# Relatório de Estágio

# TECH SPEED

**Finland May-Nov 2001**

**Norberto Guimaraes**

**Dezembro 2001**

Porto University — Nokia Mobile Phones — Helsinki University of Technology

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Universidade do Porto
FEUP Faculdade de Engenharia

Nokia Mobile Phones

NOKIA
CONNECTING PEOPLE

Helsinki University of Technology

# INTRODUÇÃO

Norberto Guimarães participou no projecto TECH SPEED na Finlândia de 15 de Maio de 2001 a 15 de Novembro do mesmo ano.

O projecto consistiu em identificar estratégias para introduzir novas tecnologias mais rapidamente em indústrias muito dinâmicas e com volumes elevados. Mais concretamente, procurou-se estudar, criar e avaliar estratégias alternativas para a NOKIA MOBILE PHONES utilizar na indústria global dos telefones móveis.

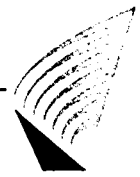
Este projecto é uma parceria entre a NOKIA MOBILE PHONES (NMP) e a HELSINKI UNIVERSITY OF TECHNOLOGY (HUT). O projecto teve início em Abril de 2001 e a primeira fase estará concluída no início de Janeiro de 2002. O responsável inicial pelo projecto da parte da NMP foi Heikki Huomo (Vice President for Research and Technology Access) e da parte da HUT o responsável foi Thomas Keil (Professor). A equipa que trabalhou no projecto tinha dois membros a tempo inteiro sendo um dos quais Norberto Guimaraes. Da parte da universidade do Porto, este projecto foi supervisionado pelo Professor António Sarsfield Cabral.

De Maio de 2001 até 15 de Novembro de 2001, realizaram-se as seguintes fases:

- Procura e escolha de literatura relevante ao projecto
- Apresentação e elaboração de relatórios sobre a literatura existente
- Procura e desenvolvimento de contactos com outras empresas noutras indústrias semelhantes
- Plano de condução de entrevistas para os casos de estudo na NOKIA
- Entrevistas para os 5 casos de estudo da NOKIA
- Entrevistas nalgumas empresas externas
- Desenvolvimento de um modelo com base nas entrevistas
- Recolha de artigos e desenvolvimento com vista a um questionário alargado
- Apresentação e elaboração de relatórios dos casos de estudo

Devido à grande confidencialidade das entrevistas realizadas e dos dados obtidos nos casos de estudo da NOKIA, ficou acordado com o supervisor e com o líder do projecto que este relatório iria basear-se no relatório de literatura pública que foi apresentado durante o projecto. De notar que este relatório foi elaborado por Norberto Guimarães juntamente com Anssi Tuulenmäki em estreito trabalho de equipa. Por forma a obter uma ideia do trabalho realizado durante a totalidade do projecto, serve a declaração do líder do projecto com a descrição e avaliação do trabalho executado por Norberto Guimarães. Na próxima página apresenta-se essa declaração.

A estrutura do relatório é a seguinte:



# PROJECT TECH SPEED

## *SHORT DESCRIPTION*

The project consisted of identifying strategies for introducing new technologies faster in highly dynamic high volume industries. In particular, it aimed at creating and evaluating strategic options that Nokia Mobile Phones could utilize in the global mobile phone industry.

## *PROJECT ORGANIZATION*

The project was conducted as a joint research between Nokia Mobile Phones (NMP) and the Institute of Strategy and International Business at Helsinki University of Technology (HUT). The project team consisted of two full-time project researchers (Anssi Tuulenmäki, post-graduate researcher; and Norberto Guimaraes, master thesis student) and a project leader (Professor Thomas Keil). Norberto Guimaraes worked for the project during 6 months (May-Nov 2001).

## *PROJECT DEVELOPMENT*

During the project phase that Norberto Guimaraes participated in (ending in November 2001), a literature review had conducted, five in-depth case studies including about 30 interviews have been conducted and reported. In addition to this extensive work in gathering material for a quantitative survey and searching for external cases had been performed by the research team.

## *NORBERTO GUIMARAES'S WORK DESCRIPTION*

During the first month after joining the project, Norberto reviewed literature related to the topic. The output of this phase was reported in a steering group meeting that took place at the 10th of June. Following that, Norberto and Anssi, produced an extensive literature review report until the beginning of July. In the next project phase, they conducted interviews for the internal NMP cases. On the second steering group meeting at 6th of August, the interview setting, the set of cases and the possible external companies where discussed. Extensive work to search for external case study and additional rounds of interviews were conducted till the beginning of October. Norberto and Anssi developed during this period a framework for understanding "Speed of Introduction of New Technologies into products" as well. Norberto also contributed to an extensive collection and analysis of Speed articles mainly done by Anssi. On the 9th of November, the third steering group meeting took place and the results of the case studies interviews were presented as well as the framework.

## *NORBERTO GUIMARAES'S WORK ASSESSMENT*

Both Norberto and Anssi participated in all the parts of the work. While this makes the assessment of the individual contribution more difficult, the output that Norberto produced and motivation that he exhibited have been impressive. Norberto has demonstrated to be able to comprehend and structure a complex literature for scientific purpose. He has significantly contributed to the development of the research framework. In addition he has shown the ability to present research results in a form that supports their application in practice. Taken together, Norberto has made an important and excellent contribution to the project.

Espoo, November 19, 2001
Tech Speed Project Leader
Professor Thomas Keil

# II. LITERATURE REVIEW REPORT

TABLE OF CONTENT

LIST OF FIGURES

# HOW CAN MARKET LEADERS INTRODUCE NEW TECHNOLOGIES RAPIDLY IN HIGHLY DYNAMIC HIGH VOLUME MARKETS?

## 1.INTRODUCTION

*Success breeds the seed of destruction.*

In technology-intensive, high volume industries, technological leadership is often one of the antecedents leading to market leadership. While market leadership might be the goal of innovation, it might as well endanger the very basis of innovation. Nokia Mobile Phones is a good example for this paradox. In the global mobile telephone industry, market leadership is connected to very large volumes being produced. In the case of Nokia Mobile Phones, this means that virtually all the new products will have production volumes in excess of one million pieces. Taken such volumes as a starting point, introducing radically new technologies becomes increasingly difficult. New technologies often need to be tested in small scale before being ready for launch in large volumes. However, external partner, markets, but also internal operations do not easily accommodate such tests within the mainstream volume production. Result of this dilemma is that market leaders face difficulties in maintaining their technological lead that is in maintaining the very fact that might have created their leadership.

### 1.1.RESEARCH OBJECTIVE

The ongoing research project aims at identifying strategies that help market leaders to maintain their capability to rapidly introduce new technology in high volume markets. The overall research question of the project can be stated as

***How can market leaders introduce new technologies rapidly in highly dynamic high volume markets?***

In particular we aim at creating and evaluating strategic options that Nokia Mobile Phones could utilize in the global mobile phone industry.

The project started in April 2001. The objective of this particular paper is to give a first review of existing literature (see reference list and appendix 1) as well as to extract technology introduction strategies and identify drivers affecting success or failure of these strategies. Emphasis is mainly on describing the key issues and raising the questions rather than giving the final answers.

### 1.2.SETTING THE STAGE

Figure 1 sets the stage for our literature review. A company is affected by present constrains, which can be both external and internal.

External constrains include the competition; market window (time constrain); customer demand; legal, political and social factors; innovation characteristics (technological and market potential, uncertainty, trends, current technology and product cycle, type of innovation, standards etc).

Internal restrictions existing at the present include degree of modularity; characteristics of partnerships; Demand Supply Chain; brand; existing products; organizational constrains; financial, technological and human resources; the history of the company; the existing capabilities etc.

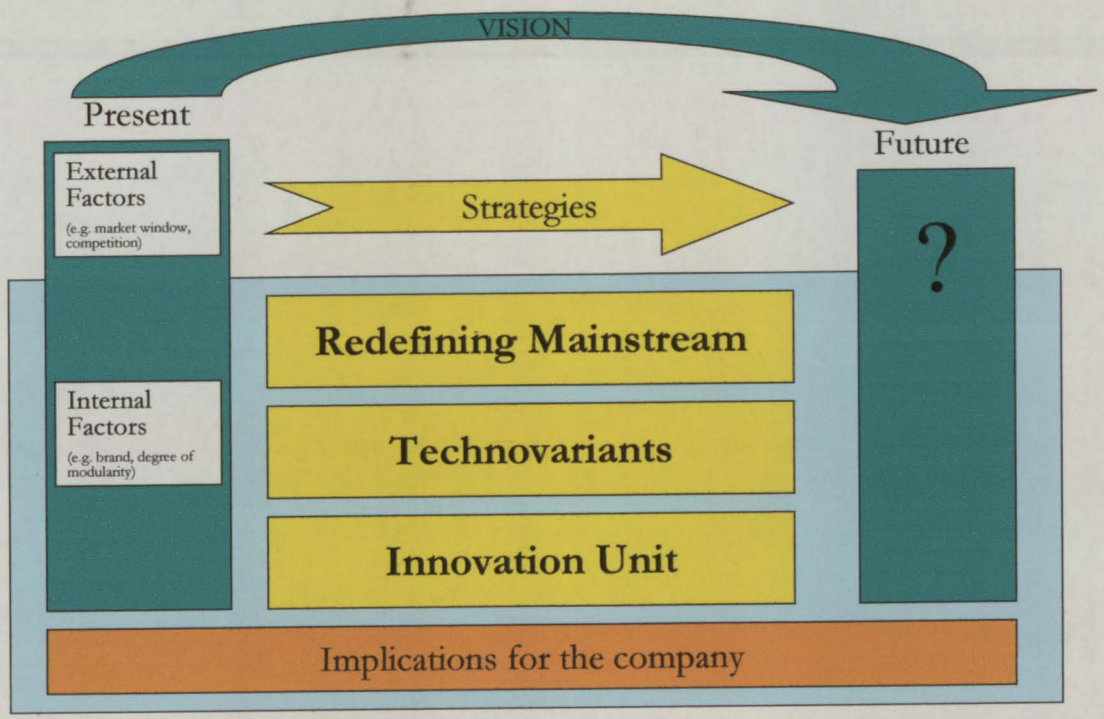



**Figure 1; Setting a stage for the research.**

The Strategic Vision guides the company in the uncertain future. It gives the direction that helps the companies deciding which strategies to choose.

The different strategic options the company takes are another relevant aspect with implications in our study. In general, they define in what business the company is, how it intends to compete and who its target customers are. They involve decisions like what kind of product and services will be produced and the range of offerings; the choices of the target markets or customers; the technology choices – which technologies to invest and how much, and the competitive timing – when to move in a product class.

The current constrains, the guidance provided by the company vision towards the future and other main strategic decisions, lead us to the three different strategy archetypes of how to introduce new technologies rapidly in dynamic high volume markets, which is the core of our study.

The three strategy archetypes define our initial working model – technovariants, redefining the mainstream and innovation unit – are taken from the framework developed by Heikki Huomo (NMP) and Thomas Keil (HUT) in a brainstorming session earlier in this year (Appendix 2). This paper is loosely organized according to those three archetypes. ***"Redefining the mainstream"***, means introducing the new technologies directly into the mainstream. Changes can be resulted from software or hardware development. Key issues are platforms, degree of modularity as well as the speed and flexibility of NPD in general. ***"Technovariant"*** strategy means introducing a relatively higher amount of variants – technologies, products, features – to the market. Key is to learn in real market conditions how different variants are accepted. Compared to mainstream changes, technovariants are often introduced and tested in a limited scale. Market introduction can be limited in terms of time, accessibility, marketplace (geographic or segment), application type etc. ***"Innovation unit"*** strategy means moving the new technology development and introduction to a certain distinct organization separated from the main organization.

Finally, the different strategies on rapid technology introduction have important implications for the company. They can imply changes to the current constrains, for example to the Demand Supply Chain, degree of modularity, partnerships and alliances, brand, and different organizational dimensions (culture, structure, processes, human resources). The strategies also have an important impact on the innovation selection, which includes among others: the type of innovation (technological and market radicalness, sustaining vs. disruptive); the range of technologies to be introduced; speed – time to market; form of introduction (secret, special edition, limited market, mainstream); and testing level.

## 1.3.KEY FACTORS AFFECTING THE NEW TECHNOLOGY INTRODUCTION

Before going to more in details of different archetypes it is useful to take a short look to few general concepts, which affect all the strategies. Firstly, *technology* itself is surely one of the key issues.

### *1.3.1.TECHNOLOGY*

Figure 2 shows how the same technology can be seen in various perspectives, depending from the point of view. Typical example from Nokia's business could be the situation in which a technology can be familiar to Nokia but radically new to the sub-unit supplier. In order to produce the new variant encompassing the new technology, the supplier may have to change its optimized operations radically. In most cases, such changes are accepted reluctantly. Naturally, that kind of inertia has certain consequences to the speed of new technology introduction (see more in chapter 1.3.3).

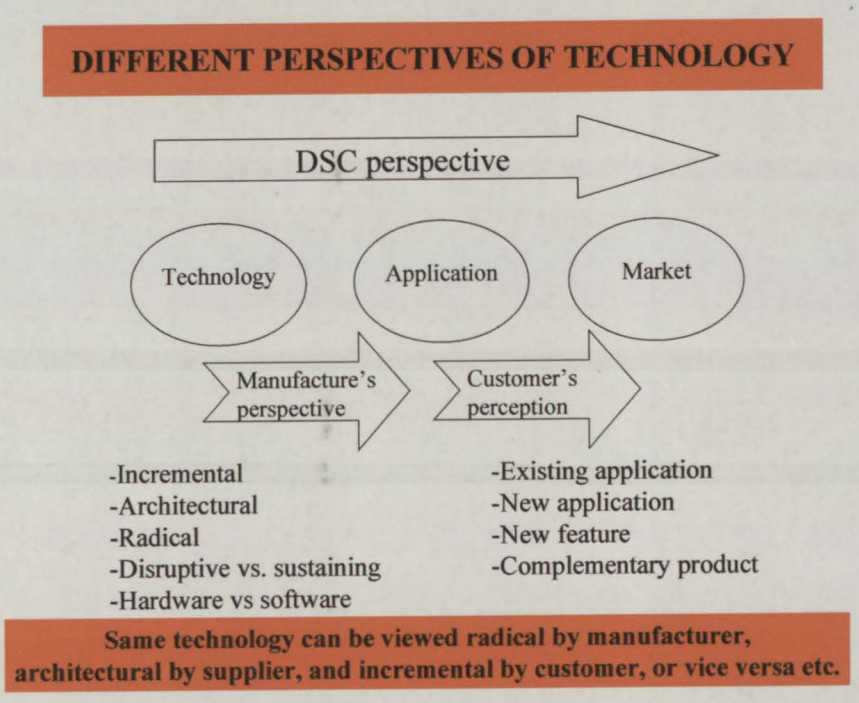



**Figure 2; Different perspectives of the technology.**

Another key issue of different technology perspectives is that, especially in the mainstream business of Nokia, customer perceptions towards the products are extremely important. Basically, the new technology incorporated to the product is either visible or invisible to the end users. From manufacturer's point of view, it is clear that the new technology introduction process differs in those two circumstances. Intuitively, the visible process is more risky, careful, and usually more time-consuming.

If the technology is visible to the customers, they can perceive it as an existing application (new feature, provider of better performance), new application or complementary product. Friar and Balachandra (1999) suggest that positioning of the new product should be based on the radicalness of the technology. Although the radical new technology may perform the same functions, it may demand considerable learning on the part of customers. Additionally, there may be some risk-averseness on the part of the established market to use an untested technology for an existing application. Because of such reluctance, it may be appropriate for the radically new technology to make inroads with current customers by providing successful new applications. This is shown in Figure 3.

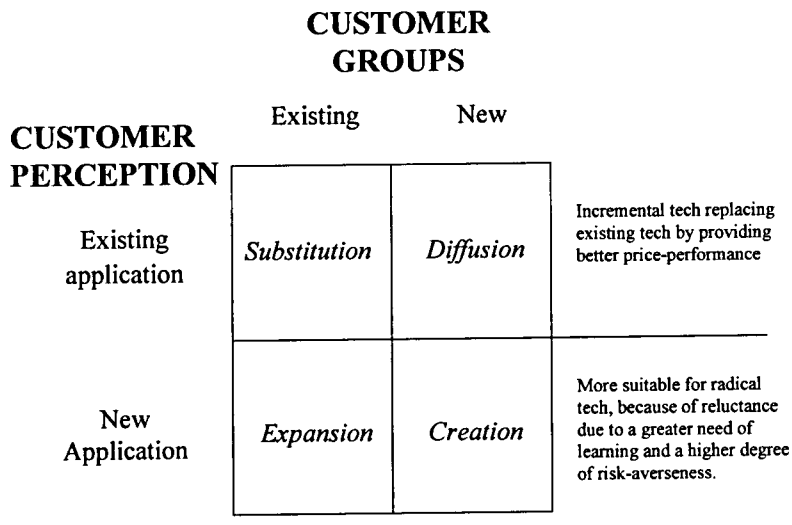



**Figure 3; Market applications matrix (Modified from Friar & Balachandra 1999:39).**

If the technology is so radical that there is not even a potential application for an established market, then the creation strategy may have to be adopted. New technology incorporated to existing applications, e.g. within the Nokia's mainstream mobile phones, may be positioned at the upper part of the matrix, i.e. substitution or diffusion quadrants.

The radicalness of the technology influences the technology life cycles. A technology cycle (Figure 4 - Tushman & O'Reilly, 1997) is triggered by a technological discontinuity, a relatively rare, unpredictable event offset by scientific or engineering advancement (e.g., batteries substituting springs in watches.) This initial step is represented by the *Variation* box in the Figure 4. This technological discontinuity ruptures existing incremental innovation patterns and generates a period of technological ferment, the second stage in the cycle.

In this *period of ferment*, different technologies compete for market acceptance. They compete among each other and with the existing technology. The end of this period is characterized by the emergence of a dominant design (or industry standard), which is a watershed event in the technology cycle. It also starts the third stage of the cycle which is named *Selection.* In these period, the competing companies switch to the new standard or risk getting locked out of the market. After *Selection* the technological progress is driven by the standard technology itself and not anymore by the competition between different technological trajectories. So, the new focus is on process innovation and continuously improving the product (incremental innovations). The authors (Tushman & O'Reilly 1997) characterize this phase as *Retention.* Architectural innovations also emerge during this last period of incremental change. They link or combine existing technologies in different ways, and the resulting reconfigured products are often brought to different markets. The authors point out that although the architectural innovations may be technologically simple and provide substantial revenues, they are frequently missed by the established firms.

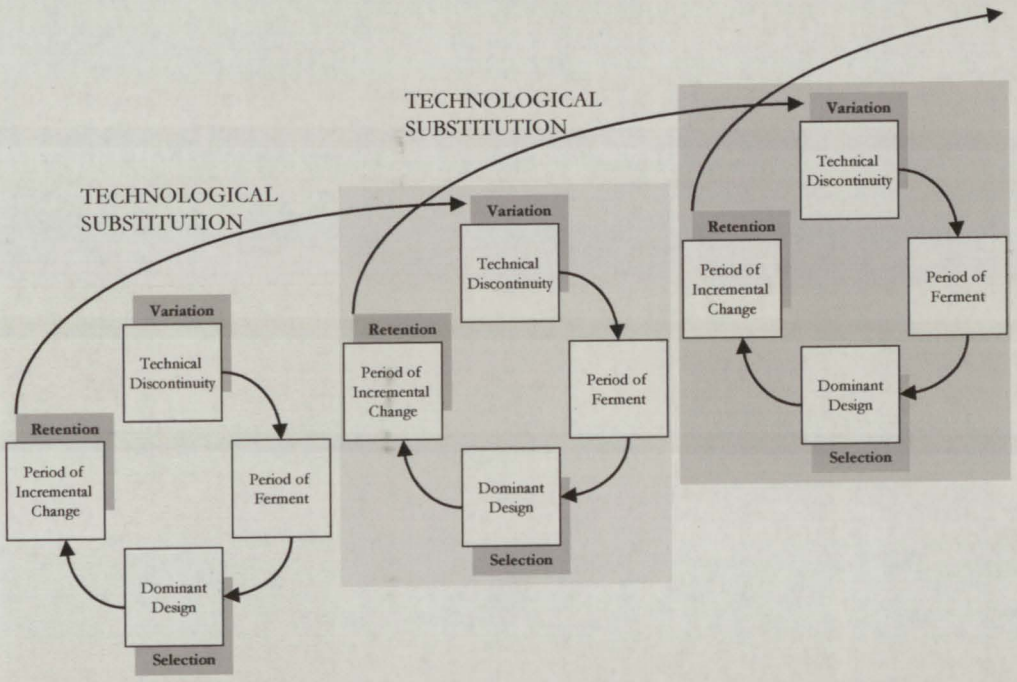



**Figure 4; Technology Cycles (Tushman & O'Reilly 1997)**

A final point in the technology cycle and the outset of a new one is another technological discontinuity represented by the arrow coming out of the *Period of Incremental Change*. A new cycle of technological variation, ferment, selection, and incremental change can then start.

Another important dimension of technology is the amount of technologies considered by a focal company. The Figure 5 integrates the three different technology introduction strategies to the amount of different new technologies considered to be introduced by the company. Logic behind the figure is that in the technology intensive, mainstream business in which e.g. Nokia is involved, huge volumes and optimizing the whole DSC are the keys to the profits. There simply is not much room for testing a large amount of new technologies. Therefore, technovariants and innovation unit strategies perhaps are more appropriate with less mature technologies, businesses, products and applications where margins are bigger and volumes are smaller.

The innovation unit strategy may be the most appropriate in the early ferment/introduction phase of the technology/product life cycle. Low sales volume and high degree of uncertainty concerning future applications, market needs and technologies characterize that phase. Innovation units may be used best as a way to map out the future. High amount of new technologies and applications may be considered but only few of them are actually developed further.

The technovariant strategy may be the most appropriate in the growth (selection) phase of the life cycle where sales volumes are higher and dominant designs are about to emerge. In this phase, the amount of new applications and technologies considered may be lower than in the ferment/introduction phase, but the amount of variants actually introduced to market is higher. Different variants may be used to learn the market needs and to see which applications are accepted as dominant designs.

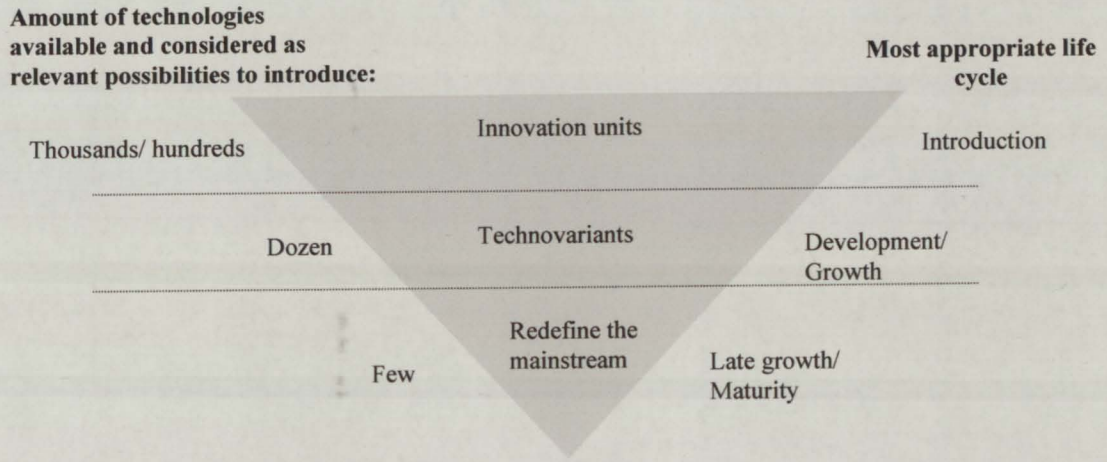



**Figure 5; Technology variety and introduction strategies.**

### *1.3.2.NEW PRODUCT DEVELOPMENT (NPD)*

The new product development is the second general concept affecting all the efforts to introduce new technologies. First, a short overview of the NPD process is provided. Then, perhaps the most important single issue in NPD from this study's point of view, the flexibility, is discussed in more detail.

#### 1.3.2.1 NPD overview

The literature about NPD is vast. Our aim in this chapter is to give a short overview of some aspects that can be relevant to our study. Ulrich & Eppinger (1995) define the product development process as the sequence of steps or activities that an enterprise employs to conceive, design, and commercialize a product. It is a traditional sequential model dividing the NPD process in five phases (Ulrich & Eppinger 1995) as shown in Figure 6.

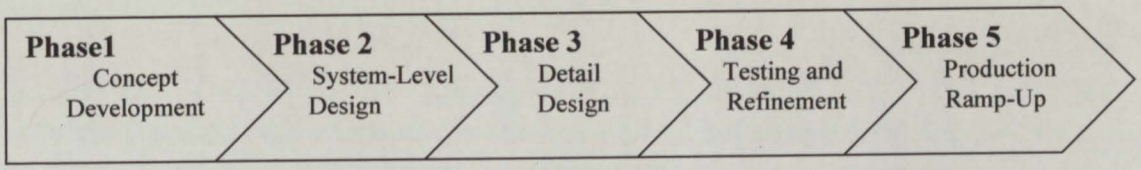



**Figure 6; New Product Development Phases (Ulrich & Eppinger 1995)**

In the **first phase, Concept Development,** the needs of the target market are identified, alternative product concept are generated and evaluated, and a single concept is selected for further development. The result of this phase are the form, function, and features of a product usually together with a set of specifications, an analysis of competitive products, and an economic justification of the project.

The **second phase, System-Level Design,** includes the definition of the product architecture and the division of the product into subsystems and components. The final assembly plan can also be defined in this phase.
The **Detail Design phase,** which is the **third,** completes the specification of all of the unique parts in the product and the identification of all the standard parts to be purchased from suppliers.

The **Testing and Refinement phase (fourth)** refers to the construction and evaluation of multiple pre-production versions of the product. Alpha and Beta prototypes are usually tested. The first are early prototypes in order to evaluate if the product satisfies the key customer needs and if it will work as designed. Beta prototypes are intended to answer the questions about performance and reliability in order to identify necessary changes for the final product.

Finally the last and **fifth phase** from this framework is characterized as the **Production Ramp-up**. In this phase, the product is made using the planned production system. The objective is to train the work force and to solve any remaining problems in the production processes. Products coming from this production are sometimes tested with selected customers. The transition from production ramp-up to ongoing production is usually gradual and continuous. The launch makes the product available for widespread distribution. Launch issues will be described in the next section.

This generic model introduced several phases that are important in the product development. Some authors suggest different frameworks, in which the general sequence of phases presented above is still valid. We present below (Figure 7) a more detailed model proposed by Jenkins, Forbes, and Durrani (1997), which includes the role of different processes affecting NPD like strategic Management, Technology Acquisition, Assessment and Risk Analysis.

