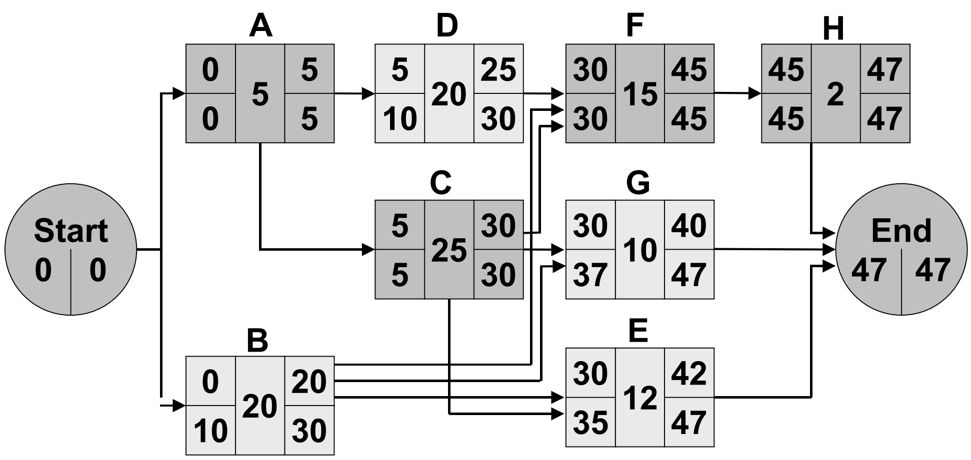

Figure 11: Network diagram (own depiction)

The earliest and latest time to start an activity, the duration, and the earliest and latest time to finish an activities are included (see *figure 12*).

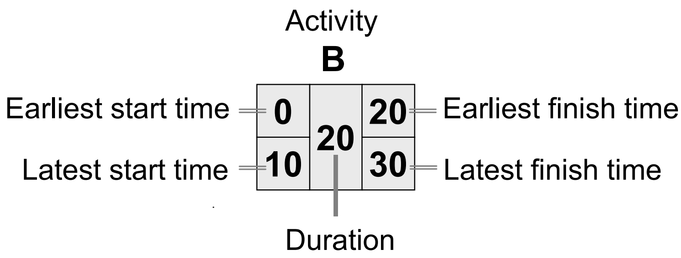

Figure 12: Detail of a network diagram (own depiction)

Latest timings are calculated by working backward from the end. This depiction enables to identify the critical path (in dark gray), and the slack between the earliest and latest time to start or finish an activity.

On the one hand, network diagrams contain more information than milestone and bar charts. They display interdependencies between different activities and can provide the critical path and slack. This is of particular use, if the diagram has to be adopted to changes. On the other hand, milestone and bar charts are simple to construct and easy to understand. There also exist mixtures between bar charts and network diagrams. The scheduling method should be selected with regard to the respective project and resources available. In practice, the easy to handle bar charts are widely spread, whereas network diagrams are seldom used.

Cost and resources estimates:

Based on the schedule, costs and resources can be estimated. Resources are human resources, equipment, and materials. There are several reasons to consider resource allocation at the beginning of a project. Firstly, inconsistencies can be avoided, e.g. the use of a particular resource on two activities at the same time. Secondly, if resources have to be shared with other projects, resource allocation provides information for the coordination of the resource between the projects.

Further tasks which should be part of a thorough project planning are the definition of responsibilities and a risk assessment. Project planning can be supported by a project management software, e.g. Microsoft Project.

A thorough project planning is vital for all kinds of innovation. For radical innovations, the time, cost, and resources estimates are of course much less accurate, whereas incremental innovations can rely on experience with similar activities. Hence, project planning is much easier to manage and do in the case of minor or routine innovation as in the case of breakthrough-type innovation.

An attempt to design a project management procedure which is useful in the case of radical innovations, Eppinger has deeloped DSM (see next chapter).

4.1.4 Design structure matrix (DSM)

According to Eppinger, “product development needs a fundamentally different planning tool” (Eppinger 2001), since generic project management approaches do not help innovation managers much further. Eppinger claims that conventional project planning methods and tools as presented in the former paragraph were created to plan large construction projects such as building houses. These projects are characterized by sequential or parallel tasks which need not to be reworked. The foundation of a house is not changed after building the walls. Complex product development products require innovation and therefore learning (feedback) loops. Network diagrams for complex product developments could run to tens or hundreds of pages and integrating changes is time-consuming.

