Creating Opportunities for Successful Design Decisions in Uncertain Environment.

Anssi Tuulenmaki

Helsinki University

It is widely recognized that properly conducted early part of the new product development process – conceptualization or fuzzy front end – is vital for new product success. Accurate and timely information during the early phases of the New Product Development (NPD) and design processes reduces rework and lead-time, enables better planning, execution and results. Therefore, the aim of the conceptualization phase can be articulated as in providing information package according to which a decision could be made whether a concept is to be developed further to a product or not. What is the role of the conceptualization in situations where adequate information is not available during the early phases? How should the design and NPD processes – and the conceptualization as a key phase of them – be organized in such highly uncertain and dynamic environments?

To address the topic, I present three generic NPD/design process approaches, which vary according to uncertainty they are confronting. In the most predictable environments Stage-Gate type of models are effective process models. The basic assumption there is that all the key issues could be defined, planned and scheduled during the conceptualization. The required information exists already; it is only matter of gathering and analyzing. The earlier the concept could be frozen the faster the process.

In case of higher levels of uncertainty, accurate information about the key features, performance variables and customer preferences is not readily available during the very front end of the process. Thus, NPD/design processes must be very flexible to reflect information acquired close to a launch. It is known that essential pieces of information are still missing for final judgment but it will be known later on, after certain pieces of product/system in hand are created. In other words, developers and designers know enough to start working but not enough to decide all the features of the concept. Quite opposite compared to the first approach, the closer to a launch (i.e. later) you are able to freeze the concept the better.

In the most uncertain and dynamic environments information is not available before an actual product is launched and emerging market is created. Then, even the first launched products could be seen as concepts as thus part of the conceptualization phase. There, managers have enough information to commit experimenting or conceptualizing, but they do not know during the initial development/design process what kinds of concepts could turn out to be winning ones. I examine several methods and business implications related to this last approach. In addition of literature review and conceptual frameworks, I present a few cases, e.g. from Nokia, that give practical insights.

Futureground Conference Nov 2004

CREATING OPPORTUNITIES FOR SUCCESSFUL DESIGN DECISIONS IN UNCERTAIN ENVIRONMENT

1. Introduction

In new product development (NPD), it is widely recognized that properly conducted early part of the process is vital for new product success (Cooper 1999, Khurana & Rosenthal 1999, Montoya-Weiss & O'Driscoll 2000, Ulrich & Eppinger 2000). Accurate and timely information during the conceptualisation or fuzzy front end reduces rework and lead-time, enables better planning, execution and results (Khurana & Rosenthal 1999, Moenart et al 1995). Therefore, the aim of the conceptualisation phase can be articulated as in providing information package according to which a decision could be made whether a concept is to be developed further to a product or not (Kim & Wilemon 2002, Ulrich&Eppinger 2000). The required information for justified decision making includes, at least, product's competitive advantage, technology feasibility, markets, customers, timing, risk assessment, manufacturability considerations, and costs (e.g. Khurana & Rosenthal 1999, Kim &Wilemon 2002). Naturally, all those issues are also closely related to product's design.

However, highly uncertain, rapidly changing environments pose the fundamental challenge for the early phases of the NPD. How should the NPD process - and the conceptualisation as a key phase of it – be organized in highly uncertain environments in which the required, accurate information is not available during the early phases of the process? What is the role of the conceptualisation in such situations? How firms can create opportunities for successful design decisions in such situations?

To address the topic this paper is organized so that first I discuss how uncertainty affects NPD processes (and thus design process). The discussion is based on literature review and desktop studies about new product introductions. Secondly, I present several methods how conceptualisation could be done in dynamic and uncertain environments. Each method has its advantages depending on iteration costs, concept/ product characteristics and market dynamics. I present a real-life example how Nokia is reducing uncertainty in mobile communication business. Nokia example is based on interviewing managers at Nokia Mobile Phones and Nokia Research Center. Finally, I conclude the discussion by linking the conceptualisation in uncertain environments to broader views of capability development and design process.

2. Uncertainty and new product development processes

Many authors have provided process models for new product development (Cooper et al 2002, MacCormack et al 2001, Rothberg 1981, Ulrich & Eppinger 2000) as well as technology development and commercialisation (Eldred & McGrath 1997a&b, Jolly 1997, Sheasley 1999, Siadad 1996, Wood & Brown 1998). The most widely used process models are variations from the Stage-Gate process (Cooper et al 2002).

