Conference Paper

Towards a Structured and Integrative Front-End of Product Innovation

Author(s):
Sandmeier, Patricia; Jamali, Nadia; Kobe, Carmen; Enkel, Ellen; Gassmann, Oliver; Meier, Markus

Publication Date:
2004

Permanent Link:

https://doi.org/10.3929/ethz-a-010090510 →

Towards a Structured and Integrative Front-End of Product Innovation

Patricia Sandmeier*, Nadia Jamali**, Carmen Kobe**, Ellen Enkel*, Oliver Gassmann*, Markus Meier**

patricia.sandmeier@unisg.ch
nadia.jamali@imes.mavt.ethz.ch
kobe@imes.mavt.ethz.ch
ellen.enkel@unisg.ch
oliver.gassmann@unisg.ch
meier@imes.mavt.ethz.ch
*Institute of Technology Management, University St. Gallen, Dufourstrasse 40a, 9000 St. Gallen, Switzerland
**Center for Product Design, ETH Swiss Federal Institute of Technology Zurich, Tannenstrasse 3, 8092 Zurich, Switzerland

The front-end phase of the innovation process comprises up to two-thirds of the total cost of new product development. Practitioners and innovation researchers agree upon the relevance of this early innovation stage, which consists of opportunity identification, idea generation and evaluation, business-plan development and product conception. Yet the need for structuring the front-end phase for improved performance in innovation is slowly gaining recognition.
Companies' current product development processes concentrate on sequential methodologies. They are not transferable to the fuzzy front-end phase with its iterative learning cycles. As a result, product requirements and technical feasibilities are typically not fixed before the official product development process starts. Furthermore customer requirements are neither fully explicit nor stable. They must be stimulated or externalised by prototype modules, which can be viewed, explored and understood by customers. Consequently, this study develops a process-model for a structured innovation front-end phase taking into account iterative learning cycles between product development stakeholders. This idea parallels the 'extreme programming' approach known from the field of software development. Short cycles with high iterative learning potential have increased efficiency and effectiveness of the innovation process by factors.
The empirical base of case study consists of 19 case studies with European companies from different modular industries. First analysis of our ongoing research provides an iterative and semi-structured process model for frontloading the explicit and hidden customer requirements.

1. Enabling Innovation Potentials in the Innovation Front-End

A) Trends in Innovation Process Management

The pressure for "innovativeness" is higher than ever. Shortened innovation cycles, the fusion of industries, and, as a consequence, a rapid changing environment of market players, organisational forms and business models lead to a call for more effective and efficient innovation activities. Cutbacks in R&D budgets and, at the same time, escalating costs of industrial research and development (R&D) forced companies to the comprehension of not being able to do all by themselves.

The innovation potential of product-development stakeholders outside the company, as suppliers, customers and even competitors, has to be captured. This phenomenon, known as "Open Innovation", has become increasingly important for both practice and theory over the last few years: out of necessity, companies are tapping

the innovation resources and capabilities of suppliers, partners, and third party designers (Hagedoorn and Duysters 2002; Muller and Välikangas 2002; Rigby and Zook 2002; Chesbrough 2003; Chesbrough 2003; Chesbrough 2003; Lüthje, Lettl et al. 2003; Gassmann, Sandmeier et al. 2004).

The underlying driver for this push to open up the innovation process lies in the increasing need for companies to develop the ability to quickly adapt to a rapidly changing environment (Muller and Välikangas 2001; Miotti and Sachwald 2003). Crucial for quick market adaptation remains, of course, time-to-market, which is enabled by a disciplined new product development process as successful simultaneous engineering examples show. The automotive industry demonstrates that with a value creation of only 20% at the OEM, the limit is reached.

An amplified challenge for quick market adaptation through development of new product lies in "betting on the right horse". Considering the stressed R&D budgets and the fact that the early phase of the innovation process comprises up to two-thirds of the total cost for new product development, the decision on the right investments has to be brought about as soon as possible. This front-end phase assigns the efficacy of innovation activities and comprises the capability to consequently renew the product portfolio according to market needs.

The strategic relevance of this front-end phase has been recognised and after focussing on a sophisticated development process, attention is now paid to the emergence mechanisms of ideas for successful product breakthroughs. Regarding the management of the front-end, R&D managers are thus divided into two groups: one believing in the additional potentials offered by a strict structuring of the front-end phase, and one rejecting any structure based on the belief that creativity and invention potentials are killed by pressing them into a defined process.