Hence, an initiative at the MIT studies another approach to manage iteration *(http://web.mit.edu/dsm)*. The tool used, the so-called Design Structure Matrix (DSM) encourages useful iteration and eliminates unnecessary iteration with only marginally benefit. DSM was developed about 20 years ago, but is note widely known or used in companies. *Figure 13* shows a simple DSM. The tasks are listed in the order in which they are carried out. They are arranged in the same order horizontally and vertically. Across each row, tasks are marked that supply necessary information to the task in the row. For example, task B needs information from tasks A, G, and J. All the X’s below the dotted diagonal show information that is available, before the task that needs that information is begun. But an X in the upper half marks an information that is not available until the task that needs that information is already finished. That means, considerable rework might be necessary.

	A	B	C	D	E	F	G	H	I	J
A	*									
B	X	*					X			X
C	X		*							
D	X		X	*						
E		X	X		*		X		X	
F			X			*				
G						X	*			X
H		X		X				*	X	X
I	X		X	X	X		X		*	
J	X	X	X	X		X				*

Figure 13: The Design Structure Matrix (Eppinger 2001)

Besides making information flows in a product development process more transparent, DSM can be used to optimize information flows. For example, the sequence of tasks can be rearranged to reduce the number of X’s in the upper half and therefore minimize rework. Another example is the reduction of information exchange by changing the content of the tasks (Eppinger 2001).

As already outlined, DSM targets at complex product development projects that require iterations. Here, it can be a substitute for conventional planning tools like network diagrams presented in section 3.1.3., since the effort to analyze information flows could be very time-consuming.

4.2 Idea and Concept generation

In this section, we will not comment on conventional marketing forecasting techniques applied during the “fuzzy front end” or “creativity techniques” as these have been described in detail by numerous authors. Further, it has been confirmed widely by many authors (e.g. Deszca et al. 1999, Lynn et al. 1996, Lynn and Green 1998, Balachandra and Friar 1997, Song and Montoya-Weiss 1998, Bower and Christensen 1995) that conventional marketing approaches and even sophisticated analytical methods are inadequate for generating radical innovations. Instead, we present some marketing forecasting techniques, which claim to address this gap.

4.2.1 TRIZ

TRIZ is a method to systematically solve problems. During the sixties, it was developed in Russia by Altschuller and his colleagues. It is based on the assumption, that there are underlying principles to solve problems which are independent from a special industry or product. TRIZ draws analogies to existing solutions. Altschuller identified several underlying principles by analyzing numerous patents.

On the basis of such principles, fundamental technical contradictions, e. g. airplane or car crashworthiness versus light weight to reduce mileage, are solved.

An example of how TRIZ draws analogies is to use a quick pressure drop to open nuts, thus to make them “explode”. Similar solutions are used to remove the stalk and seeds from sweet pepper and split diamonds along microcracks (Terninko, Zusman, and Zlotin 1998).

During the 80ies and 90ies, TRIZ became popular in the U. S., sometimes under the acronym TIPS (Theory of Inventive Problem Solving). It was integrated in software solutions like Invention Machine TechOptimizer and Ideation International Innovation WorkBench. Today, companies like General Motors, Johnson & Johnson, Ford Motors, and Proctor & Gamble are using TRIZ.

Altschuller originally targeted at incremental and technical innovation (Terninko, Zusman, and Zlotin 1998). Although there are some recent efforts to solve other problems like management problems with TRIZ, incremental and technical innovation are the main application domain of TRIZ. Although supported by software, TRIZ is very demanding to apply and needs a lot of practice.

4.2.2 The lead user method

An approach to address the issue that today’s customers are stuck to existing products and are not able to envision their future needs (“functional fixedness”) is to select qualified customers, so-called “lead users”.The “lead-user” method, originally developed by von Hippel, allows to identify such qualified customers and to either learn from their exptertise or to develop new product concepts based on their insights.