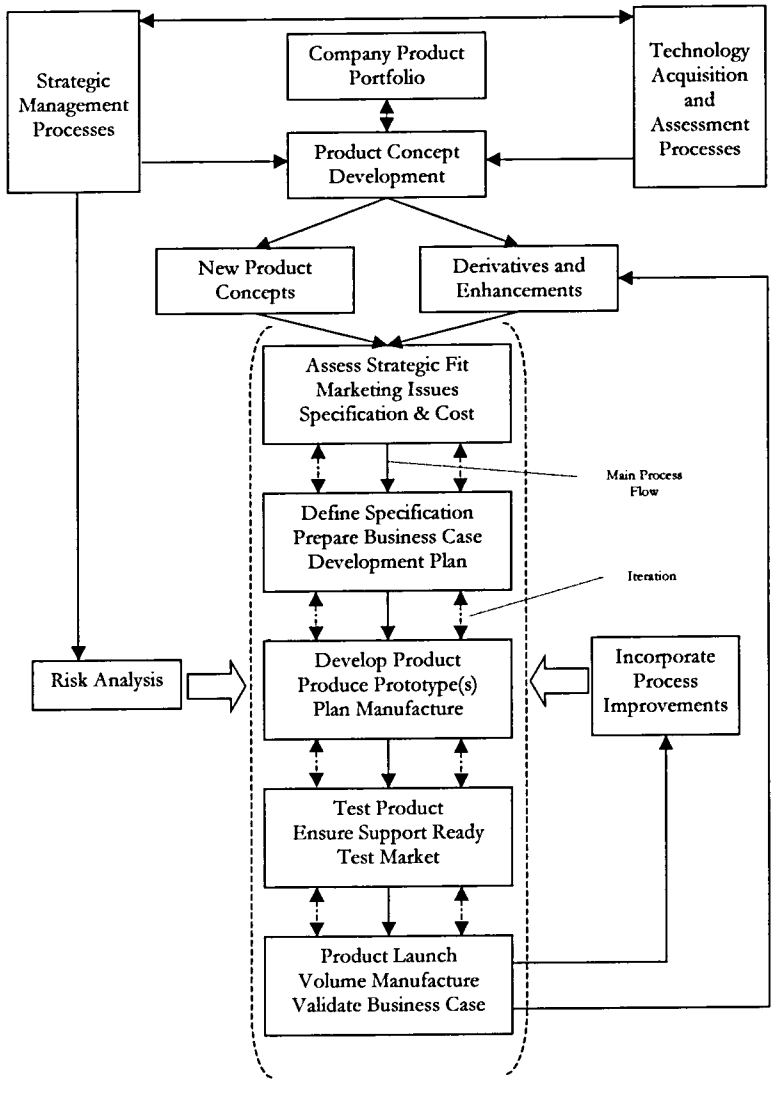



**Figure 7; Product Development Process (Jenkins, Forbes, and Durrani 1997)**

Shilling & Hill (1996) reviewed the existing literature for identifying a number of processes and techniques to optimize the new product development process. They argue that the critical objectives to achieve the optimization are to **minimize time to market** and to **maximize fit with customer requirements**. They developed a model of the attributes that a NPD process should have in order to achieve those two objectives. This model is composed of five levels that can be seen in Figure 8.

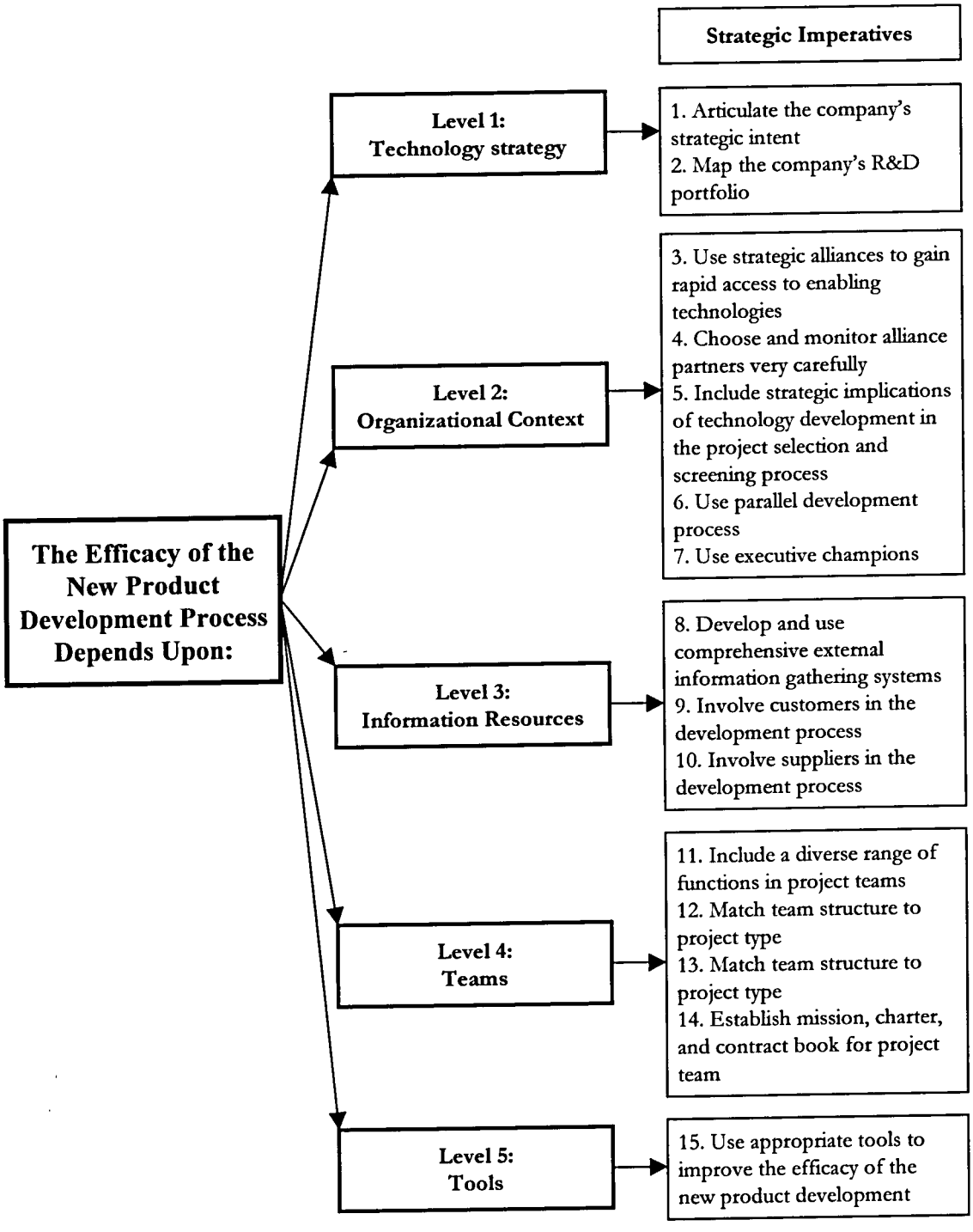



**Figure 8; NPD model - most important attributes (Shilling & Hill 1996)**

**Level 1** is about the **technology strategy**, which is process by which the company constructs their new product development portfolio. **Level 2** includes the **organizational context** of the NPD process. **Level 3** discusses about the leverage that the **information resources** can bring to NPD. In **level 4**, the **teams** building and dynamics are analyzed. Finally, on **level 5** there is an overview of the **tools** available for improving the efficacy of NPD.

Toni *et al* (1998) suggest a grouping of the most important product development techniques and methodologies into six classes:

1. Design Performance Improvement by external contributions – *early supplier involvement (ESI)*
2. Part Number Reduction – *variety reduction program(VRP)* and *modularization (Mod)*
3. Manufacturability and assemblability – *design for manufacturing (DFM)* and *design for assembly (DFA)*
4. Project Schedule and development time reduction – *work breakdown structure (WBS)* and *overlapping (OL)*
5. Product assessment – *design of experiments (DOE), early problem detector prototyping (EPDP), failure mode effect analysis (FMEA)*
6. Customer satisfaction – *quality function deployment (QFD)* and *value engineering (VE)*

The authors (Toni *et al*, 1998) propose in their study the detailed relationship between the use of these groups of techniques and different project complexity variables, including among others: the product variety, innovation degree, commonality, and supplier involvement. The detailing of the techniques and of their relationships is out of the scope of our initial overview study. Schilling & Hill (1996) give more relevance to Quality Function Deployment, Design for Manufacturing and Computer Aided Manufacturing as the most prominent tools to improve the NPD process.

Veryzer (1998) says that most product development efforts focus on incremental innovations. We can expect that many of the techniques and processes of NPD are best suited for this type of innovation. McDermott & Handfield (2000) argue that some of the "rules" and techniques that have been established for the management of incremental innovation may not only be unhelpful in less certain, riskier environments, but may in fact actively inhibit goals of this type of more radical innovations. They studied the effect of radical products in the NPD process and in particular for Concurrent Development and Strategic Outsourcing.

For our further study, it might be interesting to search if there are existing studies on the NPD process of Nokia and related issues. Those studies might exist because of the general relevance that NPD has in the literature and the importance it has for Nokia.

Ali (1994) proposes the Figure 9 to structure the different factors affecting the type of product development. Those factors are organized under three broad titles: Firm or industry characteristics, market characteristics, and innovation characteristics.

He subdivides Firm or industry characteristics in structural and behavioral aspects. Market characteristics are also divided in: technology, competition and customer.

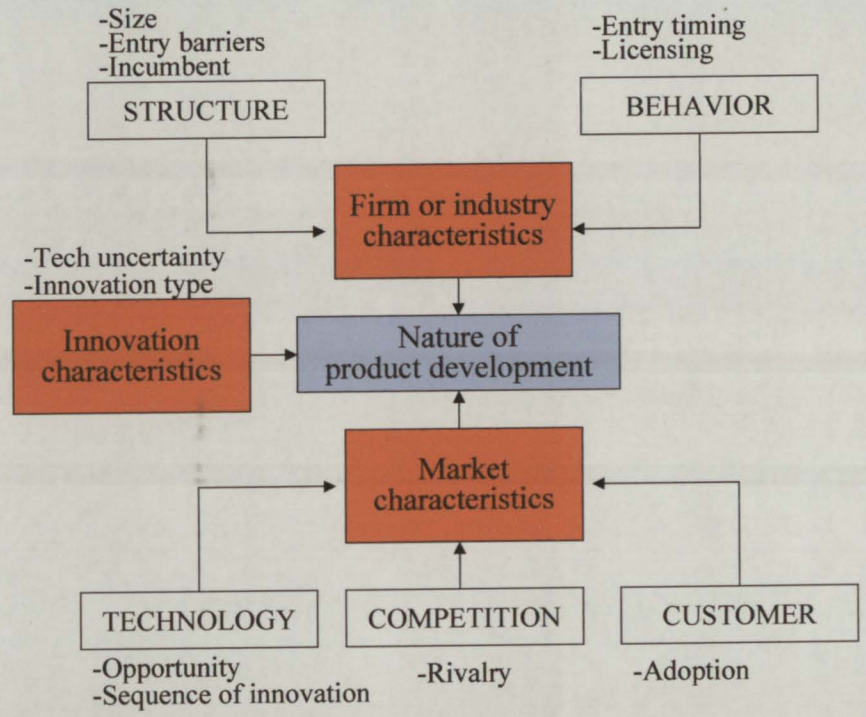



**Figure 9; Overview of the New Product Development (modified from Ali 1994)**

This section aimed to introduce some overview models for New Product Development Process, the main techniques, and factors affecting NPD. In the following chapter we describe flexibility, which is a very relevant issue of NPD in our study.

### 1.3.2.2 Flexibility

There is consolidated stream of studies that consider the early phase of the NPD as the most crucial one (e.g. Wheelwright & Clark 1992). This is because the cost and time of any corrective action and engineering change dramatically increase as one gets deep into implementation (continuous line in Figure 10). Indeed, Rubenstein's (1995:27) argumentation is hard to overcome: a "good" technical development cannot save the project if the original idea is "bad". As a direct consequence, this stream of research maintain that a major principle for managing product development is anticipation. Thus, during the early phase, great efforts should be devoted to anticipating information from downstream phases, so that early solutions already account for future constrains and opportunities. Systematic learning from previous projects, team working, i.e. early involvement of all major actors and supported proactive thinking (QFD, early prototyping etc) are examples of factors increasing the success of this approach (Verganti 1999:370).

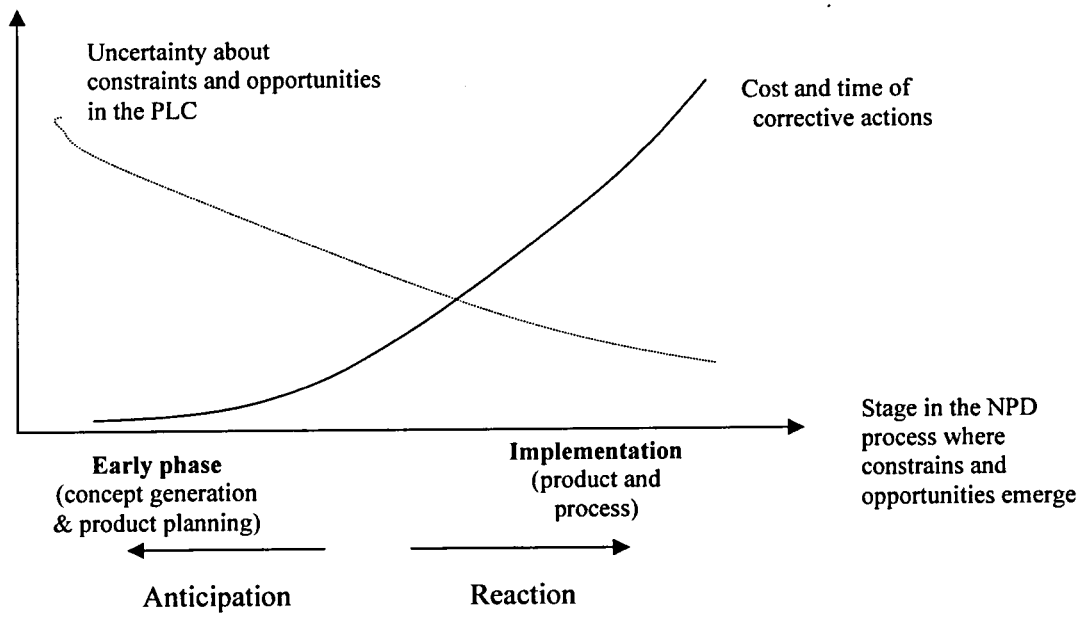



**Figure 10; Anticipation versus reaction in NPD (Source: Verganti 1999:364).**

A second stream of research focuses of *reaction*, i.e. the capability to rapidly introduce changes late in the process (e.g. Iansiti 1993-1996). These studies point out that downstream information is affected by substantial uncertainty (the dotted line in Figure 10). Importantly, this happen especially in highly dynamic industries. Therefore, the early phase is considered less crucial: early decisions are taken without intensively anticipating downstream information, and most choices, including eventual concept freeze, are delayed late in the project, when information is available and uncertainty decreases. Model "b" in the Figure 11 describes the NPD process under highly uncertain circumstances. There, a process begins with no precise idea of how it will end. Thus, the need for changes during the project is accepted as a standpoint, and to reduce the cost of changes the project responds (proactively) to technology and market changes (Iansiti & MacCormack 1996).

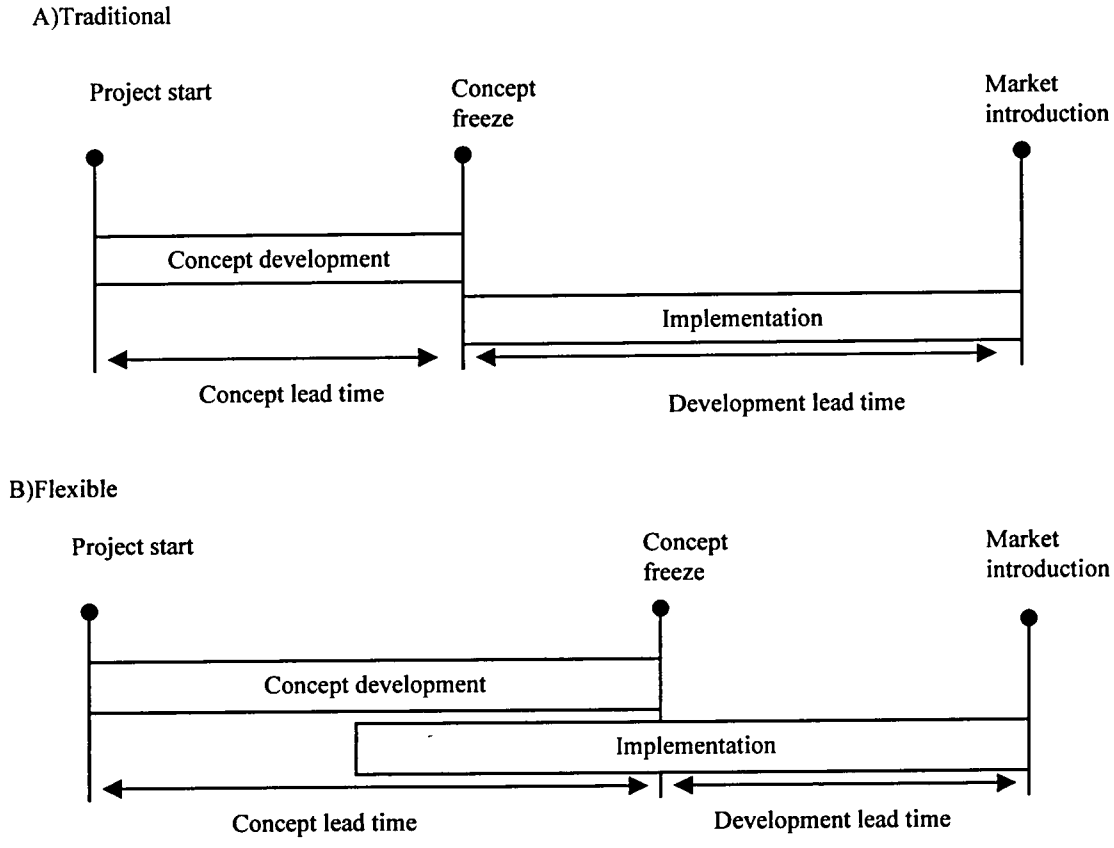



**Figure 11; Flexible NPD process (Iansiti & MacCormack 1996:5).**

Importantly, speed is a subtle concept in this model. Total lead time, the time taken to fulfill initial project objectives, is clearly important; but concept lead time and development lead time measures, are critical in their own right. Concept lead-time is the "window of opportunity" for including new information and for optimizing the match between technology and application. Development lead-time is the time when the window is closed, the product architecture is frozen, and the project is unable to react to new information. Thus, the greater the ability to respond to changes, the shorter the development lead-time. Naturally, this is very important issue especially in unstable environments where customer preferences are changing or preferences are not known. On the other hand, in the mainstream, where user requirements and technologies are to a high degree well known, the total time and in particular the concept lead time have increased importance.

What kinds of capabilities are needed then for flexible introduction of late corrective actions? Thomke & Reinertsen (1998) and Verganti (1999:369) divided capabilities in five groups:
1.Flexibility of the resources involved in the NPD (e.g. highly skilled designers, CAD/CAM systems)
2.Effective communication (e.g. multifunctional teams, co-location)
3.Overlapped development activities (e.g. product/process design, concept design/implementation)
4.Redundancies (e.g. over-allocation of resources for experimentation)
5.Leverage design architecture (e.g. modularity, isolate volatility in the design, reduce coupling between modules).

These two principles mentioned above (anticipation and reaction) are not contradictory or mutually exclusive. On the contrary, they should be integrated in order to achieve the best outcome. That is because the flexible capability to implement late corrective actions in a project depends both from reaction and anticipation capabilities. To explain this, flexibility can be divided in two major components: *Structural flexibility* is the reaction capability that unfolds through long term practice, i.e. it is not linked to a specific project. However, each project has its own critical areas and reaction measures. Therefore structural flexibility is useless unless it is coupled with *planned flexibility* (Verganti 1999:371), which is project-based flexibility, built through decisions taken in the early phase (anticipation capabilities).

### *1.3.3.SPEED*

The third key issue behind all the three strategies is the *speed.* Figure 12 summarizes (internal) factors affecting the speed. Most of the factors affecting the speed are related to the *flexibility* of the NPD process (see more in previous chapter and *modularity* in section 3). However, as described in the end of this chapter, there are some external factors as well.

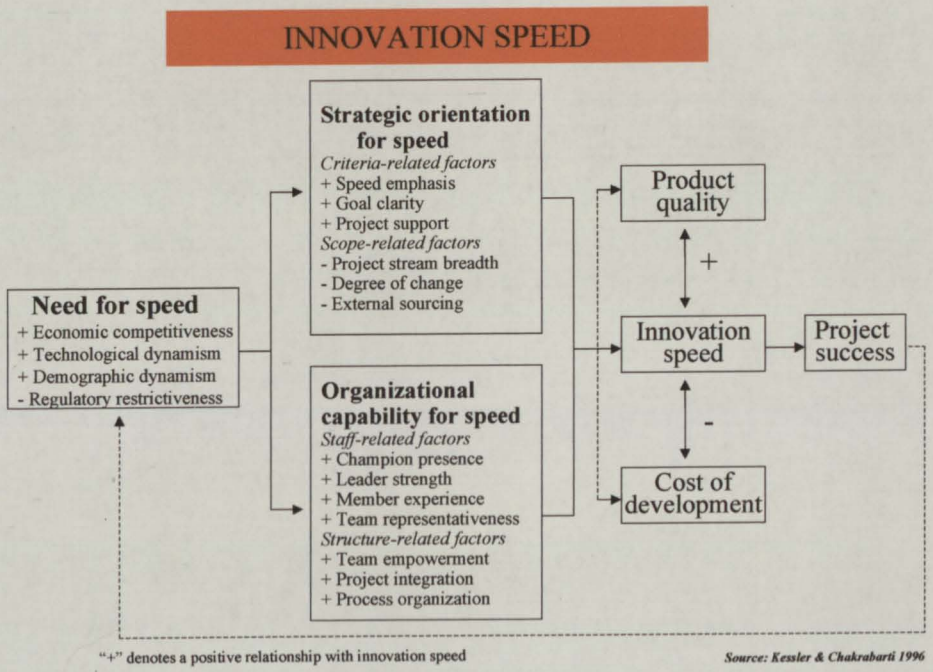



**Figure 12; (internal) innovation speed (Source: Kessler & Chakrabarti 1996).**

The primary outcomes influencing a project's success are time, cost and quality (Kessler & Chakrabarti 1996). These measures are also highly interrelated, i.e. the speed of innovation affects and is affected by project costs and product quality. Intuitively, one could say that the higher the product quality the longer the development time. However, Kessler & Chakrabarti are arguing the opposite, that innovation speed generally has been positively correlated with a product's quality. (Quality is defined as a degree to which

product satisfies customers' requirements.) This is e.g. because faster development is associated with higher rates of learning among employees and their construction of core competencies related to developing new products (longer term perspective).

In general, the more issues are done concurrently instead of sequentially, the faster the NPD process may be. This can mean overlapping stages (Calantone & Di Benedetto 2000) and/or parallel development. Karlsson & Åhlström (1996:294) proposed a framework where they compared traditional (sequential) model of concretizing a NPD project to the more concurrent model (Figure 13). In order to succeed with such concurrent model a company should utilize numerous interrelated techniques, including supplier involvement, cross-functional teams, concurrent engineering, integration (as opposed to coordination) of various functional aspects of projects, heavyweight team structure etc.

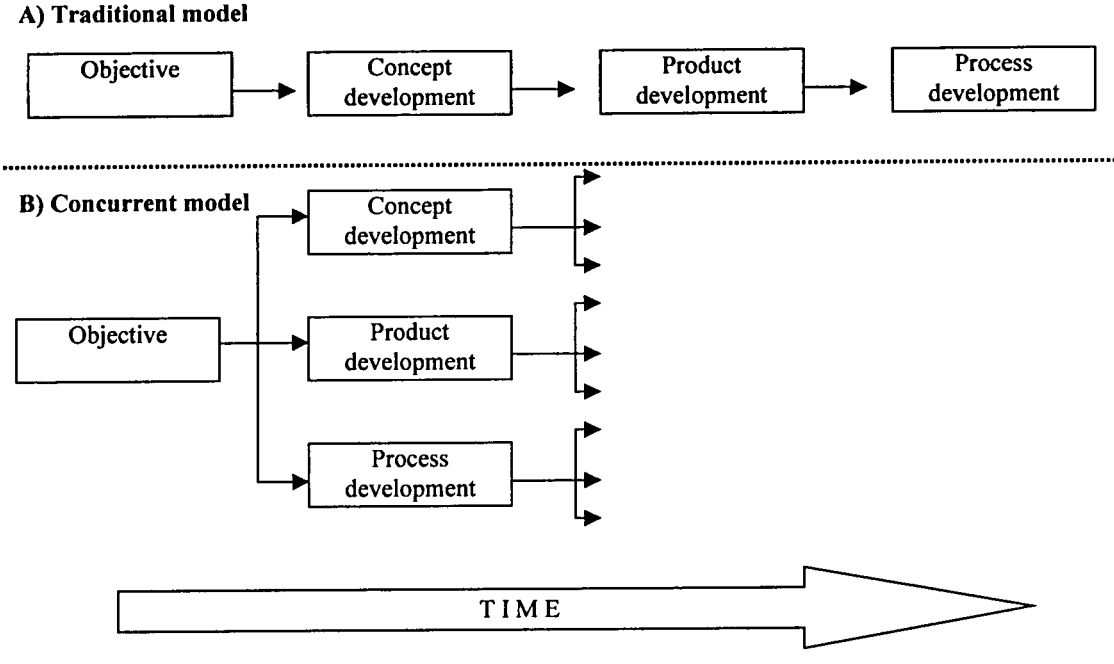



**Figure 13; Traditional versus concurrent (lean) NPD process (Karlsson & Åhlström 1996:294).**

One important question affecting the speed of the NPD is how fast a company learns what customer really needs. Langerak et al (1999) proposed a hierarchy of objectives to speed up the NPD. They argued that the most important objective is to carry out only such activities, which add value to customer. Therefore, they suggested that the second objective is customer's need identification, especially lead user involvement. Lead users face needs that will be general in a market place, but they face them months or years before the bulk of the market (Von Hippel 1986).

*External* factors are also affecting the speed of new technology introduction. Meyer & Utterback (1995) noticed that newness of customers and distribution channels increase development times. In short, it takes time to learn new customer needs and build new relationship to external distribution. Kohli et al (1999:135-136) added that there may be

some legal requirements (tests, tariffs) restricting the introduction. Also demand may be retarded because of the lacking infrastructure or other complimentary products, or because the network externalities affect adoption. Other external issues surely affecting the speed of new technology introduction are standardization processes, alliances, the partnership network, supplier involvement (Ragatz et al 1997, Handfield et al 1999) and DSC flexibility/rigidity in general.

### *1.3.4.LAUNCH*

The launch process is certainly affecting all the strategies of introducing new technology. Mistakes in launch execution can turn out be very expensive to correct. In some cases, customers' negative perceptions, caused by early mistakes, can be almost impossible to alter later on. For example, Apple's Newton PDA never really came over of its disastrous start. The product, as well as the key technology – the handwriting recognition - was perceived as unmature and unreliable by potential customers (e.g. Bayus et al 1997). However, no matter how important it might be for overall success, the launch execution details are not in the very core of this study. Therefore, only the overview of issues affecting the launch is provided in this context.