B) Structuring the Front-End Phase?

The innovation front-end consists of opportunity identification, idea generation and evaluation, business-plan development and product conception (see e.g. (Cooper and Kleinschmidt 1986; Gassmann 1997; Khurana and Rosenthal 1997; Koen, Ajamian et al. 2001; Kim and Wilemon 2002; Tidd and Bodley 2002; Ullman 2002). This innovation stage is known as well under the term *fuzzy front end*, a phrasing that points out the difficulties in managing the processes lapsing to the point of a promising concept for a new product. For instance, Dahan and Hauser (2001) state that the fuzzy front end may be viewed through the lens of an uncertain search, Koen, Ajamian et al. (2001) speak of "the mysterious portion" of the innovation process. Reasons for the lack of research in the area of the innovation front-end lie therefore in the difficulty to recognise and explain these activities resembling iterative learning cycles and the lack of common terms and definition for the early innovation phase.

Yet the need for actively managing the front-end phase for more efficient innovation is gaining recognition; companies do not want to leave the innovation of new products to chance. To find an ideal solution at the intersection of customer preferences and firm capabilities, a process structure for the front-end appears as a *conditio sine qua non*.

Companies' current attempts of actively managing the early stages of the product development processes concentrate on sequential methodologies known from the project management activities in latter innovation stages. Difficulties to implement these processes occur because these methodologies are not transferable to the fuzzy front-end phase with its iterative, and fuzzy characteristics. As a result, this process does typically not lead to defined business concepts of high potential ideas with concrete product requirements and technical feasibilities before the official product development starts.

As a consequence, theoretical models based on round illustration try to allow for the actual activities of the front-end (Khurana and Rosenthal 1997; Kim and Wilemon 2002; Koen, Ajamian et al. 2002; Walls 2002). Critiques of these dynamic models come from practitioners who speak out their difficulties to apply these methodologies. Since the models based on iterative learning cycles remain highly abstract they are hardly transferable to a business situation.

The authors look for a combination of the sequential approach and the round front-end models to find a process structure that reliably represents the reality of the front-end activities and helps practitioners to manage them. Furthermore, the authors believe that a front-end process model cannot be a rigorous code of practice as utilized for other operational actions. Instead the model should represent a detailed management guideline for the substantial front-end elements. It includes: a checklist for front-end activities with their needed inputs and outcomes, organizational integration mechanisms, and methods for implementation to approach an integral base to come to the right investment decisions. This model ensures a portfolio of new products that fit present and future customer needs.

A structured innovation front-end allows a systematic proceeding of accessing information from multiple sources resulting in more viable views of future business development. Recent research suggests that cross-functional decision-making gets better results. Therefore innovation sources from outside the company have to be involved in the front-end as well in order to broaden the perspective for new product and business opportunities. As a consequence, resources for new product development are amplified from the very beginning of product innovation.

C) Review of Front-End Literature

Despite substantial research in new product development, R&D managers acknowledge the rarity of successful practice examples of actively managing the front-end of innovation. In the literature theoretical models describing and illustrating the iterative characteristics of the front-end do exist, but few authors present descriptions of case

studies explaining the activities of opportunity identification, idea creation and product concept development as defined chains of actions (Khurana and Rosenthal 1997; Khurana and Rosenthal 1998; Dahan and Hauser 2001; Kim and Wilemon 2002; Koen, Ajamian et al. 2002; Walls 2002). Extensive literature can be found about sequential methods that can be applied to implement single front-end activities, e.g. road mapping, scenario analysis and all kinds of creativity methods (Conway and McGuinness 1986; Christensen and Anthony 2001; Kelley, (Contributor) et al. 2001; Bayer 2003; Goldenberg, Mazursky et al. 2003; Jeff Mauzy 2003; Mauzy and Harriman 2003).

Special attention should be given to the timing of the definition of the technical product concept: On the one hand, should the description of an innovation task only include requirements in order to allow multiple variants of technical solutions? On the other hand, should the most important project risk, as well as the resources and costs needed during the project be known at the point of project start (Akao 1990; Chen and Menq 1992; Billatos and Grigly 1993; Cross 1994; Eppinger, Whitney et al. 1994; Kusiak and Larson 1995; Reinertsen 1997; Cooper 1999; Ajamian and Koen 2002; Altshuller 2002; Mikkola and Gassmann 2003; Thoma 2003; Angelis 2000). Until now there is no innovation process model detailed enough to respond to this dilemma.