The existence of innovative users who create their own solutions has been proven by several studies. Examples are “TipEx”, which was invented by a secretary in the 50s and converted by 3M into a commercial product, or the sports drink “Gatorade”, which was developed by a trainer of a college football team. Urban and von Hippel identified innovative users in the field of computer-aided design (CAD) systems for printed circuit boards (Urban and von Hippel 1988). Herstatt proved the existence of innovative users in low-tech fields (Herstatt 1991), Luethje for consumer goods (Luethje 2000). A study of innovations in skateboarding, snowboarding and surfing shows that the source for almost every basic product development were sportsman and not the manufacturers of sporting equipment (Shah 2000).

Hence, it seems plausible for enterprises to identify and integrate such innovative users into their innovative projects. For this purpose, MIT professor Eric von Hippel developed an heuristic approach, the lead user method (in the 80s). According to him, lead users can be described by two characteristics:

1. Lead users face needs that will be general in a marketplace – but face them months or years before the bulk of that marketplace encounters them.
2. Lead users are positioned to benefit significantly by obtaining a solution to those needs.

Figure 14: Lead user characteristics (Urban and von Hippel 1988)

The first characteristic selects qualified users that are trendsetters in the respective marketplace and are already concerned with needs that the majority of the marketplace will face much later. The second characteristic covers the motivational aspect. Users only try to find solutions for issues if they can benefit significantly from the solutions. *Figure 15* illustrates the shape of the market trend. Lead users have needs that are well ahead of the trend.

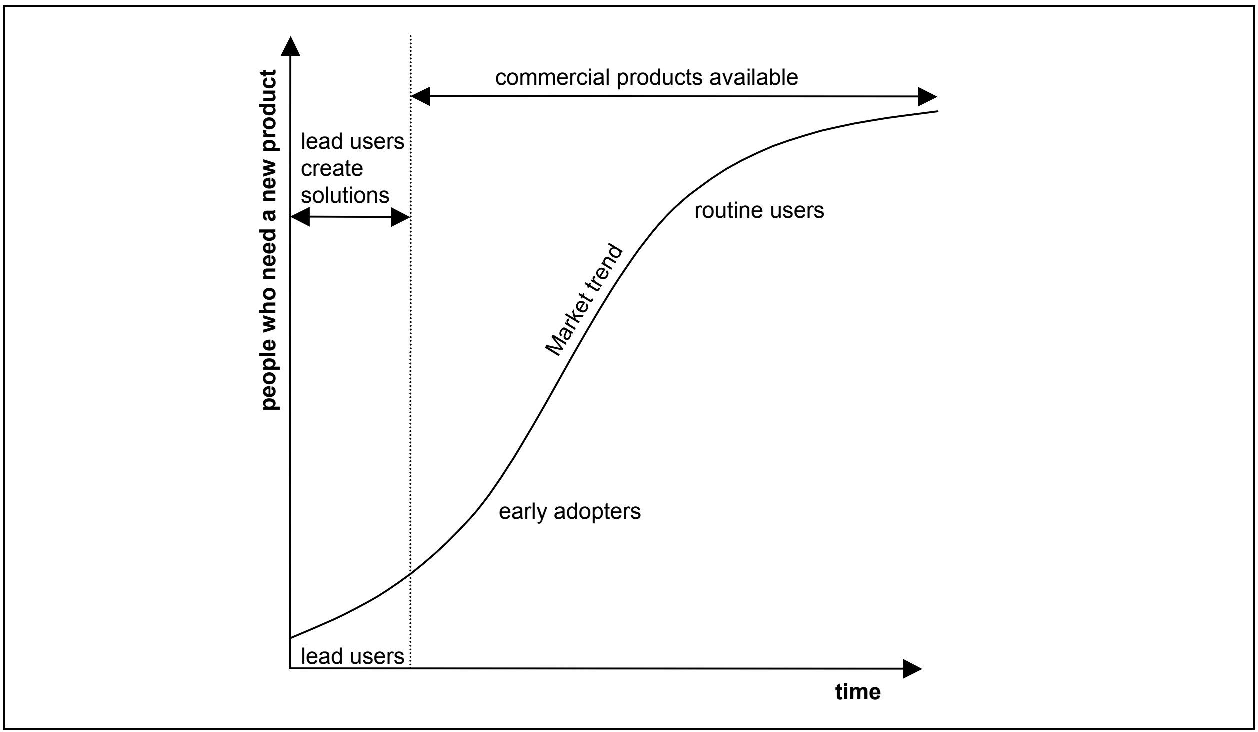

Figure 15: The lead user curve (von Hippel, Thomke, and Sonnack 1999)

