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Picture: Art by Sari Vehtari 2005, “Circle of Completion”. Photograph by Esko Vehtari.

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ABSTRACT

The electronics industry has seen strong innovation, severe price competition, and entry and exit of competitors. The fast changes within the industry can cause much uncertainty in the markets, making it more difficult to stay on top. The life cycle management assumes that what you focus on today will change and require different approaches to be successful in the future. The life cycle model can be used to describe the evolution of processes and of an industry. It is suggested that each phase of the life cycle would require different capabilities and focus from a company and its operations.

The questions: “How do manufacturing capabilities and performance contribute to business performance?” and “Will certain competitive advantages be enough when business situations change fast?” have inspired this research. The main aspect of the study was to study the combination of the manufacturing capability development and theory of life cycles. The main longitudinal case was selected within the telecommunications industry. This particular case study provided an understanding of manufacturing capability development in three different phases of life cycle. The single longitudinal case was supported by three other well-known cases also from the electronics industry.

The research results are summarized into propositions for capability development. The research confirmed that requirements for manufacturing capabilities change along the business life cycle. The business life cycle model can be used as a tool to predict needed change in capability development. It can provide a practical understanding as to how capabilities need to change along the business life cycle. Manufacturing can contribute to the competitive advantage of the company particularly during the transition phases. The operational innovation and ability to shape the future is needed especially prior to entering the growth phase or when looking for new growth. The strategic flexibility and ability to adapt are especially required prior to entering the maturity phase.

TIIVISTELMÄ

Elektroniikkateollisuus on kokenut suuria muutoksia viime vuosina. Teollisuudenala on tuottanut useita mittavia innovaatioita, siellä on koettu kovaa hintakilpailua sekä erilaisten kilpailijoiden tuloa markkinoille ja poistumista markkinoilta. Nopeat muutokset aiheuttavat epävarmuutta ja tekevät menestymisen vaikeaksi. Elinkaarimallin mukaan tarvitset menestyäksesi erilaisen lähestymistavan tulevaisuudessa kuin tänään. Elinkaarimallia voidaan käyttää kuvaamaan prosessin tai teollisuudenalan kehittymistä. Elinkaarimallissa oletetaan, että eri vaiheet vaativat erilaisia kyvykkyyksiä yritykseltä ja sen tuotannolta.

Kysymykset - “Kuinka tuotannon kyvykkyydet ja suorituskyky vaikuttavat yrityksen suorituskykyyn” ja ”Riittääkö yksi tietty kilpailuetu liiketoimintaympäristön muuttuessa nopeasti” - ovat inspiroineet tätä tutkimusta. Tutkimus keskittyy tuotannon kyvykkyyksien kehittämiseen elinkaarimallin avulla. Tutkimus koostuu yhdestä pitkittäisestä tapaustutkimuksesta, jonka avulla analysoidaan erään yrityksen tuotannon kyvykkyyksien kehittymistä kolmessa eri elinkaaren vaiheessa. Lisäksi kolme muuta hyvin tunnettua tapausta elektroniikkateollisuudesta tukivat saatuja tuloksia.

Tutkimus vahvisti, että vaatimukset tuotannon kyvykkyyksille muuttuvat elinkaaren eri vaiheissa. Yrityksen elinkaarimallia voidaan käyttää työkaluna ennustettaessa vaadittavia muutoksia kyvykkyyksille. Malli tuo käytännön tietoa siihen, kuinka tuotannon kyvykkyydet muuttuvat eri elinkaaren vaiheissa. Tuotanto voi vaikuttaa yrityksen kilpailuetuun ja etenkin muutostilanteessa vaiheesta toiseen. Operatiivista innovaatioherkkyyttä ja kykyä muokata tulevaisuutta tarvitaan erityisesti juuri ennen nopean kasvun alkua. Strategista joustavuutta ja mukautumiskykyä puolestaan tarvitaan, kun teollisuudenala on siirtymässä maturiteettivaiheeseen.

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Finally, to my love Kalle, You are the world's best research assistant! The party you waited for so long is finally here!

Espoo, October 2006
Sari Vehtari

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GLOSSARY OF TERMS

AAGR	Average Annual Growth Rate (The average increase in the value of a portfolio over the period of a year)
AMPS	Advanced Mobile Phone System
ATO	Assembly to Order
BOM	Bill of Materials
CAGR	Compound Annual Growth Rate = (Ending Value/Beginning Value) ^ (1/# of Years) – 1
CDMA	Code Division Multiple Access (a technical standard that determines how information travels and communicates through a wireless network)
CE	Concurrent Engineering
DFM	Design for Manufacturing
DL	Direct Labour
DOS	Days of Supply
DSN	Demand Supply Network
ERP	Enterprise Resource Planning
EUR	European Unions Euro
FFR	Field Failure Rate
FIM	Finnish Mark
FPO	Fixed Production Overheads
GSM	The Groupe Spécial Mobile later changed to Global System for Mobile telecommunications
MFR	Manufacturing Failure Rate
MMS	Multi Media Message
NBI	Nokia Business Infrastructure
NES	Nokia Enterprise Solutions
NET	Nokia Networks
NMP	Nokia Mobile Phones
NMT	Nordic Mobile Telephony
NRC	Nokia Research Centre

NVO	Nokia Ventures Organisation
OFLT	Order Fulfilment Lead Time
OTD	On Time Delivery
OTD	to 1st confirm = # of last period parent schedule lines delivered complete within the time window first confirmed to the customer / # of all parent schedule lines first confirmed to be shipped last period * 100 %
OTD	to customer request = # of last period schedule lines delivered complete within the time window requested by the customer / # of all schedule lines requested to be shipped last period * 100 %
ROA	Return on Asset
ROE	Return on Equity
ROI	Return on Investment
SEK	Swedish Crown (Currency)
SAP R3	Enterprise Resource Planning solution
TPO	Total Product Offering
WAP	Wireless Application Protocol

Case Specific Terms:

PLAN FOR CAPACITY

Logistics planning captures market demand data (strategy material).