Stage-Gate models, which rely on predictable information and thus anticipation, are effective in more traditional, stable markets where customer preferences and technologies are well known. The basic assumption there is that all the key issues could be defined, planned and scheduled during the conceptualisation. The earlier the concept could be frozen the faster the process.

In more uncertain, complex and dynamic environments the accurate information about the key features, performance variables and customer preferences is not readily available during the very front end of the process. Uncertainty has direct implications to a NPD process. Because the lack of early information the key factors for successful result are planned flexibility and reaction capabilities (MacCormack et al 2001, Verganti 1999).

The challenges more uncertain environments pose for Stage Gate type of models, which assume predictable environment, can be illustrated by considering a simple model of development consisting of three separate stages (Fig 1). The first stage is concept development (where the overall concept is defined and the product architecture developed), then detailed design (where individual modules are designed and tested), and finally system-level design (where these modules are integrated into a complete system and tested). The first challenge stage-gate type of model faces is that it assumes all information about potential design choices is known or can be discovered during concept development. In uncertain and dynamic environments, however, firms cannot predict every potential design choice up-front. There is, therefore, a greater need to keep the product concept open to change. To achieve this stages 1 and 2 must overlap (see Fig 1), implying that detailed design must start before the specification is complete.

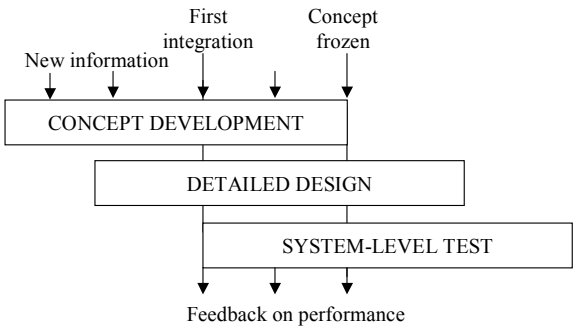

Figure 1; flexible NPD model (MacCormack et al 2001)

Complex, systemic products pose the second challenge for the stage-gate type of models. Feedback on how the product performs as a system is not obtained until late in a project, when the functionality in each module has been fully developed. In uncertain environments or with radical innovations, there is a need to gain feedback from ”early” system-level tests, implying that stages 2 and 3 must overlap (hence the first test of system-level performance occurs before the

modules are complete). Moreover, in the most flexible processes, also stages 1 and 3 will overlap, thereby allowing feedback from system-level tests to have direct impact on the evolution of the product concept.

In the most challenging end of the uncertainty-continuum are discontinuous or radical innovations in dynamic, rapidly changing environments where technologies, markets and customer preferences are emerging, fluctuating and mostly unknown. Since product development is “a very uncertain path through foggy and shifting markets and technologies” (Eisenhardt & Tabrizi 1995) traditional market testing offers limited utility (Leonard-Barton 1995, Lynn et al 1996). Similarly, being flexible during the initial NPD process is not enough. Rather, one has to launch something to the marketplace before accurate information regarding customers and features could be obtained. There, even the first launched product(s) could be seen as concepts and thus part of the conceptualisation phase. The learning is gathered from the real marketplace and according to that knowledge new variants are developed and launched. The key in this kind of iterative process is the speed and cost of market and technology knowledge accumulation rather than being right with the first launch.

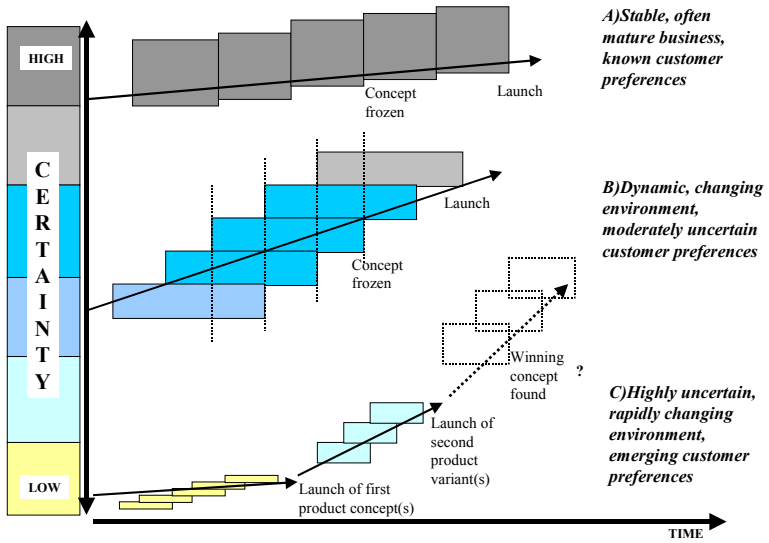

Figure 2; uncertainty and most suitable NPD/conceptualisation approach.

