Approaches to the "Fuzzy Front End" of Innovation

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ABSTRACT

In new product development (NPD) unacceptably high failure rates have often been related to insufficiencies during the early development phases. Nevertheless, only little effort is devoted to the early phases, in theory as well as in practice, and managers often indicate the front end as being one of the greatest weaknesses in product innovation. Therefore, it is surprising that only little research has treated the so called "fuzzy front end" of innovation. In this paper we discuss if process models lead to success in the early development phases. Therefore, the discussion about process models for the whole innovation process is briefly summarized and findings applied to the "fuzzy front end". Due to high uncertainties with a wide range between different innovations in the early phases, process models are found to lead to success for incremental innovations with low market and technological uncertainty only. For innovations with a high market and/or technological uncertainty, a learning-based approach is suggested.

1. INTRODUCTION

Successfully launching new products in the marketplace is vital for the long-term survival of enterprises. As life cycles shorten and the technological and competitive environment, and customer needs are changing fast, there is a strong need to optimize the innovation process.

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 execution of pre-development activities, and a well defined product and project prior to the development phase (Cooper and Kleinschmidt 1990). The early phases determine to a great extent which projects will be executed. As these result in costs, timings and success, we think it is worth having a closer look at the "fuzzy front end".

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 successes are compared to failures, about twice as much money and time is spent for the front end stages. Although the importance of the early development phases is recognized, researchers and practitioners still focus on the later phases of the innovation process, where information is more reliable. It is still doubted that the early development phases, often called "pre-development" (Cooper and Kleinschmidt 1994), "pre-project activities" (Verganti 1997), "fuzzy front end" or "pre-phase 0" (Khurana and Rosenthal 1997/1998) are manageable at all. Researchers and practitioners are afraid of coping with the conflict between creativity and systematization. The front end is dynamic with little documentation. This makes it difficult for researchers to gather reliable information and to generalize results.

In this paper, we discuss whether the application of process models leads to success during the early development phases. Therefore, we first give a short overview of the general discussion about process models and the extensive research on the systematization of the whole innovation process (chapter 2). Second, we apply these findings to the early phases (chapter 3). The sequential process model approach is found to be successful for incremental innovations only. In chapter 4, alternative approaches for innovations with high market and/or technological uncertainty are suggested. A brief summary and issues for further research are presented in chapter 5.

2. STRUCTURING THE INNOVATION PROCESS

It is extensively discussed and empirically verified whether and how the whole innovation process should be structured and systematized. There are a vast number of models existing which divide the innovation process into phases. They vary with regard to the degree of going into detail, the priorities and the perspective, e. g. market or technological.
Figure 1 shows one model which is often cited, the so called “stage-gate-process”. The innovation process is divided into five phases from the preliminary assessment of an idea to its commercialization. After every stage there is a gate deciding on continuing or terminating the project. The stage-gate-model integrates the market and technological perspective. Activities are performed in parallel and decisions at the gates are made within cross-functional teams.
One of the major advantages of process models is the systematization of the often ad hoc development. The process is transparent for all departments and a common understanding can be developed. This eases communication in teams as well as with top management. 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. Cooper (1994) developed a further so called third generation stage-gate model to make the process more flexible. The phases are fluent with fuzzy gates.
Nevertheless, a lack of flexibility due to the sequential approach is often criticized.