EXECUTE TO ORDER

Right production and materials capacity is implemented to meet the demand (strategy material).

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1 INTRODUCTION

Chapter 1 presents the background and motivation for this study. The research questions along with the focus and scope of the study are also presented in this Chapter.

1.1 Time and life cycles

The Chinese concept of time is not linear, but spiral-shaped. Following the laws of Yin and Yang, time repeats itself. Because time repeats, events are also likely to repeat. The definition for the cycle is "*an interval of time during which a sequence of a recurring succession of events or phenomena is completed"* (www.webster.com). The beauty of cyclic time is that it repeats: by looking at what is happening today, we can understand what will happen tomorrow. At the same time we then will have understood the past.

A definition of a life cycle is *"a series of stages through which something (as an individual, culture, or manufactured product) passes during its lifetime"* (www.webster.com). Moreover the transition is *"an alteration of a physical system from one state, or condition, to another"* (www.webster.com). A business can go through stages of development similar to the life cycle of the human race. Parenting strategies that work for a toddler cannot be applied to a teenager. The same is true for a business. It will face different phases of life cycle throughout its life. What you focus on today will change and require different approaches to be successful in future.

The technology adoption life cycle has been known since the 1950s in social research and serves to illustrate how communities respond to discontinuous innovations. The product life cycle model originated from product innovation studies (Abernathy and Utterback 1975, 1978), but the life cycle model can also be used to describe the evolution of processes and an industry or a branch of industry (Porter 1980). Moore (1998) combined the ideas of Tracey and Wiersema (1993) to the technology adoption life cycle model describing three different value disciplines: customer intimacy, operational excellence and product leadership. He implied that each phase would

require different capabilities and focus from a company and its operations. These thoughts have inspired this study, particularly the idea of using the life cycle model as a tool to understand the dynamics involved in the capability development towards competitive advantage for the company.

1.2 Background

The electronics industry, especially the mobile communication industry, has experienced fast changes in the business environment. The forces of globalization, technology, and economic liberalization are combining to make life harder than ever for established companies (Huyett and Viguerie 2005).

> *"Powerful supply-side forces - globalization, technology, and liberalization - are increasing the pace and altering the shape of competition across the world. Traditional players will be toppled if they don't respond by embracing the spirit of youth, by adopting a forward-looking perspective, and by implementing radical solutions rapidly. Those that make the transition will find a world of bright new opportunities." (Huyett and Viguerie 2005)*

Fine (1998) says that every industry has its own clockspeed – or rate of evolution – depending on its products, processes and customer requirements. Individual capabilities can lose value overnight, because of rapidly changing technologies, shifts in the larger economy or the new tactics of competitors.

The fast changes within the industry can cause much uncertainty in the markets making it more difficult to stay on top. In a global and dynamic environment the development of new products and processes is more intense, demanding and rigorous, creating a less forgiving environment. In addition, availability and growing demands for differentiated products and product variety has expanded significantly. According to Beach et al. (2000) change is now a permanent feature of the business environment and companies that can adapt to new environment are likely to gain a significant

competitive advantage. The ability of manufacturing companies to adapt is referred as the strategic flexibility of a company (Beach et al. 2000). Courtney et al. (1997) divided strategic posture into shaping the future and adapting to the future. But being fast and efficient is not enough; the products and processes a firm introduces must also meet market demands for value, reliability, and distinctive performance (Wheelwright and Clark 1992). In other words, manufacturing strategy should be aligned with the company's value proposition to customer (Moore 1998, Tracey and Wiersema 1993). Furthermore, effective strategy should steer companies toward where an industry is heading, not where it is today (Huyett and Viguerie 2005). In many companies, strategy means nothing more than a plan based largely on today's markets, today's product set, and today's competitors and emphasizing the financial forecast. Such a strategy may successfully identify opportunities to capture the upside of the current business over the next few years but can rarely anticipate extreme competition, much less show how to reposition a business to face it.

The idea that manufacturing should be managed from a strategic point of view and used as a competitive force in the business was introduced by Wickham Skinner's article "Manufacturing – Missing Link in Corporate Strategy" (Skinner 1969):

> *"A company's manufacturing function typically is either a competitive weapon or a corporate millstone. It is seldom neutral yet, the connection between manufacturing and corporate success is rarely seen as more than the achievement of high efficiency and low costs.*
> *… What appears to be routine manufacturing decisions frequently come to limit the corporation's strategic options, binding it with facilities, equipment, personnel, and basic controls and policies to non-competitive posture which may take years to turn around."*

The main aspect of this study is to study the combination of the manufacturing capability development and the theory of life cycles. Hayes and Wheelwright made the distinction between product and process life cycles in their 1979 article. Their studies indicate that different life cycle phases would require very different purposes

and capabilities of operations. However their research focused more on process set-up rather than on overall manufacturing capabilities and did not present clear links with manufacturing performance and its competitive advantage. Although they did admit that there are several dynamic aspects of corporate competitiveness, where concept of matching the product life cycle with process life cycle can be applied. The special interest is given to capabilities developed in an environment described by D'Aveni (1994) as "hyper competition", where demands for flexibility, delivery speed and innovation are ever-increasing. In order to maintain dynamic resource fit, manufacturing needs to alter competitive capabilities to enable quick time-to-market and "fast-cycle" businesses.