Under the term *front-loading*, researchers point out the importance of early integration and cross functional decision making of R&D, marketing, and production (Thomke and Fujimoto 2000). The goal of the front-loading approach lies in reducing product development time and cost by early identification of potential production problems to subsequently free up resources to be more innovative in the marketplace.

As a consequence of the enhanced demand for adaptability to the rapidly changing market environment, early customer integration has to be taken into account for a structured and integrative front-end. Today's literature brings out a rich body of co-development and customer co-operation examples. Instead the lead-user approach by Urban and von Hippel (1988) still remains the only overall concept of an active involvement of the sequencing value chain elements in the front-end of innovation (Urban and von Hippel 1988; Kotler 1999; Dahan and Hauser 2001; Kohn and Niethammer 2002; Lilien, Morrison et al. 2002; Thomke and von Hippel 2002; Ulwick 2002; von Hippel and Katz 2002; Sandmeier and Wecht 2004). Especially, Urban and von Hippel's advancements in the subjects of user toolkits and early customer integration enabled by new information and communication technologies, give new interesting insights (von Hippel 1986; von Hippel, Thomke et al. 1999; von Hippel 2001; Herstatt 2002; von Hippel and Katz 2002). They give hints about how the customer's knowledge as product user, and particularly how his technical development competence in the business-to-business area, can be used and institutionalized in an innovation front-end process.

D) Aims of this Paper

This paper will focus on the development of a process-model for a structured product innovation front-end phase taking into account iterative learning cycles between product development stakeholders. This idea parallels the 'extreme programming' approach known from software development. Short development steps with clearly defined tasks, aligned to the customer's needs, allow short and highly creative process cycles with high learning potential for the company. With this methodology efficiency and effectiveness of the innovation process were increased by factors.

2. Research Methodology

This research focuses on developing a detailed process model for the front-end phase of a product innovation process. In order to develop the front-end model, some 19 in-depth case studies with European companies from different modular industries are carried out. The data for the empirical base of this research stems is gathered in case studies using semi-structured interviews with senior R&D representatives. Interview data is complemented by desk research and analysis of corporate and annual reports, reports and presentations and company journals. In follow-up sessions with our interview partners, the interpretations of the case studies will be validated at each company (Yin 1994).

The formation of this research is divided into two main parts, the first one focuses on the degree of structure in the innovation front-end and the elements where early customer integration adds value. The second part focuses on a front-end process model, which shows the different front-end phases and their sub-processes.

3. Three Degrees of Structuring the Innovation Front-End

We identified three principle degrees of how companies' front-ends of innovation are structured. These categories are ordered by increasing degree of structuring the inherent activities:

A. Emergence based technical drive with canalization mechanisms
B. Reactive market drive with selective structuring mechanisms
C. Balanced market and technical drive with front-end team.

We present these concepts in this order to illustrate different degrees of structuring the innovation front-end (see Figure 1). Each concept is described in reference to the major front-end elements out of our literature review.

The question, "which one of the three degrees of structuring is the right one for a company?" is related to the determination of whether "market pull" or "technology push" innovations are more successful for the respective company. This question was subject of many surveys in

the 70s and 80s – without finding the final conclusion. Recent publications point out that the success does not primarily depend on the origin of the idea, usually market *or* technology, but on the early consideration of the "other element" (e.g. (Baker, Siegman et al. 1967; Baker, Green et al. 1985).

Since the third concept *balanced market and technical drive* is close to the front-end process model developed by the authors (introduced in section 4), it is exemplified with a successful practice case study.

A) Emergence-Based, Technical Drive with Canalization Mechanisms

Companies of this first concept type were successful in the past by constantly bringing out technological novelty leading to technology leadership and first mover advantages. Market and business fields are clearly defined and perfectly known, thus the pressure for identifying new business fields is perishable. The front-end process starts with idea generation by engineers based on their technical competencies. New product concepts are therefore dominated by R&D and production departments while marketing involvement is low. Customer influences are narrow for new product initiation as well as during the product concept development. The first product contact is only at prototype presentation.