Figure 16 shows the process of a typical lead user project. Firstly, the direction the innovation should take is determined and goals are set. An interdisciplinary team with members from technical as well as marketing functions is formed. Future trends are determined in more detail by expert interviews and trend forecasting. As a result, a deeper understanding of market and technological trends emerges, which enables the team to catch first hints of lead users in the target or analogous markets. In phase II the characteristics of the respective lead users are defined in more detail. A sample which could be the target market or analogous markets is chosen and lead user characteristics are studied in more detail. Lead users are identified via interviews or mail surveys. In addition, first solutions from these lead users are observed and collected. During the next phase, lead users and an interdisciplinary company-internal team are brought together in a workshop that takes two to three days. After presenting the collected solutions from lead users, rough concepts are developed and the best are selected. The lead users are split up in smaller groups to develop the concepts in more detail. The results are documented and tested in a wider field in phase IV. Market studies, a technical and economical feasibility study result in a technical concept and a business plan. This is the point were the lead user process flows into the conventional innovation process.

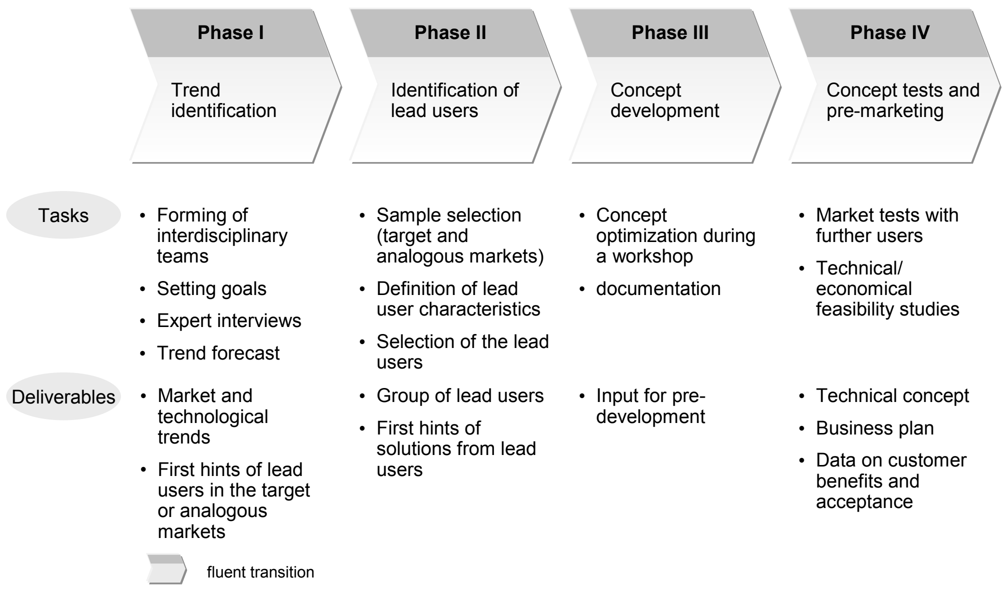

Figure 17: The lead-user process (own depiction)

The lead user approach has been used for industrial as well as consumer goods (Herstatt and von Hippel 1992, von Hippel, Thomke, and Sonnack 1999, Herstatt, Luethje, and Lettl 2001). This approach has been approven useful for all types of innovation projects.

4.3 Concept testing

4.3.1 Information acceleration

For radical innovations, it is often not obvious who the “true” customer may be and even if known, customers are often not able to envision their future needs (for example the personal computer in the 19seventies (Lynn and Green 1998, Bower and Christensen 1995). Radical innovations shift market structures, require customer learning, and induce behavior changes (Urban et al. 1996). Hence, it is often extremely difficult to determine the potential market or even the potential customer.

Information acceleration is such a method that places potential customers in a virtual future environment and measures the likelihood of purchase, perceptions, and preferences. The future environment is multi-media based and often includes virtual newspaper articles, advertising, or prototypes. A customer can choose the information sources he or she would usually use to make a buying decision. This specific approach overcomes the deficiencies of conventional techniques which do not enable the customer to envision a future environment and present only a small amount of information which might not be relevant for buying decisions (Rosenberger and de Chernatony 1995).