Figure 2 summarises the three approaches described above. Boxes and rectangles denote NPD phases, and arrows starting from certainty-bar and crossing the phases illustrate changes in certainty levels. So, in predictable environment the earlier you are able to freeze the concept the faster the rest of the product development could be executed. Comprehensive information is basically known from the start – the proper conceptualisation is mainly matter of careful gathering and analysing of existing information. The certainty level does not increase substantially during the process because it is high enough already in the beginning.

More uncertain world necessitates quite opposite - the closer to a launch (i.e. later) you are able to freeze the concept the better. It is known that essential pieces of information are still missing for final judgement but they will be known later on, after certain pieces of product/system in hand are created. In other words, developers and designers know enough to start working but not enough to decide all the features of the concept. Certainty level does increase substantially during the development process.

In very uncertain and dynamic environments information for effective conceptualisation have to be created by experimenting in a real marketplace with several concept-like products. There, managers have enough information to commit experimenting or conceptualising but they do not know what kinds of concepts could turn out to be winning ones. As Lynn et al (1996:17) argued, “probing with immature versions of the product makes sense if it serves as a vehicle for learning.” Certainty level does not increase substantially before the first version is launched and real-life experiences are being analysed. In the next section, conceptualisation in very uncertain environments will be discussed in greater detail.

3.Methods for conceptualisation in highly uncertain environments

Sometimes, even the most flexible NPD processes are not enough for an optimal design and market result with the first launched product. The market success might not be determined by the first generation product launch but by several launches. The goal of expeditionary marketing (Hamel & Prahalad 1991) is similar to the goal of conceptualisation - to determine the precise direction in which to aim i.e. the particular configuration of product functionalities that customers are really valuing, winning business logic, and the distance to the target i.e. the technical and other hurdles to overcome to achieve the combination of price and performance that will open up the new competitive space. As Hamel & Prahalad argued, there are two ways to increase the number of hits in new business development. One is to try to improve the odds on each individual bet (hit rate). Stevens & Burley (2003) suggested that individual personality-related issues are strongly affecting new business development success, especially during the very early stages when only few people are involved in the process. Selecting the right people for the right roles seems to improve the hit rate dramatically. The other way to increase the number of hits is “to place many small bets in quick succession and hope that one will hit the jackpot” (Hamel & Prahalad 1991). If the goal is to accumulate understanding as quickly as possible, a series of low cost, fast paced market incursions – expeditionary marketing – can bring the target more rapidly into view. When the target is finally known it is time to move from conceptualisation or experimentation mood to business-as-usual product development. Then, serious money is put in each of the projects with an assumption that every project is paying the invested money back.

Leonard-Barton (1995) divided experimentation strategies in three groups. In "Darwinian selection" (Fig 3) a firm launches multiple new product offerings simultaneously to see which has the greatest market appeal. Traditionally, Japanese companies have been active in this approach. For example, Sharp tried several different types of PDA models simultaneously in 1993-1994 (Leonard-Barton 1995), Sony developed hundreds of Walkman models to detect customer preferences (Leonard-Barton 1995, Sanderson & Uzumeri 1995), and Toshiba introduced 24 laptop computer models between 1986-1990 (Dhebar 1995). Interestingly, Intel who is nowadays well known of its speed of replacing the old microprocessors by improved versions (Cusumano & Gaver 2002) started the microprocessor business by experimenting with several types of microprocessors simultaneously. In 1992, nine different microprocessor types were available at the same time varying in performance levels, prices, end-user targets etc. (Dhebar 1995).