1.3 Research objective, questions, scope and focus of the study

The objective of this research is to enhance the understanding of the changing business environment's effect on manufacturing capability development. The issues of how capabilities change in different phases of life cycle, how the choices made in manufacturing affect the manufacturing and business performance and how manufacturing can provide competitive advantage are addressed throughout the research.

The research questions are formulated as follows:

1. How do manufacturing capabilities and performance change in different phases of business life cycle?
2. How can manufacturing provide a competitive advantage in different phases of business life cycle?

This study focuses on the manufacturing capability development, specifically in the growth and maturity phases. The focus is on the capabilities and performances that the manufacturing unit must have in order for the firm to compete within its overall business – to create a competitive advantage and the dynamics involved within the changing business and industry environment. The main interest of the study is to

understand the effects of life cycle dynamics and how the capabilities have changed accordingly along the business life cycle.

Forrester (1964) modelled the dynamic process of corporate growth and indicated that there can be several different patterns for the individual company (figure 1). However, the scope of this study is to look at S-shaped curve illustrating introduction, growth and maturity phases, excluding decline. In this research this is understood as a business life cycle.

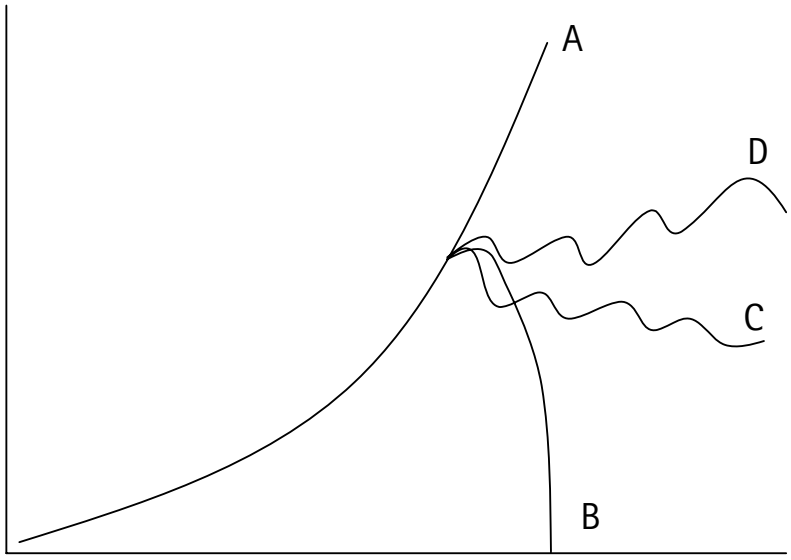


Figure 1. Patterns of corporate growth (adopted from Forrester 1964)

Due to the type of industry focus in electronics, the main interest lies especially in the S-curve where growth is particularly deep, as seen in figure 2 (Rogers 1995), describing the interactive diffusion of the adoption. The scope of this study is to look at the capabilities and their development over time in different phases of the business life cycle. This is done through a longitudinal case study in the growth company in a fast changing industry.

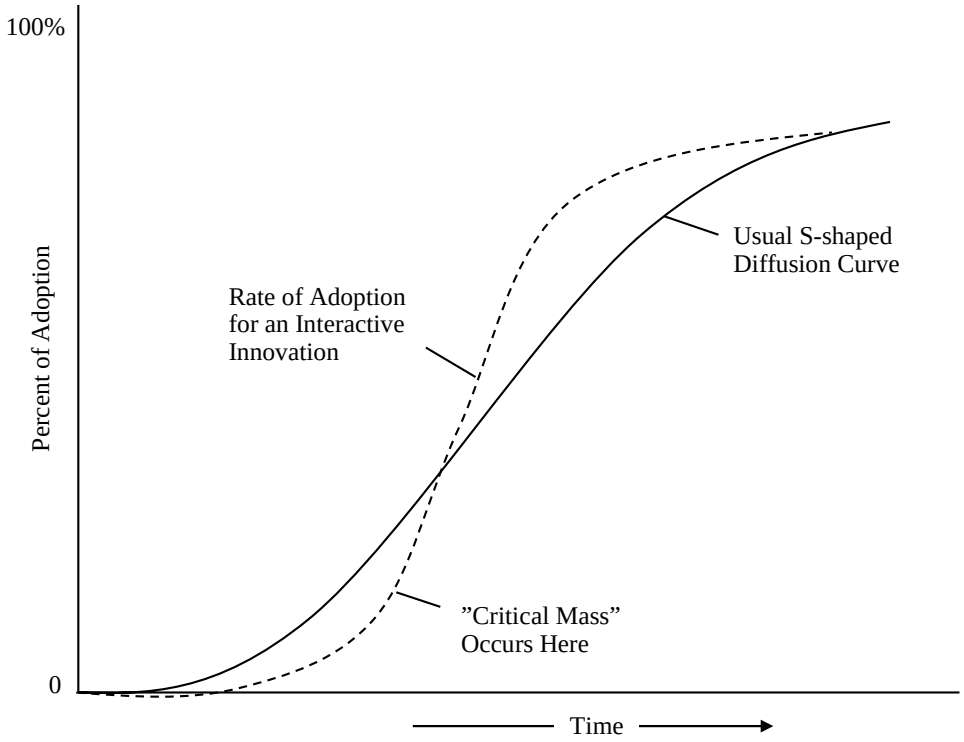


Figure 2. The rate of adoption for a usual innovation and for an interactive innovation, showing the critical mass (adopted from Rogers 1995)

The scope of the study is within a single firm’s operations, while bearing in mind that achieving capabilities and performance is more than simply enhancing the existing technologies and competencies that a particular firm may possess. Instead, the whole supply chain may need to be reconfigured and, in doing so, greater responsibility might be placed on firms within the supply network (Brown and Bessant 2003). To succeed, a company must operate more effectively and innovate the business concurrently across the entire demand-supply chain (Eloranta et al. 2001). Lewis (2003) also discussed that a competitive advantage exists at the boundary between operations and its external environment and that shifting of both internal and external priorities should be accommodated. It should also not be forgotten that operational excellence may not come from the manufacturing of the product itself, but overall effectiveness or value can be created by a company’s supply network that it orchestrates (e.g. IKEA or Wal-Mart).

