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The innovation process: an introduction to process models

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The innovation process:
an introduction to process models

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The innovation process: an introduction to process models

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Key-words: innovation management, new product development, concurrent engineering, success factors, stage-gate-process

ABSTRACT

In research as well as in practice, process models are an expatiated element of innovation management. They fulfill different tasks. In practice, for instance, process models are used as a management tool to standardize development activities. Researchers try to identify activities to be found in every product development process. The design of the different process models is as manifold as their application. It heavily depends on the intention of the practitioner or academic. Therefore, there exists no ‘one best way’. Partially, one academic uses different process models for different research designs.

The aim of this working papaer is to give management scholars and practitioners a review of different fields of application and design of innovation process models. For this purpose, a brief retrospection of the emergence and advancement of process models and a selection of process models is provided.

1. INTRODUCTION

Today, new products or services are launched at an increasing rate. Therefore, innovation management has gained in importance with the objective of enhancing the effectiveness and efficiency of new product development.

Conceptual models which describe the development and commercialization of new products are an essential element of innovation management. The literature features numerous process models that describe how companies develop or should develop new products or services. Virtually every management handbook provides a process model to visualize product development activities. Empirical studies in the field of innovation management represent observed activities in the form of process models. Companies develop process models to standardize their innovative efforts. This raises the question, why there are so many different process models. Is there a generally accepted model? This paper tries to answer this question.

In the following section, we give an overview of design and application fields of process models for innovation projects. Section three describes different generations of process models in the English literature. Section four focuses on process particularities in the German-speaking area. Due to the large quantity of literature on innovation processes, we select exemplary process models which we think exerted or exert influence on research or are used by companies. This selection does not claim to be complete. A brief summary of the discussion on process models for innovation projects is given in section five.

2. PROCESS MODELS: FIELDS OF APPLICATION

A first possibility to classify models of the innovation process, is to distinguish between objectives. So far, process models were categorized as descriptive versus normative (Cooper 1983-1, p. 6). Normative models are often derived from practical experience, case studies or quantitative studies analyzing successful new product development. Approaches found to be successful are condensed in an ideal process model. Examples are described by Cooper (1983-1, p. 7), Cooper et al. (1990, p. 45), Kuczmarski (1992, p. 163), Rosenau (1996, p. 79), and Ulrich et al. (1995, p. 14). Normative models can provide the basis for process clarification and systematization in companies. In this case, process models fulfill the function of a management tool (see e. g. Bernasco et al. 1999, p. 124, Cohen et al. 1998, p. 3, Cooper et al. 1991, p. 137, Cooper et al. 1994, p. 24, Hughes et al. 1996, p. 97, O'Connor 1994, p. 185). In contrast, descriptive models evolve from empirical studies and are not intended to advice managers. Their objective is to describe and evaluate actual practice (e. g. Cooper 1983-2, p. 1). Handbooks or lectures about innovation management for students are another application field for flow diagrams. In this didactic context, they are intended to visualize innovation processes (e. g. Crawford 1994, p. 26, Tidd et al. 1997, p. 255, Clark et al. 1993, p. 90, Pleschak et al., p. 24).

Figure 1 summarizes the described subgroups of process models. Individual process models may have divers objectives and therefore belong to more than one of the subgroups. As indicated by the arrows in *figure 1*, in some cases process models of one subgroup are the basis for models belonging to another subgroup. For instance, management tools are often derived from normative process models. Although the scheme is not a strict classification in independent categories, we think it might be helpful to cope with the large quantity of process models in the literature.

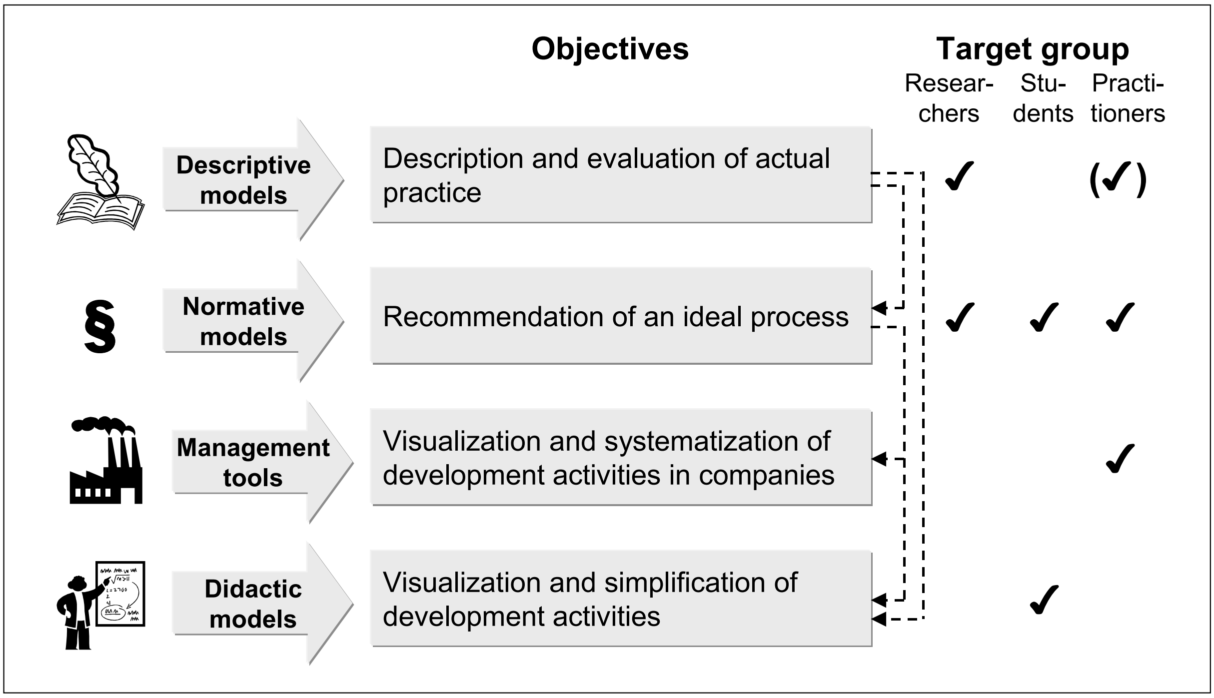


Figure 1: Objectives of process models (own depiction)

Besides the objective of a process, there are several other reasons explaining the existence of innumerable models. The literature often provides multiphase models which break the new product development process into sequential tasks. They differ with regard to the objective, level of detail and the main focus chosen. The lower the level of detail, the higher the compliance with other models and with real new product development processes. On the other hand, models with a low level of detail may lack specificity. Explicit process models have a higher force of expression, although they may be confined to for instance special branches or types of firms. Independent of the purpose a process model serves, it has to be well-balanced between the reduction of complexity and excessive specialization.