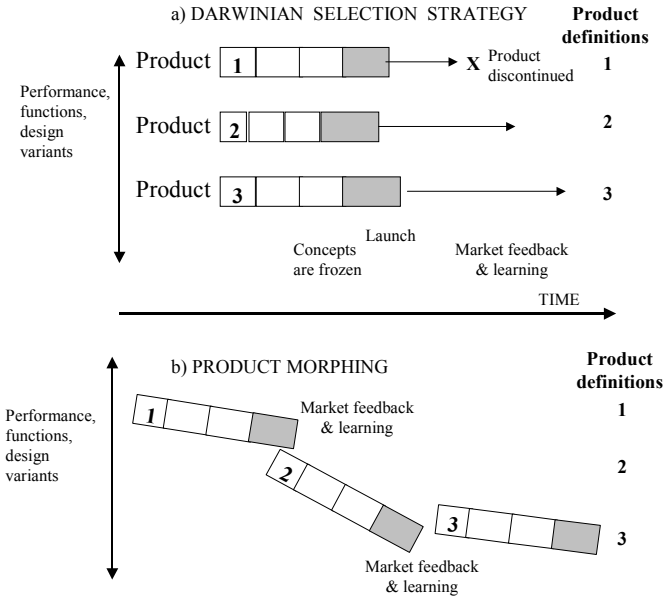

Figure 3; learning from market - Darwinian Selection and Product Morphing strategies (modified from Leonard-Barton 1995:208).

In "the Product morphing" (also in Fig 3) strategy initial product features evolve as consumers adopt, adapt, and implement the new technology offering. This is very close to probe and learn process described by Lynn et al (1996). They documented how General Electric used this approach in CT scanning business during 1975-1985 and Motorola in emerging handheld cellular phone business during 1973-1984.

In "the Vicarious experiments" strategy (see Fig 4), firms learn from competitors as well as from their potential customers. The best elements are then

incorporated into new offerings. This strategy includes the learning from others mistakes and thus “wait and see how market evolves” attitude. This is surely the cheapest kind of market experimentation – unless the pioneers succeed to create dominant standards and/or dominant designs (Anderson & Tushman 1990) or if the market is strongly affected by network externalities and/or high switching costs (Moore 1999). Then, the result might be the technological or market lockout (Schilling 1998).

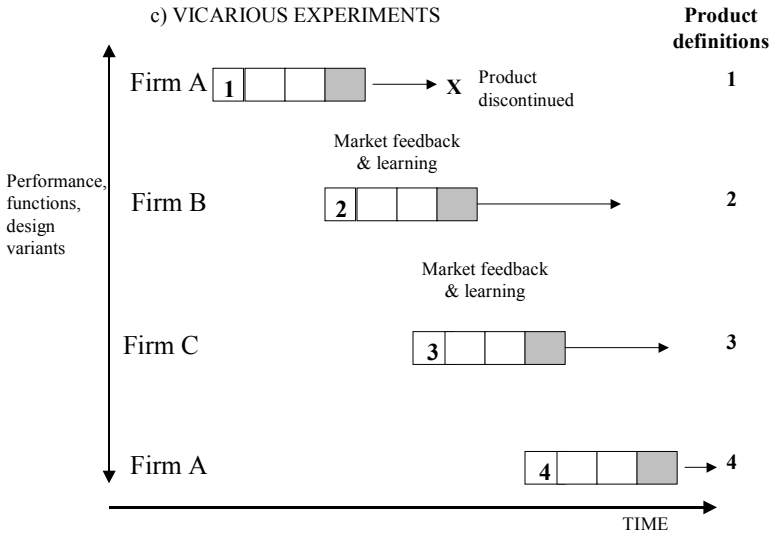

Figure 4; leaning from market - Vicarious Experiments strategy (modified from Leonard-Barton 1995:208).

Figure 5 presents another possible strategy, titled as “Variants strategy”. There, experimentation (or, when used in more mature markets, segmentation) is based on variants from the original “mother product”, the product 1. Instead of starting a new product project from scratch, the variants 1-2 and 1-3 are using parts of the Product 1 but new technology, new design and/or new features are introduced on top of it, rapidly and cost effectively. Thus, one could argue that conceptualisation continues after the mother product is launched. Best parts (from customers point of view) or well-developed parts (from manufacturers’ point of view) of the mother product are used in several variant launches, which aim to probe evolving customer preferences and to detect potential new concept ideas. Naturally, this approach calls for a high degree of modularity in product architectures.