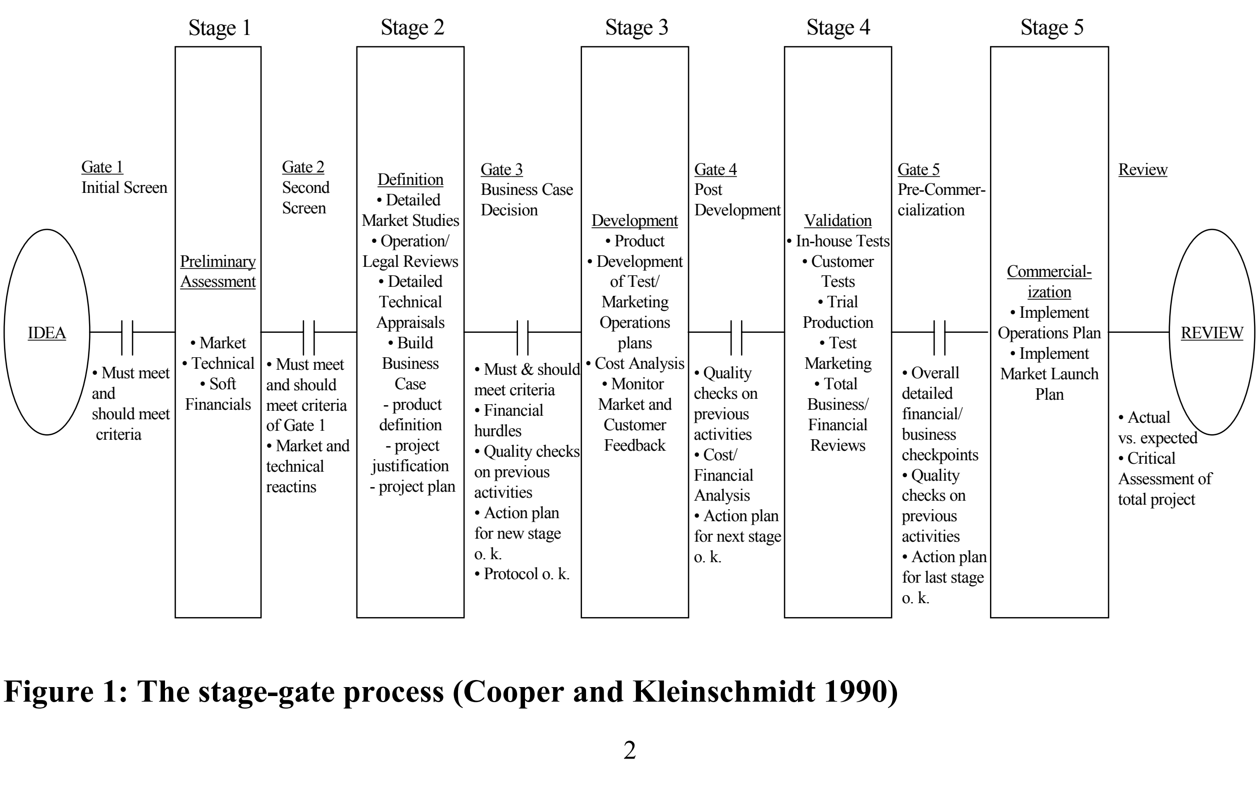

Figure 1: The stage-gate process (Cooper and Kleinschmidt 1990)

Figure 2 shows the overlapping of five tasks instead of a linear, sequential approach. The single tasks from strategic planning to commercialization do not have to be completed before the following task is begun.

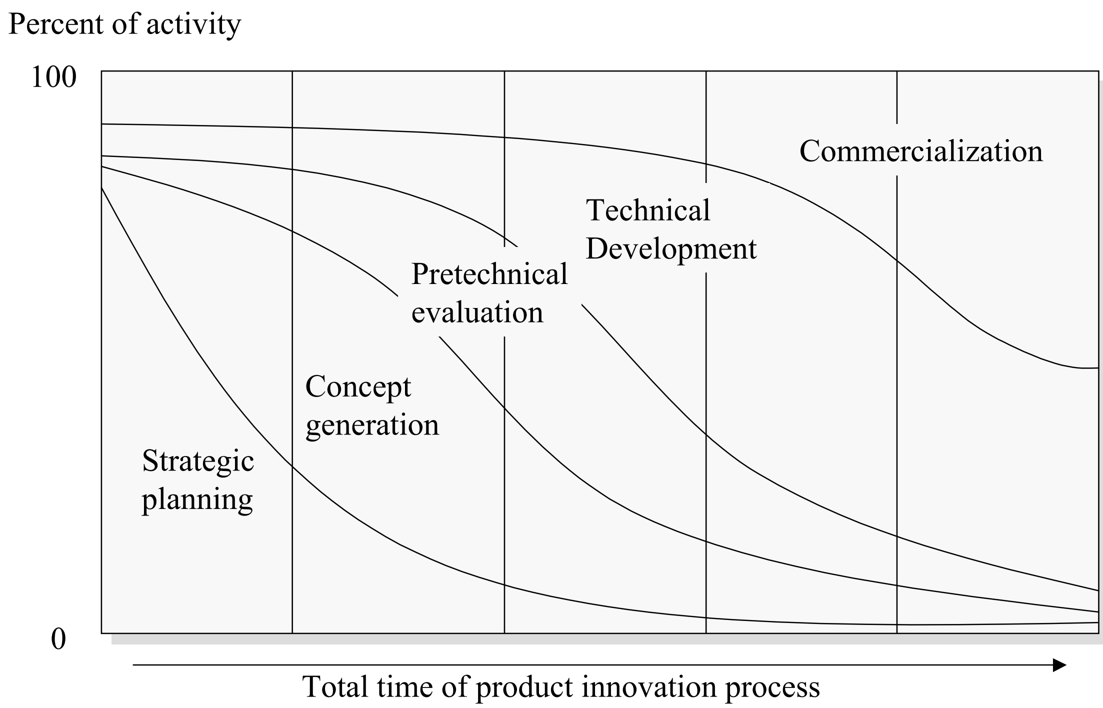

Figure 2: Simultaneous activities in the innovation process (Crawford 1994)