1.4 Overview of the research methodology

The research methodology for this research is a qualitative case study, based primarily on a single longitudinal case supported by three parallel cases. Qualitative research is fundamentally interpretive, meaning that the researcher makes an interpretation of the data. This includes developing a description of an individual or setting, analyzing data for themes or categories, and finally making an interpretation or drawing conclusions about what is learned, and offering further questions to be asked (Wolcott 1994, Creswell 2003). According to Creswell one cannot escape the personal interpretation brought to qualitative data analysis:

> *"Qualitative research is an inquiry process of understanding based on distinct methodological traditions of inquiry that explore a social or human problem. The researcher builds a complex, holistic picture, analyzes words, reports detailed views of informants, and conducts the study in a natural setting." (Creswell 1998)*

Qualitative inquiry requires an extensive commitment of time in the field, engagement in the complex, time-consuming process of data analysis, and capability of demonstrating multiple perspectives. The qualitative researcher strives for "understanding" and deep structure of knowledge that involves going out to the setting, gaining access, gathering material and probing to obtain detailed meanings (Creswell 1998). The research methodology and research design are discussed more in detail in Chapter 3.

1.5 Structure of the thesis

Chapter 1 presented the background and the main research questions together with the motivation for the study, including a short overview of the research methodology.

Chapter 2 presents the conducted literature review. The research questions were first divided into more detailed sub-questions, since without a research focus, it is easy to

become overwhelmed by the volume of data. Then the theoretical backgrounds for the initial constructs were developed to guide the case analysis.

Possible research approaches are introduced in Chapter 3.1. The research method is introduced in Chapter 3.2 and the criteria for choosing the case is presented in Chapter 3.3. The research design is presented in Chapter 3.4, followed by the data collection and reliability in Chapters 3.5. Written case descriptions and analysis were structured according to the constructs used in the data collection.

In Chapter 4 the case is presented along with the synchronic case analysis. Since there was one company used as the longitudinal case, three different life cycle phases were analysed diachronically as the cross-cases to understand if there were similar or dissimilar patterns in each phase. This improved the likelihood of accurate and reliable theory, that is, a theory that closely fits the data. The probability of capturing the novel findings was also enhanced. In Chapter 4.5.4 the manufacturing capability learnings are summarised as a table and in the format of a life cycle model for capability development.

To support the findings of Chapter 4, well-known parallel cases (Cisco, Dell and SonyEricsson) are presented for comparison in Chapter 5.

In Chapter 6 the research findings and existing comparison literature are presented. An essential feature of theory building is comparison of the emergent concepts, theory, or hypotheses with the extant literature. This involves asking what this is similar to, what it contradicts, and why. The literature, which conflicts with the emergent theory, is important for two reasons. First, if researchers ignore conflicting findings, then confidence in the findings is reduced. Second, conflicting literature represents an opportunity. In the literature discussion similar findings are important as well because it ties together underlying similarities in phenomena normally not associated with one another.

In Chapter 7 the conclusion and discussion are presented. Chapter 7.1 includes the research findings and contribution of the study and in Chapter 7.2 managerial implications are discussed. The validity and reliability of the research are discussed in Chapter 7.3. Further research issues are presented in Chapter 7.4.

2 THEORETICAL CONSTRUCTS

The theoretical background is presented through the literature review in Chapter 2. The theoretical framework and constructs are summarized in Chapter 2.4. According to Maxwell (2005) the theoretical framework's purpose is to ground the study in previous work and indicate the theoretical approach to the phenomena being studied. The research questions were divided into sub-questions in order to understand the most relevant constructs to guide the literature review:

1. How do manufacturing capabilities and performance change in different phases of business life cycle?
    A. What are manufacturing capabilities?
    B. How is manufacturing performance measured?
    C. What is the link between manufacturing performance and business performance?
2. How can manufacturing provide a competitive advantage in different phases of business life cycle?
    A. Can manufacturing provide competitive advantage?
    B. If so, do manufacturing capabilities providing competitive advantage change along the business life cycle?

Therefore the initial constructs were set as: *manufacturing capabilities and performance, competitive advantage and life cycle*. These are explored more in detail in Chapter 2. The theory in operations management research is particularly important as it shapes how the researcher interprets phenomena of interest. Actions to control the environment are shaped by the theories implicitly and explicitly used for observation. So whether one believes in trade-offs in manufacturing strategy, or in cumulative capabilities, one will arrive at different conclusions for a given situation and hence offer different recommendations for managers (Amundson 1998).

2.1 Manufacturing capabilities and performance

The first research question was how do manufacturing capabilities and performance change in different phases of business life cycle? Based on this question the defined initial constructs were manufacturing capabilities and performance, therefore Chapter 2.1.1 will first asses the concept of manufacturing capability and then Chapter 2.1.2 will assess the concept of manufacturing performance. Chapter 2.1.3 will discuss the link between manufacturing and business performance. The literature review conclusions on manufacturing capabilities and manufacturing performance are presented in Chapter 2.4 together with the conclusions on competitive advantage.