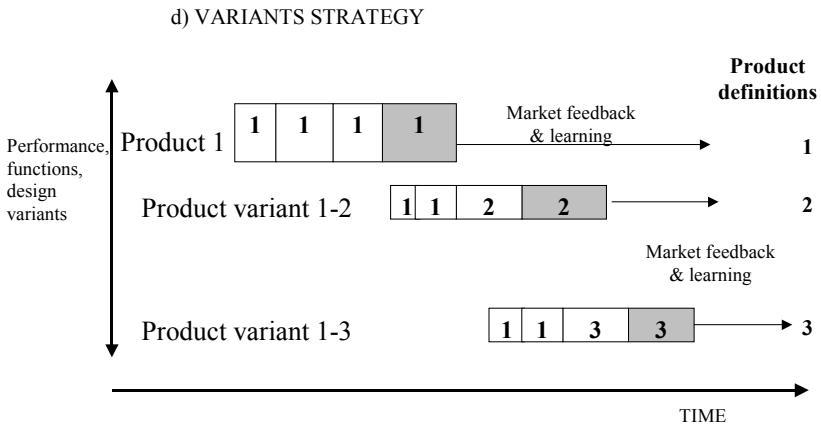

Figure 5; leaning from market - Variants strategy.

4.Finding optimal conceptualization strategy in highly uncertain environment

How many new versions of concepts companies should introduce? Optimal amount of introductions depends on iteration costs, product/ concept/ market characteristics and competitive pressures. Sorenson (2000) showed that in markets with few rival products, the importance of monitoring and learning from market with higher variety of products outweighs the benefits of culling. Similarly, product variety is more valuable when uncertainty makes the accurate prediction difficult. Further, the benefits from concepts decreases when the cost of iteration (i.e. cost of learning) increases.

When competitive pressures are low and cost of iteration is high, as was the case with GE's CT scanning business (Lynn et al 1996), then the product morphing strategy might be the optimal. The company had ten years opportunity window to introduce new, improved but very expensive models and to find the winning concept.

If products and concepts are expensive to develop but a market is more dynamic, product morphing might be too slow approach. Instead, the variants strategy might be more appropriate since there companies are using the expensive/ well developed parts in several variant models and just add new technologies or features on top of it. Of course, there is a delicate trade-off between gains and risks of such approach since developing a product architecture that is modular and flexible enough to accommodate such add-on variants could be an expensive and time-consuming initiative.

WHICH METHOD TO CHOOSE?

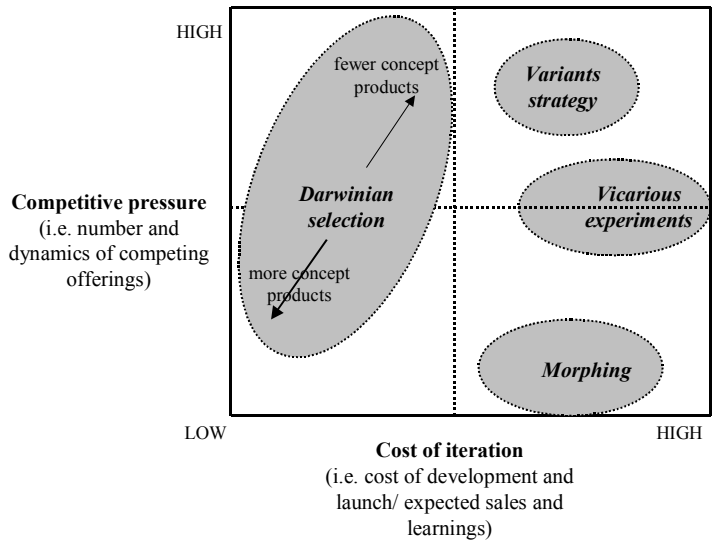

Figure 6; choosing optimal experimenting/ conceptualization approach.

When expected gains from new concepts are lowest, - i.e. the costs of iteration are high and yet dynamics of the new market seem moderate - then it makes sense to let others to blaze the trail. Thus the vicarious experiments strategy might be the most appropriate. A company might introduce something to a new market but the emphasis is on market observation.

If concepts/ products are relatively cheap to develop, as was the case with Sony Walkman (Sanderson & Uzumeri 1995) then the Darwinian selection strategy might be appropriate. The gains from high variety of concepts decreases when amount of competing offering or cost of iteration increases.