3. PROCESS MODELS IN THE ENGLISH LITERATURE

3.1 First-generation innovation processes

In the North American area, Cooper distinguishes between several generations of process models (Cooper 1994, p. 4). The first-generation “phase-review-processes” were developed by NASA in the 1960s. Phase-review-processes were intended as a management tool. Development was broken into sequential phases to systematize and control work with contractors and suppliers on space projects (see *figure 2*). Inputs and outputs for each phase were defined and a management review was held at the end of every phase to decide on the continuation of a project (“go-no-go”). Thus, former ad-hoc activities were standardized. Phase-review-processes were e. g. adopted by the US military and firms like Hewlett Packard. As phase-review-processes were engineering driven, one of their major advantages was the reduction of technical uncertainty. In addition, the phased approach ensured that tasks were completed. This could make for delays, due to the fact that activities were put on hold until every task part of the next management review was completed. Another shortcoming of the phase-review-processes was that they only dealt with the development phase and not with the complete innovation process from idea generation to launch. Marketing activities were neglected. The discussion on phase-review-processes are summarized by Cooper (1994, p.4) and Hughes et al. (1996, p. 90).

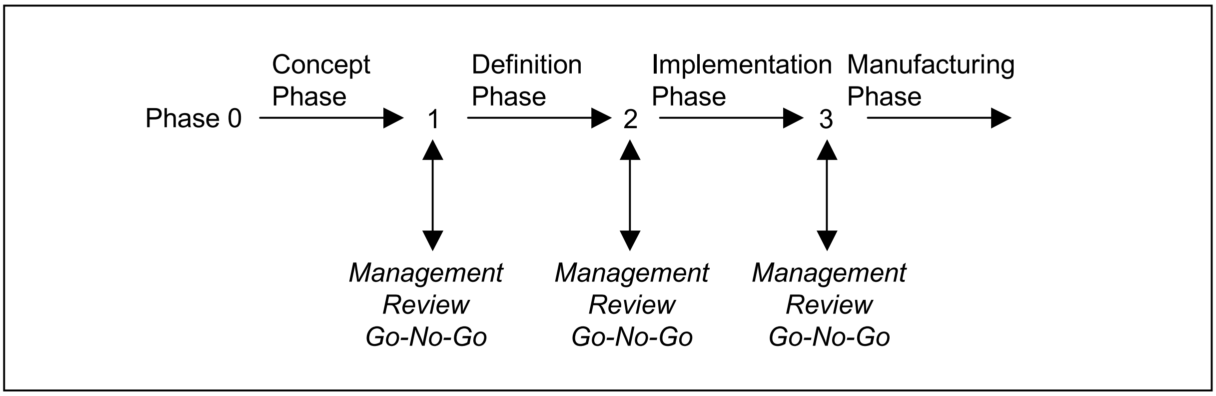


Figure 2: Phase-review-process (Hughes et al. 1996, p. 92)

3.2 Second-generation innovation processes

The second-generation of North American process models resulted from empirical studies on success factors for new product development (e. g., Myers et al. 1969, the British SAPHO studies by Rothwell et al. 1974), in particular from the Canadian NewProd studies by Cooper (see Cooper 1979, Cooper et al. 1984, Cooper 1994).

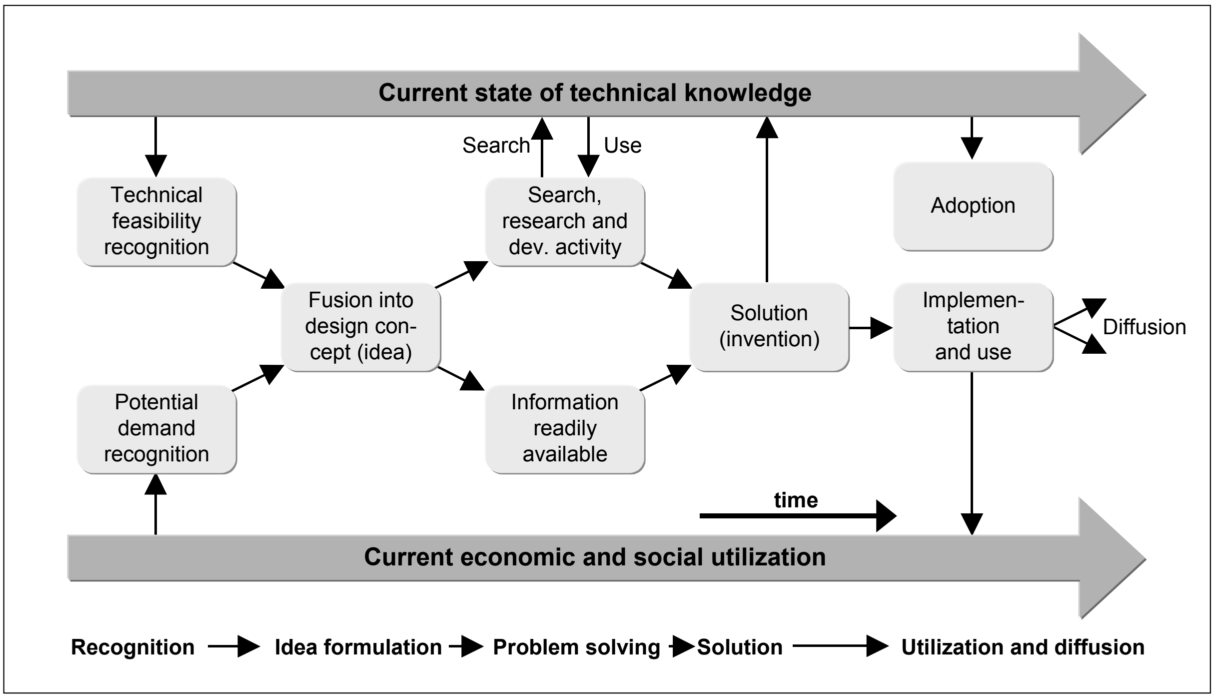


Figure 3: Descriptive process model (Myers et al. 1969, p. 4)

While Myers et al. (1969) still used a descriptive process model to arrange their empirical results (see *figure 3*), Cooper et al. merge critical success factors in a normative model (Cooper et al. 1990, p. 45).

Cooper et al. identified a standardized approach for development projects, which he calls “game plan”, as a critical success factor (Cooper et al. 1986, p. 84, Cooper et al. 1990, p. 44). As expected, Myers’ et al. process model is more conceptional than Coopers concrete recommendations to enhance the success of a firm. *Figure 4* shows a typical second-generation stage-gate-process.