2.1.1 Manufacturing capabilities

Various authors in operations management literature have used mixed or overlapping terms to describe manufacturing capabilities and solid research paradigms have been lacking (Leong et al. 1990 and Ward et al. 1996). The terms resources, capabilities, competencies, practices, priorities and dimensions are not consistently defined and seem to be used in different ways and with different meanings. Furthermore, how researchers measure resources and capabilities also varies (Hoopes et al. 2003).

Already Skinner (1969) argued that a close link should be established between corporate strategy and manufacturing practices, and proposed the concept of competitive priorities. The framework of the resource-based view of the firm (RBV) introduced by Wernerfelt (1984) assumes that firms can be conceptualized as bundles of resources, that those resources heterogeneously are distributed across firms, and that resource differences persist over time. Competitive advantage is achieved by implementing fresh value-creating strategies that cannot easily be duplicated by competing firms. By a resource is meant anything that could be thought of as a strength or weakness of a given firm. According to Hill (1983) manufacturing tasks were defined as those capabilities that are critical to winning customer orders. Hill's (2000) order-winning criteria included price, quality, delivery, product design and variety. A company should identify the criteria that will win orders against the

competition (order winning criteria), but without excluding other criteria that will also be important (qualifying criteria). Prahalad and Hamel (1990) contend that firms should focus on building "core competencies" that could create competitive advantages in a variety of markets. Roth and van der Velde (1991) distinguish between intended and realized capabilities by referring to the former as competitive priorities and the latter as competitive capabilities. Kim and Arnold (1992) define manufacturing competence as a construct that measures the degree of fit between competitive priorities and manufacturing strength. A firm's manufacturing function is competent, if it has strong capability on a variable (such as flexibility) that is also considered important.

Makadok (2001) summarized that a company can develop capabilities by resource-picking or capability building. The resource picking asserts that firms gain competitive advantage by being more effective than their rivals at selecting resources (Barney 1986). On the other hand, capability building assumes that firms are more effective than their rivals at deploying resources (Teece et al. 1997). The ultimate goal is to develop a position (capability) on one or more of the market performance dimensions that is both highly valued by customers, and superior to that of competitors (Wheelwright and Bowen 1996, Pandza et al. 2003). Capabilities are also unique to each company, and may not even be easily recognized and categorized. Swink and Hegarty (1998) defined capability as organisationally specific and internally developed, not something a firm can buy or transfer as such. Capabilities are difficult to imitate or transfer, rendering them valuable. Capabilities derive less from specific technologies or manufacturing facilities and more from manufacturing infrastructure: people, management and information systems, learning and, organisational focus. Furthermore, the Meyer and Ferdows (1990) sand cone model proposes that lasting cost improvements can only be the result of cumulative improvements in all the capability areas. Competencies reinforce one another and are dynamic in time. Tunälv (1992) concludes that the order in which the priorities or capabilities should be handled is a matter of philosophy or strategy. On the other hand, others suggest that better performing firms are more likely to address multiple manufacturing capabilities simultaneously, which supports the rationale behind the cumulative model (Roth and

Miller 1992, Noble 1997). The well-known Japanese experience indicates that organisations can shift the efficiency and flexibility trade-off to attain both superior efficiency and superior flexibility (Womack and Roos 1990, Adler et al. 1999). As an example, the study of the NUMMI plant demonstrated that by increasing the organisation's capacity for flexibility at a given level of efficiency also created capabilities that served to improve efficiency (Adler et al. 1999).

Makadok (2001) defined a resource as an observable asset that can be valued and traded – such as a brand, a patent, a parcel of land, or a license. A capability, on the other hand, is not observable, cannot be valued and changes as part of its entire unit. Also Ketokivi and Heikkilä (2003) propose that the manufacturing function should be viewed as a collection of resources, practices and structural factors (the manufacturing assets). They conclude that the key to manufacturing capabilities lies within a system of these manufacturing assets. Hayes and Upton (1998) divide capabilities into three types: process-based capabilities (e.g. the ability to provide advantages such as low cost and high quality), systems (coordination) based (e.g. the ability to create short lead times and to customize), and organisational based (e.g. the ability to master new technologies and introduce new products) operating capabilities. While Helfat and Peteraf (2003) similarly defined capability as the ability of an organisation to perform a coordinated set of tasks, utilizing organisational resources, for the purpose of achieving a particular end result. They classify capabilities as either 'operational' or 'dynamic'. An operational capability generally involves performing an activity, such as manufacturing a particular product, using a collection of routines to execute and coordinate the variety of tasks required to perform the activity. Whereas dynamic capabilities, as defined by Teece et al. (1994, 1997), build, integrate, or reconfigure operational capabilities. Dynamic capabilities do not directly affect output for the firm in which they reside, but indirectly contribute to the output of the firm through an impact on operational capabilities. However it is emphasised that the capability building and change do not necessarily require dynamic capabilities (Helfat and Peteraf 2003).