Unfortunately, only very few examples of applications of this marketing technique are described in the form of case studies, e.g. electric vehicles at General Motors (Urban et al. 1996). This is not surprising as the costs for a single application of information acceleration are very high, often exceeding $100.000 for a single application (Urban et al. 1996). Therefore, information acceleration is only recommended for high-risk products requiring large capital commitments (Urban et al. 1997). For such kinds of products the risk and development time can be reduced, and product improvements can be identified earlier. Hence, as early prototyping described in the previous section, information acceleration is a method that can be applied in the context of a “front-loading” approach. Information acceleration is limited to the testing of existing concepts. It does not enable customers to develop own ideas. From this perspective, information acceleration may support radical innovation but will not naturally lead to it.

4.3.2 Web-based conjoint analysis

Hauser and his colleagues at the MIT have developed further, less expensive and time-consuming ways instead of information acceleration, using information and communication technologies for concept testing (Dahan and Hauser 2000). Here, we present web-based conjoint analysis as an example of how a traditional method uses the possibilities of the World Wide Web.

Conjoint analysis is known since more than 20 years and is the most used quantitative method for concept testing. Basically, in a conjoint analysis a product is decomposed into features with different characteristics for each feature. The aim of a conjoint analysis is to find out which characteristics of the features customers prefer and how much they value the features. It is a mathematical technique to reduce the amount of combinations of feature characteristics which have to be ranked or rated by customers (for a detailed description of conjoint analysis see Urban and Hauser 1993).

For example, an instant camera for teens might be represented by features such as picture quality (low, high), picture taking (1-step, 2-step), or picture removal method (manual, automatic) (Dahan and Hauser 2000).

Virtual conjoint analysis enables concept tests without building physical prototypes. On the one hand, as the costs for virtual prototypes are lower than for physical prototypes, more concepts can be tested within the same market research budget. On the other hand, there is a serious risk of sample bias from using web-based respondents. Although studies at MIT so far indicate that virtual prototypes deliver similar results as physical prototypes, this might strongly depend on the kind of product. To overcome this disadvantage, the results with virtual prototypes should be compared to a small amount of physical prototypes. As the product must be decomposed into features and the customer must be able to grasp the concept, web-based conjoint analysis is limited to incremental, market, and technical innovation. For radical innovation, we believe, this method is not appropriate.

Further methods that integrate information and communication technology are presented on a web page at the MIT *(http://mitsloan.mit.edu/vc)*. They go beyond porting traditional methods to the web, e. g. by enhancing the communication between customers.

5. SUMMARY AND CONCLUSIONS

This chapter described “fuzzy front end” of innovation, it´s vital importance for the innovation process, processes, structures and methods supporting it´s management. A framework was presented to systematize the application fields of such processes and methods to support the front end. Eight methods concerned with process improvement, concept generation, and concept testing were selected and described in more detail. *Figure 18* gives an overview of these methods and their respective application fields. They range from “basic” methods like thorough project planning to relatively demanding marketing techniques such as information acceleration.

Area	**Chapter**	**Method**	**Application**			
			Incremental innovation	Market innovation	Technical innovation	Radical innovation
Process	4.1.1	“Stage-gate” approach	**X**			
	4.1.2	“Front-loading” problem-solving	**X**	**X**	**X**	
	4.1.3	Project planning	**X**	**X**	**X**	X
	4.1.4	Design structure matrix (DSM)		**X**	**X**	**X**
Concept generation	4.2.1	TRIZ	**X**	X	**X**	
	4.2.2	Lead user approach	**X**	**X**	**X**	**X**
Concept testing	4.3.1	Information acceleration		X	X	**X**
	4.3.2	Web-based conjoint analysis	**X**	**X**	**X**	

X= applicable with good results for
X= difficult to apply

Figure 18: Front end methods and their application field (own depiction)

We cannot and shall not recommend a particular method. Instead, the degree of newness to the firm, the importance of an opportunity, and the resources of an enterprise (e. g. depending on the size), have to be taken into consideration. In addition, it might be useful to apply several methods to level the advantages and disadvantages of the single methods, which are described in section 4.

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