#### 1.3.4.1.Launch overview

There are a huge variety of possible decisions and activities contained in a launch plan. Issues vary from pre-announcements (e.g. Lilly & Walters 1997), when the product is not finalized, to product replacement strategies (Saunders & Jobber 1994), where a company already considers the deletion of the older products in the market. In addition, decisions are varying across industries (e.g. Guiltinan 1999). Similarly, one could present different models explaining how launches should be planned and executed. The key factors affecting the high tech launch are gathered in Figure 14 below, which presents the launch factors in extend appropriate to the scope of this report.

The degree of newness of technology and innovation/application together with opportunity space creates the starting point of the launch planning. Then process may continue with strategic and tactical considerations where firm's vision, resources, competencies as well as market characteristics are taken account. Competition and rival introductions are surely playing a role in the launch. The competition affects the opportunity, but also the strategic and tactical launch variables. So, customer perception and realized demand are affected by strategic launch choices, launch execution and competitors' operations. In addition of those, even the firm's past patterns of new product introduction influence consumers' perceptions of the firm's product's rate of technological change, as Boone et al (2001) revealed. And normally, marketer-customer relationship is a two-way process, in which both are affected interactively.

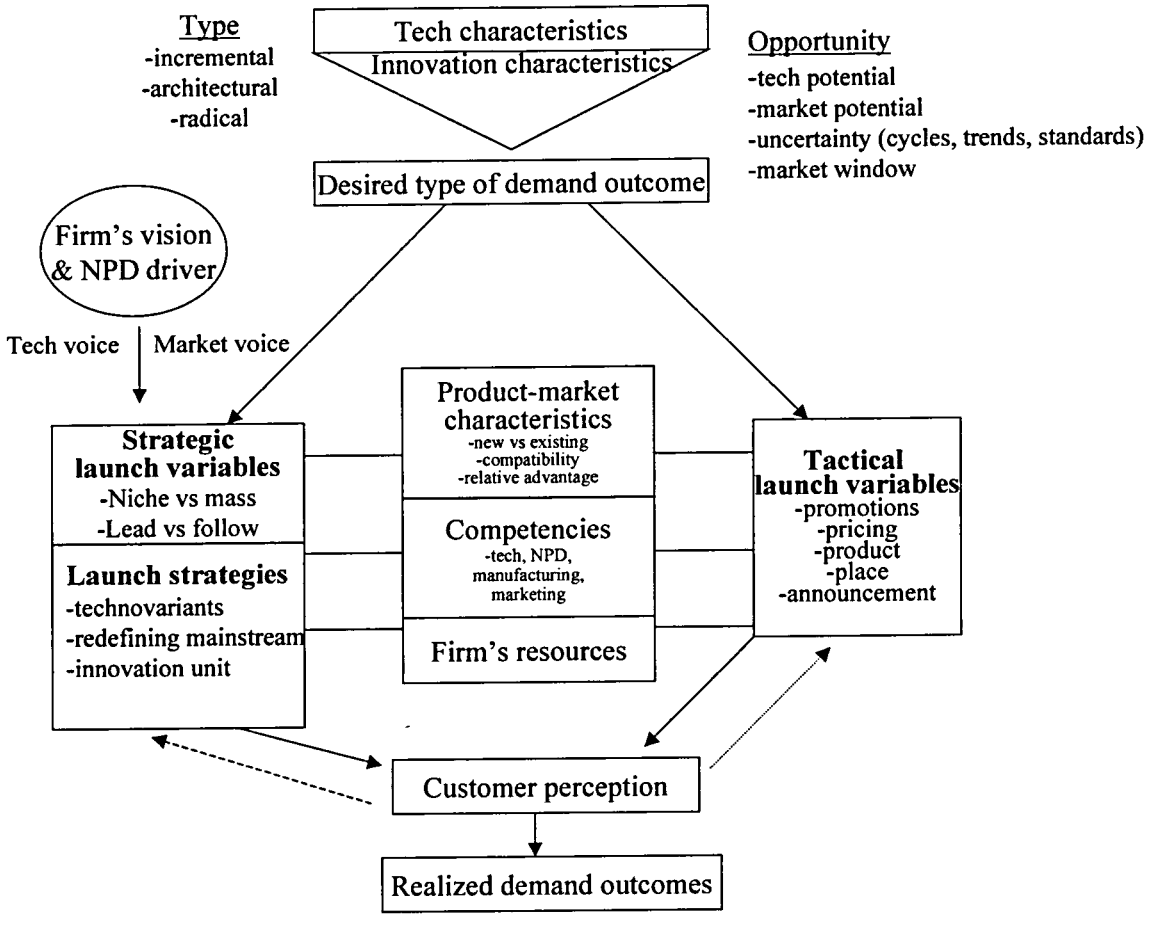



**Figure 14; Factors affecting the launch planning (Modified from Guiltinan 1999:516)**

### 1.3.4.2.Launch tactics for different kinds of products

To go in more practical level, the tactical launch variables are gathered in Figure 15 according to perhaps two most important product/technology features, namely relative advantage and compatibility (e.g. Rogers 1995).

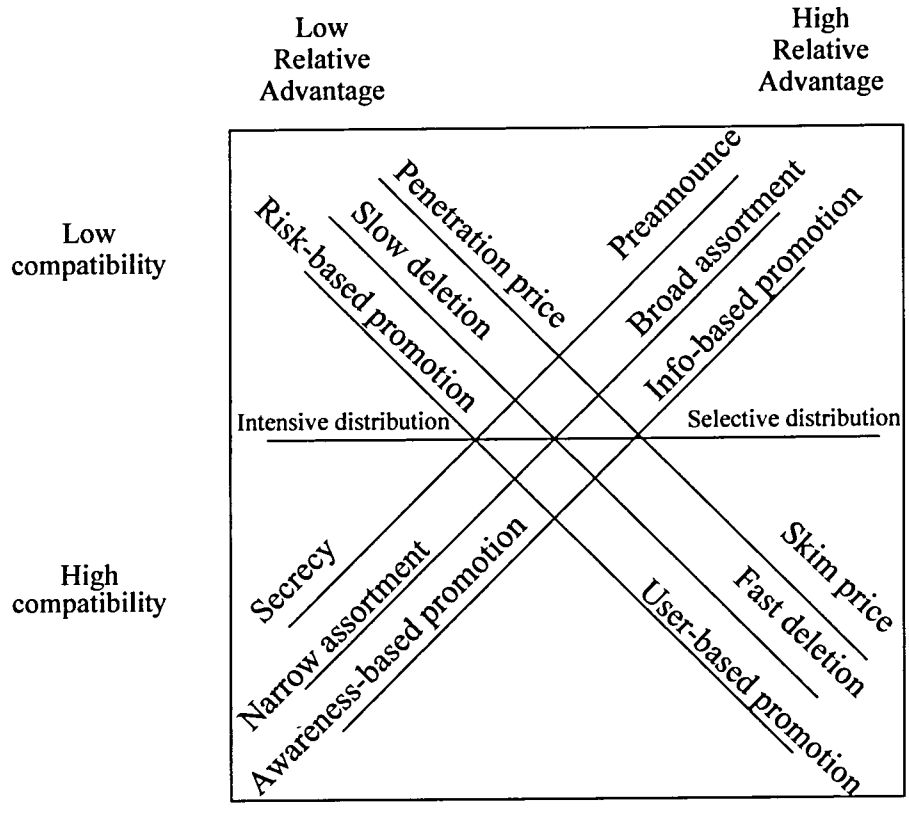



**Figure 15; Launch Tactics (Guiltinan 1999:521)**

Products belonging to the area of low relative advantage and low compatibility can be new products that mainly offer value for buyers in segments with special functional needs or usage situations, but which are targeted at mass audiences (Guiltinan 1999:520). Many novelties or experiential products are fitting into this category (e.g. Apple Newton). Such innovations may be perceived as carrying economic, social, or other risks as a consequence of their "incompatibility" while offering modest incremental benefits. Thus, a launch plan should attend to risk reduction.

Combination of high relative advantage/ low compatibility best reflects the really new products offering important new benefits (Guiltinan 1999:521). However, new benefits are usually requiring significant changes in usage patterns or in expectations/ values associated with the category. Thus, extensive product information must be directed at prospects both to underscore the relative advantages and to overcome incompatibles.

Products with low relative advantage and high compatibility are similar to existing offerings. Therefore awareness is the primary determinant of trial and thus awareness-based promotion is central to launch planning.

New product offers high relative advantage and high compatibility at the same time when the product is perceived superior on attributes that are already well established. This combination normally presents the best opportunity for a successful product introduction. Communications need not to be focused on altering product values or usage patterns. Rather promotions can emphasize the fact that the innovation provides a

higher level of benefits that are already desirable, e.g. video game consoles offering faster and more realistic gaming experience, or mobile phones offering longer battery life.

### *1.3.5.BRAND*

Strong brands are extremely important in mainstream consumer business like Nokia's (e.g. Aaker 1988-2000, Davis 2000, Doyle 1995, Loden 1992). The importance of branding is reflected by the vast branding literature. The real brand gurus, like Aaker, have written thousands of pages about branding details. Initiative here is not to challenge the gurus or to provide complete introduction to branding, but to figure out the key branding issues from this study's point of view.

The most profound question in this context is whether to bring new technology to the market under the Nokia's existing brand or by using a separate brand. To answer that question one has to look how Nokia's existing brand is generating value, i.e. how does it help in bringing new technologies to market, and at the same time, what might be lost in case that something goes wrong. In short, what are the benefits of using Nokia brand, and respectively, what are the benefits of using a separate brand? After those brief considerations, a few ideas how the new technology could be introduced to the market under the Nokia's brand is provided.

#### 1.3.5.1. Benefits and risks of using Nokia's existing brand

The key determinants of the existing Nokia brand equity are presented in Figure 16. Those issues are on stake when deciding whether to go out with Nokia brand or not.

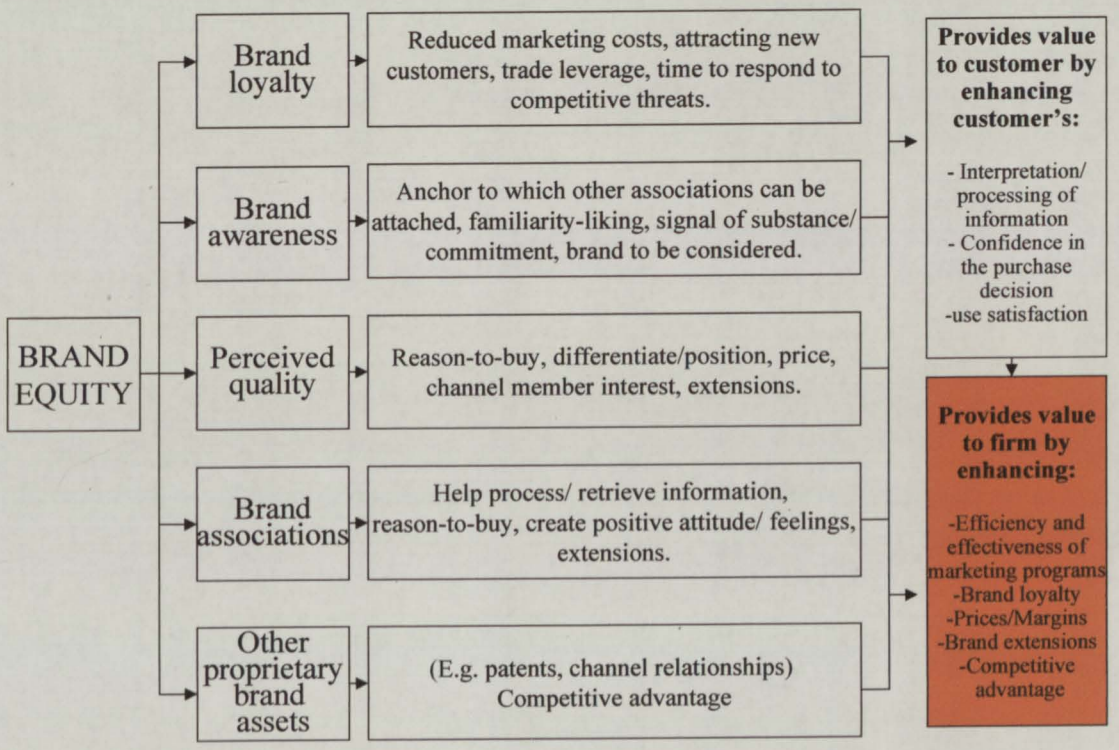



**Figure 16; How existing Nokia brand generates value (Modified from Mahajan et al 1993:2; Aaker 1996)**

As seen in the figure, the strong Nokia brand generates value in many ways. Nokia brand offers creditability and awareness, which are often needed when introducing new technology. Interestingly, a company brand name is even more important in Asian cultures than it is in western countries (Han & Schmitt 1997). Further, a strong position in marketing channels helps in distribution choices and price margins. In addition, a separate new brand, might be in some cases too expensive to develop or not even feasible (to become 3rd or 4th in mind and on the shelf – Aaker 1996). In short, under the Nokia brand, the new technology has better changes to be profitable. And of course, it has better changes to reach the mainstream faster.

However, at the same time, Nokia's brand identity can be in danger. This can be because the brand is used in too different product class (e.g. Pettis 1995). Such over-stretch can danger the whole mission statement "Nokia – Connecting people". Brand can be diluted also because of too different price/ quality perception. The new technology can fail to perform as expected in many reasons, like low degree of compatibility, untested features, lack of infrastructure, unfamiliar consequences etc.

### 1.3.5.2.Benefits of using a separate brand

Separate brand can be a company brand or product brand, it can be new or some existing. Existing brands can be acquired e.g. through acquisitions, and they might have a strong national/ segment identity which can be utilized when introduce new technology (Hatch & Schultz 2001).

When the technology is really radically new, it may be safer to introduce it under the separate brand. Rationale here is even intuitively clear; if something goes really wrong with consumer perceptions or how the technology actually performs, Nokia's brand stays untouchable.

Literature pointed out another benefit of using separate brand. With new brand, it may be easier to target niches because no compromises are needed at positioning (Aaker 1996). There are no issues to consider related to the megabrand (e.g. Loden 1992).

### 1.3.5.3.How to introduce new technology under the Nokia brand?

When using a brand relationship concept presented in Figure 17, Nokia is a branded house at the moment. All the mobile phones are under Nokia brand name, separated only by numbering (3210, 8810 etc). For example, in 1999 at CeBIT in Hannover, a product-launch manager from Nokia explained the target groups (Pantzar & Ainamo 2000):
1) Trendsetters, whose desire is to be the leading edge of technology, are targeted with the WAP-phone.
2) Nokia 8810 is suited for people who, apart from enjoying feature richness of the typical Nokia mobile phone, wants to make a personal fashion statement.
3) Nokia 6110 or 9110 Communicator is targeted at "heavy users".
4) Nokia 3210 is targeted at social contact seekers, who want quality and reliability in an affordable package.

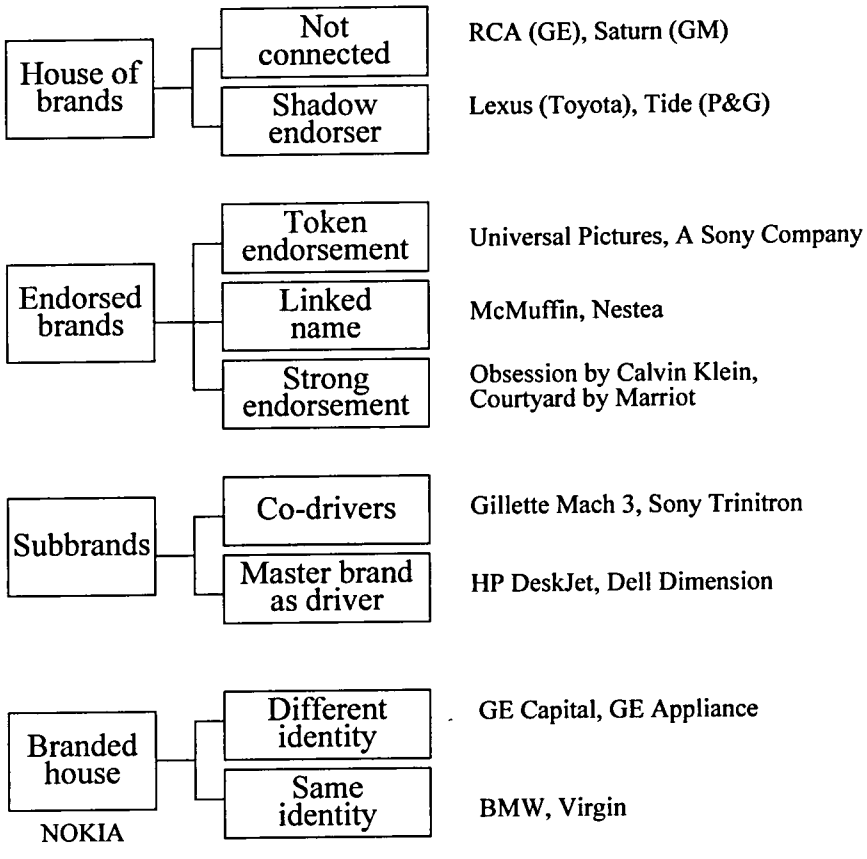



**Figure 17; The brand relationship spectrum (Modified from Aaker & Joachimsthaler 2000).**

So, new technology can be introduced within the mainstream products, using the existing branded house strategy. However, the Nokia brand can be leveraged in several other ways also, as seen in the Figure 18 below.

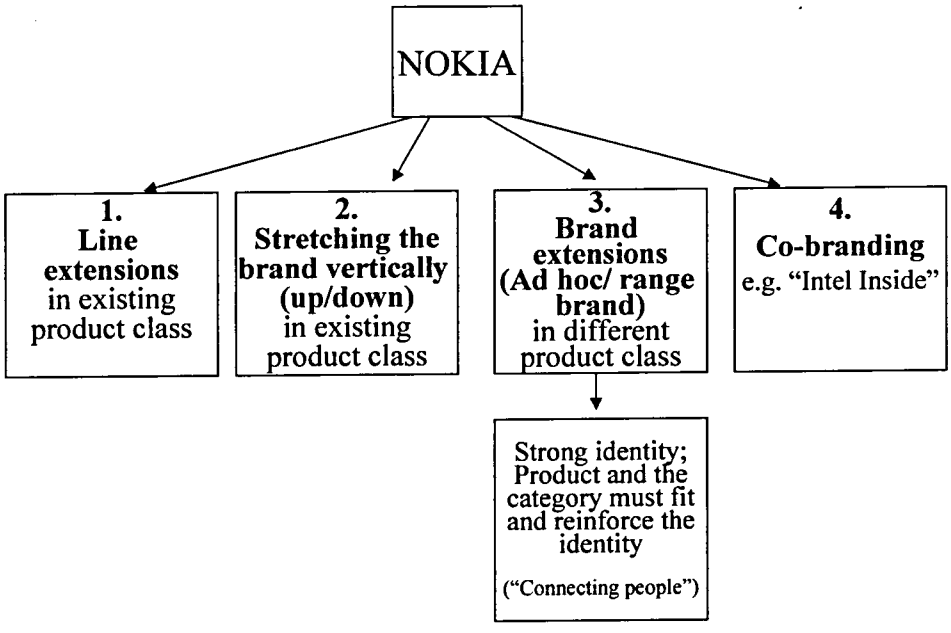



**Figure 18; Leveraging the existing Nokia brand name (Modified from Aaker 1996).**

The first choice is already used within different phone numbering. Line extensions can be made for expanding the user base, providing variety, energizing the brand or they can be channels for innovations.

Stretching can be done upwards by using sub-brand or "silver bullet", like Kodak Gold or Platinum Card. It can be done easily down wards as well, but protecting the brand becomes difficult, especially with technology leadership image, which Nokia has at the moment. One possibility to solve this problem is to create a parent-child relationship with a brand name like "Nokia Jr". It could be a viable option to test "funny" new technology applications targeted at children. Later on, of course, those funny little applications could become a part of the mainstream business.

Brand extensions can be made in different product classes. Then, a careful considerations should be made whether the identity of chosen (new) product class supports and reinforces the prevailing Nokia image and mission statement ("Connecting people").

New technology may also be introduced by using co-branding. Perhaps the most well known example of this is the PC market, where Intel has branded a part of the product by its own brand ("Intel inside").

In our case studies the brand issues will be an important dimension to take into account.

# 2.TECHNOVARIANTS

Literature has pointed out three different market experimentation strategies for new technologies and products:

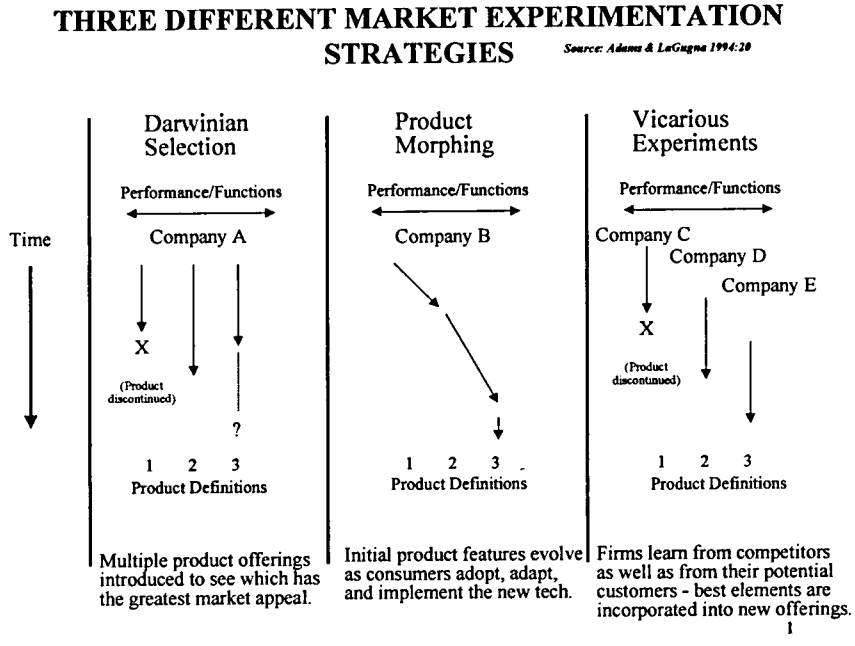



**Figure 19; three different market experimentation strategies.**

*1. **Darwinian selection*** refers to firms that introduce multiple product offerings to see which has the greatest market appeal. The successful product serves to define the market, the technological standard, and the initial target market of early adopters.

Similarly, Hamel and Prahalad (1991:85) argued that the traditional market research and segmentation analyses are unlikely to reveal opportunities for innovation, one has to get a deep insight into the needs, lifestyles and aspirations of today's and tomorrows customer. Hamel & Prahalad (1991:86-87) propose that experimentation with real products and in real markets is the best way to learn about customers. They called the method as *expeditionary marketing.* According to their view little is learnt in laboratory. True learning begins only when a product –imperfect as it may be – is launched in test markets.

Sony Walkman is a brilliant example of expeditionary marketing. During the 1980s Sony launched almost 250 different Walkman models to US market alone. By executing expeditionary marketing Sony was able to learn much more about technology variants, markets and segments than any of its competitors.

When utilizing expeditionary marketing the company has to be able to change its attitude towards setbacks with new product launches. The key is to learn from the market. The failure should not been seen as dollars lost, but as dollars forgone. This means that the managers should be evaluated with number of hits that they generate (successful products) , not hit rate (successful products divided by number of trials)

There are two key factors that contribute to the success of expeditionary marketing. The first one is the ability of company to minimize the speed of iteration, which refers to the time it takes a company to develop and launch a product/variant, accumulate insights from the marketplace and then recalibrate and re-launch. The second factor is cost of the iteration, which relates to manufacturing and product development costs.

In traditional new product introductions, projected sales are fully supported in terms of pre-introduction inventory deployment. Naturally, when introducing radical new technology product, the appropriate inventory stock level and deployment plan to support anticipatory launch is extremely difficult to predict. The entire process is driven by forecasts. As a result of the great uncertainty involved, new product managers often restrict anticipatory launches to one product variation. Problem with such a market entry is that it puts all the eggs in one basket: the single version will either succeed or not.

In general, with traditional anticipatory launch, problems are likely to materialize when the product turns out to be a real success or flop. The first situation causes unplanned out-of-stock problems while latter causes losses in terms of overstock.

Utilization of response-based logistics and supply chain capabilities offers an alternative way to support successful new product launch. This new conceptualization is called **"lean launch strategy"** (Bowersox et al 1999:561-564). The key of the success of this strategy is real-time information support (i.e. electronic data interchange EDI), and flexible logistics system capable of rapidly responding to early sales success. Flexible logistics systems are characterized by coordinated source, make, and deliver operations. Procurement and production techniques such as concurrent engineering and design, supplier partnerships, and agile manufacturing create those flexible processes. Uncertainty can be reduced by cutting lead times and increasing supply chain's flexibility so that it can produce to order or at least manufacture the product at a time closer to when demand materializes.

Writers mention two general types of such postponement: time-related and form-related. In time postponement the key differential is the timing of inventory deployment (exact quantities just in time) to the next location in the distribution process. Form related postponement involves activities associated with assembly, packaging, and labeling. Those postponements are options in which firms initially manufacture products to an intermediate or neutral form with the intend to delay customization until specific customer orders are received.

In a lean launch, principles of time and form postponement supported by agile supply and manufacturing operations enable two types of flexibility. Time postponement provides inventory-positioning flexibility, and form postponement provides product variation flexibility. Both can play important role in new technology product launch success. In addition, as Hamel & Prahalad (1991) and Dhebar (1995) suggested, the product variety – extensive and dynamic product lines – can be used for listening and learning the market as well. Idea of the lean launch is presented in Figure 20 below.

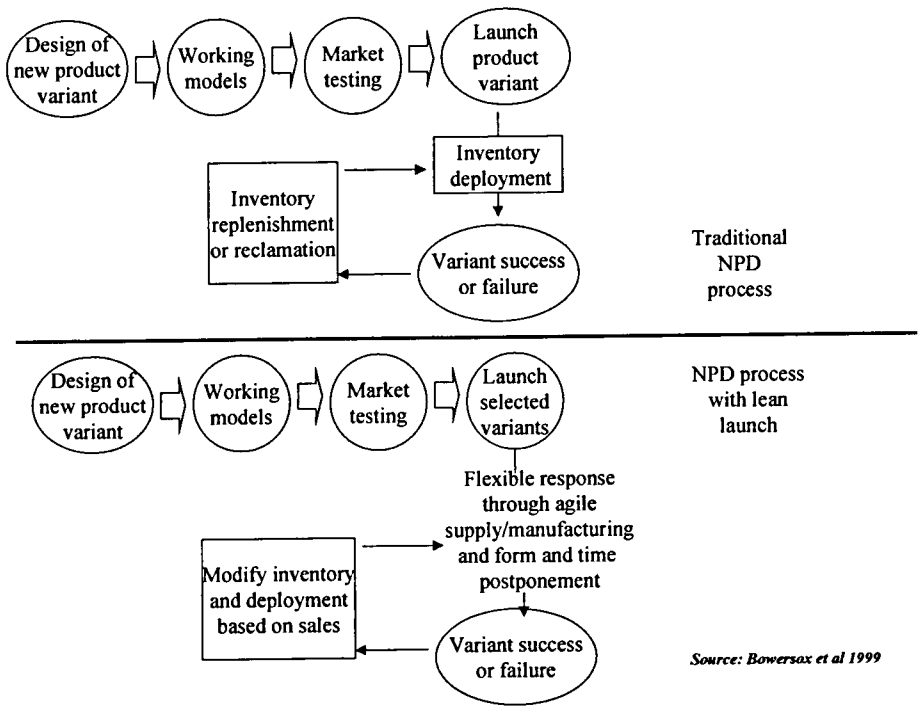



**Figure 20; traditional versus lean launch process.**

**2. Product morphing** refers to firms that introduce an initial product whose features evolve as consumers adopt, adapt and implement the new technology. Such an approach recognizes the evolutionary and adaptive process of consumer acceptance and incorporates user experience into later product generations. This approach is typical for software developers (e.g. MacCormack 2001).