Despite the differences in terminology and types of classification, several authors (Skinner 1985, Hayes and Wheelwright 1984, Fine and Hax 1985, Hayes et al. 1988, Wheelwright and Bowen 1996, Berry et al. 1999, Kim and Arnold 1992, Ward et al. 1995, Corbett and Wassenhove 1993) have identified candidate dimensions as *cost/price, quality, dependability* or *delivery performance, flexibility* and sometimes *innovativeness* (Leong et al. 1990, Sharma and Reddy 1999) and *service* (Kim and Arnold 1992) that represent the desired competitive advantage that manufacturing would be expected to support and enhance. Manufacturing function's competitive role is to specify these priorities and pursue them through consistent structural and infrastructural decisions (Wheelwright 1984 and Kim and Arnold 1992). According to Ketokivi and Heikkilä (2003) the manufacturing infrastructure elements can be a more significant source of unique, long-term competitive advantage than the 'hard' structure. The classification of the manufacturing capability variables under the competitive priorities describe what the manufacturing function should achieve with regard to *cost, quality, flexibility, delivery* and *services* in order to support the business strategy effectively (Hayes and Wheelwright 1984, Kim and Arnold 1992,1996) (see table 1). However, the after-sales services and support is beyond the scope of this study.

Table 1. Categorization of manufacturing capabilities based on competitive priorities (modified from Kim and Arnold 1992)

Prize	
	Examples:
Price	Ability to profit in price competitive markets (Low price)
Flexibility	
	Examples:
Design change	Ability to make rapid changes in design (Design change)
New products	Ability to introduce new products quickly (MPI)
Volume change	Ability to make rapid volume changes (Volume change)
Mix change	Ability to make rapid product mix changes (Mix change)
Broad line	Ability to offer a broad product line (Broad line)
Quality	
	Examples:
Conformance	Ability to offer consistently low defect rates (Conformance quality)
Performance	Ability to provide high performance products or product amenities
Reliable	(Performance quality)
products	Ability to provide reliable/durable products (Reliable/durable)
Delivery	
	Examples:
Fast delivery	Ability to provide fast deliveries (Fast delivery)
On-time	Ability to make dependable delivery promises (On-time delivery)
delivery	
Services	Examples:
After-sales	Ability to provide effective after-sales services
services	
Support	Ability to provide product support effectively
Distribute	Ability to make product easily available
Customize	Ability to customize product and services to customer needs

2.1.2 Manufacturing performance

The second initial construct to be studied was *manufacturing performance* in order to understand how manufacturing capabilities affect the manufacturing and business performance.

The conclusion from the previous chapter was that manufacturing capabilities can be categorized by the competitive priorities of *price*, *quality*, *delivery*, *flexibility* and *service*. However, according to Swink and Hagerty (1998), the limitations of current conceptualisations of competitive priorities are that they do not discriminate between manufacturing capabilities and manufacturing outcomes (see also Corbett and Van Wassenhowe 1993, Coates and McDermott 2002). Swink and Hegarty (1998) defined

manufacturing competence as distinct from capability, as a measure of the extent of alignment between manufacturing capabilities and the competitive needs of the firm. Ketokivi and Heikkilä (2003) also emphasise the distinction between external and internal measures, saying that operational measures are directly linked with manufacturing function and that operative management has at least some degree of control over them, whereas market measures are those metrics that are directly linked to customer satisfaction (e.g. cost vs. price). As Mills and Platts (2002) proposed, architecture exists in reflecting the collection of individual services, routines, and competencies into higher and higher level competencies, which at the highest level are recognized by customers as offering particular levels of performance on competitive factors. Therefore market and operational measures should not be mixed however similarly categorized by *cost, quality, delivery* and *flexibility*. Market performance measures, such as *price, quality, delivery* and *flexibility*, are external (Swink and Hegarty 1998, Ketokivi and Heikkilä 2003).

However, flexibility could also be seen as a manufacturing capability, since it can be seen as referring to a means to an end (Hayes 1985), although some measures are presented in the literature (e.g. product customization ability, volume flexibility, mix flexibility and time to market) (Laugen et al. 2005). Innovation can also be seen as a contributing factor to the manufacturing performance measures of cost, time and quality and alone does not determine the outcome of manufacturing. As a matter of fact, time encompasses the role of dependability, flexibility, and rate of innovation (Kaplan and Norton 1996). Kaplan and Norton (1996) state that virtually all value propositions typically incorporate measures related to the response time, quality and price of customer-based processes. Some manufacturing objectives are closely related with cost (i.e. unit variable cost, materials cost and overhead costs), while others are more directly concerned with time (delivery lead time, procurement lead time, new product development cycle and equipment change over time), or quality (defect rates and vendor quality). In order to support the competitive priorities, manufacturing managers need to select a few objectives and concentrate their effort on achieving them (Kim and Arnold 1996). However, a direct linkage between individual competitive priorities and particular objectives may be difficult to establish, since

greater emphasis on quality objectives does not necessary mean less emphasis on cost reduction (Kim and Arnold 1996). There is also no simple cause-effect relationship between single improvement programs and manufacturing performance - some action programs can have short-term negative results and may become effective only after a fairly long transition period (Meyer and Ferdows 1990).

2.1.3 Cost

According to Hill (2000), the external customer is interested in purchase price, which is the expenditure of resources required of the customer to acquire the product, including the costs of return or replacement. As the manufacturing outcome there is the development cost of production processes and the production cost to make and deliver the product. These costs are normally separated into two categories: direct costs and indirect costs (Atrill and McLaney 2001). Direct costs are those that can be identified with specific cost units. Indirect costs are all other costs that cannot be directly measured in respect of each particular unit of output. The cost of manufacturing includes several elements such as overhead cost, inventory cost (days of supply, cost of inventory holding, etc.), direct labour cost, procurement cost, capacity utilization, etc (Ward et al.1995, Neely et al. 1994, Laugen et al. 2005). For example, low work-in-process inventory (days-of-supply, DOS) reduces the cost of excess and obsolete inventories.