During the last years, several process models try to overcome the described deficiencies and increase flexibility, e. g. "chain-link" models (Kline and Rosenberg 1986) or the value proposition cycle (Hughes and Chafin 1996).

3. STRUCTURING THE "FUZZY FRONT END"

In this chapter, we discuss whether the findings for the whole innovation process presented in chapter 2 can be applied to the front end.

The "fuzzy front end" ranges from the generation of an idea to either its approval for development or its termination (Murphy and Kumar 1997). There are several process models for the early phases existing (e. g. Cooper 1988, Murphy and Kumar 1997). The probably most sophisticated process model of the "fuzzy front end" is shown in figure 3. 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".

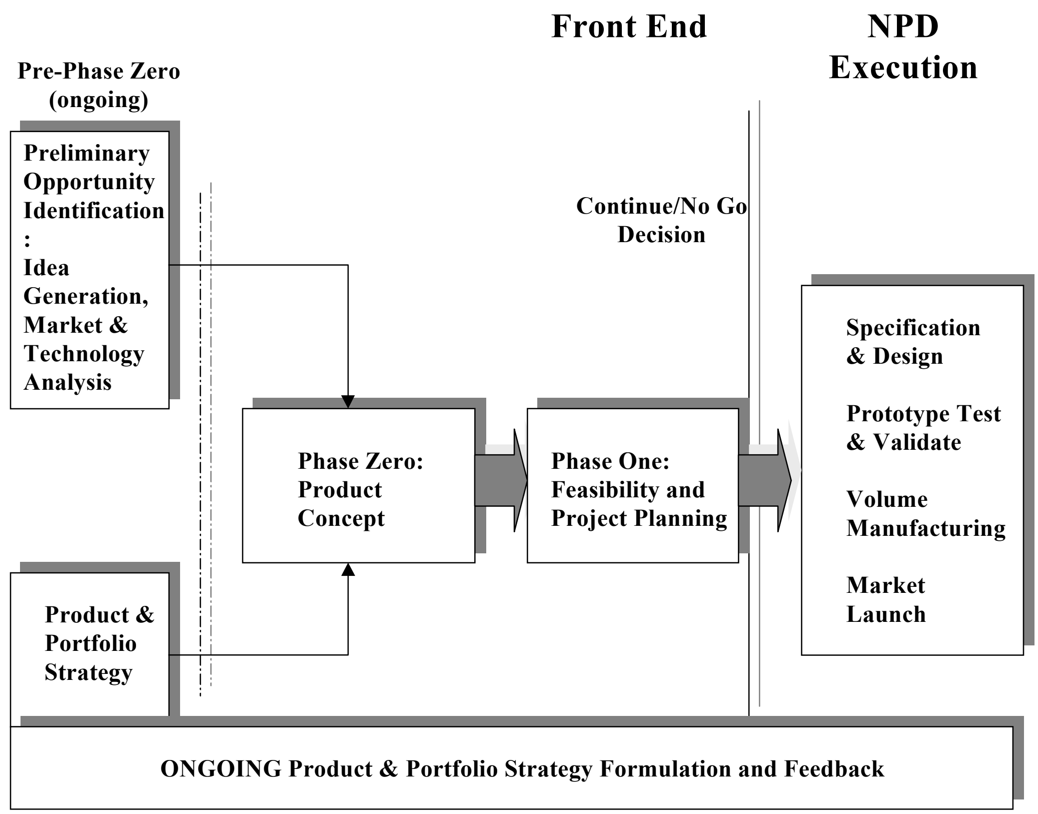

Figure 3: A model of the front end of NPD (Khurana and Rosenthal 1998)

The process model 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.