Lynn et al (1996) studied successful discontinuous innovations and agreed that the best, and in most cases only, way to learn the market needs for such innovations is to test it with real customers. The firms entered an initial market with an early version of the product, learned from the experience, modified the product and marketing approach, and tried again. They found that development of a discontinuous innovation becomes a process of successive approximation, probing and learning again and again, each time striving to take a step closer to a winning combination of product and market.

The key of the success is releasing the evolving concept as soon as possible to consumers for testing and to get the feedback. Due to the importance of getting insight of features and development project's overall direction from customer's perspective, the early release of first versions is strongly related to time-to-market as well as quality of the final product. Another key point is naturally the ability to gain from feedback; i.e. rapidly incorporate and execute the changes.

**3.Vicarious experiments** refers to firms that learn from their competitors as well as from their potential customers. In such an approach, other firms' product failures and successes are scrutinized, and the best elements are incorporated into subsequent generations of product offerings. Efficiency and effectiveness of marketing intelligence plays a major role in the success of this approach.

How the consumers perceive the technology experimentation? Even intuitively it is clear that it can be very risky for a focal company's existing business and brand to test new technologies in real marketplace. Indeed, the degree of risk is certainly one of the attributes affecting the choice of how to do the experimentation and testing in reality. The Figure 21 below shows how risks of new technology introduction are increased and what are the most appropriate experimentation practices in each situation. In general, the more with the masses the new technology experimentation is executed the more risky it is. Similarly, the lower the compatibility with existing technologies, operations, products etc, the more testing is needed and less expected are the outcomes.

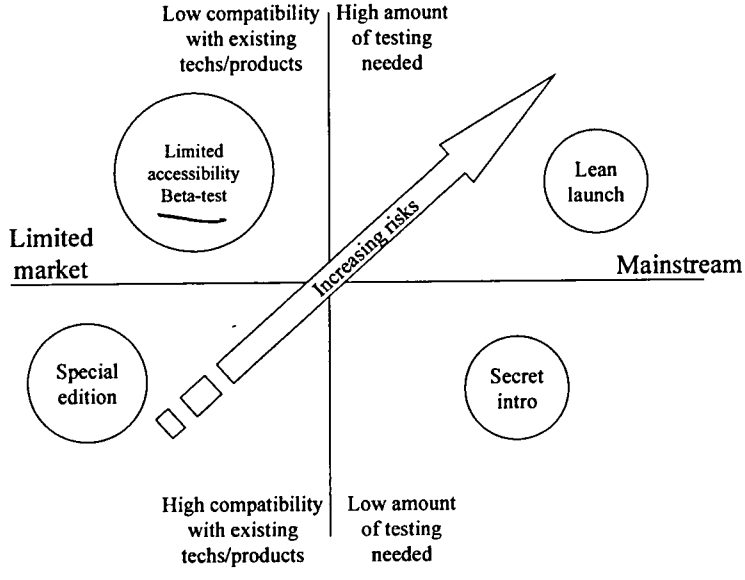



**Figure 21; Placing the technovariant introduction strategies according to risk.**

If a company wishes to experiment a very radical new technology (with low compatibility), it is easiest and safest to try it in a limited basis. In addition, the emphasis in experiments with radically new technologies is often to market learning and getting the feedback from users. Feedback and interactive processes are most easily achieved in limited settings where both parties are committed to testing and developing. Limited basis experimentation can be organized within the limited market and/or by reducing the customers' accessibility in other ways. It can mean limitations in geographic coverage, in time, types of applications etc. Well-known examples are Sony Shop and Nike Town where the manufacturers are introducing their experimental product concepts (Sanchez 1996:130). In those "antenna shops" in trend setting cities, the producers can do real-time market research at the retail level.

Limited accessibility can also mean a normal Beta-testing together with some carefully selected customers. Selected customers can be those with strangest problems (MacCormack 2001:82) or they can be the lead users (Von Hippel 1986). Also, companies can find Beta test sites even within the social sector, as Rosabeth Moss Kanter suggested (1999). Apart from obvious social benefits there are two distinct business advantages of using social sector as Beta test site. The first is the opportunity to test the new technology in real life situations, and the second is the chance to build

political capital. For instance, to influence regulations, to reshape public institutions on which the company depends, to augment a public image as a leader, or to build closer relationships with government officials.

If the company have to test radical new technology with mainstream customers then the lean launch strategy is the most appropriate choice. Real-time information flows, postponement practices together with agile supply and manufacturing operations decrease the costs and at the same time increase the flexibility and learning options during the introduction.

When the technology is highly compatible with existing operations and products it is much less risky to test it in real-markets. Such technology can offer some new benefits or improvement of existing benefits, e.g. more processing power, better resolution display, more powerful battery. Perhaps the most appropriate way to introduce it then is to launch it as a special edition. The special edition can be launched through selected channels, or the amount of offerings available is limited by some other distinctive way. Of course previously mentioned Sony Shop and Nike Town type of facilities can be useful channels as well.

Finally, in most cases, new technology can also be tested secretly. One way to do it is just to incorporate the new technology with existing products in order to see how it works. In case that the new technology is highly compatible, it can be incorporated with mainstream products. Naturally, the secret introduction of low compatible technologies to the mainstream can jeopardize the existing market position in terms of vastly increasing complains, malfunctions and reclaims.

*Is Nokia using technovariants?*

Authors of this paper do not know if Nokia is already using technovariant strategy or not, and in what extend if yes. In any case, it can be said that if Nokia wishes to execute technovariants in broader scope, it certainly has implications to Nokia's internal operations and DSC. Product architectures, and the whole DSC should accommodate smaller volumes and greater amount of variants. To do this economically, perhaps technovariants should be used only within certain business groups or in certain product categories. This could mean for example to use the technovariants strategy in add-ins or accessories that would fit with the mainstream mobile phones (eg. The strategy that Handspring Visor is using in the Palmtop business). Nokia's real moneymaker, the basic mobile phone business, does not accommodate such approach without decreasing profit margins.

Other issues to consider are the brand equity and the leadership image, including quality perception, pricing, services etc. Technovariants are effective way to test technologies, learn market needs and thus to introduce better technology products. However, it may be safer to do some of the technovariant introductions under the separate brands and/or using separate organizations. If something goes wrong when testing new technologies or features, the Nokia's existing brand is not put at risk. Key challenge in this approach is how to integrate the knowledge gained in executing technovariants to the mainstream products.

# 3.REDEFINING THE MAINSTREAM

This section searches the answer to the question of how to introduce new technology to the mainstream. In Nokia's case, the mainstream means really high volumes and tough competition on margins and market shares.

Traditionally, new products are created when promising technology comes out of the R&D laboratory, a new market is targeted in response to a move by a competitor, an acquisition is made because an attractive target becomes available. This way of doing business is called *event pacing* (Eisenhardt & Brown 1998). In stable markets, event pacing is an opportunistic and effective way to deal with change. By definition, however, it is also a reactive and often erratic strategy.

Quite opposite to that, *time pacing* refers to creation of new products/services, launching new businesses or entering new markets according to calendar (Eisenhardt & Brown 1998). By definition, time pacing is regular, rhythmic and proactive. In rapidly shifting industries, time pacing can help managers anticipate change, and in case of market leader, set the pace for change. Like a metronome, time pacing creates a predictable rhythm for change in a company.

Intel is certainly the most well-known example of the time pacing. Intel is following the Moore's "law", which predicts that capacity of microprocessor chip will double every 18 months. In addition, Intel adds a new fabrication facility to its operations ca every nine months, two years before they have products to run them. Those $2 billion "fabs" keeps rivals from gaining a toehold because Intel cannot meet demand (Eisenhardt & Brown 1998)! Other well-documented examples: 3M dictates that 30 % of revenues will come from new products every year, Netscape introduces a new product about every six months.

Another perspective to the mainstream changes is to look them as fashion shifts. As product category evolves and reaches its mature mainstream phase, the product's original buying motivation changes simultaneously. Quite generally, product life cycles of technological devices seem to follow a domestication metamorphosis: e.g. from "toys" to "instruments", from "luxuries" to "necessities", from "pleasure" to "comfort" (Pantzar 1996). The examples given above suggest that a reinvention of a product is needed to start metamorphoses anew, e.g. from useful tools to playful toys and/or luxury items. This was exactly what Nokia made to mobile phones in the 1990s (Kotro & Pantzar 2001). Price-sensitivity and utilitarian user motives gave way to factors like pleasure, feelings, fashion, luxury. From 1999 Nokia started presenting itself as the "world's leading design house for mobile communication". At the same time Nokia announced its fashion phone model 8210 together with Kenzo design (Pantzar & Ainamo 2000). Similarly, Sony is not anymore producing mechanical devices but "digital dreams". That is, Sony is purposefully changing cultural landscape surrounding existing products.

Being a fashion house, a trend setter, means that a company is managing and sensing the trends and expectations at the same time. This argument follows the logic, or should we say illogic, of fashion itself: the act of simultaneously following and creating. Philips people are saying: "we know there is no need for any of this (new products). Our job is now to create the need, so that we have the reason to make the products - and sell them (Pantzar & Ainamo 2000). Figure 22 presents this idea.

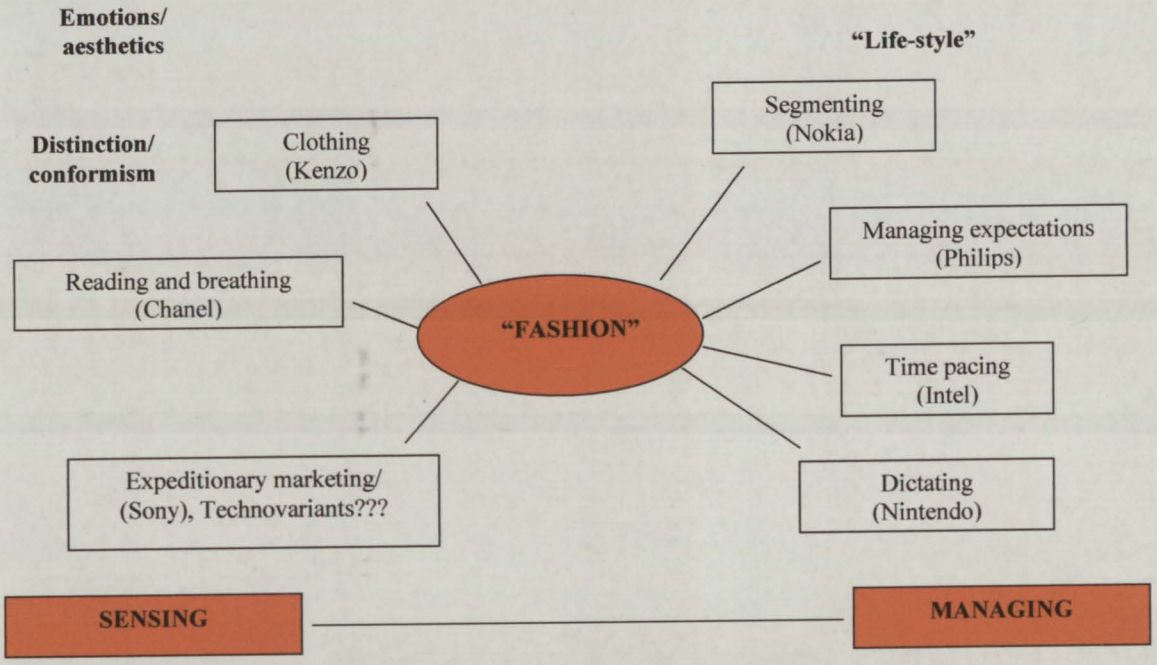



**Figure 22; the fashion house (Modified from Pantzar & Ainamo 2000).**

So, there are several perspectives to mainstream management. Now it is time to take a closer look to the concrete ways of how companies can introduce new technologies to the mainstream products. Literature has been divided under three major issues, namely modularity, platforms and software development.

## 3.1.MODULARITY

The concept of modularity is closely related to the concept of architecture. The architecture is a system design for which designers have specified the way overall functionalities of the product or process design are decomposed into individual components, and the ways in which the individual components interact to provide the overall functionalities of the system design (Sanchez 1999). In the process of creating and realizing products, organizations explicitly or implicitly create three kinds of architectures: product-, process- and knowledge architectures (PPKAs). Modularity is a multifaceted strategy for managing PPKAs.

Modularity is created in an architecture when the *interfaces* between functional components are *standardized* and specified to allow the substitution of a range of variations in components into the product architecture without requiring changes in the designs of other components (Sanchez 1999). Component interface specification may cover the way components connect (the attachment interface), how power is transferred (transfer interface), how signals are exchanged (control and communication interface), the spatial location and dimensions of the component (spatial interface) and the effects that one component may have upon others in the form of heat, magnetic field etc (the environmental interface) (Galvin 1999:469).

The various kinds of modularity options are listed below (Rosenau et al 1996:234-235):

1.Component sharing modularity; is when the same component is used across many different products.
2.Component swapping modularity; different components are used with the same basic product. For example, the basic Swatch watch is made up of hands, faces, movements, cases, and wristbands. New watches are created by swapping individual components to create new styles.
3.Fabricate-to-fit modularity; one or more components is variable in some way, such as size and shape.
4.Bus modularity; many different kinds of components can be attached to a common structure through a standard interface. For example, in track lighting a bus is attached to the wall and a variety of lights can be attached anywhere along the bus.
5.Mix modularity; several standard components are mixed together to produce a new product. For example, a huge variety of paint colors can be created with standard paint components.
6.Sectional modularity; sections of a product can be configured in a variety of ways through a standard interface, e.g. office furniture.

The distinct nature of modularity can be clarified more by comparing it to the more traditional product design optimizing approach. The more traditional product design *optimizing approach* results tightly coupled component designs, which are difficult and costly to modify. In contrast, modular architectures create a system of loosely coupled component design, which enables changes in various ways without having to make compensating changes in other components. In the next chapter, benefits of the modularity are discussed in more detail.

### *3.1.1 BENEFITS OF MODULARITY*

The key benefits of modularity are listed below (Dhebar 1996 a & b; Sanchez 1996 & 1999):
***1.Modularity enables the leveraging of product variations by substitution of component variations.*** Product variations can be created at low cost by mixing and matching component variations. This can be used to explore consumer preferences, increase segmentation, support mass customization etc. For example, Motorola offered 20 million modular pager variations to customers. Also, by substituting new components, improved products can be brought to market quickly.

***2.Modularity helps contain change by enabling common components to be used within and across product lines.*** Firstly, reuse of common components reduces costs in many ways, e.g. reusing existing component designs, learning curve effects, increasing buyer power. Secondly, reuse of component designs helps improve component reliability. Thirdly, containment of change enables late differentiation of products (see more in chapter 1.3. flexibility). Fourth, different kinds of components are often subject to different rates of technological change. By de-coupling of components it is possible to accommodate differential rates of technology development. For example, Sony's modular design for HandyCam camera allows improved versions of key components to be introduced as they became available.

***3.Modularity facilitates de-coupling technology development and product development, enabling concurrent and distributed component development processes.*** Concurrent development of components increases efficiency and speed of

component development. Also, it enables more efficient use of subcontractors and therefore reduces resources and initial investment to develop new products. Chrysler is reaping advantages of modularity by decomposing its new car platforms into 28 subsystems and defines interfaces ("hard points") between subsystems.

***4.Modularity enables the loose coupling of component designs and thereby creates loosely coupled knowledge domains.*** Perhaps the most well-known example of that is the PC's modular architecture, which facilitates high rates of innovation in component technologies. Industry standard modular architectures create positive network externalities in technological learning and stimulate also market learning.

### *3.1.2 INTERFIRM MODULARITY*

The fourth point described above referred to the broader perspectives of modularity. In addition of a single company view, modularity clearly has industry-wide advantages and implications. In Figure 23 below, the factors influencing the migration toward (or away from) increasing interfirm modularity are gathered.

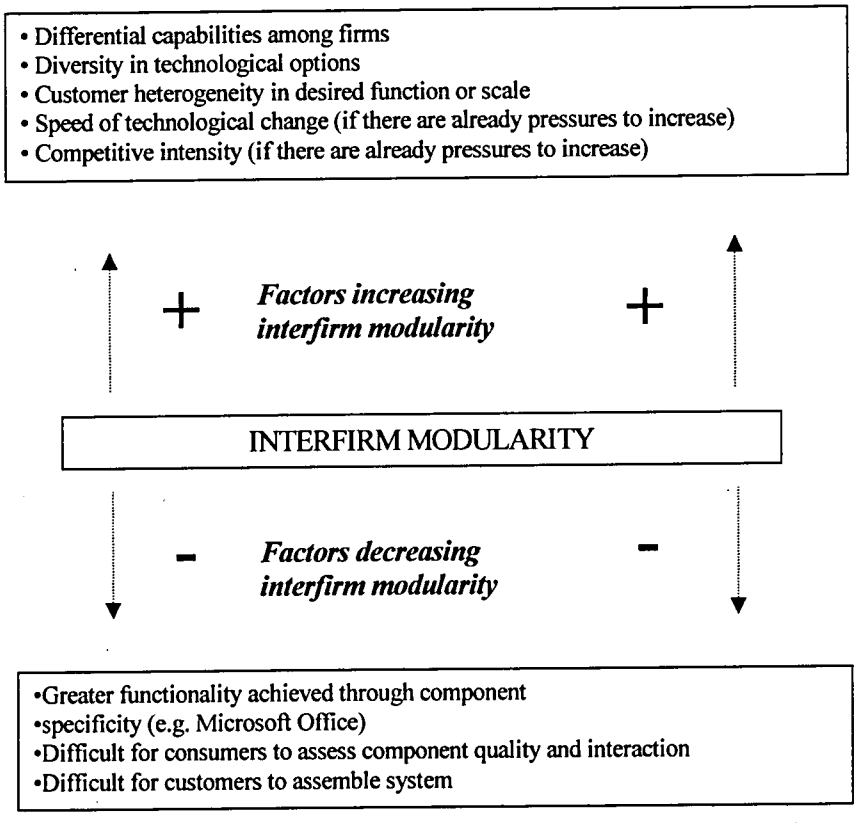



**Figure 23; Interfirm Modularity**

As seen in the figure, the first factor decreasing the interfirm modularity is the functionality achieved through component specificity. For example, early 1990s witnessed a move from stand-alone software products (such as Word-Perfect) to suites of integrated software products (such as Microsoft Office), designed to work better together than with other components. This factor is closely related to the market power and architectural control. A firm possessing proprietary control over an important component in a system can restrict market access by offering that component only as a part of a total product system. Similarly, a firm with a unique and powerful asset or

position in the market may avoid modular designs because it wishes to retain architectural control of a product. However, it does so at risk: if the benefits of a modular product design are very strong, the firm's integrated system eventually might be rejected by the market in favor of modular alternatives (Schilling 2000:330).

Other two factors decreasing the interfirm modularity are more straightforward. Where quality, performance or component interactions are difficult to assess, or when the product is hard to assemble, the customer is more likely to rely on a credible external source to choose and configure components. Thus, a readily integrated system may provide additional functionality and value.

In contrast, differential capabilities *increase* the interfirm modularity. The logic behind that is the fact that the greater the difference between the capabilities that firm possess, the greater the benefit they reap from specializing in different components. Thus, greater differentiation in firm capabilities can make modular solutions an attractive option for producers. Similarly, when there is a wide array of different technological options available, firms may face a win-or-lose scenario: the either becomes a customer's sole supplier of an entire product system or it does no business with the customer at all. Under conditions of modularity, the firm does not face such a scenario because multiple technologies can coexist more peacefully (John et al 1999:86; Schilling 2000:323).

Customer heterogeneous demand in desired function or scale calls for increases in interfirm modularity. When customers for a particular technology solution have very different needs, it is difficult for a single integrated solution to closely match their requirements. Moreover, if those modular products meet the heterogeneous demands of consumers better than tightly integrated products, many other competitors may be forced to follow suit. So, if there are pressures to increase or decrease the interfirm modularity of a product system, competitive intensity will increase the likelihood of such migration (Schilling 2000:328).

Likewise, if there are pressures to increase or decrease the interfirm modularity of a product system, the speed of technological change will increase the likelihood of such a migration (Schilling 2000:324). Where technologies advance rapidly, a modular solution becomes very attractive because both customers and producers desire flexibility. For customers, modularity reduces switching costs by offering better change to upgrade. For producers, modularity enables to incorporate new technologies into products as they become available.

### *3.1.3 OPTIMIZING THE FLEXIBILITY OF MODULAR ARCHITECTURE*

So, it is clear that modularity has certain advantages to the companies and industries. However, it is not so straightforward to create such a flexible architecture. There are certainly tradeoffs between financial benefits of increasing the flexibility and costs and constrains of creating such flexibility.

Several risks of utilizing the modularity has been identified (Rosenau et al 1996:220). Firstly, too much modularity can make products look too much alike. Secondly, as already mentioned in previous chapter, (open) modularity makes it easier to for competitors to imitate the design. Thirdly, modular design are usually more expensive that integral designs (at least the initial cost of developing them). Finally, when compared to highly optimized integral design, the modularity reduces product performance.

How to optimize the flexibility of modular architectures then? A developer has to concern issues like what is the optimal number of modular parts that should be created to serve various consumer preferences, optimal range of component-based functionalities, features, and performance levels. The developer has to define also the common parts that can be used most effectively in various product models. By defining them, useful questions are e.g. which elements will require upgrading, will there be any add-on products, what components does your firm use in large amounts, which existing components do you want to use in new products, what are the most critical performance factors of a product?

In modular product markets, marketers must be able to define and manage the strategic roles that various components will play in creating perceived value in the product variations that are leveraged from a modular architecture. The components in a modular architecture are performing one of four strategic roles listed below (Sanchez 1999):
*1.Plus-only attributes* are derived from components that provide features that add value by delighting most consumers when they are present in a product but that, if absent, do not detract from the product's perceived value. The strategic role for plus-only components is often selective probing of consumer reactions to novel functions and features. Thölke et al (2001) proposed a feature life cycle model in which they called new to the product category features as feature innovations. For example, airbags in the 1970s can be seen as an example of the plus-only feature innovation.
*2.Variety-enhancing attributes* are provided by components that are perceived by most consumers as sources of value-adding variety, e.g. features or styling variations. Those features are often neither new nor standard. For example, in the 1980s, the airbag was neither new nor a standard.
*3.Central attributes* are perceived by consumers as central to a product concept, in the sense that increasing levels of performance by a central attribute will increase the perceived value of the product for most consumers. Faster microprocessor is a good example of this.
*4.Threshold attributes* are functions provided by components that are essential to the overall functioning of a product but are not perceived by consumers as adding value to the product as long as they function adequately. For example, the chassis and battery of a car are such standard features.

As Sanchez (1999) and Thölke et al (2001) are arguing, attributes and feature-types mentioned above often follow certain patterns of evolution in a product market. Basically, features evolve from innovative, plus-only features to threshold, standard features, or they disappear before developing as standards. The key implication for a producer is to acknowledge that the features of a product category may be involved in different life cycle phases. This helps to manage the evolution and development of both new and existing features and modules.

### *3.1.4.IMPLICATIONS FOR MARKETING*

Modularity enables certain new ways of satisfying customer's needs. Unlike "one-off" product designs, modular architectures can be used to support a relational marketing strategy in which a firm position itself as a provider of products that offer its customers benefits like backward/forward compatibility, scalability, upgradability, and easy servicing.

Each of those issues offers significant benefits for consumers. Consider for example upgradability. In the fast-paced markets, the rapid introduction of new and improved versions can make a consumer regret a previous purchase, hesitate over any new purchase, and agonize over similar financial commitments in the future. To overcome these considerations and hesitations, a producer has basically two choices. First, it can optimize its pace of product improvement (see more in chapter 1.3.4 "launch" and beginning of chapter 3 "time pacing"). The second choice is to offer modular upgrades (Dhebar 1996). By doing so, it may be easier to maintain the customer relationship. This allows existing (and future) version owners to selectively upgrade the version they own rather than dispose of it entirely to purchase a new and improved version. In that way, it is also cheaper to customer to have always the best available version in hands.

Further, in some modular product markets, consumer familiarity with the functions provided by key components may create the potential for branding components, such as "Intel inside". Of course, use of strong component brands is a two-edged sword because consumers' perceptions of the assembled product may be significantly influenced by their perception of the components or vice versa.

## 3.2.PLATFORM THINKING

Competing with a multi-product strategy, based on product families sharing a common platform, has proved to be a successful approach for many industries, e.g. electronics, automobile and software (Sanderson & Uzumeri 1995; Meyer 1997; Meyer & Lehnerd 1997). "Platform" has been used as a buzzword in various occasions. Similarly, there are a great variety of definitions of platforms (Muffatto & Roveda 2000:618-619). In this study the ***product platform is a set of subsystems and interfaces intentionally planned and developed to form a common structure from which a stream of derivative products can be efficiently developed and produced*** (Meyer & Lehnerd 1997:39; Muffatto & Roveda 2000:619).

Derivative products are the products that are designed around a product family platform (Rosenau et al 1996:227; Tatikonda 1999:4). Usually the design of these products involves incremental improvements in either technology or customer needs. Derivative products can be divided in three classes: cost-reduced products, product line extensions and enhanced products (Rosenau et al 1996:227-228).

In order to be effective, platform strategy requires a great deal of modularity (e.g. Sanderson & Uzumeri 1995). However, a company utilizing modularity does not necessarily have product platforms in use. Therefore, platform thinking can be treated as a sub-concept of modularity. Similarly, the most of the issues described with connection to modularity are valid also with platforms. To explain more the platforms' position inside the company, the relationship between platforms, NPD and process flow is presented in Figure 24 below.