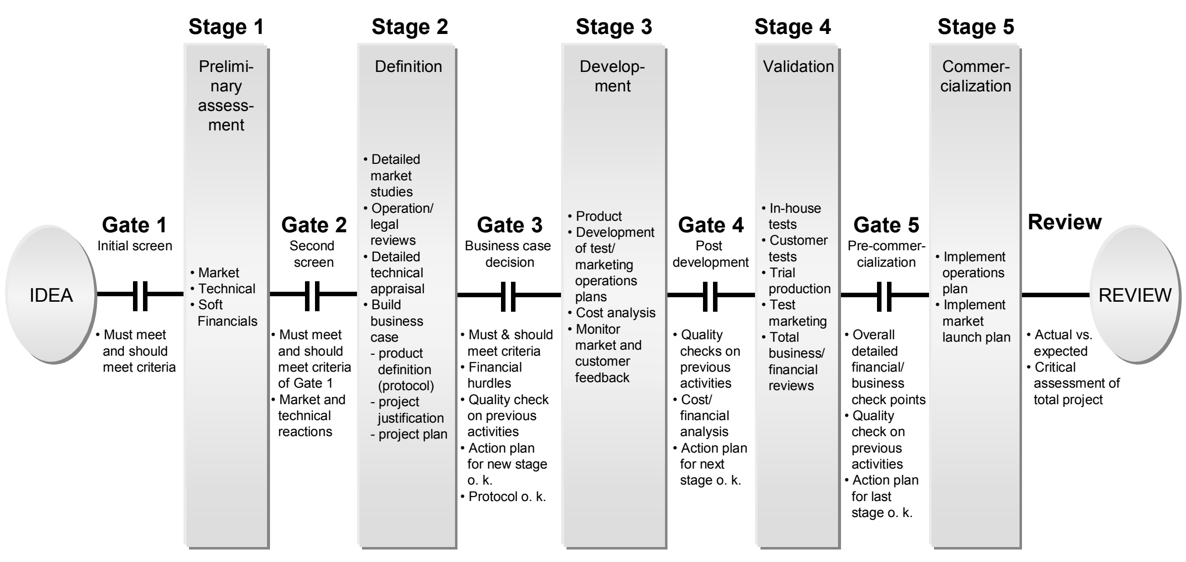


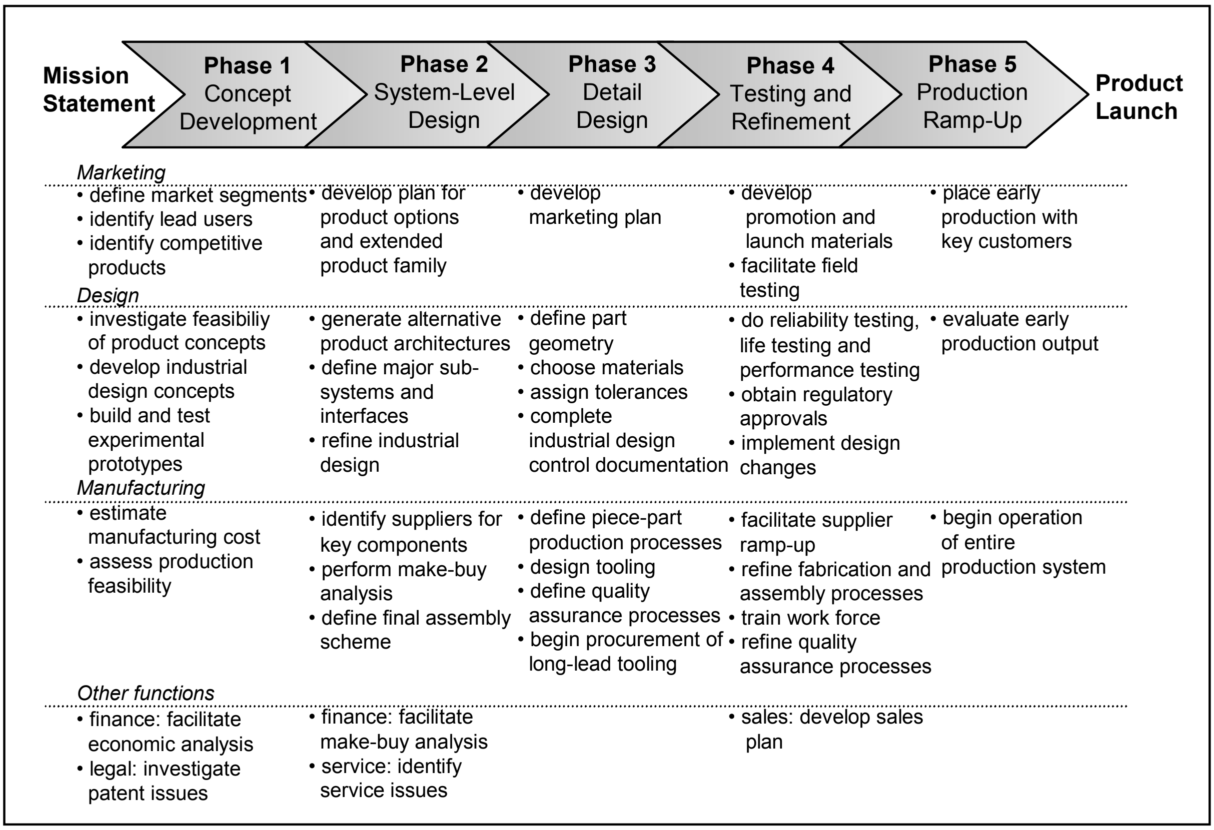
Figure 4: Typical second-generation stage-gate-process (Cooper et al. 1990, p. 46)

The product development process starts with an idea originating from basic research, seed or unfounded projects, customer-based techniques, and creativity techniques (Cooper et al. 1990, p. 45). At gate 1, the idea is evaluated according to must meet and should meet criteria such as strategic alignment, feasibility or fit with company policies. Stage 1 is a quick and inexpensive assessment of the project in terms of market, technology, and financials. After passing a second gate, a detailed investigations follows during stage 2. Output of this stage is a business plan which is the basis for the decision on business case at gate 3. Stage 3 contains the actual development of the product and a marketing concept. Deliverable of this stage is a prototype product. Gate 4 ensures that the developed product is consistent with the definition specified at gate 3. In-house product tests, customer field trials, test markets, and trial productions are typical activities during the validation stage 4. Gate 5 decides on production start-up and market launch, which follow during stage 5. Objective of a terminating review is to compare actual with expected results an assess the entire project.

Second-generation stage-gate processes resemble first-generation phase-review-processes but overcome some of their disadvantages. Again, the innovation process is broken into discrete stages. However, in contrast to the phase-review-process, a stage-gate-process integrates the engineering and marketing perspective. Decisions at gates are made by multifunctional teams according to well-defined go/kill criteria. In addition, the stage-gate-process covers the whole innovation process from idea generation to launch. The process is not strictly sequential, parallel activities are permitted to speed up the process (Cooper 1994, p. 5, Cooper et al. 1990, p. 45).

A major advantage of the implementation of stage-gate-processes in companies is the systematization of the often ad-hoc development. The new product process is transparent for all functions involved, and a common understanding is shared. This facilitates communication within the project team as well as with top management. Several authors give advice on the implementation of stage-gate-processes in companies (e. g., Rosenau 1996, p. 84, O'Connor 1996, p. 101). Stage-gate-processes were and are used as a management tool by many large companies such as IBM, 3M, General Motors and Northern Telecom. Empirical studies indicated that firms using a stage-gate approach were more successful than firms without a standardized innovation process (Cooper et al. 1990, p. 44, Cooper et al. 1991, p. 139, Whiteley et al. 1998, p. 16).