B) Reactive market drive with selective structuring mechanisms

Companies of the second concept type are consequently looking for new business fields to broaden their product application portfolio. Scenario analysis, search field identification and idea generation with creativity methods are selectively adopted, but rarely as institutionalized process methodology with defined input and output measures for the sequencing front-end step. According to high market pressure responsibilities for front-end management are assigned, but mostly hard to arrange with the daily business tasks. Customer integration is based on marketing activities and informal contacts of R&D engineers. Lead-user approaches are in part adopted for idea creation. Successful examples of singular co-developments with customers can be observed. Potential difficulties for customer communication lie at the interface between R&D and product marketing.

C) Balanced market and technical drive with front-end team

The third degree of innovation-front-end structure is illustrated by a short case study of Bayer MaterialScience. This company demonstrates a new and highly structured front-end process with a balanced technological and future market orientation:

At the forefront of Bayer MaterialScience innovation efforts stands a group called Creative Center, aimed at the identification and start of future projects, characterized by a combination of new technologies and new markets. The Creative Center is built up by four specialists, called

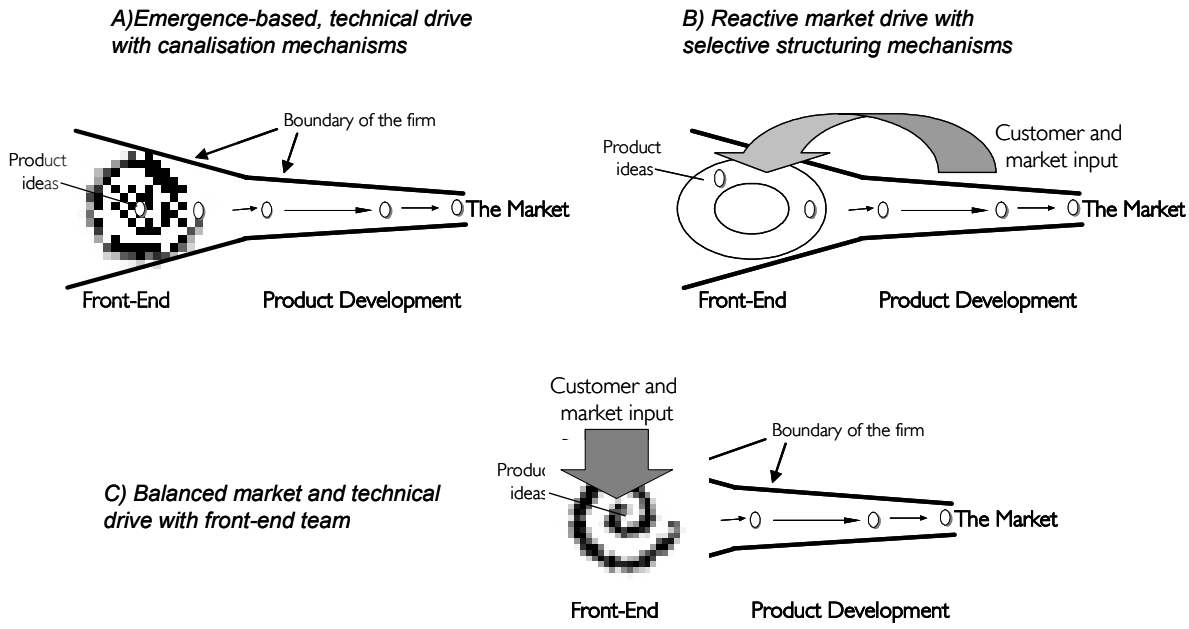

Figure 1: Three principle degrees of structuring the innovation front-end

market scouts, plus one manager and assistant. Each market scout covers a defined area, e.g. plastics or rubber. One of them in addition functions as technology scout for the whole range of polymers. Besides using traditional methods such as TRIZ and scenario techniques, the Creative Center also tries to develop new methods. One approach is the establishment of an external network stemming from the work with up to 10 students every

year.

The process for the front-end phase comprises seven steps with a strong result orientation, as in the Stage-Gate-Process (Cooper and Kleinschmidt 1986; Cooper 2001) promoted. As a contrast to known management practice these steps do not have to be passed through strictly in sequence but rather represent a checklist for iterative task completion in the early innovation phase. A strong focus lies on customer integration, which is systematically done in every step.

The following table 1 lists the seven front-end steps of the Creative Center with their relative output, players, methods employed and customer integration activities.