In reality, firms are often using some dynamic combination of abovementioned strategies. Nokia provides a good example of that (Fig 7). When introduced in 2001, Nokia 5510 looked like no other previous Nokia phone in spite of the fact that it inherited most of its components and technical solutions from the standard Nokia 3300 series phone. Nokias' designers diminished 5510's phone-like features to make the gadget looking more like an entertainment or a gaming device (interviews and Nykänen 2001). On top of the old components, Nokia added new keyboard, a MP3 player and more memory for games and MP3s. By utilizing Variants strategy this way Nokia was able to test customers' reactions about new positioning, design, features, sales channels etc. These experiences gained helped Nokia to develop three new phone categories (Roope Takala Nokia Research Center): Nokia 3300 series media phone, Nokia N-Gage gaming phone and Nokia 6800 series business phone.

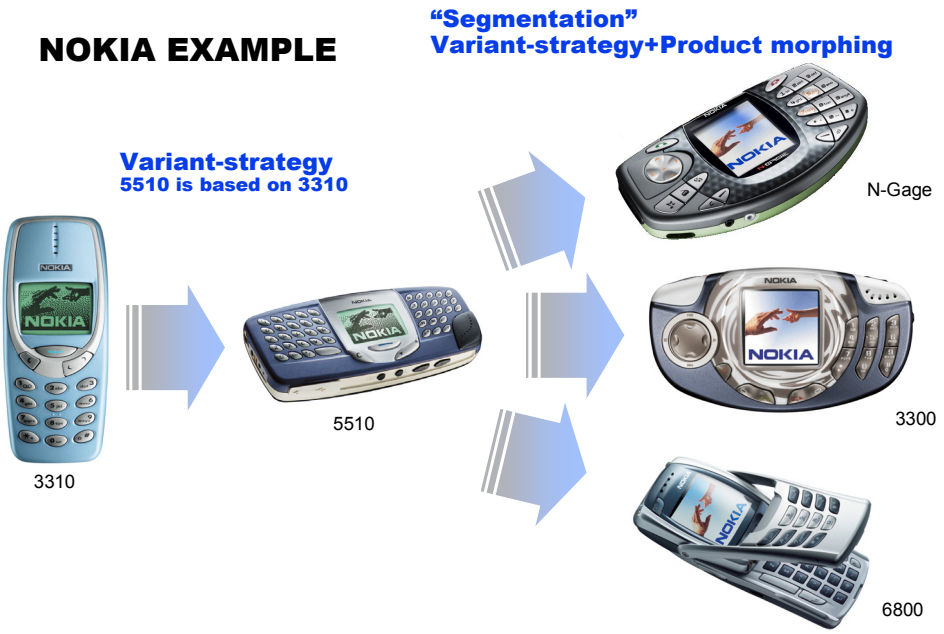

Figure 7; how Nokia is reducing uncertainty (from Roope Lahtinen Nokia Research Center 2003).

4. Conclusion

Conceptualisation in highly uncertain environment is a challenging task. The methods and strategies presented in this paper are based on the assumption that the most effective, and often, the only way to get enough information for justified decision making in highly uncertain environments is to introduce products to the evolving marketplace. In all of the strategies for conceptualisation in the highly uncertain environments, what counts most is not being right the first time but the pace and cost at which the company recalibrate its product offering and learns from a new market. Faster learners might gain competitive advantage in two general arenas. Firstly, because experimentation gives them first-hand experience about customer preferences and value expectations as well as technologies and functionalities they are most likely in a better competitive position to develop higher volume products into that specific product-technology-market domain. In other words, they know exactly where to aim with the higher volume products. Secondly, companies active in experimentation might gain advantages in experimentation and conceptualisation itself, i.e. capability development. They might develop capabilities of faster learning and faster adaptation thus becoming more effective when facing uncertainty and constant changes.

Design plays a key role when creating the winning combinations in new market situations. Design process, similar to any other process, which is aiming to create something new, always contain some degree of uncertainty. Iteration and

experimentation, which are vital for new market creation, are also in the core of the design process. When used effectively, design process is thus one of the key capabilities when operating in uncertain environments.

5. References

Anderson P & Tushman M.L (1990); Technological discontinuities and dominant designs: a cyclical model of technological change. Administrative Science Quarterly 35, 604-633.