Figure 5 shows a process model by Ulrich et al. which resembles Cooper's stage-gate-process. Ulrich et al., too, regard process models as a successful management tool and present an own, normative model (Ulrich et al. 1995, p. 14). The activities each function carries out during the development of a new product are described. The noteworthiness of this model is the interdisciplinary point of view. Every function is weaved into each phase of the development process.



	Phase 1 Concept Development	**Phase 2** System-Level Design	**Phase 3** Detail Design	**Phase 4** Testing and Refinement	**Phase 5** Production Ramp-Up
Marketing	• define market segments • identify lead users • identify competitive products	• develop plan for product options and extended product family	• develop marketing plan	• develop promotion and launch materials • facilitate field testing	• place early production with key customers
Design	• investigate feasibiliy of product concepts • develop industrial design concepts • build and test experimental prototypes	• generate alternative product architectures • define major sub-systems and interfaces • refine industrial design	• define part geometry • choose materials • assign tolerances • complete industrial design control documentation	• do reliability testing, life testing and performance testing • obtain regulatory approvals • implement design changes	• evaluate early production output
Manufacturing	• estimate manufacturing cost • assess production feasibility	• identify suppliers for key components • perform make-buy analysis • define final assembly scheme	• define piece-part production processes • design tooling • define quality assurance processes • begin procurement of long-lead tooling	• facilitate supplier ramp-up • refine fabrication and assembly processes • train work force • refine quality assurance processes	• begin operation of entire production system
Other functions	• finance: facilitate economic analysis • legal: investigate patent issues	• finance: facilitate make-buy analysis • service: identify service issues		• sales: develop sales plan	

Figure 5: Normative process model by Ulrich et al. (1995, p. 15)

3.3 Third-generation innovation processes and beyond

Coopers normative third-generation stage-gate-models strive for more flexible processes (Cooper 1996, p. 472). Third-generation stages and gates are not strictly sequential and less stringent than second-generation stages and gates. They are rather guidelines than strict rules how to operate and adopted to the level of risk inherent in a project (see *figure 6*). To speed up the product development process, transitions between stages are fluent and tasks are to an increasing degree performed in parallel (Cooper 1996, p. 472).

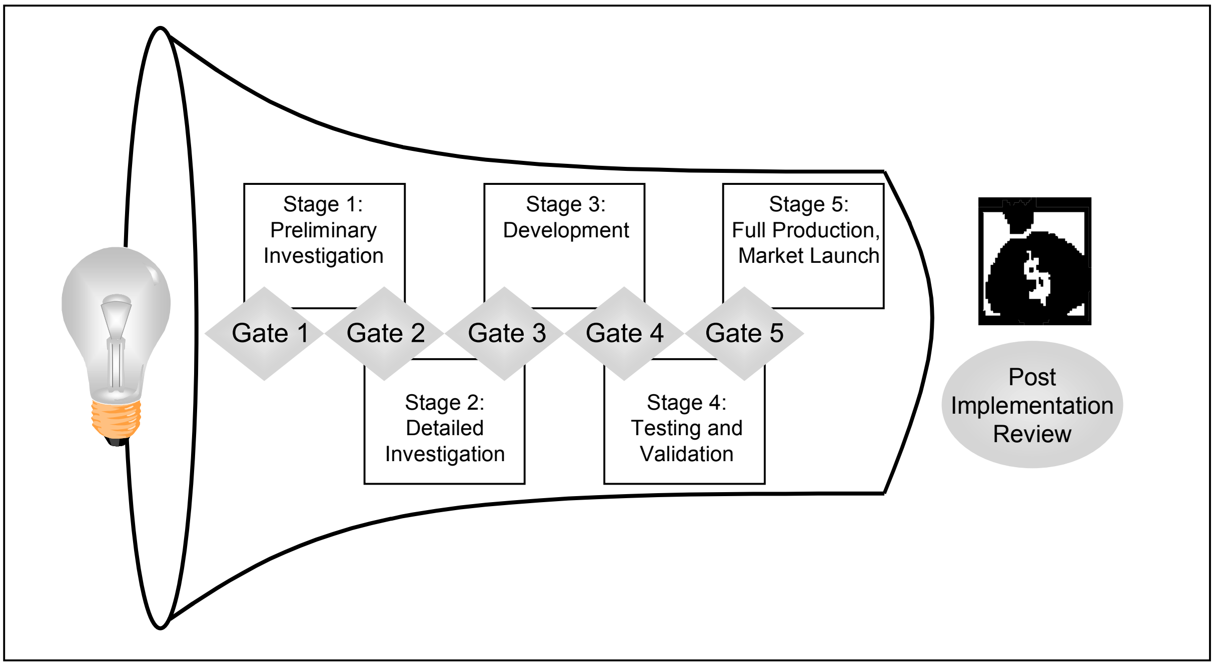


Figure 6: Third-generation stage-gate-process (Cooper 1996, p. 479)

The third-generation stage-gate-process is closer to reality and therefore the effort to implement it in a company is smaller.

From the 80s up to now, besides further improvements by Cooper, several other normative process models and management tools were developed. The majority tries to overcome delays due to a sequential approach to the innovation process. Parallel activities were regarded as powerful way to reduce development time. *Figure 7* gives an idea of parallel phases instead of sequential phases in new product development processes.