The front-end of Bayer MaterialScience's innovation process is an example of active customer involvement. During three out of seven steps, members of the Creative Center are either visiting customers or inviting them for brainstorming sessions. Doing so ensures more than mere coordination with the actual market demand namely active customer involvement in the creation of the scenarios and ideas respectively.

The case of the Bayer MaterialScience Creative Center shows that it is possible to institutionalize a process to capture external input, with special emphasis on customers, in the early phase of radical innovation projects. However it also proves that without a dedicated top management willing to spend resources to work on the fuzzy front-end of innovation a promising approach will not be reasonable. Process steps have to be defined, methods to be found or developed, and most importantly, internal and external networks to be established before the first results will be delivered. All this cannot be done as an additional task on top of a regular job. A dedicated group of employees has to be formed and empowered to run this process. Only then will the so often cited importance of innovation for a company's success in the market be truly taken into account.

4. An Integrative Front-End Process Model

As a result of a thorough literature search and the analysis of different case studies for existing front-end process models, a new approach was taken. This new approach illustrates a newly structured methodology for the front-end phase of an innovation process.

Figure 2 shows the comprehensive arrangement of how to accomplish the steps of the process. The Model is divided into three phases. Phase one is dedicated to *market and technology opportunity identification*, phase two focuses on the *product and business idea development* and phase three is based on the *product concept phase and business plan creation*, that represents the interface to and the base for the sequencing product development process.

A) Phase One: Market and Technology Opportunities

Phase one concentrates on the market and technology opportunities of a company. The strategies and goals of an innovation are the centre of activities in this phase. This phase is divided into four sub-processes including the analysis of the future needs and requirements of an innovation, the identification of a company's potential, and finally, the identification and analysis of search areas. These processes are very iterative, since their sequence depends on the input of the feedback loop, which comes from the Idea Phase and Product Concept Phase.

The result of this phase is one to two opportunities and search areas, which will pass through the filter to the Idea generation and evaluation phase.

Step No.	Output generated	Players evolved	Methods employed	Customer integration activities
1) Input Collection	Trends, opportunities, weak signals, hints	CC plus passive role of external sources	Fair visits, literature review, discussions	One-way input of visionary customers and potential new applications
2) Scenario evolution	Scenarios	CC	Clustering, internal discussions	Ad hoc integration of customers to collect their business scenarios and future demands
3) Scenario reflection	Scenarios aligned with external scenarios	CC plus selected customers or suppliers	Visits of external partners; discussions	Interactive reflection of value and validity of developed scenario with customers; common scenario integration
4) Idea generation	Ideas for individual scenarios	CC plus circle of experts (e.g. customers)	Facilitated workshops, brainstorming	Interactive development of new items with customers; confrontation of technological potential with future applications
5) Idea rating	Rated ideas	Bayer internal innovation community	Rating sheets filled out individually	Passive involvement of explicit customer knowledge
6) Idea discussion	Enriched ideas	CC plus lead-users and trendsetters	Discussion with externals	Visionary customer knowledge and potential customer engagement (from ideas to plans)
7) Feasibility check	Feasibility study	CC	Balanced Innovation Card	Passive involvement of explicit customer knowledge

Table 1: Steps of front-end together with their respective outputs putting the focus on the involvement of external partners

B) Phase Two: Product and Business Idea

Phase two concentrates on the idea generation and evaluation of an opportunity or search area. This phase is structured into three sub-processes, the first of which involves the analysis of the Idea impulse from a technical and commercial perspective. The idea impulse can be derived from the output of phase one (opportunities and search areas) and combined with additional observations and ideas.

The second sub-process is the collecting and generation of product and business ideas. Once this is done the third process, elaboration of the collected and generated ideas will ensue, followed at last by feasibility checks.
Since it is too laborious to elaborate all ideas, the ideas are pre-selected (idea screen) based on a rough idea description. This is also the possible incoming point for all ideas inadvertently generated by any member of the company. The team must subsequently write the idea description and present it to the idea screening team.

The result of this phase is the creation of a balanced business and product card, which will ease the selection of the ideas passing through the idea filter to the product concept phase.

D) Responsibilities and Budgets

Phase one as well as phase two should be accomplished by an interdisciplinary strategy team in collaboration with an interdisciplinary idea team. When it is not the same team, at least some persons should be a member of both teams. The strategy team should include some management personnel to strengthen decisions regarding search areas and opportunities. The idea team either makes decisions upon idea selection themselves or there is a separate idea selection team.