2.1.4 Time

The lead time is the time a customer must wait between order placement and receipt (New 1992). Reliability or dependability (on-time delivery, OTD) reflects on the company's reliability in delivering a customer's order on or before the quoted delivery date (New 1992). There is growing recognition of the importance of delivery reliability as a criterion in most markets. Its change toward being a qualifier is part of that competitive perspective (Hill 2000, 1983, Roth and Miller 1990, Meyer and Pycke 1996). Delivery lead time or speed (Order Fulfilment lead time, OFLT) is about short delivery lead times and involves decisions in production stability, investments in

capacity and/or inventory and the control of workflow (Hill 1983, Roth & Miller 1990, Neely et al. 1994, Laugen et al. 2005). Another measure could be Time-to-Market for new products which manufacturing effects.

2.1.5 Quality

The quality of a product is a measure of its relative 'usefulness' to the customer. It includes product features, which might differentiate it from competitive products (New 1992). Two of the mentioned measures are consistent quality and high performance products (Roth and Miller 1990). Essential decisions need to be made in terms of cost/quality, product technology and process technology (Hill 1983). Measures for product and process quality can include, for example:

- Manufacturing conformance, product quality and reliability, customer service and support, delivery reliability, environmental performance (Laugen et. al. 2005)
- Return rate, defective rate (Ward et al. 1995)
- Vendor quality (Ward et al. 1995)
- Quality control circles (Ward et al. 1995)
- ISO 9000 certification (Ward et al. 1995)
- Field failure under warranty (Neely et al. 1994)
- In process quality (Neely et al. 1994)
- Incoming parts quality (Neely et al. 1994)
- Consistent quality with low defects (Meyer and Pycke 1996)

2.1.6 Linking business and manufacturing performance

The researchers have verified positive effects on performance resulting from consistency in operations and marketing (Hayes and Wheelwright 1984, Swamidass and Newell 1987, Swink and Hegarty 1998, Hill 2000). Gupta and Lonial (1998) provided empirical evidence that the link between manufacturing and business strategy should lead to better business performance. Hill (2000) also suggests a

framework for linking corporate objectives to manufacturing strategies through marketing strategies. The hierarchy of strategy has three levels: corporate-level strategy, business-level strategy, and functional-level strategy (Gupta and Lonial 1998, Fine and Hax 1985, Hofer and Schendel 1978). At the functional-level (e.g. marketing and manufacturing) the objectives are to support the desired business level strategy in a manner that will provide a competitive advantage and to determine how the functional-level strategies will complement each other. Financial business measures could include profitability, ROA, ROE, growth and market share, for example (Schroeder et al. 1989). However, this study does not address how a business strategy should be developed within a particular competitive environment, or whether a specific type of business strategy affects performance measures differently.

White (1996) proposes that the most direct relationships between manufacturing capabilities and business performance are through decreased cost and, consequently, higher profitability. Kim and Arnold (1992) provide some indications that manufacturing does not appear to equally affect all the financial and market performance measures, having a greater effect on return on assets and profit ratio than on growth rate and market share. However, their study did indicate a strong relationship between manufacturing competence and business performance, especially in the electronics industry. On the other hand, according to Roth and Miller (1992), good manufacturing does not necessarily lead to positive business outcomes, and positive business outcomes are not always associated with effective manufacturing. It is possible for a firm to be successful with a bad manufacturing strategy, and fail with a good one. Manufacturing surely matters but not unconditionally. Superior manufacturing capabilities provide opportunity for business success, but it is up to the executive management to seize the opportunity (Roth and Miller 1992).

Kaplan and Norton (1996) introduced the idea of a Balanced Scorecard, which combines financial measures of past performance with measures of the drivers of future performance. The objectives and measures view organisational performance from four perspectives: financial, customer, internal business process, and learning and growth. The idea is to measure how business units create value for current and

future customers and how they must enhance internal capabilities and the investment in people, systems, and procedures necessary to improve future performance. They also maintain that the chain and cause effect should pervade all four perspectives of a Balanced Scorecard. As an example, improved OTD is expected to lead to higher customer loyalty, which in turn, is expected to lead to higher financial performance. So both customer loyalty and OTD are incorporated into the customer perspective of the scorecard. Balanced Scorecard can therefore be used to connect the business and manufacturing performance measures. However, Ketokivi and Heikkilä (2003) comment in their article that Balanced Scorecard is somewhat limited in offering operational management an insight as to how goals can be met and represents, therefore, more of a top management tool.

2.2 Manufacturing competitive advantage

The second research question was how manufacturing can provide a competitive advantage in different phases of business life cycle. Chapter 2.2 reviews the concept of competitive advantage and the strategic role of manufacturing.

2.2.1 Competitive advantage

Following the initial work of Skinner (1969), many agree that the strategic choices in manufacturing need to be competitive, enabling manufacturing to do certain things better than competitors (Clark 1996, Fine and Hax 1985, Berry et al. 1999) and more so, if properly operated and achieving strong performance outcomes (Wheelwright and Hayes 1985, Hayes and Wheelwright 1984). Hayes and Pisano (1996) also suggested that capabilities are activities that a firm can do better than its competitors. However, if the policy is not consistent with the corporate strategy, a negative influence on the company's performance may result (Skinner 1992, 1985). According to Porter (1998) competitive advantage grows out of the entire system of activities. To compete in any industry, companies must perform a wide array of discrete activities such as processing orders, calling on customers, assembling products, and training

employees. Activities that generate cost and create value for buyers are the basic units of competitive advantage.