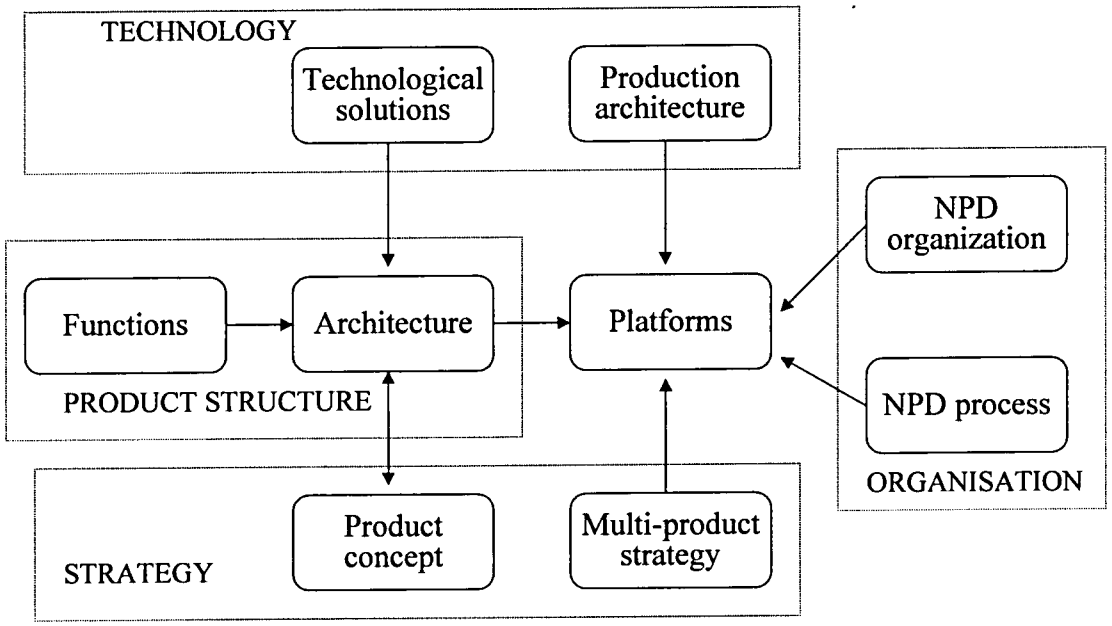



**Figure 24; Relationship between platform, NPD organization and process flow (Muffatto & Roveda 2000: 626)**

As described already in the definition of the platform, the intrinsic feature of platform strategy is to efficiently derive streams of incremental (derivative) innovations. This feature modifies radically the product introduction flow. First of all there is sharp distinction between platform introduction and derivative product introduction. Findings of Tatikonda (1999) indicate that platform and derivative projects differ in project task characteristics, like complexity and amount of new technology development. Secondly, the way in which the process follows preferably one of these two patters allows the definition of a sort of platform efficiency (Muffatto & Roveda 2000:626). Basically, the more numerous the streams of derivatives and enhancements, the more efficient the initial definition and planning of the platform.

### *3.2.1 BENEFITS OF USING PLATFORMS*

Several benefits of using platforms are presented in the literature. The first advantage recognized is an increased speed in product development. A great example of this can be taken from Black & Decker. The company introduced a platform approach to their new product lines development during the 70s. Their achievement was an average of one new product introduction per week, which lasted for several years (Meyer & Lehnerd 1997).

Secondly, the reduction of product development costs. For example, the automotive industry is introducing car models marketed worldwide. In those models, important regional market customization is derived from the same unique platform (Muffatto & roveda 2000).

Thirdly, product reliability may be increased after the platform's adoption because the great majority of parts and mechanisms are communized. This was the case with e.g. Sony Walkman (Sanderson & Uzumeri 1995).

The Sony Walkman's example shows also how platforms allow increasing on-the-market variety and contemporarily reducing internal variety. During the 80s Sony introduced over 250 different Walkman models to US market by using only four to five different platforms (Sanderson & Uzumeri 1995). Therefore, platforms can increase business flexibility through scaling them up and/or down. Of course, this has implications for branding (see more in chapter 1.3.5).

### *3.2.2. MANAGING PRODUCT PLATFORMS*

The combination of subsystems and interfaces defines the architecture of any single product (see also more in chapter 3.1). Every product has an architecture: the goal of platform thinking is to make the architecture common across many products. Each subsystem of product platform has a specific function; when combined, they create a higher form of function for the overall product platform architecture. Not all subsystems and interfaces are equal in their importance to the evolution of a product line. Some subsystems, if changed, will require changes in many other subsystems while other will have little ripple effect. Some of the subsystem interfaces can be strategic providing designers degrees of freedom needed for the rapid and cost-efficient creation of derivative products. Some of the interfaces can be even industry standards (Meyer & Lehnerd 1997).

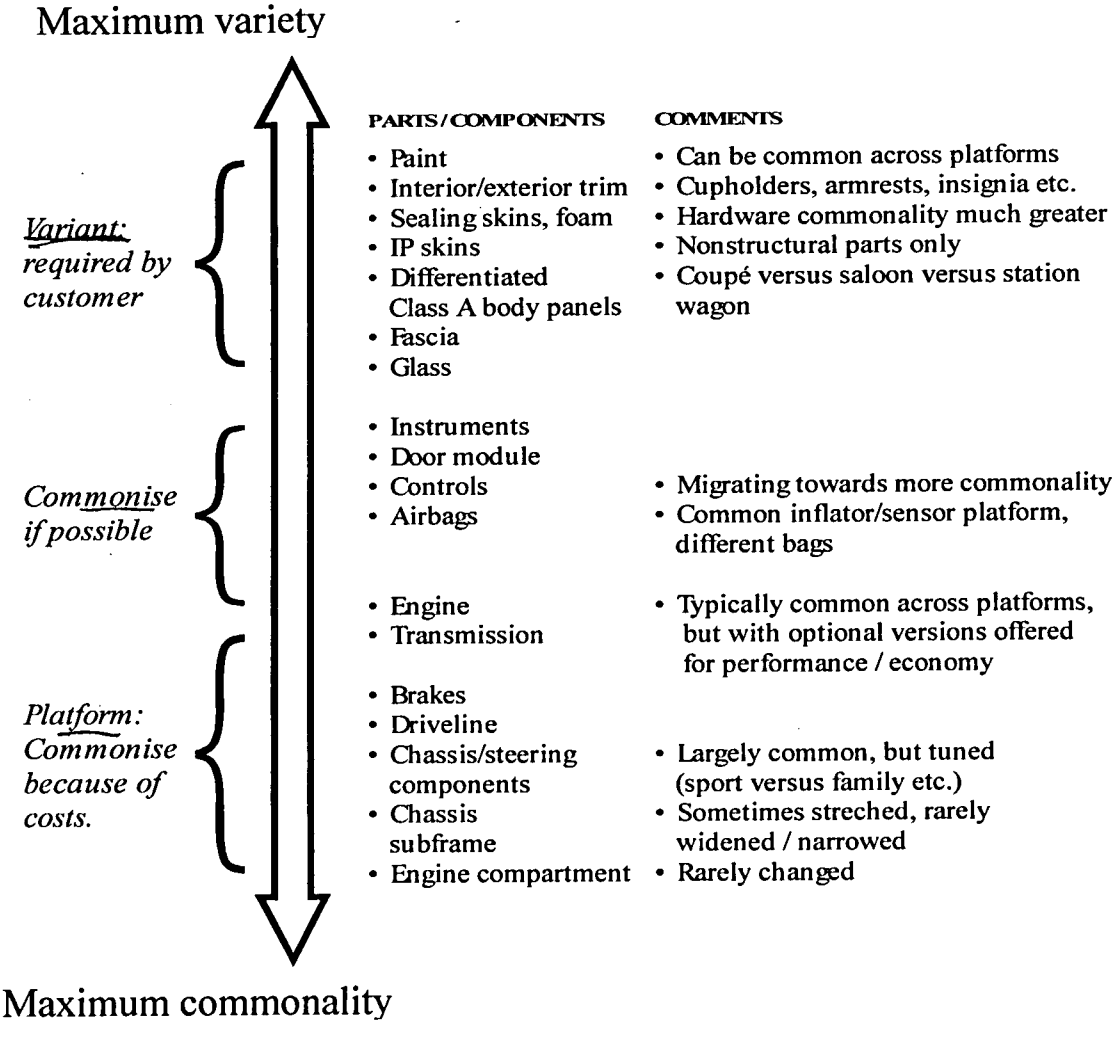



**Figure 25; Managing platform components (Ealey et al 1996)**

Figure 25 describes one approach of platform planning. Example is taken from automobile industry but is easily adaptable for e.g. mobile phones. The key is to decide which parts are common and which parts will vary. Successful decisions takes account different perspectives of technology (see more in chapter 1.3.1) as well as cost optimization.

Another perspective for management of platforms is that they must be managed as evolving entities, not as frozen. How to define changes to product platforms then? Following figures illustrate the changes in general sense. Figure 26 shows the initial platform and a platform extension. In the extension, the number and types of subsystems and interfaces remain constant, but one or more are substantially improved with new technology (Meyer & Lehnerd 1997:42).

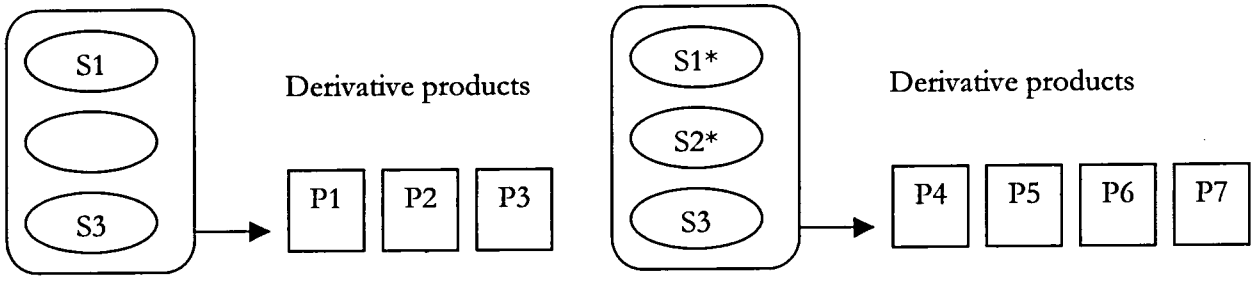



**Figure 26; 1 - Initial platform and Platform extension.**

The Figure 27 describes new product platforms, i.e. a new combination of subsystems and interfaces. Some subsystems and interfaces from prior generations may be carried forward and combined with new subsystems and interfaces in the new composite platform design.

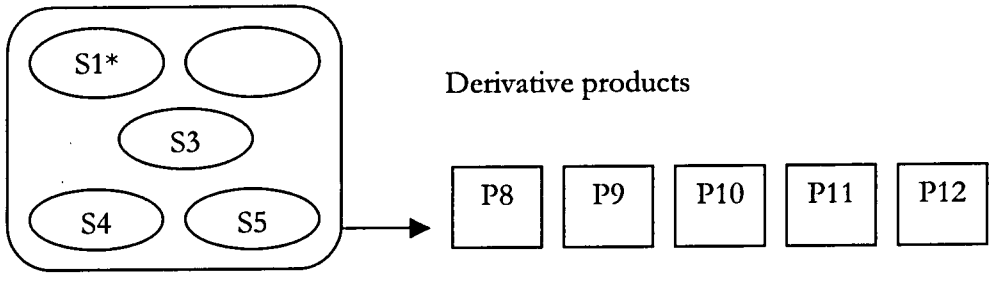



**Figure 27; New platforms.**

Platform *planning* is extremely important, especially in rapidly changing high volume industries. Carefully planned platforms may provide cost efficiencies, increased speed and flexibility to introduce new technologies and products. However, risks are also huge. Initial cost of such platforms is significantly higher than single products. It may also turn out to be a time-consuming effort, depending naturally the company capabilities and previous efforts. Too fixed platforms - in terms of changes in technology and derivative product flows - can be a hindrance in fast-evolving environment.

Figure 28 illustrates an example of platform planning. The developer should plan multiple generations, plan effective derivative product flow, and if possible, take account the technology changes. In order to be successful, platform decisions should provide leverage. Platforms capable of accommodating new component technologies and variations make it possible for a firm to create derivative products at incremental cost relative to initial investments in the platform itself.

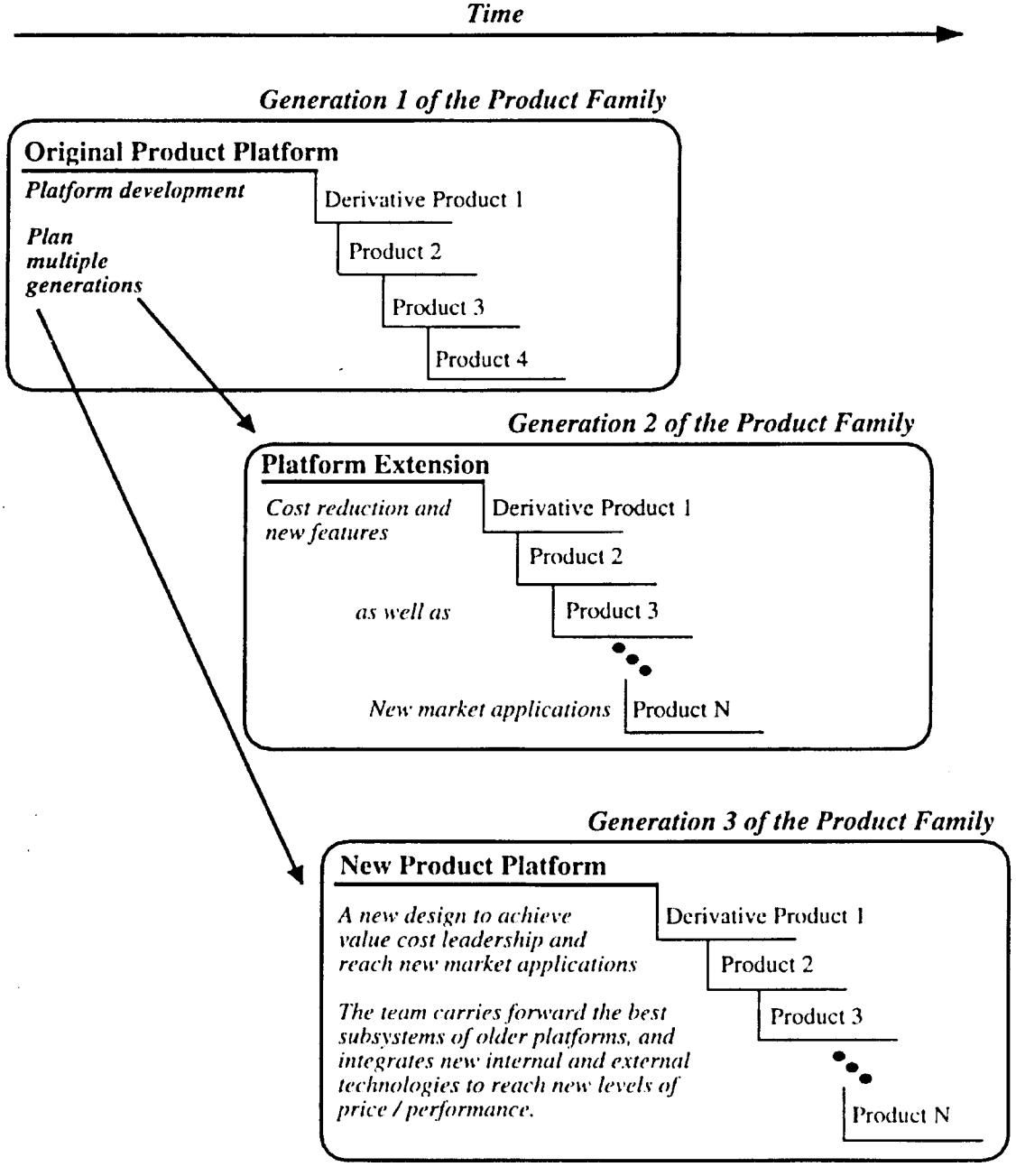



**Figure 28; Example of Product Family Roll-Out Plan (Meyer & Lehnerd 1997)**

How to estimate whether to invest in platforms or not? Kogut & Kulatilaka (1994) evaluated platform investments as options; investments in opportunities. They argued that the platforms are valuable due to four conditions:

1) Uncertainty; flexibility in uncertain conditions.
2) Opportunity; platform may be extremely good venue into multiple opportunities. It may provide a broader scope of opportunities and some platforms may lead to products and services that are more valued by customers.
3) Time dependence; proprietary and difficult to imitate, risk of preemption.
4) Managerial discretion to exercise the option. Many firms complain that they have more technologies than they use. It is not uncommon to hear the complaint that the benefits of investment in technology were reaped by other firms.

In following phases of this study, the platform planning and changes in the mainstream product families are certainly among the key issues to focus on. As mentioned above the flexibility affects the value of platform approach. How to make platforms more flexible, how to manage the platform generation shifts, how Nokia could maximize the advantages of modularity and platforms, how to minimize risks, what constrains are the biggest hindrances? Those are examples of key question to be answered. Perhaps, it is possible to develop intermediary platforms to speed up the new technology introduction into mainstream – sort of "platform prototypes"?

## 3.3.SOFTWARE DEVELOPMENT

In the present economy, innovation increasingly occurs through software. Software is the key element of smart products, Internet, new entertainment, even the services like banking, health care and education. In addition of software's ubiquity, the amount of code in most consumer products and systems is doubling every two or three years (Hosalkar & Bowonder 2000).

Software's role in Nokia's business, telecommunications, is also rapidly increasing. Gal & van Genuchten (1996) proposed a four-stage model, which describes the transition of the electronics industry. The four stages are the hardware stage, the embedded software stage, the proprietary software stage and the open system stage. The authors are arguing that market forces will drive most of the electronics industries to the open system stage in which software is the driving force. In short, software capabilities are surely important when discussing about redefining the mainstream.

### *3.3.1.DIFFERENT KINDS OF SOFTWARE PRODUCTS*

Software differs considerably in terms of complexity, novelty, interactiveness and value addition. Schematically, software development projects can be classified under four broad classes (Hosalkar & Bowonder 2000):

*Conversion projects*; the main focus of such projects is not evolving new software but adapting existing software through conversion for use in new environments (e.g. Y2K conversion). In these projects the customer requirement analysis and software design are already available.

*Client specific software*; these projects do not represent stand-alone software but catering specific individual needs of users or user equipment. Naturally, understanding the specific customer needs, and customizing for special requirements through joint working are the critical success factors.

*Packaged software*; projects aimed at developing completely new products, which need to be marketed separately, and they have to be generic in use as no customization is envisaged at the installation stage. Critical success factors are market potential, ensuring the limited customization at the user end, and excellent marketing strategy and maintenance support at the user end.
*Enterprise system software*; development of such software requires an enormous amount of interaction and development of independent but inter-linked sub-modules. Internal consistency is the major characteristic needed. In this case the software is high value, low volume product. The critical success factors are evolving integrated and customizable sub-modules (see more 3.2. modularity), rigorous monitoring, concurrent validation, and upgradability.

### *3.3.2.SOFTWARE DEVELOPMENT MODES*

So, similar to consumer (hardware) products, software products differ considerably. Likewise, models of how software products are developed differ as well. Each type of software requires distinct development and marketing strategies, along with the required distribution and life cycle support arrangements. Short look to the various software development models is provided next (Iansiti & MacCormack 1996; Vendelo 1998; Hosalkar & Bowonder 2000; MacCormack 2001):
*a)Waterfall-model*; highly structured, sequential process maintaining a document trail. This model is bests for environments in which user requirements (and the technologies to meet those requirements) are well understood. Uncertain environments call for more interactivity that lets customers evaluate the design.
*b)Rapid prototyping*; a disposable prototype helps establishing customer preferences.
*c)Spiral-model*; a series of prototypes identifies major risks. In models c and b the prototypes are not part of the design itself but merely representations. The bulk of the development work carried out after the prototypes is performed in a similar manner to the waterfall-model.
*d)Staged-delivery* (or incremental) model; a system is delivered to customers in chunks.
*e)Evolutionary-Delivery model*; iterative approach in which customers test an actual version of software. A project is broken down into many micro-projects (teams), each of which is designed to deliver a subset of the functionality in the overall product. The micro-project teams can make changes in direction during development by altering the focus of subsequent micro-projects.

In addition of success factors mentioned in connection with different kinds of software products, the literature has revealed few general successful practices when developing software (Rauscher & Smith 1995; Iansiti & MacCormack 1996; Vendelo 1998; MacCormack 2001):
-An early release of the evolving product design to customers improves quality dramatically and reduces risks by allowing the development team to react to unforeseen circumstances.
-Daily incorporation of new software code and rapid feedback on design changes.
-A team with broad-based experience of shipping multiple projects
-Major investments in the design of the product architecture. The key is to develop an architecture that is both modular and scaleable. A more modular system is better at accommodating changes, it enables concurrent development and code recycling.
-Freeze the concept as late as possible, as close to market introduction as possible. The key to a flexible product development process is the ability to rapidly gather and respond to new knowledge about technology and its presumed application context as the project

itself unfolds. This implies that concept development and implementation are tightly linked activities, not sequential phases; the product's concept and detailed design are developed simultaneously.
-Manage the scheduling links between hardware and software (if hardware plays a role). Co-plan hardware and software activities so that hardware development supports software testing requirements and vice versa.

Community-based creation (Sawhney & Prandelli 2000) of software is also worth mentioning in this context. Both IBM, through its "AplhaWorks" team, and Linux, under GNU General Public license, have developed an open approach to innovation (part of the Open Source Movement). The basic idea is simple: a piece of software will evolve more rapidly if programmers on the Internet can co-operate and freely modify its sources, adapting it and fixing possible bugs.

IBM AlphaWorks's aim is to accelerate the transfer of technology out of IBM research and into NPD, using the Web. The team works to bring IBM researchers and developers, product groups, and decision-makers together to learn more about the opportunities for commercial use of IBM's emerging technologies (Sawhney & Prandelli 2000:38). Mission is to provide early adopter developers direct access to IBM's emerging "alpha-code" technologies, allowing its lead user clients to download and evaluate them. The feedback generated by AlphaWorks users is incorporate into IBM's technologies, reducing development time. AlphaWorks also provides a "venture capital" function for emerging technologies from IBM Research, attracting promising projects, and aiding IBM researchers by building a business case (Sawhney & Prandelli 2000:39). Instead of actual funding, AlphaWorks invest information capital in an IBM Research project, using real-time application developer feedback to discover what market thinks about the new technologies.

The major problem with the open community-based approach is to incentives for developers to share their knowledge with the company. IBM has offered free commercial licenses to developers for IBM products. AlphaWorks also provides Web developers a community environment, moderate bulletin boards etc. The second major problem arises in screening mechanisms for single contributions. IBM states a sort of "honor code", forbidding the transmission of material that is unlawful, vulgar etc (Sawhney & Prandelli 2000:40). The absence of clear control over compatibility and quality is also a drawback.

Sun's Jini project is an attempt to combine the advantages of closed hierarchy-based model and the open market-based model (Sawhney & Prandelli 2000:40-41). It has created a community of widely available software source code – so called "Community Source". It functions like the Open Source with two significant differences:

- Compatibility among deployed versions of the software is required and enforced through testing, so that internal coherence and cohesion are assured.
- Proprietary modifications and extensions including performance improvements are allowed, granting for variations that catalyze innovation.

# 4.INNOVATION UNIT

In this section we will talk about different ways to foster innovation and in particular the case of an innovation unit. This strategy of having a special separate unit for innovation is the most radical approach for addressing the problem of fast technology introduction into the mainstream products. We will discuss different types of innovation units on the general option space of how to cultivate innovation. Then will describe in more detail two of these strategies that are particularly interesting to our study: ambidextrous organizations and corporate venturing.

## 4.1. SCOPE OF STRATEGIES TO FOSTER INNOVATION

That innovation is a strategic imperative is nowadays generally accepted.
On the other hand, the effect of firm size in the ability and propensity for innovation is not yet definitively concluded despite being widely studied (Tether 1998).

In a recent study of the growth records of the Fortune 50 sponsored by Hewlett-Packard and the Corporate Strategy Board concluded that the single biggest growth inhibitor for large companies was "mismanagement of the innovation process" (Stringer 2000). There are several strategies of how to stimulate innovation. Stringer (2000) proposed a set of nine different strategies that are listed below (Figure 29) and give a good overview of the strategical option space. They are ordered by their potential for generating radical innovation and their usefulness in dealing with rapid industry and technological change:

<table>
<tr><td rowspan="5">1. Talk about Innovation<br>2. Hire more Innovators<br>3. Informal Project Laboratories<br>4. Idea Markets<br>5. Ambidextrous Organizations<br>6. Acquisitions and Alliances<br>7. Corporate Venturing<br>8. Corporate Venture Capital Fund<br>9. Emerging Industry Fund</td><td rowspan="2">Working from the Inside out</td><td>Easy to implement but unlikely generate breakthrough innovations</td></tr>
<tr><td rowspan="2">Harder to structure and more difficult to manage, but more potentially drive radical innovations in dynamic industries</td></tr>
<tr><td rowspan="2">Working from the Outside In</td></tr>
<tr><td>Risky and much harder to implement, more likely to result in big ideas in emerging new industries</td></tr>
</table>

**Figure 29; Strategies to foster innovation (modified from Stringer 2000)**

The **first two strategies** are not innovation units but they help to foster innovation and are easily put into practice. The results that they can generate are also modest if they are left to work alone. It is not enough just to encourage people to support new ideas as the first strategy suggests or only to hire more creative and innovative people as the second one advocates. Rhetoric and some new individuals, although contributing to rejuvenate

an old-line organization, can only be successful if they are matched with other strategies for growing and implementing the ideas.

The **third strategy** is to grow informal project laboratories within the traditional organization. This is achieved by building flexibility, and giving an excess of resources than the minimum necessary to the R&D so that "crazy" new ideas without immediate payoffs are not punished. This strategy is implemented successfully by 3M.

From the fourth strategy onwards, we can perhaps start talking about the concept of an innovation unit. That means an organizational entity with a structure and set of processes separated from the mainstream business that is concerned with fostering and selecting innovations for the needs of the company.

The **fourth strategy** is to create autonomous teams, called "idea markets" to identify and commercialize radical innovations. They are funded separately from the traditional R&D budget and their task is to collect the best ideas and independently develop and commercialize those that make most sense.
Traditional companies like Royal Dutch/Shell Group, Nortel, P&G are more and more charging small teams of volunteer internal entrepreneurs with the responsibility for driving radical innovation.

The **fifth strategy** is known as ambidextrous organization. Michael Tushman & Charles O'Reilly are their main promoters. They argue that a company must simultaneously be engaged in multiple types of innovations and manage these streams of innovation over time. This provides the company with a range of capabilities for excelling both at the present and in the future.

But there is a huge organizational stress due to serving the mainstream needs of today and developing the radical innovations of tomorrow. Therefore the ambidextrous organization will have internally inconsistent competencies, structures and cultures. We will discuss this issue in more detail in a following chapter.

According to Tushman & O'Reilly (1997), the most important tool for dealing with the conflicting interests of the two parts of the organization is having a clear, emotionally engaging, overarching vision for the total business. The vision bridges the gap and brings consistency between the two different systems inside the company. The authors also stress the importance of having a highly skilled senior management team with diverse competencies. One team that is able to balance the multiple organizational architectures while spreading a simple, consistent vision for the whole business.

Examples of companies referred by the authors that successfully have used this strategy are Seiko, HP Printers, Alcoa, Ciba Vision.

The **sixth strategy** is the first from this set that works from the outside to the inside of the company. This strategy is about acquisitions, Joint Ventures, cooperative ventures, and alliances with external innovative entities.
Many companies use this strategy in order to acquire radical innovations. But in most of the cases the company would only acquire the new product or service and not the new capability. Therefore most mergers, acquisitions, Joint Ventures and other kinds of external alliances have failed to produce a stream of commercial breakthroughs (Stringer 2000). If the reason for the acquisition or alliance are the processes and values of the

external entity, then the best strategy is to let that business stand alone and to infuse the parent's resources into the external entity's culture and processes, instead of trying to guide, control and influence the commercialization of their ideas (Christensen 1997). Doing this would drive away the entrepreneurs and innovators from the acquired company or alliance.