The project specific elements start with the so called "pre-phase zero". Unfortunately, Khurana and Rosenthal do not describe the preliminary opportunity identification and idea in detail. We suggest to start any kind innovation with an assessment of the potential market. Nevertheless, the ideas are often generated in the technical area ("technology push" vs. "market pull"). Particularly for radical new products the first assessment is often qualitative. In the course of time information gets more reliable and uncertainty reduces. Result of a first qualitative screening is an idea portfolio. This has to be aligned with the 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 alignment with existing plans. In phase one, the business and technical feasibility are assessed, the product is defined, and the NPD project is planned. Primary front-end deliverables are therefore a clear product concept, the product definition, and the project plan. If a product concept is approved, the NPD execution starts.

Khurana and Rosenthal's front end model has the same advantages and disadvantages as the linear, sequential process models described in chapter 2. On the one hand, it is a good tool to visualize and structure front end activities, reduce the fuzziness, and ease communication. On the other hand, it lacks flexibility.

While we think that a systematic process as Cooper empirically verified leads to success during the later phases (development and commercialization), the early phases need a closer look. This is due to the fact, that different degrees of uncertainties at the beginning are reduced to similar amounts until start of development. Therefore, the later phases can be managed in a similar way. Veryzer ‘s case studies (1998) suggest, that discontinuous new product processes should flow into conventional new product process. However, management of the early phases must be adopted to the wide range of uncertainties possible for different innovations. In addition, flexibility is even more important during the early phases, as uncertainties are highest.
A common differentiation is made between incremental and radical, “breakthrough” innovation or continuous and discontinuous innovation (Lynn, Morone, Paulson 1996). There are several definitions of “breakthrough” innovations[1] (e. g. Rice 1999, Song and Montoya-Weiss 1998). However, there has not emerged a common understanding of these terms yet, which limits the comparability of theoretical considerations and empirical research as well. To discuss whether process models lead to success in the front end, we think the differentiation between incremental and “breakthrough” is not sufficient, as the innovation differs depending on market or technology uncertainties (see figure 4). Uncertainty is the difference between the amount of information required to perform a particular task and the amount of information already possessed (Galbraith 1973). Innovation strategies must be adopted to the respective uncertainties.

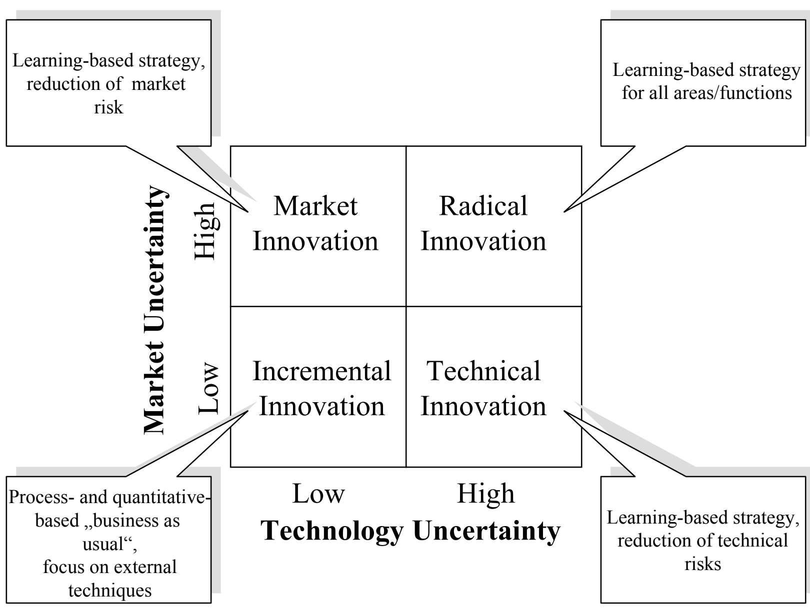

Figure 4: Market and technology uncertainty determine NPD strategies (according to Lynn and Akgun 1998/modified by the authors)

We think, that for pre-development activities a systematic approach with process models leads to success for incremental innovations with low market and technological uncertainty. By way of contrast, there is no detailed model or “roadmap” how to develop a product or process innovation with high uncertainty. For high uncertainties, a more flexible approach with iterations and parallel activities is needed. In addition, successful radical innovations often use methods like rapid prototyping or virtual prototypes in the phases zero or one instead of during NPD execution (compare figure 3). Early prototypes enable better visualization and communication of the

[1] A detailed review is given by Veryzer (1998)

product concept, which strengthens early top management support, linkage to the overall portfolio, and better decision making before NPD execution. Idea generation takes part throughout the whole project, instead of in the beginning only (Rice, O'Connor, Peters and Morone 1998).
To summarize, process models lead to success in the early phases of incremental innovations.