In phase two the expenses per idea are relatively low, so there should be a general budget including all ideas. In contrast to this, every idea elaborated to a product concept and business plan should be conducted as a pre-project, with a project budget and project leader.

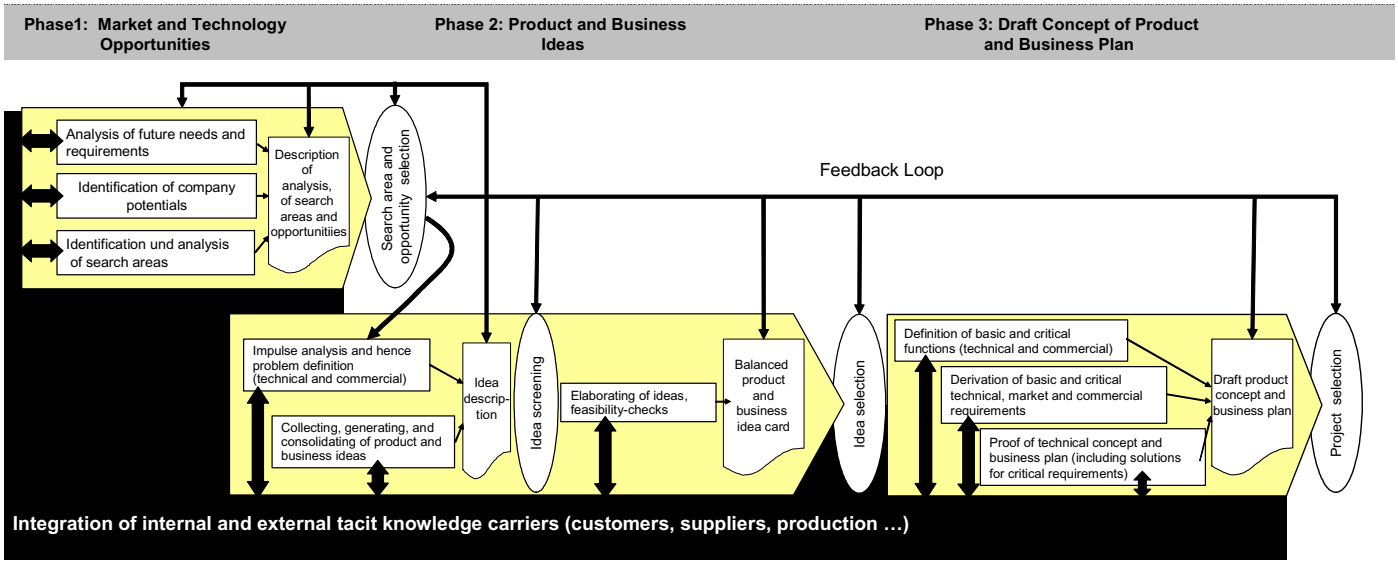

Figure 2: Integrated Front-End Process Model

C) Phase Three: Product Concept and Business Plan

In this phase the focus is turned to the way by which a business and product idea is transformed into a successful business plan and product concept with a high profit potential. This phase also consists of three processes. The first process is based on the definition of the basic and critical functions of a future product. The next process is the derivation of the product requirements from a technical and commercial perspective. Finally, the third process focuses on the proof of the technical concept and business plan.

The result of this phase is a product concept and a business plan on which the product development phase will be based.

5. Conclusion

Based on an extensive literature research and first analysis of our ongoing research with 19 European companies, a detailed process-model for the front-end of product innovation was proposed.

The front-end process model should not imply that it is the only way or methodology of idea generation through the product innovation proceeds. Instead it is a methodology that consists of the opportunity identification and idea generation as a well structured phase with defined processes. This enables a fast and integral approach to a reliable product concept and business plan development. In general very few of the generated ideas in

the early phases will make it to successful products to the market.

The model presented in this paper is based on a collaborative research project between the ZPE at ETH, the ITEM at HSG and 10 companies. The application objective of this study is to implement this model, which includes the processes and methods that will be used for the integration of internal and external groups at these companies with modifications made per each firm's specifications.

6. References

Ajamian, G. M. and P. A. Koen (2002). Technology Stage Gate: A structured Process for Managing High-Risk New Technology Projects. The PDMA Tool Book for New Product Development. P. Belliveau, A. Griffin and S. Somermeyer. New York, John Wiley and Sons.