High technology companies have employed this strategy with greater success than large companies in other industries. Examples are Cisco Systems, Intel, Microsoft and Hewlett-Packard. A reason for their higher success rate could be that those companies spend many resources trying to manage their external partnerships and not just negotiating them. (Stringer 2000)

The **seventh strategy** is to engage in corporate venturing. It is the overall activity of building new businesses in an established organization (Keil 2000: 9), that are managed apart from a company's existing business. Backholm (1999) stresses that in contrast to independent ventures, corporate ventures have two major operating environments: the market environment and the parent organization. Besides, the markets are less fragmented than in the case of independent ventures. The corporate environment in which the corporate ventures are inserted can be advantageous because of the ability to utilize the resources and capabilities as well as some routines of the parent firm. On the other hand Backholm (1999) also notes that the different operating logics and perceptions between the parent firm and the venture offer dynamic complementarities, which are can lead to the emergence of innovations, learning and unique competitive advantages. We will describe in more detail the issues affecting corporate venturing in a further chapter dedicated to it.

Examples of companies that have used the corporate venturing strategy successfully according to Stringer (2000) are Teradyne, Sun Microsystems and Intel. Block and McMillan (1993) add to this list companies like Merk, 3M, Motorola, Rubbermaid, Johnson & Johnson, Corning, General Electric, Raychem, Compaq and Wal-Mart. These are potential external study cases for our research on issues related with corporate venturing.

The **eighth strategy** to stimulate innovation in a large company is to establish a corporate venture capital fund. Recent studies have shown that the partnership with independent venture capitalists is one of the main reasons for the innovativeness of the small companies and the commercialization of their radical breakthroughs. Indeed a recent research (Hellmann & Puri 1999) shows that venture capital support plays a critical role in bringing innovative ideas to market. They also found out that venture capital is associated with faster time to market for radical innovators rather then incremental innovators. Therefore, companies willing to generate more radical innovations are now trying to establish venture capital funds. These funds are used for investing in start-up companies that are interesting for the corporate's growth strategy.

One of the problems of venture capital funds being managed by corporations are the issues of control and independence over the venture which are very important for the entrepreneurs, because they are afraid of loosing control of their operations and the theft of their ideas. Another problem is that most corporate venture capitalists are not comfortable with the long time frames that usual venture capitalists use for their investments. Finally it is difficult for the corporate venture capitalists to give the

incentives and equity participation to attract the best ventures for their portfolio (Stringer 2000).
An example given by Stringer (2000) for a relatively successful corporate venture capital strategy application is J&J Development Corporation, which has a lot of experience with it.

The **ninth** and final strategy proposed by Stringer (2000) is to participate in an "emerging industry fund"(EIF). Like the previous strategy it is based on the benefits of working with venture capital. This time though, the EIF is managed by independent venture capitalists. Besides, in the fund there is also the inclusion of institutional capital.

As a result, the companies invest in, but do not control, the operations of the fund. On the other hand, the skills, passion, and discipline of the independent venture capitalist allied to the existence of institutional capital, prevent the problems associated with the venture funds owned exclusively by corporations (Stringer 2000).

The EIF funds often invest in ventures with proved results that need growth capital, not in early stage start-ups. Thereby the technological risk involved with radical innovations is minimized. The following commercialization initiatives from the ventures can be more quickly evaluated by the corporations participating in the fund and valuable lessons learned. In addition, the above average financial returns that the EIF fund seeks to provide, is also advantageous for the corporation. In fact, the multi-dimensional knowledge transfer process significantly enhances the EIF's ability to generate above average returns Stringer 2000).

Examples of companies that use this last strategy are Adobe and Texas Instruments, which have established funds that are managed by H&Q Venture Associates.

## 4.2. AMBIDEXTROUS ORGANIZATION

Being an ambidextrous organization was one of the strategies for nurturing innovation presented in the Figure 29 and already described shortly in the previous chapter. We think it is useful to describe it in some more detail because it attempts to give a solution for the problem at the root of our study: the difficulty of producing high volumes efficiently and being at the same time innovative in order to maintain the technology and market leadership.

Tushman and O'Reilly (1997: 167) suggest that organizations can sustain their competitive advantage by operating in multiple modes simultaneously – managing for short term efficiency by emphasizing stability and control, as well as for long-term innovation by taking risks and learning by doing. Organizations that operate this way may be though of ambidextrous – hosting multiple, internally inconsistent architectures, competencies and cultures, with built-in capabilities for efficiency, consistency, and reliability on the one hand and experimentation, improvisation, and luck on the other. This separation is a main concept around which the theory evolves and links it to the innovation unit strategic archetype in our study.

Their reasoning is based on the conclusion that in order to maintain the competitive advantages, the company must produce streams of innovation and not only either incremental, architectural or discontinuous innovation. This means that managers should

concentrate not in a "particular innovation or innovation orientation (e.g. market push versus technology pull; incremental versus discontinuous), but towards series of contrasting innovations that must be produced within a firm over time." (Tushman and O'Reilly 1997: 166). As an example of a company managing innovation streams they name Sony, which was able to develop four Walkman product families (architectural innovations) and more than 160 incremental innovations of those four families. Sony proactively initiated radical innovations at the subsystem level (e.g., flat motor and miniature battery), closed on a few standards platforms, and finally lead incremental change in their products. This combined actions of managing innovation streams assured for Sony a sustained competitive advantage, outperforming their worldwide competitors.

Managing the different kinds of innovation (innovation streams) require different organizational architectures dependent on the particular stage of the technology life cycle (see Figure 30 ).

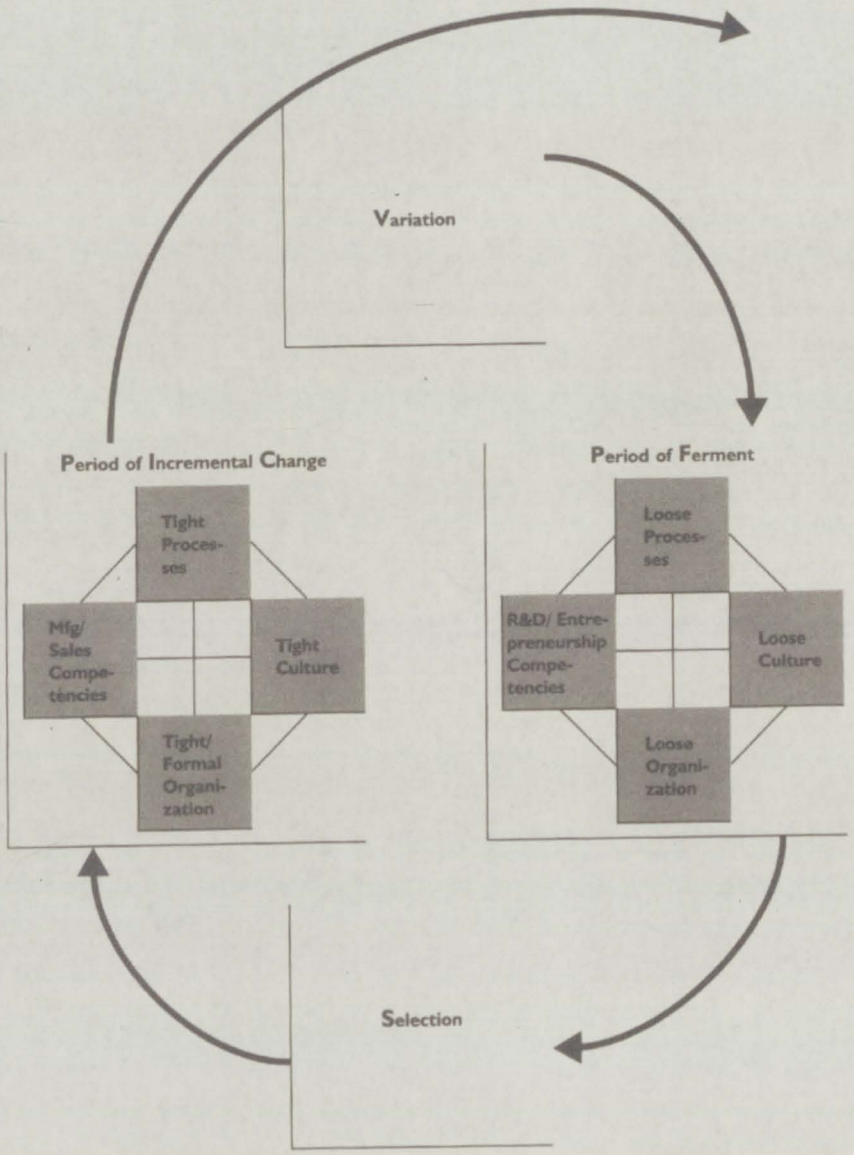



**Figure 30; Technological cycle and different organizational architectures**

The different stages of the technology life cycle (described in detail in the technology chapter of section 1) require different kinds of innovation, and those in turn need different organizational architectures so they can emerge. This means different kinds of "organizational hardware" – structures, systems, and rewards – and different kinds of "software" – human resources, networks, and culture depending on the stage of the technological cycle. In particular, the authors point out that during *periods of incremental change*, organizations require units with: relatively formalized roles and responsibilities, centralized procedures, functional structures, efficiency-oriented cultures, highly engineered work processes, strong manufacturing and sales capabilities, and relatively homogeneous , older, and experienced human resources (Tushman & O'Reilly 1997: 167). They could be described as efficiency-oriented units.

On the other hand, the discontinuous innovation needed for the *periods of ferment* emerges from entrepreneurial, skunk-woks types of organizations. Those units are relatively small, have loose, decentralized product structures, experimental cultures, loose work processes, strong entrepreneurial and technical competencies, and relatively young and heterogeneous employees (Tushman & O'Reilly 1997: 169).

Ambidextrous organizations are those that host these different types of units: ones that provide the efficiency for today and others that create the options for the future.

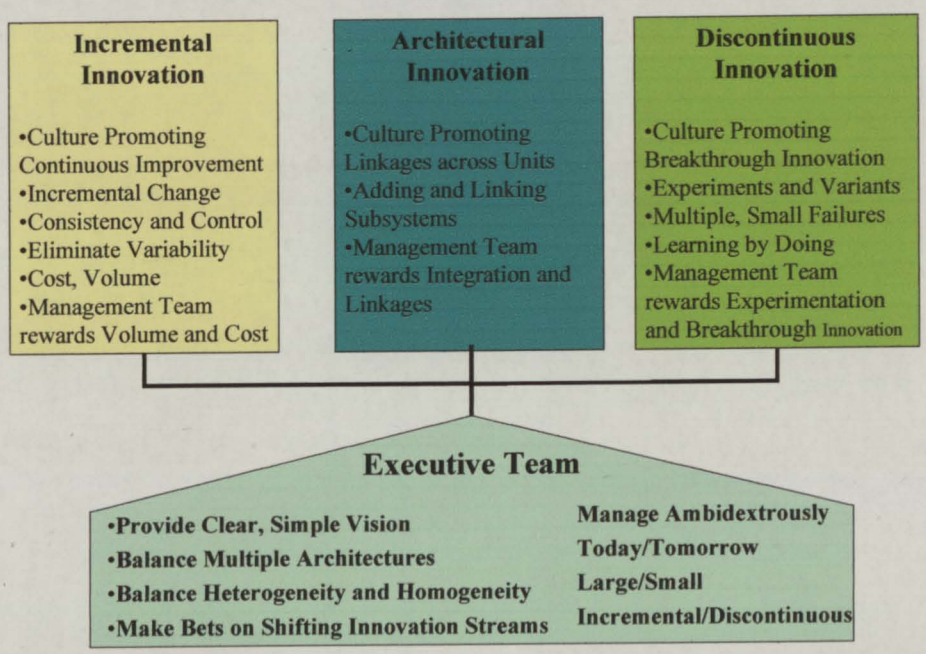



**Figure 31; Innovation Streams - managing Ambidextrouxly**

The contradictions between these units are extensive. The historically profitable, large, efficient, older, cash-generating units do not accommodate easily the young, entrepreneurial, risky, cash-absorbing units. Besides the more traditional units usually have the power and resources of the organization. This creates a conflict between them, with the traditional units usually trying to ignore, put down or kill the entrepreneurial units. Therefore in Tushman and O'Reilly opinion, "the management team must not only protect and legitimize the entrepreneurial units, but also keep them physically, culturally, and structurally separate from the rest of the organization."

In fact, the role of the management team is crucial for the success of the ambidextrous organization. If the conflicts between the units cannot be minimized, the potential of the ambidextrous organization is lost. The authors propose three tools for the senior management how to achieve integration: a clear, emotionally engaging, and consistent vision; building a senior team with diverse competencies; and developing healthy team processes.

Perhaps the most important tool is the vision. It reconciles the multiple contradictions between the units, by proving a clear, overarching purpose for the whole company. (Tushman & O'Reilly 1997: 172). The vision is also present in our initial working model (Figure 1; Setting a stage for the research.).

The second powerful tool is to have a senior team that mirrors the ambidextrousity of the company by having flexible members capable of adjusting their leadership styles and their team's competencies to manage the contrasting demands of short-term efficiency and long-term adaptation (Tushman & O'Reilly 1997: 223). Senior teams must be intellectually fresh, able to balance old and new perspectives, and not get caught up in a single viewpoint (Tushman & O'Reilly 1997: 173). Members not able to adapt, collaborate, or resolve conflicts have no place in the senior team.

Finally, the third tool to achieve integration is to develop healthy team processes. Team members need to be comfortable working together and understand one another's strengths and weaknesses (Tushman & O'Reilly 1997: 173). The literature on team management and processes is vast and can be a good source of information on how to develop healthy team processes, but it would be out of our initial scope of the project to investigate this literature in detail.

Tushman & O'Reilly (1997: 225) give a final statement on how important it is in their perspective to have an excellent management team: "While it may be true, as Tom Peters has claimed, that there are no excellent organizations, our experience is that there are excellent managers – those men and women who have learned how to build diverse executive teams and use social control and diverse cultures in creating ambidextrous organizations. They are the individuals from whom we have learned how organizations can go from today's o tomorrow's strength; they have mastered the architectural, network, and juggling skills necessary to win through innovation."

## 4.3. CORPORATE VENTURING

As we have discussed previously, a powerful strategy to encourage innovation is Corporate Venturing. This strategy is particularly interesting because it has been used by several companies for many years and Nokia has been using venturing as an important tool of it's innovation strategy. Corporate venturing is nowadays one of the hot topics in mouths of both academics and practitioners (Backholm 1999).

We will first argue on some motives and factors affecting corporate venturing. We will then discuss the need of separation of the new initiatives from the mainstream business and the drawbacks that the separation brings. After that we present several frameworks that help to choose which organizational design is the best for the new project. In the

following chapter we continue with the mechanisms that link the mainstream business with the new ventures.

### *4.3.1. MOTIVES AND FACTORS AFFECTING CORPORATE VENTURING*

Backholm (1999) in his overview study of corporate venturing notes that there are direct and indirect motives for engaging in corporate venturing. Direct motives include new business creation, growth and diversification through new ventures. Indirect motives include strategic renewal, development of new products and competencies, fostering organizational learning and entrepreneurship.

The factors that affect the ventures from the parent organization environment include tangible ones like: the organizational structure, formal communication, integration components and organizational controls. Less tangible ones that also influence the venture are the institutionalized practices and routines of the organization (Backholm 1999). The corporate venture requires new organizational architectures in order to host the innovative activity.

Factors affecting the corporate ventures from the market environment are seen to be the same as the ones affecting independent ventures. These environments were categorized by their munificence and competitive hostility (Backholm 1999). In addition, new ventures are affected by the potential danger of newness and smallness.

### *4.3.2. SEPARATION FROM THE MAINSTREAM*

In the recent paper from McKinsey (Day *et al,* 2001) argue that separating the new ventures from the company mainstream frees them from the processes that were designed for the established businesses. The companies have customers, organizational structures, and prejudices that influence them to stay with the well-known when considering the investments and therefore tend to neglect the needs of the new ventures.

Another problem is to catch the attention of the management, because the new unproved ideas are difficult to defend when evaluated against the existing businesses. If they are separated from the mainstream, managers will evaluate them on another scale and a new paradigm of nurturing new ideas instead of ignoring them can emerge.

Separation from the mainstream, also shelters the ventures from the politics that could mine their success. Managers of existing businesses might feel their status-quo endangered by the new initiatives and make their progression more difficult. By breeding the new ideas in separate organizational structures, the managers of ventures and of existing businesses could concentrate more in their own performance than fighting in the internal conflicts.

Since the historical management model was the development of new ideas in-house, the literature describes more the virtues of separation than it's drawbacks. But when it comes to aiming at the right balance between separation and integration, the drawbacks of it play an equally important role.

According to Day *et al,* 2001, three main problems arise when a company decides to start partitioning. First is that higher-level managers get the responsibility to recognize and select the ventures that will get the support. The needs to understand the customers,

markets and employees already and the increased responsibility to supervise the new ventures contribute to a growing information overload. Therefore the risk increases to misjudge certain ventures either by suppressing certain ideas too quickly or to foster others whose potential is not yet accurately calculated.

Second problem of separation discussed by the authors is that partitioning creates new organizational boundaries difficulting thereby the flow of information and ideas. This can result in loosing new growth opportunities identified from the operating mainstream business. Many incremental and radical innovations emerge in this way. On the other hand, the new ventures by being separated from the mainstream are also loosing the close contact with the mainstream's related key customers, technology providers and competitors. The relation with those contacts usually is a source of good new opportunities. (Day *et al*, 2001). Besides, the opportunity and easiness of the operational synergies between the mainstream and the corporate venture decrease the more separate they are.

Finally and in our opinion probably the most important drawback of separation is the problem of re-integration into the mainstream. The separation is done in order two foster different systems. One based on efficiency of cost and volume, producing the mainstream products of the company and on the other hand another system based on creativity and breakthrough innovations. The cultures, human resources, competencies, formal organization and tasks are completely different in these two systems (Tushman 1997). The process of integrating the venture unit into the mainstream requires that all dimensions of the venture be reshaped in order to fit into the mainstream system.

To sum up, separation or integration have supporting arguments and both are necessary to achieve profitable growth. Therefore companies should conduct them simultaneously.

### *4.3.3. WHICH ORGANIZATIONAL DESIGN FOR THE NEW VENTURES?*

If an organization needs to react to an innovation started by a competitor or to pro-actively initiate one, the management has to decide where that new project should be developed. There are in the scientific literature different approaches how to choose the best organizational design to deal with a new idea. We will present several frameworks from key authors that researched this topic.

**Framework based on fit with values and processes**

Christensen (2000) suggests this model to explain which organizational mode and which team is most appropriate for different innovation challenges.

He proposes two dimensions for his framework: on the horizontal axis, the extent of how the organization's existing processes are suitable for doing the new job effectively. On the vertical axis. Christensen presents the dimension of the fit with the organization's values, which means whether the companies values will permit the company to allocate the resources to the new project.

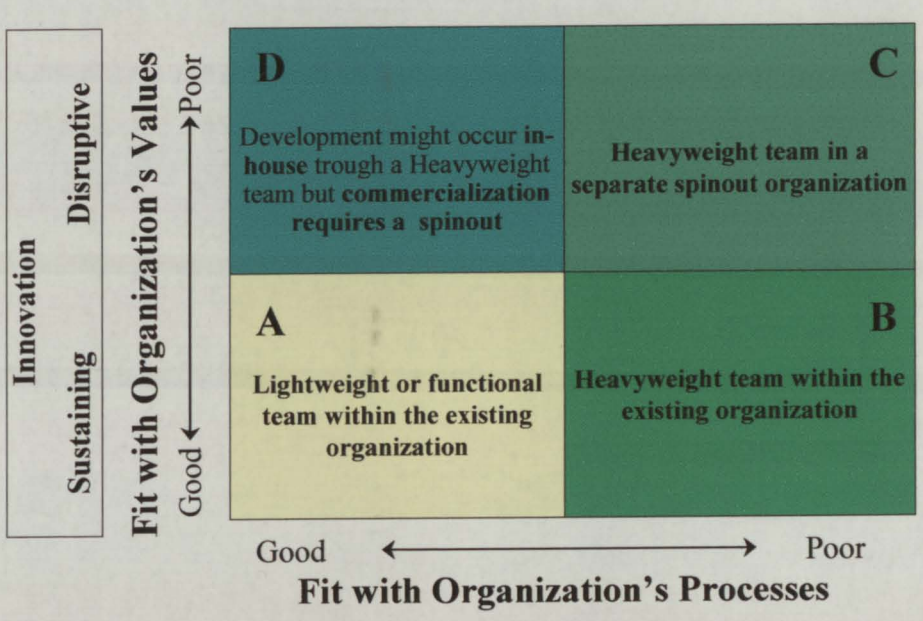



**Figure 32; Framework based on fit with values and processes. (Christensen 2000)**

In region A, the project has a good fit with values and processes, therefore there is no need to get new capabilities, and the project can be conducted using a lightweight team or a functional team within the existing organization's structure.

In region B, there is a good fit with values but not with the processes, which means that the project demands the company new types of interactions and coordination among groups or individuals. This can be achieved within the existing organization with a heavyweight team, which is designed in a way that new processes and new ways of working together can be developed. The members of this team work exclusively for it and carry the responsibility for the project success.

On the other hand, in region C, there is no fit with the values anymore (the innovation is disruptive) and a new space (spinout organization) must be developed where the new values and processes can be created. In this spinout organization, also a heavyweight team should be in charge of dealing with the new project because (as in region B) it will ensure that new processes can emerge.

In region D, similarly, according to the author, the best approach almost always to assign a heavyweight team to work in a spinout. Occasionally the spinout of the commercialization part may be sufficient for the success of the project and the development could be done in-house.

Analyzing the framework we can also conclude that the more the project fits with the organization's values, the easier it is to do the project within the existing organization. On the other hand, the less the project fits with the existing processes, the more the team has too build new processes separate from the current ones. Combining the two statements we can say in short that:

***The less fit between the new initiative and the current business, the more separated it should be.***

This result is also coherent with the other frameworks that we present.

**Framework based on Strategic Importance and Operational Relatedness**
This framework details more the options than the previous model. It divides the strategic option space in two dimensions: the strategic importance to the company and the operational relatedness.

One can see that the more the strategic importance, the more control should exist over the venture. On the other hand, the more operational relatedness, the more should the venture be coupled with the existing business. This framework enhances the idea that when the venture has low strategic and operational relatedness to the mainstream business, then it is best managed as an independent organization.

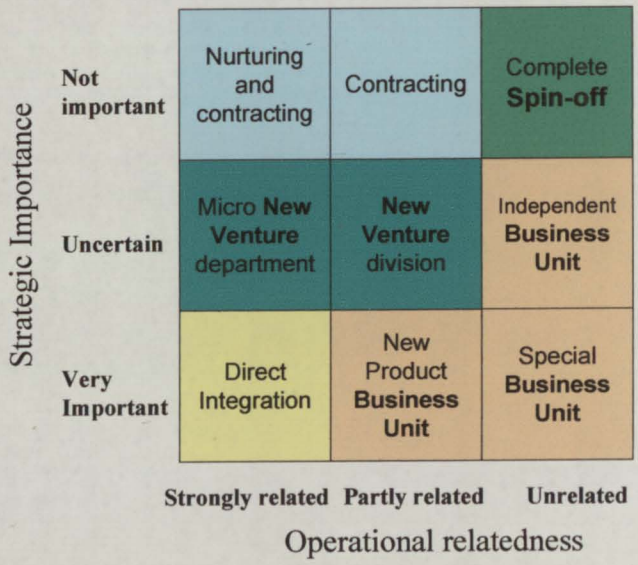



**Figure 33; Framework based on Strategic Importance and Operational Relatedness (modified from Burgelman 1986 in Keil 2000: 74)**

Background information about this framework is that it was developed from the perspective of mature industries such as the chemicals. In the early phases of the telecommunication equipment industry this was certainly not the case, but the maturing of this industry brings more interest towards this type of framework. Transferring the recommendations of Burgelman's framework requires still a careful adaptation to the NMP environment. The underlying assumptions should be analyzed and the differences from NMP to the companies referred in this study evaluated.

One limitation of this model is that it ignores the time and oversimplifies the operational relatedness (Backholm 1999). The strategic importance and operational relatedness can be partly determined only during the venturing process. This is even more important in

dynamic environments as the one where Nokia is inserted. In addition, operational relatedness is composed of several dimensions like technology, production, and marketing relatedness (Backholm 1999). Finally, the framework is more focused on internal venturing and has few options concerning external venturing. About this latter topic, an in-depth discussion is provided by Keil (2000).

**Framework based on Market factors and Technologies Familiarity**
In this framework there are more options for external venturing than the previous model.

Some further comments are needed to explain some of the options proposed by these authors. The model distinguishes between *Venture capital* and *Venture Nurturing*. The first one refers to a financial view of venture capital when there is not extensive management assistance by the organization to the entrepreneurial company. *New style joint ventures* are meant as alliances between small and large companies. *Educational acquisitions* refer to acquisitions of small firms in order to have a first beachhead on a market or technology. Roberts & Berry (in Roberts 1987: 196) see them as a way of enabling the company to learn about the unfamiliar markets and technologies rather then controlling them. Acquisitions on the other hand are seen as a tool for strengthening familiar markets and technologies.

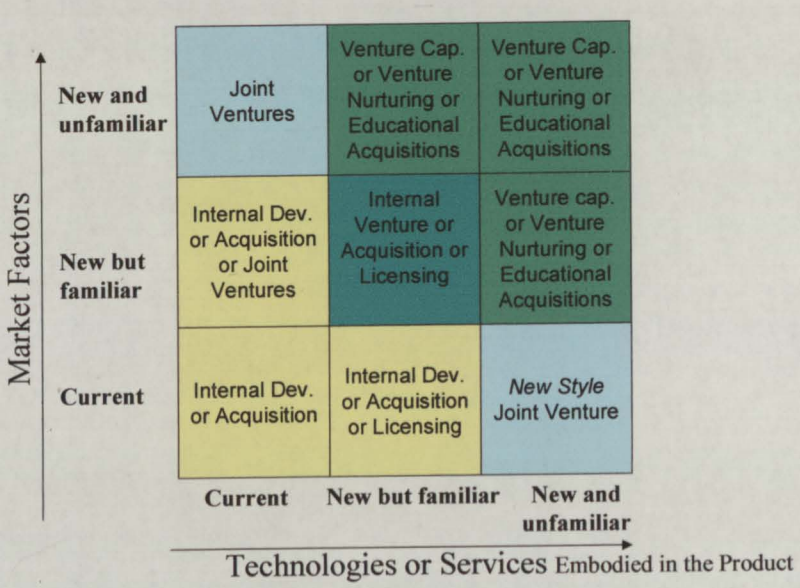



**Figure 34; Framework based on Market factors and Technologies Familiarity (Roberts & Berry in Roberts 1987: 196)**

Keil (2000) says that this framework was a first approach to build a dynamic framework. There is a natural evolution path from the external top right corner to the internalization in the lower left. As the companies learn about the market and technology, they increase the familiarity of the venture measured by the axes defined in this framework, consequently shifting the venture towards the left lowest corner.

Like the previous model, this framework was built based on extensive empirical work from established industries. Therefore the application of it's suggestions to the high dynamic environment of NMP should be done with this in mind.

The focus of our study are the mainstream products of Nokia and not the unfamiliar markets or technologies. Particularly the current market (lowest row of the model) with the *current* or *new but familiar* technologies are the most important for Nokia in this study. For these boxes, the framework suggests internal development, acquisitions, or licensing.

**Framework about Speed and organizational structure of new ventures**

This framework (Utterback *et al*, 1992) deals with the organizational question where to place a new venture as the previous models but the authors wanted to build in the model the influence of the need for speed – what characteristics of a new venture or product warrant that speed be the driving priority.