Cooper, Robert G (1999); The invisible success factors in product innovation. Journal of Product Innovation Management, 16:115-133.

Cooper R.G; Edgett S.J; Kleinschmidt E.J (2002); Optimizing the stage-gate process: what best-practice companies do – I. Research Technology Management 45 (5), Sep-Oct, 21-27.

Cusumano, Michael A & Gawer, Annabella (2002); The elements of platform leadership. MIT Sloan Management Review, Spring, 51-58.

Dhebar, Anirudh (1995); Using extensive, dynamic product lines for listening in on evolving demand. European Management Journal 13, No 2, pp 187-192.

Eisenhardt K.M & Tabrizi B (1995); Accelerating adaptive processes: product innovation in the global computer industry. Administrative Science Quarterly, Vol 40, pp 84-110.

Eldred, Emmett W & McGrath, Michael E. (1997a); Commercializing new technology I. Research Technology Management, Vol 40, No.1 Jan-Feb.

Eldred, Emmett W & McGrath, Michael E. (1997b); Commercializing new technology II. Research Technology Management, Vol 40, No.2 March-April.

Hamel, Gary & Prahalad C.K. (1991); Corporate imagination and expeditionary marketing. Harvard Business Review, July-August, pp. 81-92.

Jolly, Vijay K (1997); Commercializing new technologies: Getting from mind to market. Harvard Business School Press; Boston.

Khurana, Anil & Rosenthal, Stephen R (1999); Towards “holistic” front ends in new product development. Journal of Product Innovation Management, 15:57-74.

Kim, Jongbae & Wilemon, David (2002); Strategic issues in managing innovation’s fuzzy front end. European Journal of Innovation Management, Vol 5, No 1, pp 27-39.

Leonard-Barton, Dorothy (1995); Wellsprings of knowledge. Harvard Business School Press; Boston.

Lynn G.S; Morone J.G; Paulson A.S (1996); Marketing and discontinuous innovation: The probe and learn process. California Management Review, 38, No 3: 8-34.

MacCormack, Alan; Verganti, Roberto; Iansiti, Marco (2001); Developing products on ”Internet time”: The anatomy of a flexible development process. Management Science, Vol 47, No 1 January, pp. 133-150.

Moenard R; De Meyer A; Souder W; Deschoolmeester D (1995); R&D/ Marketing communication during the fuzzy front end. IEEE Transactions on Engineering Management, Vol. 42,No 3, pp 243-258.

Montoya-Weiss M & O’Driscoll T (2000); Applying performance support technology in fuzzy front end. Journal of Product Innovation Management, 17:143-161.

Moore, Geoffrey A (1999); Inside the tornado. HarperPerennial.

Nykänen, Pekka (2001); Viihdepuhelimien mahdollisuuksia suuriin myyntimääriin epäillään. Kauppalehti 12.10.2001

Rothberg, Robert R. ed (1981); corporate strategy and product innovation. The Free Press; NY-London.

Sanderson, Susan & Uzumeri, Mustafa (1995); Managing product families: The case of Sony Walkman. Research Policy, Vol 24, pp.761-782.

Schilling, Melissa A (1998); Technological lockout: An integrative model of the economic and strategic factors driving technology success and failure. The Academy of Management Review, Vol 23, No. 2, pp 267-284.

Sheasley W.D. (1999); Leading the technology development process. Research Technology Management, Vol 42, No.3 May-June.
Siadad, Barry (1996); Technology delivery challenges at W.R. Grace. Research Technology Management, Vol 39, No 5.
Sorenson, Olav (2000); Letting the market work for you: An evolutionary perspective on product strategy. Strategic Management Journal, Vol 21, pp.577-592.
Stevens, Greg A & Burley, James (2003); Piloting the rocket of radical innovation. Research Technology Management 46, No 2: 16-25.
Ulrich, Karl T & Eppinger, Steven D (2000); Product design and development, 2nd ed. Irwin-McGraw-Hill.
Verganti, Roberto (1999); Planned flexibility: Linking anticipation and reaction in product development projects. The Journal of Product Innovation Management, Vol 16, pp. 363-376.
Wood, Samuel C.& Brown, Gary S.(1998); Commercializing nascent technology: The case of laser diodes at Sony. Journal of Product Innovation Management, Vol 15, pp.167-183.