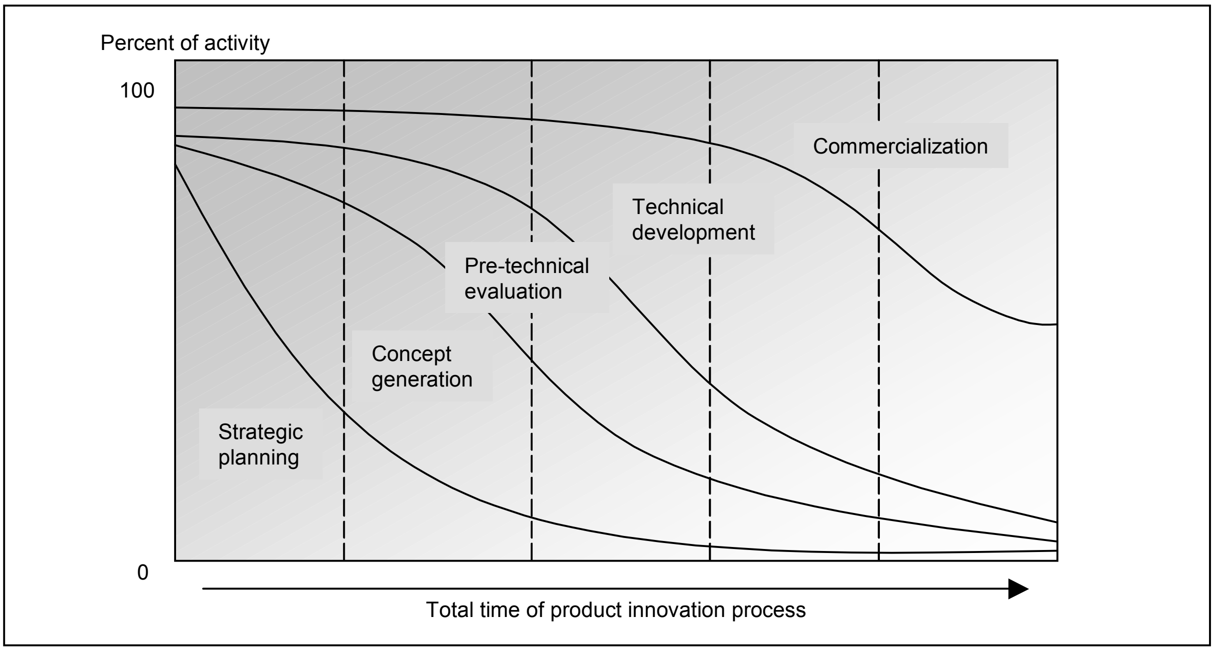


Figure 7: Simultaneous development phases (Crawford 1994, p. 27)

A widespread approach used by many well-known companies, including General Motors, Chrysler, Ford, Motorola, Hewlett Packard, and Intel, is called concurrent engineering or integrated product development. Concurrent engineering is defined as the simultaneous design and development of all the processes and information needed in new product development (Swink 1998, p. 104). The focus is on improving product manufacturability and quality while reducing development cycle time and cost by resolving product, process, and organizational issues at earlier stages (Deszca et al. 1999, p. 614, Swink 1998, p. 103). For example, manufacturing process designers start developing tooling and manufacturing processes in close contact with product designers before the product specifications are completed. Thus, project phases overlap. In addition, *figure 8* shows two other types of concurrency: product concurrency and design concurrency. An example for product concurrency is the development of a first and a next generation of a product in parallel. Design concurrency enables parallel system level and component level design (Swink 1998, p. 113).

To maximize the effectiveness of concurrent engineering, it has to be customized to the respective company. It has to evaluated, what activities should be done simultaneously. In addition, factors like program priorities (e. g., cost, quality, timing), the level of innovation and the technical risk influence the concurrent engineering program design (Swink 1998, p. 111, 112). The involvement of corporate-level management is regarded as a key to the successful implementation of concurrent engineering. To increase the probability of success, top management should: “(1) elevate the project, (2) elucidate goals, (3) eliminate barriers to integration, and (4) elaborate concurrent engineering processes” (Swink 1998, p. 113).

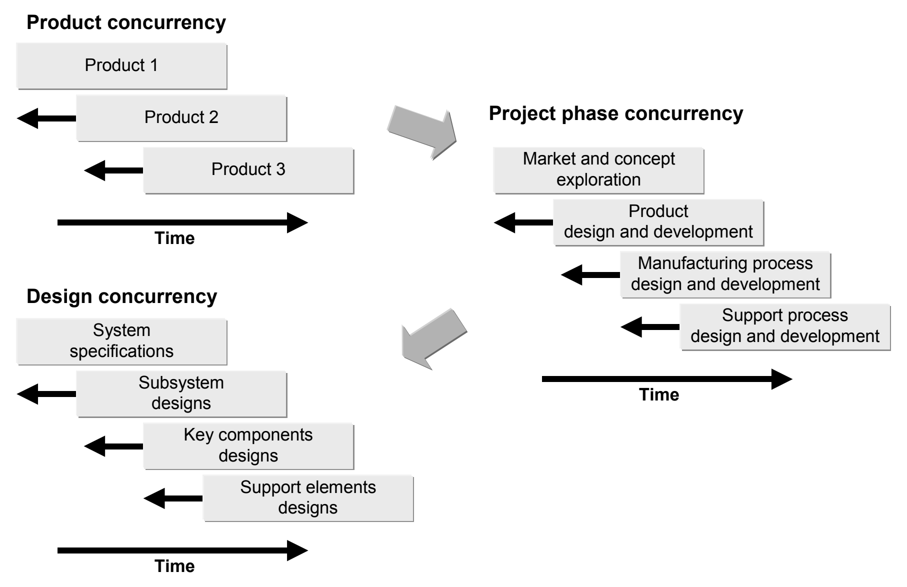


Figure 8: Different types of concurrency (Swink 1998, p. 114)

Figure 9 shows a further example of a process model developed as a management tool for a company. In this company, an existing stage-gate-process was superseded by a so-called "value proposition cycle" (Hughes et al. 1996, p. 90). This approach tries to make the new product development process more flexible end enhance efficiency and effectiveness through "continuous learning, identifying the certainty of knowledge, building consensus, and focusing on adding value to customers and end users" (Hughes et al. 1996, p. 91).

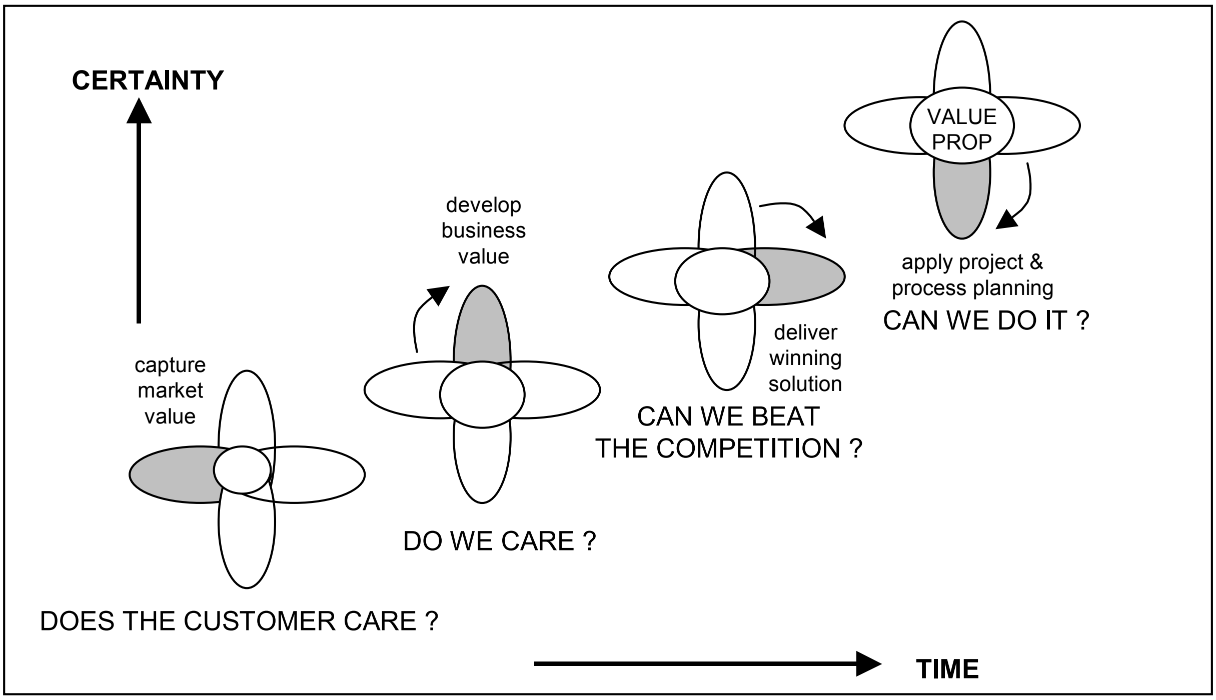


Figure 9: Value proposition cycle (Hughes et al. 1996, p. 93)