Akao, Y. (1990). QFD Integration of customer requierments into Product Design, Productivity Press.

Altshuller, G. (2002). The Innovation Algorithm: TRIZ, Systematic Innovation and Technical Creativity. Worchester, MA: Technical Innovation Center.

Angelis, D. e. a. (2000). "Capturing the Option Value of R&D." Research Technology Management **43**(4): 31-35.

Baker, N. R., S. G. Green, et al. (1985). "How Management Can Influence the Generation of Ideas." Research Management(November-December): 35-42.

Baker, N. R., J. Siegman, et al. (1967). "The Effect of Perceived Needs and Means on the Generation of Ideas for Industrial R&D Projects." IEEE Transactions on Engineering Management **EM-14 (4)**(December): 156-163.

Bayer (2003). Role of Creative Center in Business Development.

Billatos, S. B. and L. J. Grigly (1993). "Functional Requirements Mapping as a Framework for Concurrent Engineering." CERA: The Int. Journal of Concurrent Engineering: Research, and Applications **1**(3): 171-178.

Chen, B. and C. H. Menq (1992). "Initial Attempts on the Characterization of Functional Requirements of Mechnical Products." ASME Annual Symposium on Concurrent Engineering, Anaheim California **PED-Vol. 59**(November 8-12): 315-319.

Chesbrough, H. W. (2003). "The Era of Open Innovation." MIT Sloan Management Review **44**(3): 35.

Chesbrough, H. W. (2003). "The New Business Logic of Open Innovation." Strategy & Innovation(July-August 2003): 3p.

Chesbrough, H. W. (2003). Open Innovation: The New Imperative for Creating and Profiting from Technology, Harvard Business School Press.

Christensen, C. M. and S. D. Anthony (2001). What´s the BIG Idea? HBS case.

Conway, H. A. and N. W. McGuinness (1986). "Idea generation in technology-based firms." Journal of Product Innovation Management **3**(4): 276-291.

Cooper, R. G. (1999). "The Invisible Success Factors in Product Innovation." Journal of Product Innovation Management **16**: 115-133.

Cooper, R. G. (2001). Winning at New Products: Accelerating the Process from Idea to Launch, Perseus Publishing.

Cooper, R. G. and E. J. Kleinschmidt (1986). "An investigation into the new product process: Steps, deficiencies, and impact." Journal of Product Innovation Management **3**(2): 71-85.

Cross, N. (1994). Engineering Design Methods: Strategies for Product Design, Second Edition, JohnWiley & Sons.

Dahan, E. and J. R. Hauser (2001). Product Development - Managing a Dispersed Process. Handbook of Marketing. B. A. Weitz and R. Wensley. London, Sage**:** 179-222.

Eppinger, S. D., D. E. Whitney, et al. (1994). "A Model- based Method for organizing taskes in Produkt Development." Journal of Engineering Design.

Gassmann, O. (1997). "Kreativer Freiraum für Entwickler - Eine Zweiteilung des F&E-Prozesses steigert die Innovationsrate." io new management(7/8): 26-33.

Gassmann, O., P. Sandmeier, et al. (2004). "Innovationsprozesse: Öffnung statt Alleingang." io new management(1-2): 22-27.

Goldenberg, J., D. Mazursky, et al. (2003). "Finding Your Innovation Sweet Spot." Harvard Business Review **81**(3): 120.

Hagedoorn, J. and G. Duysters (2002). "External Sources of Innovative Capabilities: The Preferences for Strategic Alliances or Mergers and Acquisitions." Journal of Management Studies **39**(2): 167.

Herstatt, C. (2002). Suchfelder für radikale Innovationen gemeinsam mit Lead Usern erschliessen. Verkauf. Albers, Hassmann, Somm and Tomczak, Symposion.

Jeff Mauzy , R. A. H. (2003). "Creativity, Inc: Building an Inventive Organization."

Kelley, T., J. L. (Contributor), et al. (2001). The Art of Innovation: Lessons in Creativity from Ideo, America's Leading Design Firm, Doubleday.

Khurana, A. and S. R. Rosenthal (1997). "Integrating the Fuzzy Front End of New Product Development." Sloan Management Review **Vol. 38**(Issue 2): 18p.