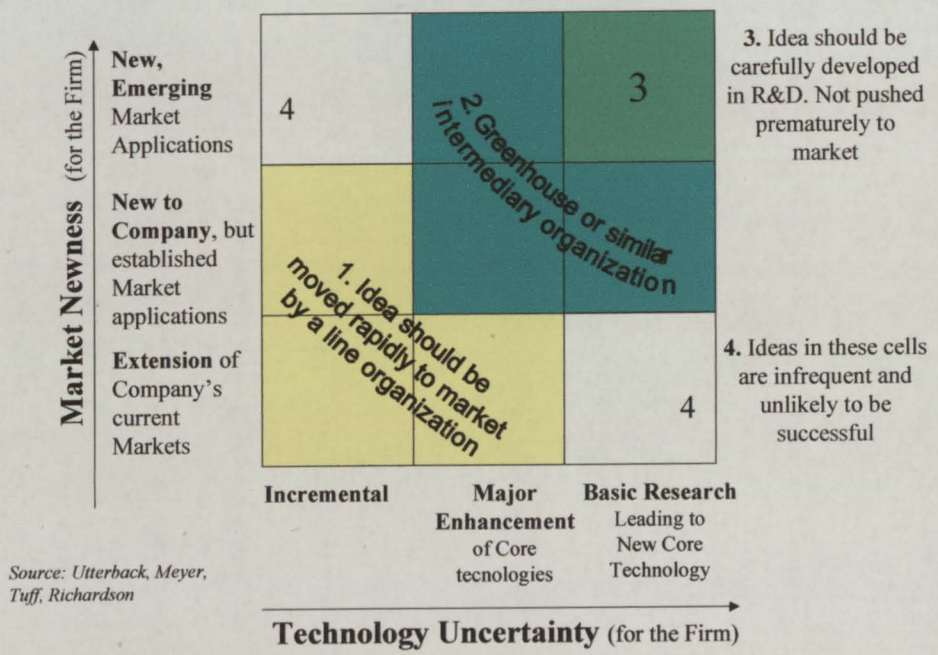



**Figure 35; Framework about Speed and organizational structure of new ventures (Utterback et al 1992)**

In line with previous models, when uncertainties are low, one should put technology development under the responsibility of a commercial or line manager. When uncertainties are greater and a new venture is created, it should be moved through a greenhouse or a bridging organization. The most uncertain cases should on the other hand be kept within research and explored until clearer promise justifies greater levels of expenditure and movement into a venture. The cases which the authors have studied indicate that effort should be devoted first and only then pressing to move quickly.

Like the previous two models, this framework was grounded on rich empirical work from mature industries. It should be noted that the authors ignore the ideas coming from the right lowest corner, and comment that they are infrequent and unlikely to be successful. We argue that it can be a very dangerous attitude because the disruptive

innovations (Cristensen 1997) that can come from basic research and replace the companies current markets are potentially devastating.

The same reasoning as the previous framework can be told about where would Nokia mainstream fit in this model. Perhaps the two left-most boxes of the lowest row are the appropriate ones. The authors (Utterback *et al*, 1992) suggest that the ideas in this fields should be moved rapidly to market by a line organization.

**Some conclusions from the framework's analysis**

The frameworks proposed by the different authors try to guide the managers in the choice of the best organizational mode when they are confronted with a new idea. It deals with the problem of how the organizational structure can help or not to foster the innovations. The managers when analyzing which is the best place to breed the new ideas and not simply leaving them in the existing organizational structures can help avoiding the trap of "success breeding the seeds of destruction". Innovations are not necessarily left in the structures created from the past successes, but have the opportunity to be developed in a new environment.

An important conclusion that is common to all the frameworks is the trend that the further away from the current business the more separation is needed. Perhaps with the case studies we can test if this holds with Nokia's ventures.

From the analysis we concluded the models do not emphasize or simply ignore the dynamics of the environment and time. With the time passing, the fit, familiarity, uncertainty (which are the dimensions in the models) of a venture also changes in dynamic environments. This results in a movement from the venture within the framework.

Except for the first model, the presented frameworks were constructed based on empirical work from traditional industries. Therefore one must analyse to what extent the assumptions upon which they are based differ from the industry where NMP is inserted and their conclusions should be adapted accordingly.

They tell that decision criteria like the innovation's strategic importance to the company, market and technology familiarity and the fit of the new idea with the current companies values and processes are important drivers for the choice of the structure for the new initiative. Besides, the different structures influence greatly the speed by which the new ideas will be developed.

To our research question and NMP these frameworks help in the issue of creating new innovations and the speed of developing them. Yet, they don't help clarifying the processes by which the new technologies should be incorporated into the mainstream products.

### *4.3.4. MECHANISMS LINKING MAINSTREAM AND VENTURES*

As illustrated in the previous chapter, there are several frameworks to help deciding which organizational structure should a new inactive have in order to grow in an adequate environment. But the structure is only one of the dimensions described in the literature that affect the new venture.

Day *et al* (2001) argue that other tools could be the management processes, human-resources policies and corporate culture.
The authors discuss the mechanisms being used by Nokia to achieve more integration between the ventures organization and the mainstream business units. In the Figure 36 below, those mechanisms would be represented by horizontal lines linking Nokia business units and NVO ventures.

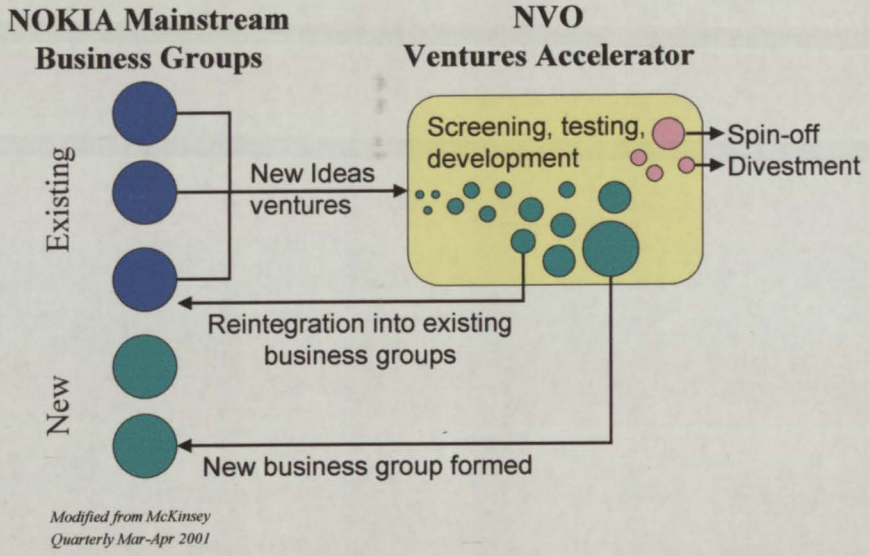



**Figure 36; Separation and Integration (Modified from Day *et al* 2001)**

In the interest of our study, the discussion of these linking mechanisms is very important, because they help to bring new ideas into the mainstream business. In addition, if the mechanisms work efficiently, then the innovations flow from the ventures to the mainstream will be faster, and this links to the speed dimension of our research work.

One form to achieve integration is to ensure that the new ventures organization (NVO) only exists as an accelerator for the parent organization (Nokia). This means that if the ventures can run on their own they should leave the venture organization. If they fit into the overall plan of Nokia then they should either to be incorporated into a current business group or form a new one. If they don't, then they should be spun-off or divested. Important is that they cannot stay in NVO indefinitely.

Another way of linking the different systems is via the rewards and incentives system. In order that the innovators don't get excessively attached to their "pet projects", NVO and NMP business groups share financial and incentives salary schemes. In addition, the authors (Day *et al,* 2001) note that performance related bonuses tend to reward the achievements of teams and the whole company rather then individuals, therefore encouraging the managers to see the company as a whole.

Keeping Ideas mobile is another important way to link the ventures and the parent organization and thereby contribute for the mainstream products to have access to the latest innovations. The Nokia Ventures Board includes several senior managers from the

business units like the president of NMP. The Board makes sure that the initiatives developed in NVO are interesting to the core business and are not too far fetched from it.
More mechanisms contribute to keeping the ideas mobile like the common Nokia intranet that hosts the opportunities to develop ideas in the several units. The managers of the units don't inhibit their people to be transferred to other units. The innovative employees can join a promising venture if they are motivated for that. Later, after the NVO initiative has been developed, the people who worked on it are expected to return to the mainstream. This horizontal movements across the company help to diffuse the ideas and knowledge to and from the mainstream products to the ventures.

In addition to the promotion of horizontal movements, the fostering of personal networks is yet another mechanism to spread the ideas across the units boundaries. Workers know that the more one idea circulates the more chance it has to be developed. In the particular case of Nokia, the finish culture can also be important factor because it's "egalitarian, nonhierarchical, and informal style" (Day *et al,* 2001) helps to keep the ideas mobile within the company.

Summing up, the several mechanisms identified enhance the mobility of the ideas, promote the innovations across the company and contribute for having the mainstream products with the latest technologies available.

We might want to investigate further in-depth the different mechanisms used by Nokia to link the mainstream with the ventures (not only from NVO but also from the business groups). In particular we could investigate the mechanisms directly contributing for the flow of the new technologies into the mainstream products. We might also investigate the differences between NVO ventures and the business units ventures concerning their influence on the mainstream products. We are expecting that the business units internal ventures would contribute with more technologies and do it faster than the NVO's counterpart because they interact more with the mainstream and the information loop is faster, but to what extent is this true? Case this assumption holds, then perhaps a way that for introducing new technologies faster into the products would be to use ideas and technologies from the ventures within mainstream business units rather then the technologies being deployed by NVO ventures.

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# APPENDIX 1: REVIEWED JOURNALS

| | |
|---|---|
| The Academy of Management Journal | 2001-1998 |
| The Academy of Management Review | 2001-1994 |
| Business Horizons | 2001-1999 |
| Business + Strategy | 2001-2000 |
| Business Strategy Review | 2000-1995 |
| California Management Review | 2000-1993 |
| Economics of Innovation and New Technology | 2000-1997 |
| Emerging Markets Review | 2001-2000 |
| European Journal of Innovation Management | 2001-1998 (no more available) |
| European Journal of Marketing | 2000-1997 |
| European Management Journal | 2001-1995 |
| Harvard Business Review | 2001-1993 |
| IEEE Transactions on Engineering Management | 2001-1998 |
| International Business Review | 2001- 2000 |
| International Journal of Innovation Management | 2000- (no more available) |
| International Journal of Management | 2001-1998 |
| International Journal of Research in Marketing | 2001-1999 |
| International Journal of Technology Management | 2001-1994 |
| Journal of Business Research | 2001-1999 |
| Journal of Business Strategy | 2001-2000 |
| Journal of Consumer Marketing | 2001-1998 |
| Journal of Engineering and Technology Management | 2001-1996 |
| Journal of General Management | 2001-1997 |
| Journal of High Technology Management Research | 2000-1999 (no more available) |
| Journal of International Management | 2001-1998 |

| | |
|---|---|
| Journal of Management | 2001-2000 |
| Journal of Management Studies | 2001-1999 |
| Journal of Marketing | 2001-1994 |
| Journal of Product Innov Management | 2001-1992 |
| Journal of Technology Management | 2001-1999 |
| Mit Sloan Management Review | 2001-1998 |
| Research Policy | 2001-1996 |
| Research Technology Management | 2000-1996 |
| Scandinavian Journal of Management | 2001-2000 |
| Technology Analysis & Strategic Management | 2000-1999 |
| Technology in Society | 2001-2000 |
| Technovasion | 2001-1994 |

Note: Books and Working Papers are in the reference list.

# APPENDIX 2: STRATEGY ARCHETYPES FRAMEWORK

| *Strategy* | *Dimensions* | *Relationship to value network* |
|---|---|---|
| Technovariants | Format of introduction<br>• Secret<br>• Special edition<br>• Limited accessibility<br>• Limited market<br>Architecture changing<br>Relation to existing manufacturing/D-S-C system<br>New to the world or New to NMP | Vertically integrated |
| Redefining Mainstream | Software development process<br>Hardware development process<br>Architecture (modularity, functionality) | Horizontal refocus |
| Innovation Unit | Separate brand<br>Separate organization<br>Ambidextrous organization | Reconfiguration of network |

# III. NOKIA ENVIRONMENT

## BASIC FACTS

Nokia is the world leader in mobile communications. The company sold 128,4 million mobile phones in 2000, which equals ca 32 % share of the global mobile phone market (405 million units). The company employs over 60 000 people and net sales in 2000 were EUR 30,4 billion.[1]

## ORGANIZATION

Nokia's headquarters are located in Espoo, Finland. The company is divided in two business groups: the biggest is Nokia Mobile Phones (NMP) – net sales in 2000 ca EUR 22 billion - and the second is Nokia Networks (NN).
In addition of those main business areas, Nokia Ventures Organization (NVO) was established in 1998 to focus on new business areas and new growth opportunities. The group also includes Nokia Head Office (NHO), which takes care the general administrative issues, and the Nokia Research Center (NRC), which is the particular corporate research unit.

Nokia has production locations in 10 countries and sales to over 130 countries supported by global network of distribution, sales and customer services. It undergoes research and development in 15 countries.

Regarding the organization, it is generally regarded as being very flat and having a non-hierarchical working style, that nurtures discussion and openness as well as encouraging entrepreneurism and risk-taking.

## NOKIA SPECIFIC ATTRIBUTES

NOKIA's specific attributes shape our research, introducing certain constrains or pointing out opportunities that are important in NOKIA's context.

**Operating Efficiency**
In the letter to shareholders (2001) , Jorma Ollila considered Nokia's experiences and unique way of operating as being the main reason for the increasing advantage over the competition In his words, winning in the complex industry will **be less about what** Nokia does, but **more about the way** it does it.

For NMP efficiency means to manage the daily the flow of 250 million components with strict attention to logistics and study of every detail. This makes up to 80 billion components a year.[2]

[1] All the information written in these pages was extracted from material that is publicly available. Mainly from the Nokia Internet pages, letter to shareholders 2001 and the internet site Nordic Wireless Watch.
[2] Source: Nordic Wireless Watch Newsletter 13. Sep 2001

For developing new businesses, the efficiency imperative translates into efficient processes which identify "which new trees will make up the future forest"[3].
The continuous increase in productivity is supported by the numbers of 2000 in which a 54% increase in revenues were reached only with an increase of 9% in personnel.

Nokia efficiency is moving to the next level with the "transformation of Nokia into a global e-business that will support huge volumes in a faster, more flexible and customer-centric way"[4]. It is a new way to combine electronics of scale and agility as well as to speed up productivity and enhance costumer satisfaction[5]. By doing so, Nokia can re-invent itself when analysing the best way to conduct the processes in an electronic mode.

**Strong Brand**
Nokia has a very strong brand. It currently ranks as the 5th most valuable brand in the world. It's value is estimated in ca. USD 35 Billlions.[6] More than 50 per cent of the population aged between 16 and 75 on three continents now have spontaneous awareness of Nokia[7].

Tapio Hedman, Nokia's spokesman, commented that branding and external design play a much bigger role in the mobile-phone sector than they do in the PC industry. "It's not about anonymous boxes, it's about personal devices"[8].

**Market Leader and volumes**
Being the market leader in the production of mobile phones with ca 32 % share, corresponding to 128,4 million mobile phones sold in 2000, constitutes one of the main specificities of Nokia when compared with other companies and other industries.

This level of volumes is unique of the mobile phones industry, making it the world's single largest electronics market[9]. By 2002, it is projected that there will be more than one billion mobile phone users around the world. For example in the Video Game Console industry, SONY is the market leader and sold since the launch of Playstation in 1994 till 2001 a total of 80 million units.[10] As another example, Dell is the market leader in the PC industry, and sold in the second quarter of 2001 a total of 4 million units worldwide [11], which is less than 20% of the units shipped by Nokia in the same period [12].

With these volumes, many of the strategic options that could be available for smaller players are not feasible for Nokia.

**Nokia relation with partners**
Nokia has a special relation with it's partners and suppliers. It uses the network of external entities in a singular way, enabling their contribution to Nokia's success. Further comments on partners strategy and current figures were not included in this report for confidentiality reasons.

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[3] Jorma Ollila in letter to shareholders - 2001
[4] letter to shareholders 2001
[5] www: Nokia/Insight/FAQs
[6] BusinessWeek & Interbrand in Nokia news 26.07.2001
[7] www: Nokia/Insight/What We Do
[8] Tapio Hedman in Wall Street Journal Europe – 03.09.2001
[9] High Technology Finland 2001: 66
[10] www: Sony/Playstation/Facts
[11] Dataquest
[12] www: Nordic Wireless Watch News 29.08.2001

**Innovativeness – wining technologies**
Nokia has been able to introduce many new technologies and lead the development of key areas in the telecommunication expertise.

Sustainable innovation means investing in research and development. About 30% of total personnel is dedicated to R&D and the investment in this area represents 8.5% of net sales, totalling ca EUR 2600 Million. The company intends to maintain this level of investment for the future.[13]

NOKIA is heavily involved with its partners for new technology access. Besides, on other areas away from Nokia's core operations, it has been increasing the effort in internal incubation and venture capital activities like a new USD 500 million fund.[14]

**People at Nokia**
The group of people that works in Nokia might also distinguish this from other companies. Nokia's success has been very much a team effort.[15] Nokians are regarded as a dynamic, entrepreneurial, enthusiastic group of people. "Respect for individual qualities, as well as willingness to work together in a constructive positive and even enjoyable way are all essential for high-quality results"[16]. Nokia believes that speed and flexibility in decisions making are key to maintaining a competitive edge. Decisions being made as close as possible to the frontline and by those people most knowledgeable.[17] The management environment nurtures discussion and openness as well as encouraging entrepreneurism and risk-taking. Job rotation is also strongly encouraged – even at very senior levels.[18] The basic ideology about how mobility changes the way people live is firmly established and employees look forward to the next generation of products and services.[19]

## THE CHALLENGES AHEAD

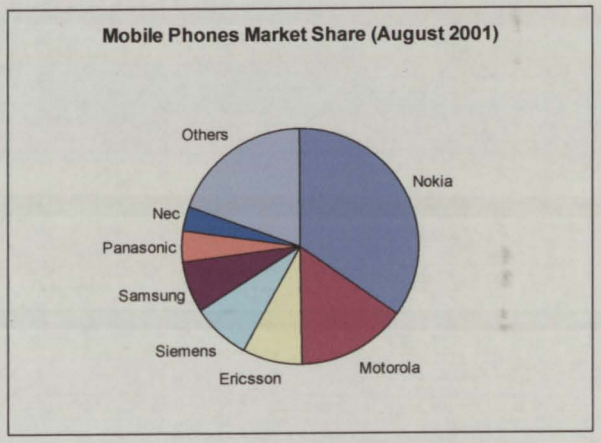
The financial figures for 2000 were impressive historical highs. On the other hand, Nokia is also aware of the possible trap of success and that complacency must be avoided.[20]

## COMPETITION

In the intense competitive environment where Nokia is operation, the competition is a major factor when analyzing possible strategies for fast technology introduction. The intent of this section is to give an overview of this competitive environment.

[13] www: Nokia/Insight/FAQs
[14] letter to shareholders 2001
[15] www: Nokia/Insight/FAQs
[16] www: Nokia/Insight/FAQs
[17] letter to shareholders 2001
[18] www: Nokia/Insight/FAQs
[19] letter to shareholders 2001
[20] Web Page: Insight/FAQs: company

The market share distribution by the middle of 2001 was:




Nokia: 34.8%
Motorola (US): 14.8%
Ericsson (Sweden): 8.3%
Siemens (Germany): 7.9%
Samsung (South Korea): 6.9%
Panasonic (Japan): 4.6%
NEC (Japan): 3.2%

"Ever since Nokia overtook Motorola as the world's largest maker of mobile phones in 1997, it has gradually built up its market share to near 35 percent, more than double that of its U.S. rival. It has done this through the right mix of products, with a focus on inexpensive but trendy phones, branding and design. Volume deliveries have ensured profits are by far the industry's highest - in fact it is the only major mobile phone maker that is currently profitable. It has also cut prices at difficult times to pressure loss-making rivals even more. This has helped push Philips and Alcatel out of the handset business and forced Ericsson to team up with consumer electronics giant Sony in mobile phones."[21]

[21] www: Nordic Wireless Watch, 23.07.2001

# IV. FRAMEWORK FOR NEW TECH INTRODUCTION

During the project, a model for Technology Introduction to the products was developed. First, there is a need to clarify the meaning of several terms that appear in the model.

## *DEFINITION OF TERMS*

**Technology** should be understood as product technology, i.e. knowledge or artifact that contributes to allow a certain feature in a product. The **Product** is where the technologies are embodied. And in Nokia's context, **platform** means a common architecture, set of design rules, or commonalization of different systems shared by different products. Finally, before the **hurdle**, the technologies are developed to a general state independent of any particular product or platform, whereas after the hurdle there is the commitment to develop the technology for a particular product or platform. **Emergence** means the point in time when the idea of a technology first appears in the world. **Launch** in the context of the model, should be understood as the launch of a product by Nokia including a particular technology. **Mainstream** means when the technology integrated in certain Nokia phones reaches the high volumes sales characteristic of Nokia mainstream products.

## *PATH FROM EMERGENCE TO MAINSTREAM*

There are three different important phases from the emergence of a technology until the technology being available in a mainstream product. The following figure shows them.

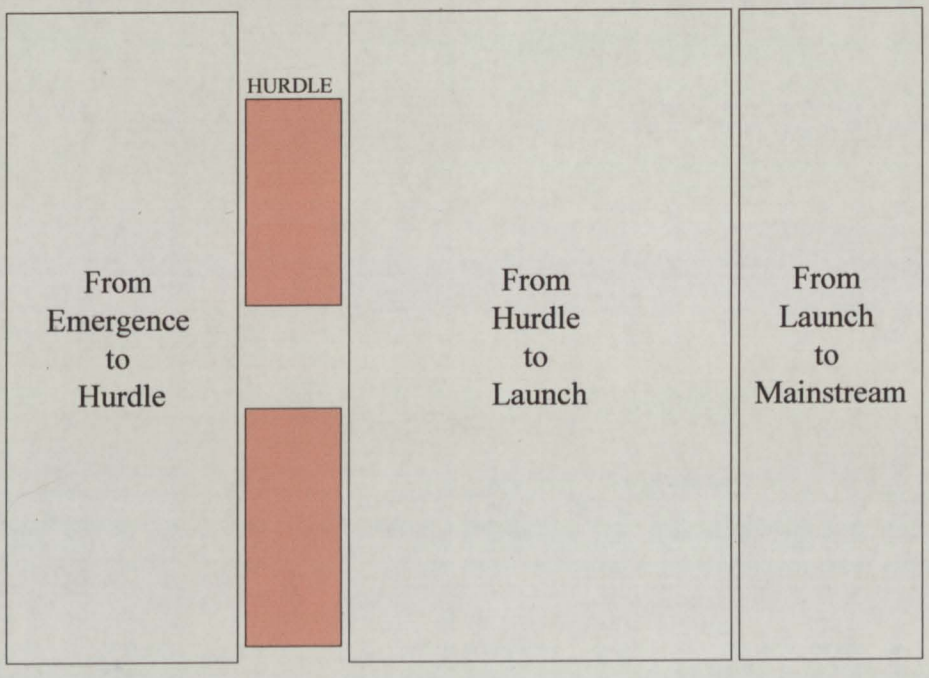



**Figure 1: Major phases from Technology Emergence to Mainstream**

In more detail, the path of one technology from its emergence to mainstream sales can be seen in the next figure.

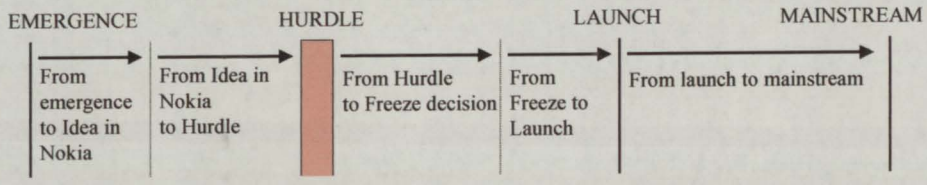



**Figure 2: More detailed phases from Emergence to Mainstream**

The first event is when the idea of a technology first emerges in the world. This can be for example in an university, in a competitor, in another industry, or internally inside Nokia. For many technologies there is a significant time elapsed since this event until the event of the awareness of the idea at Nokia. We have called this phase, **From emergence to Idea in Nokia**. Important activities there are to detect and create new ideas internally and to scan and evaluate external technologies.

A second phase can be identified as **From Idea in Nokia to Hurdle**. In this phase, first it needed to realize the link of the technology to the market opportunity. Case the technology seems promising then usually it basic internal development of the technology is done. As long as it is developed in a general state without a commitment to any particular product or platform, it is considered as being before the hurdle. The technology working principle is chosen and the basic functioning of the technology is proven in this phase. Important activities is also to search internal customers (products or platforms) for this technology.

Once the technology basic working principle is proven and an internal customer for it is found inside Nokia, then there must be a decision of commitment to that technology in order to further develop it together with a product or platform. If the decision is taken, then the technology passed the hurdle in our model. Important to note is that there are several factors influencing this decision and it involves important risks for the company. An immature technology in a product development process can delay the whole effort and result in huge losses for the company. This was the case for example with the WAP technology in the 7110 phone.

After the hurdle until the launch of the product with the technology, we have divided it in two phases: **From Hurdle to Freeze** decision and **from Freeze to Launch**. Until the freeze decision, modifications to the product and platform can be done. The technology will be integrated with the product or platform. After the freeze decision, the manufacturing and assembly lines are configured, the production is ramped up, and launch and distribution activities prepared. In this phase, modifications to the technology are more difficult, costly and can delay the launch (exception made to software changes).

The ultimate goal of any Nokia technology is to be introduced in products that will be sold in high volumes. For some technologies this can happen rather fast (e.g. the typing dictionary tool in SMS messages) but usually that is not the case. So, there is the phase from **Launch to mainstream**, where activities like technology improvement and market development are pursued. The Nokia Communicator has some technologies that are in this phase.

# TECHNOLOGY INTRODUCTION FRAMEWORK

The following picture is a simplified version of the Technology Introduction framework developed.