The value proposition cycle consists of four iterative loops to identify the market value, develop the business value, deliver a solution superior to competition and plan the process. The enlarging center in *figure 9* illustrates the increase in created value. As the team continuously traverses the loops, it can react to changes more quickly which enables a continuous learning process, which Hughes et al. miss in Cooper's stage-gate-models (Hughes et al. 1996, p. 94).

Besides attempts to generate more flexible process models, recent studies apply the contingency approach to process models (e. g., Balachandra et al. 1997, p. 285). They question the existence of critical development activities that must be done similarly regardless of environmental, company or project characteristics. Song et al. (1998, p. 125), for instance, survey the impact of product innovativeness on new product development activities. Their results suggest that there are critical development activities that have to be done well in every new product development. Nevertheless, they also provide empirical support for the notion that the emphasis on single activities should be adopted to the level of product innovativeness (Song et al. 1998, p. 132): "The key difference in the determinants of new product success between really new and incremental products is the impact of strategic planning and business and market opportunity analysis activities." (Song et al. 1998, p. 130) While a detailed business and market opportunity analysis contributes to the success of incremental products development it is counter-productive for the development of really new products.

Eldred et al. go further into products utilizing a significant new technology (Eldred et al. 1997-1, p. 41). In this case, they suggest a technology development process prior to the actual new product development process (*figure 10*). These two processes are linked by a technology transfer step.

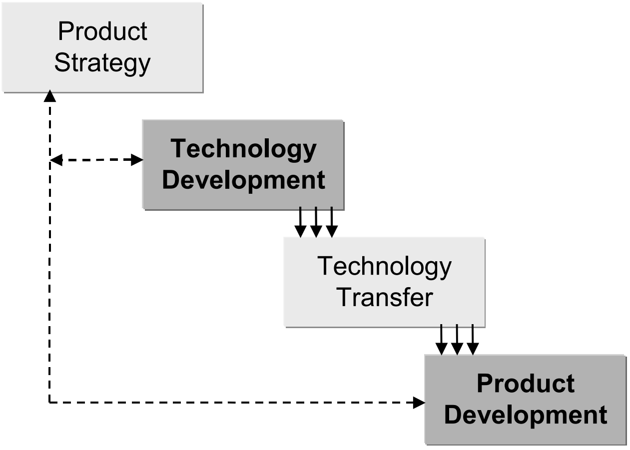


Figure 10: Technology and product development process (Eldred et al. 1997-1, p. 42)

The objective of the technology process is to develop a technology to a point where feasibility is demonstrated (Eldred et al. 1997-2, p. 30). The technology transfer step consists of three elements (Eldred et al. 1997-2, p. 31):

- program synchronization to synchronize the technology development and product development programs
- technology equalization to broaden the project's technical scope to consider supporting technologies besides the already developed core technology

- technology transfer management to transfer knowledge between the technology development and product development team.

A preliminary technology development process prior to the product development process was observed in case studies (e. g., Kobe 2001, p. 72 and 185).

To summarize, process models in the English literature are influenced strongly by Cooper's phased stage-gate-process derived from the NewProd studies. In the 80s and 90s many companies implemented phased process models to standardize their innovation processes. Recent studies on innovation processes try to create more flexible process models which overcome the insufficiencies of a phased approach. In addition, recent research include factors such as product innovativeness or technical newness influencing the new product development process.

4. PROCESS MODELS IN THE GERMAN-SPEAKING AREA

The literature on innovation management in the German-speaking area likewise often quotes Cooper's stage-gate-process. Almost every handbook on innovation management contains process models to illustrate the innovation steps. We select two examples from Thom (1992, p. 9) and Pleschak et al. (1996, p. 24). Thom's scheme was selected because it had a strong influence on the German literature about innovation management. Pleschak's model was chosen because we consider it as typical and particularly comprehensive for the German-speaking area. In addition, we introduce a normative process model by Ebert et al. (1992, p. 148) which highlights a distinctive feature of new product development processes in the German-speaking area: the use of two documents which could be translated into requirement specification ("Lastenheft") and functional specification ("Pflichtenheft"). The requirement specification contains the needs and requirements of the users. These user needs are translated into technical specifications documented in the functional specification (Sabisch et al. 1999, p. 30).

One of the most frequently quoted schemes of the innovation process in the German literature is shown in *figure 11*. It was developed by Thom at the beginning of the 80s. The idea centers the three main phases of idea generation, idea acceptance, and idea implementation.

Phases of the innovation process		
Main phases		
1 Idea generation	2 Idea acceptance	3 Idea implementation
Specification of the main phases		
1.1 Definition of the search field	2.1 Idea evaluation	3.1 Realization of the new idea
1.2 Idea detection	2.2 Preparation of implementation plans	3.2 Sale of the new idea to target customers
1.3 Idea proposal	2.3 Decision on one implementation plan	3.3 Check on acceptance

Figure 11: Scheme of the innovation process (Thom 1992, p.9)

In contrast to Thom's scheme, the process model by Pleschak et al. goes into details (see *figure 12*). It knowingly includes the possibility of truncation during every stage of the innovation process due to the rejection of an idea, technical or economical failure similar to Cooper's gates.