Khurana, A. and S. R. Rosenthal (1998). "Towards Holistic "Front Ends" In New Product Development." Journal of Product Innovation Management **15**(1): 57-74.
Kim, J. and D. Wilemon (2002). "Focusing the fuzzy front–end in new product development." R & D Management **Vol. 32**(Issue 4): 11p.
Koen, P., G. Ajamian, et al. (2001). "Providing Clarity and a Common Language to the 'Fuzzy Front End'." Research Technology Management **Vol. 44**(Issue 2): 10p.
Koen, P. A., G. M. Ajamian, et al. (2002). Fuzzy Front End: Effective Methods, Tools, and Techniques. PDMA Toolbook for New Product Development. P. Belliveau, A. Griffin and S. Somermeyer. New York, John Wiley and Sons.
Kohn, S. and R. Niethammer (2002). Aufgabengerechte Kundeneinbindung im Innovationsprozess. Das innovative Unternehmen. B. e. al., Symposion.
Kotler, P. (1999). Kotler on Marketing: How to Create, Win, and Dominate Markets, Free Press.
Kusiak, A. and N. Larson (1995). "Decomposition and Representation Methods in Machine Design." Special 50th Anniversary Design Issue, Transaction of ASME **117**.
Lilien, G. L., P. D. Morrison, et al. (2002). "Performance Assessment of the Lead User Idea-Generation Process for New Product Development." Management Science **Vol. 48**(Issue 8): 18p.
Lüthje, C., C. Lettl, et al. (2003). "Knowledge distribution among market experts: a closer look into the efficiency of information gathering for innovation projects." International Journal of Technology Management **26**(5/6): 561.
Mauzy, J. and R. A. Harriman (2003). Creativity, Inc: Building an Inventive Organization, HBS Press.
Mikkola, J. H. and O. Gassmann (2003). "Managing Modularity of Product Architectures: Toward an Integrated Theory." IEEE Transactions on Engineering Management **50**(2): 204-217.
Miotti, L. and F. Sachwald (2003). "Co-operative R&D: why and with whom?: An integrated framework of analysis." Research Policy **32**(8): 1481-1499.
Muller, A. and L. Välikangas (2001). Extending innovation beyond the corporate boundary, Paper presented at Strategic Management Society Annual Conference, San Francisco.
Muller, A. and L. Välikangas (2002). "Extending the boundary of corporate innovation." Strategy and Leadership **30**(3): 4 - 9.
Reinertsen, D. G. (1997). Managing th Design Factory: A Product Developers'sToolkit. New York, The Free Press.
Rigby, D. and C. Zook (2002). "Open-Market Innovation." Harvard Business Review **80**(10): 80-89.
Sandmeier, P. and C. H. Wecht (2004). "Von der Kundenorientierung zur Kundenintegration." Technische Rundschau **96**(4): 31-33.
Thoma, A. (2003). Die frühe Phase des Innovationsprozesses Struktur und Methoden im Überblick. ZPE Zentrum für Produktentwicklung. Zürich, ETH Zürich.
Thomke, S. and T. Fujimoto (2000). "The Effect of "Front-Loading" Problem-Solving on Product Development Performance." Journal of Product Innovation Management **17**: 128-142.
Thomke, S. and E. von Hippel (2002). "Customers as Innovators: A New Way to Create Value." Harvard Business Review **Vol. 80**(Issue 4): 8p.
Tidd, J. and K. Bodley (2002). "The influence of project novelty on the new product development process." R&D Management **32**(2): 127-138.
Ullman, D. G. (2002). The Mechanical Design Process, McGraw-Hill.
Ulwick, A. W. (2002). "Turn Customer Input into Innovation." Harvard Business Review **Vol. 80**(Issue 1): p91, 7p.
Urban, G. L. and E. von Hippel (1988). "Lead User Analyses for the Development of New Industrial Products." Management Science **34**(5): 569.
von Hippel, E. (1986). "Lead Users: A Source of Novel Product Concepts." Management Science **32**(7): 791 - 805.
von Hippel, E. (2001). "Innovation by User Communities: Learning from Open-Source Software." MIT Sloan Management Review **42**(4): 82.
von Hippel, E. and R. Katz (2002). "Shifting Innovation to Users via Toolkits." Management Science **48**(7): 821.
von Hippel, E., S. Thomke, et al. (1999). "Creating Breakthroughs at 3M." Harvard Business Review **77**(5): 47.
Walls, G. (2002). Defuzzing the Fuzzy Front End.
Yin, R. K. (1994). Case Study Research: Design and Methods., Sage Publications.