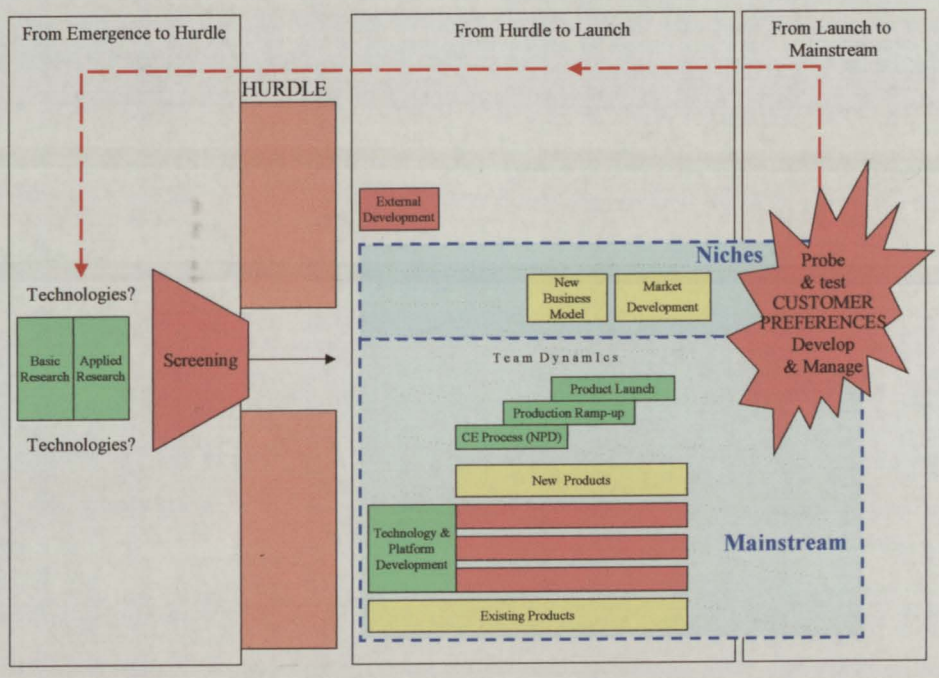



**Figure 3: Simplified Framework**

The three major phases from figure 1 can be seen as the major building blocks.
After Emergence of an Idea of a Technology, it undergoes basic research, followed by applied research after which the working principle is proven. If it passes the screening and there is a commitment to bring the technology to a product or to a platform, then it passed the hurdle. On this side, there is a major vertical division between the niches and the mainstream products. The niches are often characterized by having new applications and many times new business models and there is the need for market development. This is the case for example of the M2M (machine-to-machine) Nokia solutions. In some cases, the development of the technology is done by an external partner. In most of the cases, though, the technology is developed inside Nokia either with a product project or for a platform (that will be used across different products). It is also important to distinguish the cases where the technology will be used in existing products or for a new product. Finally, in the third phase (after product launch with the technology), there will be important learnings for Nokia from the technology use in the real market. Here again, there is the important difference between the niche markets and the mainstream markets. In the first ones, Nokia can probe and test new technologies (e.g. 5510 phone, and first communicator). Whereas in the second case, Nokia will use the new technologies more for developing and managing the market (e.g. WAP in 3330). In any case, it will better understand the customer preferences, which in turn can be a source of further ideas for new technologies or its improvements. This is represented by the loop arrow from the right to the left of the framework.

### *HURDLE*

As told before, the hurdle is a critical concept in the framework. The hurdle materializes the decision of commitment with a technology. It is particularly important for this study, because this commitment is more difficult to have when the volumes are very large since a wrong bet will also result in large losses. These losses can also be in the brand equity and be reflected in the sales of other products not involved with the failed technology.

The dynamics around the hurdle were analyzed in more detail in this study. The following figure is the framework including them.

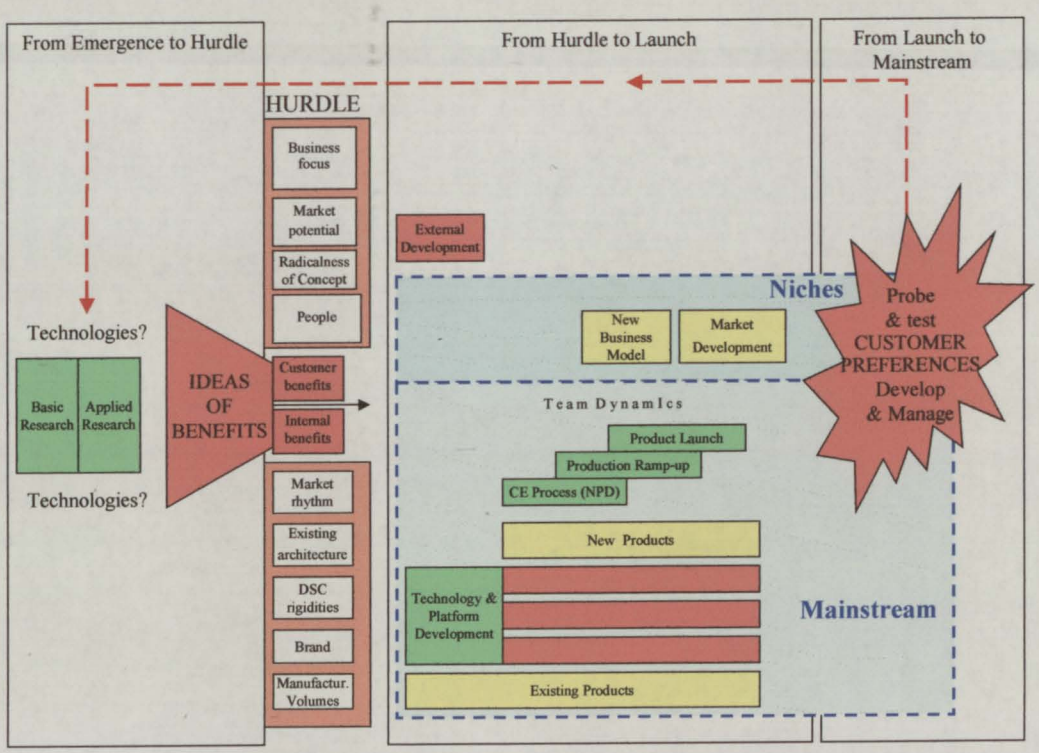



**Figure 4: Complete Framework** (under development – version in Nov)

From the several interviews conducted and the Nokia internal cases studied , we have summarized a set of factors at the hurdle level that push the technologies against the hurdle and also other factors at Nokia side that can make the hurdle more "flexible" or "thinner"[22], so that the technologies can pass it more easily. This can be seen in the next Figure 5.

A new element in these figures is also the inclusion of the "Ideas of Benefits" divided into "Customer benefits" and "Internal Benefits". Thereby, it is given importance to the implicit ranking of benefits of the managers that will guide the decision at the screening process to pass the hurdle. That ranking of benefits is dynamic and depends on several factors like the current market conditions, trends, current difficulties, competitive positioning, corporate vision, etc. "Internal benefits" are about advantages that a particular technology will bring in regard to the variables that Nokia can control to a

[22] In the figure 5 it appears a symbol for the "destruction" of the wall.

large extent. Whereas "Customer benefits" are about the advantages that a particular technology can bring in regard to the customers of Nokia products.

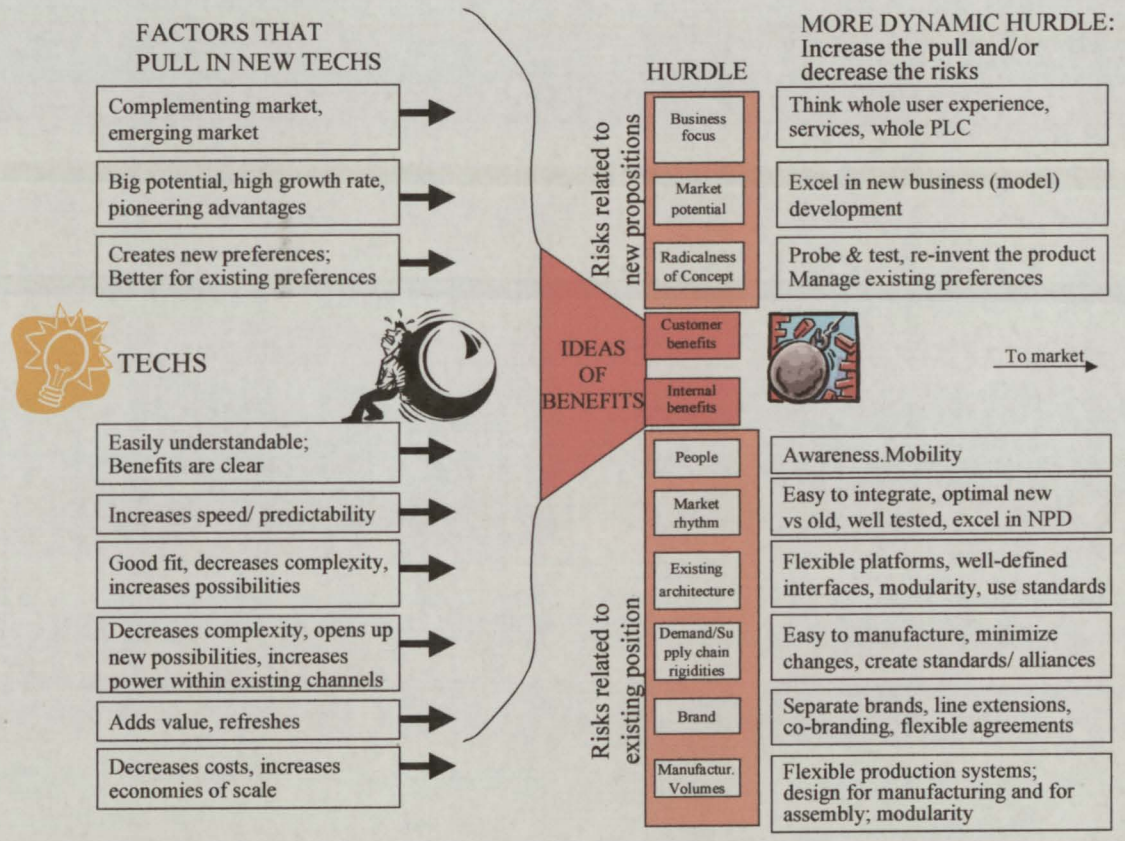



**Figure 5: Hurdle in more detail**

The building blocks of the hurdle are the risks that Nokia weights when deciding to adopt a new technology to or not. Without being exhaustive, the major "risk blocks" are:

**Business Focus:** In a dynamic and fast moving industry it is important not to loose the focus. There is no possibility to follow every potential market due to scarce resources. Therefore, there is need to make sure that a particular technology is contributing significantly to the business of Nokia. In fact Nokia proceeded to several divestments in the past years (e.g. monitors business) to concentrate on the telecommunication business.

To exemplify how the figure 5 was built, the block to the left of "Business Focus" means that some technologies, although not being core for Nokia, might complement a market or might be an emerging market that Nokia has to pursue. Those are factors that pull in certain technologies. On the other hand, the building blocks on the right exemplify certain policies that help to decrease the risks of the hurdle or increase the pull of the technology. For example if Nokia thinks the whole user experience, it might lower the hurdle for certain technologies that would be otherwise considered out of business focus. Similarly, if Nokia wants to sell more services and not only mobile phones which is admitted publicly by its officials, then this also opens the hurdle for technologies that would not pass it otherwise. The same reasoning could be done for a strategy of offering technologies for the whole Product Life Cycle (PLC).

**Market Potential:** The market potential is sometimes difficult to assess. As the market develops it might turn out that the initially promising market did not unfold as expected (e.g. mobile satellite business). It is important that Nokia is able to quit such markets as soon as possible and follow more attractive opportunities.

**Radicalness of Concept:** Some technologies imply a radical change in the way customers will use or perceive the product. The customers can sometimes resist to those technologies and have to undergo a learning path before they accept them (e.g. Apple Newton and the Palmtop industry).

The blocks presented so far, are mostly risks that exist mostly because of uncertainty regarding the new propositions. On the lower side of the hurdle, the model presents "risk blocks" that exist mainly because of the technology changing the existing conditions or positions.

**People:** People dynamics, organizational issues, motivation, entrepreneurship and other issues involving people are critical elements in the decision of commitment to one technology in the products of platforms. Nokia Ventures Organization, internal venturing efforts, internal fairs to increase the awareness of technologies, increase in mobility within Nokia, etc, are examples of organizational mechanisms that facilitate the pull of the technologies through the hurdle.

**Market rhythm:** For some technologies, the commitment is dependent on timing issues with other existing products, technologies or network development. The difficulty in bringing WAP technology forward was partly due to a problem in market rhythm. It can therefore be an important part of the hurdle.

**Existing architecture:** An efficient integration of a technology in a product or platform is a critical factor for its success. And for this integration, the existing architecture of the product or platform is the crucial element. Therefore, the evaluation of the fit between the new technology and the existing architecture can dictate whether the technology will pass the hurdle or not. This is even more important in companies producing very large volumes and where platforms are increasingly important to achieve cost-efficiency as it is the case in Nokia.

**Demand/Supply chain (DSC) rigidities:** Partners play a very important role in the whole production system. Therefore their role in the development of new technologies is equally important. A new technology can have implications in the DSC network either because it forces a new configuration in the network (e.g. a change in partners) or because it requires from the existing partners a change in their technologies. Therefore, the changes in the DSC can be a hard factor to overcome for a new technology and hinder the commitment of Nokia to it.

**Brand:** Brand is one of the most important assets for Nokia.[23] New technologies can have both positive or negative impacts on the brand. But the bigger the brand asset, the more dramatic can be the damage in brand value due to a technology flop in the mainstream product. Reasons are the exposure of important brands to the general public and the attention they get from the media. On the other hand, a new technology can have implications in the product portfolio and require a change in product categories

[23] Ver "Brand" na secção "Nokia na Indústria de telefones móveis"

(e.g. 5510 and the Nokia Communicator). The company could have separate brands to minimize the consequences to the Nokia brand of a failure in new technology. Being flexible on line extensions, co-branding, and flexible agreements can also lower the hurdle in terms of the brand risk for a new technology.

**Manufacturing Volumes:** Mobile phones is the electronic product most sold in the world and Nokia is its largest producer. One of the biggest hindrances for a new technology is the risk to change a production system that is optimized for this large volumes. In fact, the larger the volumes, the more difficult it is to accommodate small production batches to test and further develop new technologies. This modifications in the production line in order to accommodate new technologies can have bad implications in the large volumes production needed. These production systems are usually running at its maximum capacity and any test of prototypes or line configurations will decrease their output rate production (unless they are software related). Not only internally this is a problem, but also for the partners and suppliers that have to be able to ramp-up the volumes needed for the production of the new technologies. This block in the hurdle is certainly one of the most important elements of the hurdle. Nokia can soften this problem for example by having state-of-the-art flexible production systems, designing for manufacturing and for assembly and emphasizing modularity.

# V. SPEED – AN ANALYSIS

This report will end with a discussion about Speed. Since the name of the project is Tech Speed, this clarification of what can be understood under Speed is clearly important.

Speed is relative by definition. It is a comparison between the times, i.e. a comparison of the time elapsed between two events with another activity. One can only speak about an activity being faster comparing it to the time that another activity took to complete.

Therefore, it cannot be just said that Nokia is fast or that it should be faster, without defining which time is being measured and explaining with what is being compared. Using the model of technology introduction from the previous chapter, we have named several Speeds according to the events that define its start and its end. Then, if one wants to assess the Speed, it has to be compared with a similar activity.

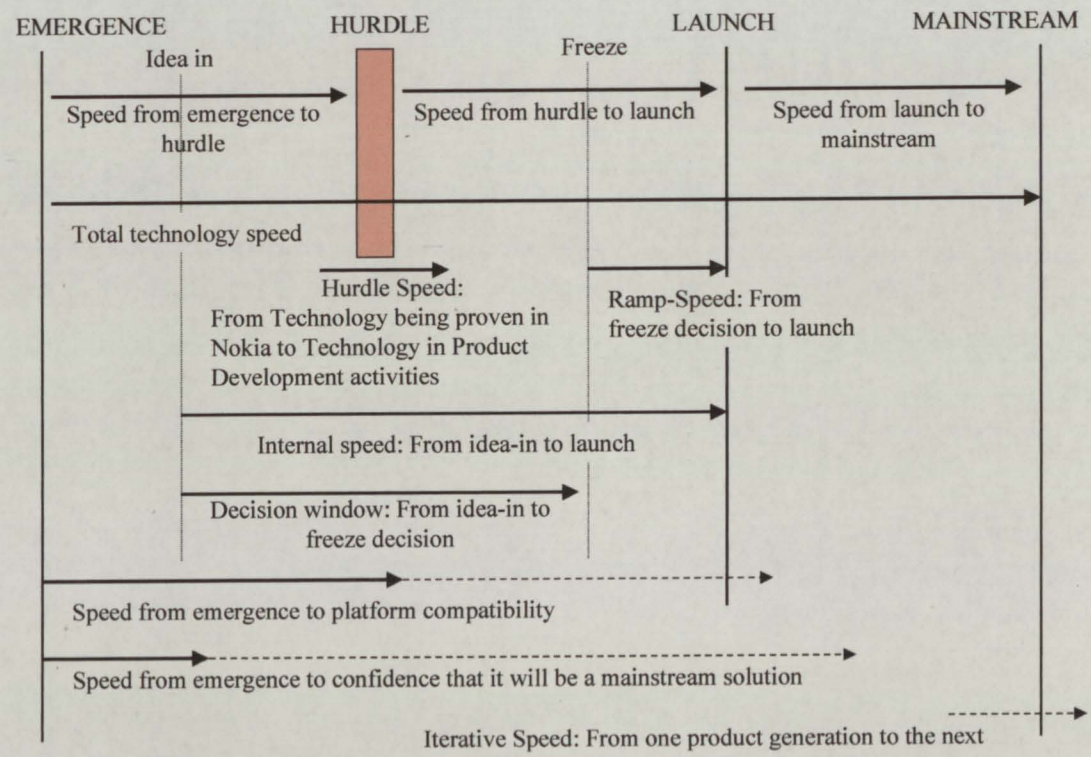



**Figure 6: Different Speeds**

In the first row of Speeds in figure 6, it can be seen the Speeds that derive directly from the major phases identified in the previous chapter. One can say that the responsibility for the first Speed (Speed from emergence to hurdle) is more on the basic and applied research teams and on the technology intelligence side.

The second speed (Speed from hurdle to Launch) is more on the product project teams responsibility. This speed is closely related with the cycle time – one term that appears often in literature meaning how fast one new product can be developed from the initial concept to production. The difference here is that this model is done from the

perspective of the technologies and not from the perspective of the products. So, the "Speed from Hurdle to Launch" starts with the decision of commitment to a Technology for being included in a product or platform.

The third Speed (from Launch to Mainstream) can be the most critical one in some cases. For example the M2M products have technologies whose speed to reach the mainstream sales is the most important one. Independently of how fast Nokia would have developed the M2M products comparing to the competitors or to other products, still the longest time would probably be the one from launch of the first product with that technology until the M2M business reaches significant sales and with it, the technology as well.

In general Nokia is probably mostly interested in having a fast Total Technology Speed when comparing with other competitors. In that way, Nokia products will be the first with a particular technology reaching mainstream sales. For the mainstream customer this is probably also the most important Speed, because he will compare the different phones available and understand which companies introduced the technologies and which companies didn't. It is not visible to him whether Nokia was for example fast in the early basic research of the technology and then took a long time to bring it to a product.

Different other Speeds can be named to point out particular activities or sequence of activities. One of those is the concept of "Hurdle Speed". It means the time that it takes from the moment that a particular technology working principle is proven inside Nokia (usually by a macro-prototype) to the moment that the first activities to include that technology in a specific product or platform start. In our interviews we have observed cases where this time was several times longer than the time "from emergence to hurdle" (from the idea to the technology being proven in the macro-prototype). Therefore meaning that the decision speed was much slower that the technology development speed.

Another important concept is the "Ramp-Speed". It starts when the freeze decision[24] is taken and ends when the product with the particular technology is launched. If Nokia uses technovariants, then this Ramp-up speed can be dramatically fast when comparing with other products, because the tools are already done for the product that originated the technovariant, suppliers are previously set and their systems also working, etc.

The "internal speed" – from idea initial awareness inside Nokia to the launch of a product with that technology – is another concept derived from our analysis. At this moment, when the mobile phone industry is waiting for the 3G, it is more difficult to convince the consumers for buying the new products that will be launched until 3G is available. Perhaps one way to increase the sales until then, is to introduce more and more new technologies in the currently available phones or technovariants of them. For that, the "internal speed" might be the best indicator of Speed, because it measures the time Nokia is able to bring one idea to a product available for sale. The faster Nokia can do this compared with their competitors the more chances it has of maintain the profit margins and to increase the market share.

[24] Freeze decision should be understood as the decision that the product concept or platform will not suffer more modifications. This means that tools will be developed if needed and that suppliers will start getting production orders, launch activities start and production ramps-up.

The "decision window" is not a speed, because it does not make sense to tell that it is faster or slower. The bigger the decision window the better because the company can have more information on the technology when the final decision to have it or not has to be taken (freeze decision). The decision window will be larger if the ideas get sooner inside Nokia or if Nokia is flexible to take the freeze decision later. The first could be achieved by being more efficient in the technology scanning process, and the later for example by being more flexible in the production system or using modularity.

Other concepts like the "Speed from emergence to platform compatibility" and "Speed from emergence to confidence that it will be a mainstream solution" are examples of Speeds that can be built for measuring other particular issues.

Finally, the "Iterative Speed", measures the Speed that one generation of a product with certain technologies available in the market will gather ideas and learn about the customer preferences in order to start the development of the next generation technologies. This is particularly important in emerging markets (e.g. the first generations of the Communicator). Such speed is critical in the study of platforms development.

The following figures 7 and 8, present examples of measures for the different Speeds against which they can be assessed whether it was a slow or a fast development.

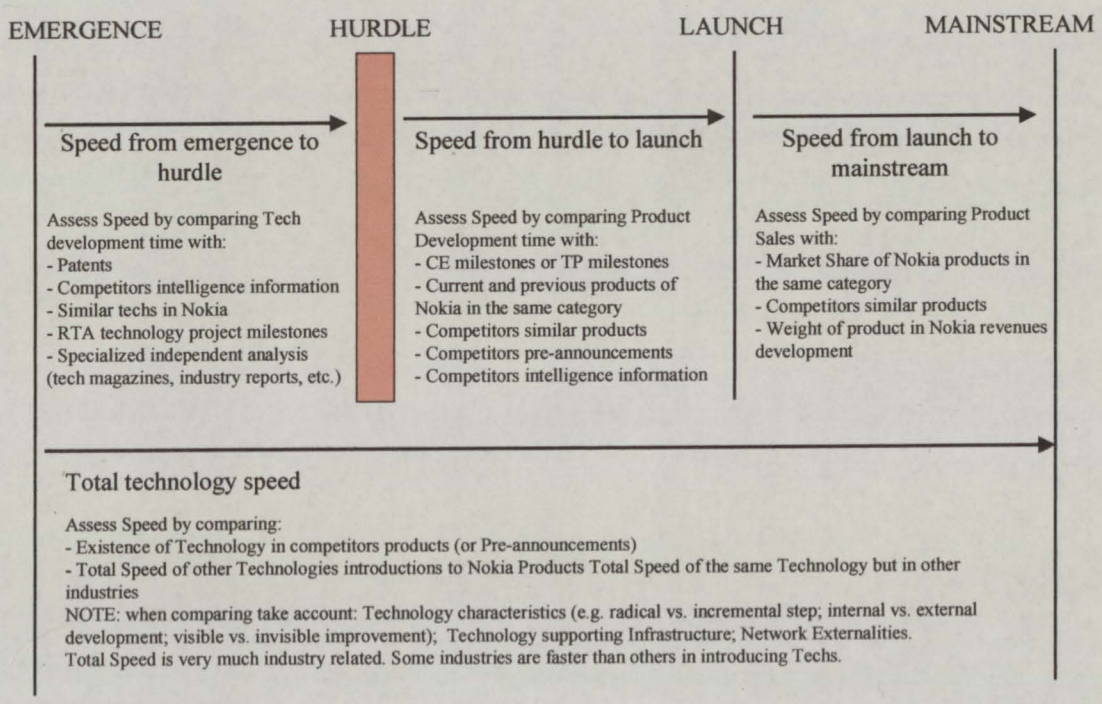
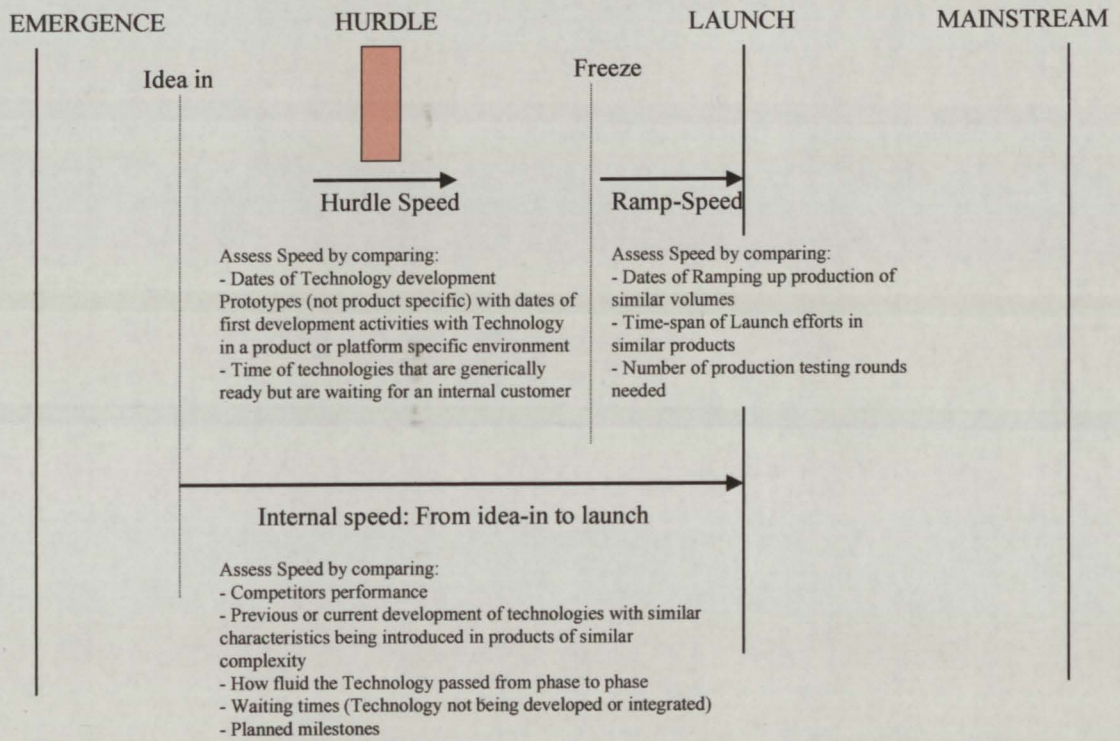



**Figure 7: Measures for Speeds**

**Figure 8: Measures for Speeds**




Nokia can draw important conclusions from the Speed analysis developed in this study. Specially, it is crucial to understand there are different speeds in the path from the emergence of an idea till that technology is available in mainstream products. It is important to clarify which speed is most important for which situation. Then it can be analyzed how that speed can be influenced by the people involved in that phase and how the phases can be coordinated so that the most relevant speed is the fastest possible.

# VI. FINAL COMMENTS

I would like to close my report with some personal notes.

First of all, I would like to thank the professors that made it possible for me to do my final project at Nokia in Finland. They were Professor Thomas Keil from the Helsinki University of Technology and Professor António Sarsfield Cabral from Porto University. My thanks go also to Anssi Tuulenmäki, who was a friendly colleague at work and together we constructed a good and enjoyable working environment and overcame the frustrations whenever we were not proceeding as we would like to. Finally, my words go to Nokia, that provided me with an excellent experience. To all my sincere thanks!

The experience of working in Finland was not always easy for me. Not only the traditional climate and cultural shock, but also the fact of being my first longer time job and as well for living alone without seeing family or friends for long periods. But I can surely say that it was worth the effort and I have learned very much about work and about life.

Now that the report is coming to an end, it means also the end of a long journey in the Porto University. Those were years that shaped not only my education, but also partly my personality and my life.

From my experience, I think it was very positive to participate in as many extra-curricular activities as possible. It is important to remember that: To be an engineer is important but is not everything!

With my best regards to all that read this report,

Norberto Guimaraes
Porto, 17th of December 2001.