4. MANAGING THE "FUZZY FRONT END"

As process models are found to be successful for the early phases of incremental innovations only, in the following, management approaches for the "fuzzy front end" of innovations with different amounts of uncertainty are described.
First, we take a closer look at the lower left quadrant of figure 4: For incremental innovations that use a mature technology in known markets, the focus should be on the innovation process and accurate quantitative analysis (Lynn and Akgun 1998). Successful incremental innovations use external market forecasting techniques, such as customer interviews or customer surveys (Lynn and Green 1998). Typical examples are small product improvements, product line extensions or "me too" products that are similar to competition and use an already existing technology.
Under the condition of low technology and high market uncertainty, a learning-based strategy should be applied. This is also valid for the other conditions with at least one high uncertainty. For this condition, the focus should naturally be on reducing the market uncertainty, for the condition of high technology but low market uncertainty, it is important to reduce the technological risk. Examples for these conditions are 3M post-it-flags and designer jeans, or pharmaceuticals, where the customers are well known, but the technology uncertainty is often high, respectively.
The right upper quadrant shows radical innovations with high market as well as technological uncertainty. The final product might not be known, or its ultimate features, costs or technical feasibility. Therefore, it is difficult to determine the potential market. An empirically study by Song and Montoya-Weiss (1998) suggests that for these kind of innovations, thorough strategic planning is a key success factor. Several empirical studies confirm, that a learning-based approach is especially adequate for these kinds of innovations (Lynn and Akgun 1998, Lynn and Green 1998, Rice, O'Connor, Peters and Morone 1998). All areas and functions have to go through extensive learning-processes and sometimes years of trial-and-errors. One example for such a successful learning-based strategy is 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. Furthermore, it is often suggested, that especially in the front end radical products or processes should be developed separately from ongoing business activities (Rice 1999, Rice, O'Connor, Peters and Morone 1998, Lynn 1998) to reduce the fixedness on already existing solutions. It is confirmed by several empirical studies (e. g. Lynn, Morone and Paulson 1996, Lynn and Green 1998, Balachandra and Friar 1997, Song and Montoya-Weiss 1998) that conventional marketing approaches and sophisticated analytical methods for evaluating new product opportunities (e. g. cash flow) are inaccurate for "breakthrough" innovations. It is often not clear who the customer is and customers are sometimes not able to envision their future needs, e. g. the personal computer in the seventies (Lynn and Green 1998). While a detailed quantitative market analysis is one of the key factors for success for incremental innovations, they could even hinder "breakthroughs", which in this case means the upper quadrants of figure 3 with a high market uncertainty. Instead, a "probe and learn" process (Lynn, Morone and Paulson 1996) with early prototypes (Lynn, Morone and Paulson 1996, Rice, O'Connor, Peters and Morone 1998, Mullins and Sutherland

1998, Verganti 1997, Veryzer 1998) seems to be appropriate for large innovation steps. In many cases, the first experiences with prototypes are negative (f. i. GE's CT scanners). The emphasis is on gaining maximum information and not on "getting it right" the first time. As "breakthrough" innovations sometimes cause high costs for years with no guarantee of success due to high uncertainties a short term cost-oriented perspective would not allow for any "breakthroughs". This is valid for all quadrants with a high market and/or technological uncertainty.

To summarize, while in the early phases process models lead to success for incremental innovations, successful innovations with high market and/or technological uncertainty use a learning-based approach.

5. CONCLUSIONS AND ISSUES FOR FUTURE RESEARCH

In this paper, we discuss whether process models lead to success during the early development phases. It is found, that due to high uncertainties in the "fuzzy front end" and the wide range of uncertainties possible, this question cannot simply be answered with yes or no.

Instead, market and technological uncertainty have to be taken into consideration:

Research suggests, that a process- and quantitative-based approach with use of external market forecasting techniques, is a successful approach to incremental innovations only.

For radical innovations, however, a learning-based approach integrating all functions is appropriate. Market and investment forecasting should be qualitative. Early prototypes accelerate the "probe-and-learn" process.

For innovations with a high market or technological uncertainty, the respective risk should be reduced by using an iterative, learning-bases approach as well.

Until now, the value of process models as well as the influence of market and technology uncertainty have been examined and discussed for the whole innovation process only. We outlined, that these factors are particularly important for the "fuzzy front end". Therefore we suggest to join these three research streams and examine the "fuzzy front end" considering the market/technology uncertainty matrix, e. g. for the consumer goods industry, where process models are applied. This systematic approach could reduce the "fuzziness" of research on the "fuzzy front end".

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