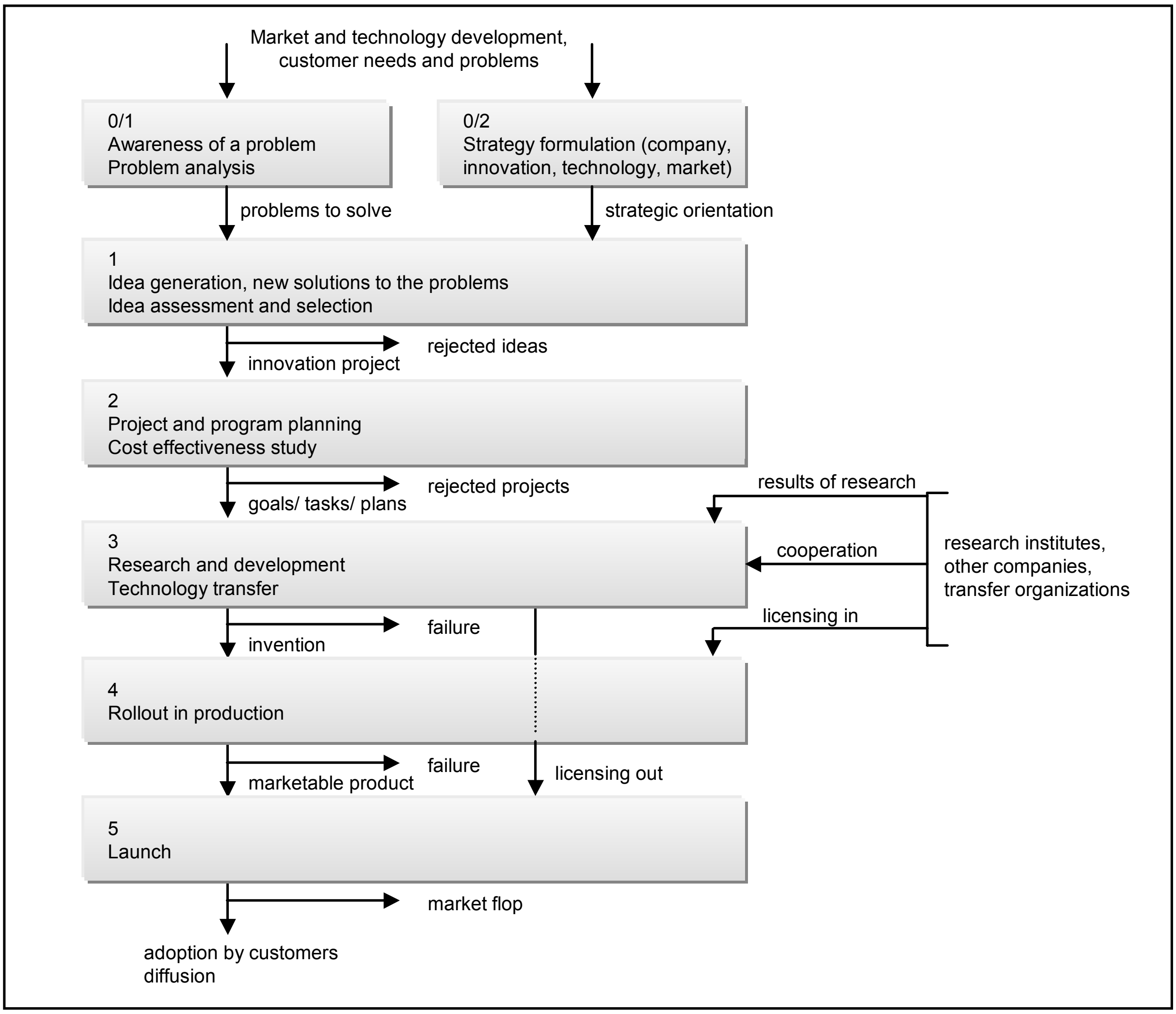


Figure 12: Process model including failures (Pleschak et al. 1996, p.24)

Whilst the German process models presented so far are redolent of English process models, the process model shown in *figure 13* points out a particularity in the German-speaking area: the compilation of requirement specifications ("Lastenheft") and functional specifications ("Pflichtenheft"). The requirement specifications are based on results from marketing research. It contains the needs and requirements of the users. In the functional specifications, these user needs in a user-oriented language are translated into technical specifications in a technical-oriented language (Boutellier et al. 1997, p. 92). The functional specifications should include a project overview, economical and technical goals and information concerning the environment of the project (Boutellier et al. 1997, p. 94). A study indicates that every German company in at least some industrial sectors uses functional specifications and almost half of the companies use requirement specifications (Sabisch et al. 1999, p. 30: 51 interviews with German companies in mechanical and electrical engineering). Usually, requirement specifications are generated by the marketing function and functional specifications by the development department.

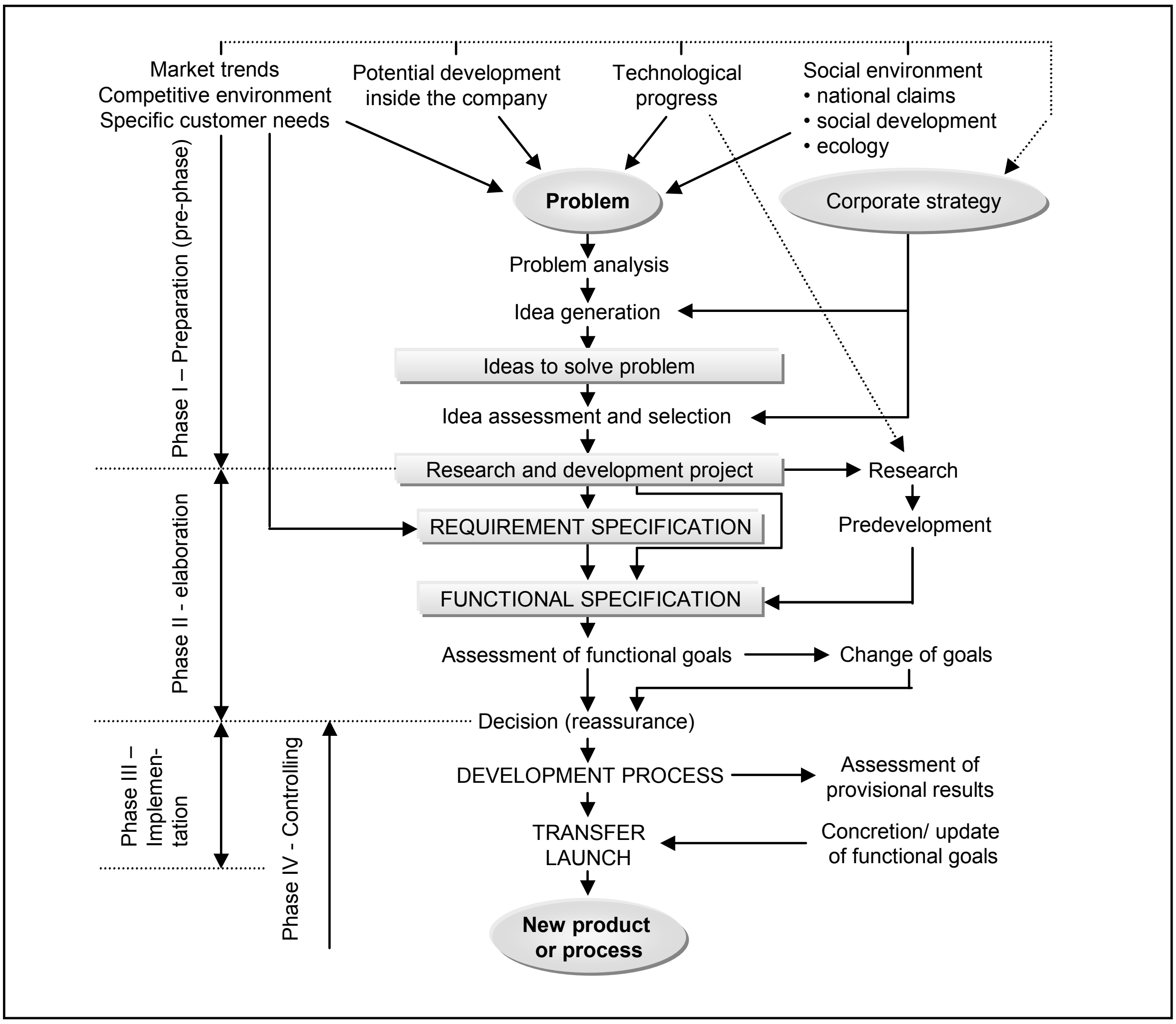


Figure 13: Process model including requirement specification and functional specification (Ebert et al. 1992, p. 148)

To summarize, many German process models resemble Cooper's stage-gate-process. The standardized utilization of requirement and in particular functional specifications discriminates new product development processes in the German-speaking area from other countries. This is at least true for traditional industrial sectors. We reckon that this might be different for younger areas like biotechnology or the service sector.

5. SUMMARY

This working paper tries to help people dealing with innovation management to gain access to process models. The literature presents numerous process models which are difficult overlook. We gave a brief review of the emergence and advancement of process models in two regions. We tried to select models which had a significant effect on innovation research or practice. With regard to the vast number of process models described in the literature, our selection is of course highly subjective.

In North America, Cooper's stage-gate-process gave direction to the spread of process models in practice. Cooper also stimulated the emergence of standardized processes in the German-speaking area. Yet, a particularity in this area is the utilization of requirement specifications and functional specifications.

Overall, we claim that there exists no 'one best way', no generally applicable process model. In fact, various process models make sense simply because they address different objectives or problems or have a different focus. We suggest to roughly differentiate between descriptive models, normative models, didactic models and process models used as a management tool.

REFERENCES

W. Bernasco et al.: Balanced matrix structure and new product development process at Texas Instruments materials and controls division, R & D Management 29 (1999) 2: 121-131

R. Boutellier/ R. Völker: Erfolg durch innovative Produkte, München et al. (1997): Hanser

K. B. Clark/ S. C. Wheelwright: Managing new product and process development – text and cases, New York et al. (1993): The Free Press

L. Y. Cohen/ P. W. Kamienski/ R. L. Espino: Gate system focuses industrial basic research, Research Technology Management (1998) 7-8: 34-37

R. G. Cooper: The dimensions of industrial new product success and failure, Journal of Marketing 43 (1979) 3: 93-103

R. G. Cooper: A process model for industrial new product development, IEEE Transactions on Engineering Management 30 (1983) 1: 2-11

R. G. Cooper: The new product process: an empirically-based classification scheme, R & D Management 13 (1983-2) 1: 1-13

R. G. Cooper: Third-generation new product processes, Journal of Product Innovation Management 11 (1994): 3-14

R. G. Cooper: Overhauling the new product process, Industrial Marketing Management 25 (1996) 6: 465-482

R. G. Cooper/ E. J. Kleinschmidt: An investigation into the new product process: steps, deficiencies, and impact, Journal of Product Innovation Management (1986) 3: 7-85

R. G. Cooper/ E. J. Kleinschmidt: Success factors in product innovation, Industrial Marketing Management 16 (1987) 3: 215-223

R. G. Cooper/ E. J. Kleinschmidt: New products - the key factors in success, Chicago (1990): American Marketing Association

R. G. Cooper/ E. J. Kleinschmidt: New product processes at leading industrial firms, Industrial Marketing Management 20 (1991): 137-147

R. G. Cooper/ E. J. Kleinschmidt: Screening new products for potential winners, IEEE Engineering Management Review 22 (1994) 4: 24-30

C. M. Crawford: New products management, 4th edition, Boston (1994): Irwin, Burr Ridge

G. Deszca/ H. Munro/ H. Noori: Developing breakthrough products: challenges and options for market assessment; Journal of Operations Management 17 (1999): 613-630

G. Ebert/ F. Pleschak/ H. Sabisch: Aktuelle Aufgaben des Forschungs- und Entwicklungscontrolling in Industrieunternehmen“, in: H. G. Gemünden/ F. Pleschak (eds.): Innovationsmanagement und Wettbewerbsfähigkeit, Wiesbaden (1992): Gabler

G. D. Hughes/ D. C. Chafin: Turning new product development into a continuous learning process, Journal of Product Innovation Management 13 (1996): 89-104

C. Kobe: Integration der Technologiebeobachtung in die Frühphase von Innovationsprojekten, Dissertation No. 2550 at the University of St. Gallen, St. Gallen (2001)

T. D. Kuczmarski: Managing new products – the power of innovation, 2nd edition, London et al. (1992): Prentice-Hall

S. Myers/ D. G. Marquis: Successful industrial innovations, National Science Foundation Tech. Rep. NSF 69-17 (1969)

P. O'Connor: Implementing a stage-gate process: a multi-company perspective, Journal of Product Innovation Management 11 (1994) 3: 183-200

P. O'Connor: Implementing a product development process, in: M. D. Rosenau Jr. et al. (eds.): The PDMA handbook of new product development, New York et al. (1996): John Wiley & Sons: 93-106

F. Pleschak/ H. Sabisch: Innovationsmanagement, Stuttgart (1996): Schäffer-Poeschel

M. D. Rosenau Jr.: Choosing a development process that's right for your company, in: M. D. Rosenau Jr. et al. (eds.): The PDMA handbook of new product development, New York et al. (1996): John Wiley & Sons: 77-92

R. Rothwell/ C. Freeman/ A. Horlsey et al.: SAPHO updated – project SAPHO phase II, Research Policy 3 (1974): 258-291

H. Sabisch/ J. Wylegalla: Pflichten- und Lastenhefte für Innovationsprojekte, Technologie & Management 48 (1999) 1: 28-32

X. M. Song/ M. M. Montoya-Weiss: Critical development activities for really new versus incremental products, Journal of Product Innovation Management 5 (1998) 2: 124-135

M. L. Swink: A tutorial on implementing concurrent engineering in new product development programs, Journal of Operations Management 16 (1998): 103-116

J. Tidd/ J. Bessant/ K. Pavitt: Managing innovation – integrating technological, market and organizational change, Chichester et al. (1998): John Wiley & Sons

N. Thom: Innovationsmanagement, Bern (1992): Schweizerische Volksbank

K. T. Ulrich/ S. D. Eppinger: Product design and development, New York et al. (1995): McGraw-Hill

R. L. Whiteley/ A. S. Bean/ M. J. Russo: Using the IRI/CIMS R&D Database, Research Technology Management 41 (1998) 4: 15-16