Value denotes what customers are willing to pay, and superior value stems from offering lower prices than competitors for equivalent benefits or providing unique benefits that more than offset a higher price. According to Porter (1998), the two basic types of competitive advantage (low cost or differentiation) combined with the scope of activities for which a firm seeks to achieve lead to three generic strategies for achieving above-average performance in an industry: cost leadership, differentiation, and focus. Mintzberg (1988) simplifies generic strategies as different means of achieving differentiation. His typology describes the strategies of differentiation by quality, design, support and image in addition to Porter's differentiation by price. The study of Kotha and Vadlamani (1995) supports the Mintzberg's typology and maintains that it also out-performs Porter's typology in its conceptual clarity and descriptive power. Chiesa and Manzini (1998) define three different ways of creating competitive advantage: by performing better than competitors on an already existing dimension of competition, by establishing a new dimension on which to compete, and by creating a new product/market combination. The third approach addresses industries where the competitive arena is dynamic (Chiesa & Manzini 1998). The competitive advantage may manifest itself as a price advantage or an advantage along some other dimension of value to the customer such as delivery time, flexibility to changing customer needs or product quality (Banker and Khosla 1995, Lewis 2003). Brown (1996) also suggests that companies need to make basic strategic choices to compete, either on low cost or by offering perceived differentiated products, but other equally important competitive factors, such as delivery speed and reliability, flexibility, quality, etc., are needed to win in chosen markets. In addition, he states that it is vital to know where the product stands in terms of its position in the product life cycle. For him, focus simply means organising in a way that makes some sense of the rapid change that will be needed in order to satisfy various customer needs (Brown 1996). Schlie and Goldhar (1995) propose to add a multiple niche competition to Porter's generic strategies for competitive scope, which would allow the firms to simultaneously achieve both low-cost leadership and differentiation. In fact, Hill

(1988) proposed that once differentiation becomes an industry norm, then failure to differentiate by a firm might result in a declining market share and the loss of scale economies. The simultaneous pursuit of both differentiation and low cost may be necessary to both establish and maintain a sustained competitive advantage, especially in mature industries where all experience curve economies have been exhausted and several firms have achieved a minimum-cost position. Actually, differentiation could be the path towards establishing a low-cost position with economies of scope, by sharing resources for a range of products (Hill 1988) or, in other words, providing value at the lowest cost. The recent studies of Ketokivi and Heikkilä (2003) indicate that manufacturing seems to contribute specifically to the differentiator's strategy and not to the price competition. When competing with price vital elements include economies of scale and scope and learning curve effects. They comment that at the manufacturing level it is difficult to affect to scales benefits, since these are more company level decisions or environment driven issues. Already Schmenner (1976) and Wheelwright (1979) argued that "economies of scale" is among the most discussed, but least understood, concept in manufacturing management today. Being such a vague concept it can be used to justify just about any decision, right or wrong. The differentiation from competitors occurs by doing things differently (competence development, unique manufacturing technology, unique practices) or by doing things more efficiently (predicting new technologies, efficient implementation of new processes and practices, efficient execution and coordination) (Ketokivi and Heikkilä 2003). As Holweg and Pil (2004) emphasise, profitability is obtained not by optimizing cost, but by building the right product at the right time.

To develop a successful and sustainable strategy, alignment between an organisation's internal activities and its customer's value proposition is needed (Treacy and Wiersema 1993). According to Teece and Pisano (1994), in order to be strategic, a capability must be honed to a user need (so that there are customers), unique (so that the products/services produced can be priced without too much regard to competition), and difficult to replicate (so that profits will not be competed away). In wider terms, Barney (1991) explored four similar attributes for gaining competitive advantage: (a) it must be valuable, in the sense that it exploits opportunities and/or neutralizes threats

in a firm's environment, (b) it must be rare among a firm's current and potential competition, (c) it must be imperfectly imitable, and (d) there cannot be strategically equivalent substitutes for this resource. The competitive advantage is achieved through a combination of unique resources and capabilities that allows firms to capture near monopoly positions in their market (Hamel and Prahalad 1994, Prahalad and Hamel 1990).

2.2.2 Sustainability of competitive advantage

Porter (1998) also defined five competitive forces that determine industry profitability: the entry of new competitors, the threat of substitutes, the bargaining power of buyers, the bargaining power of suppliers, and the rivalry among existing competitors. The aim of competitive strategy is to cope with and, ideally, change those rules in the firm's favour. The firm's relative position within the industry determines whether a firm's profitability is above or below the industry average. In contrast to Porter's five forces model based on understanding the external environment, the resource-based view highlights the need for a fit between the external market context and its internal capabilities. Additionally Hayes (1985) discusses that a generic strategy does not lead to above-average performance unless it is sustainable vis-à-vis competitors. The sustainability of a generic strategy requires that a firm possess some barriers that make imitation of the strategy difficult. This is especially true when a firm with a competitive advantage does not understand the source of its competitive advantage any better than firms without this advantage. This kind of competitive advantage may be sustained because it is not subject to imitation (Barney 1991, Lippman and Rumelt 1982).

However in a competitive context, there is always a time dimension to any performance advantage created. Stalk (1988) emphasises that the competitive advantage is a constantly moving target, when the best competitors, the most successful ones, know how to keep moving and always remain on the cutting edge. Anderson et al. (1989) also conclude in their literature survey that operations can give the firm a competitive advantage by turning operations outward toward the customers,

competition and markets. This would also require a forward-looking and proactive role for operations. According to Collis (1994) some organisational capabilities can be very valuable sources of sustainable competitive advantage in some industries at certain periods of time, but they are not generically valuable in all industries at all periods of time, nor do firms necessarily know which capabilities they should invest in. The range of capabilities does not necessarily come about through "good fortune" or change, in spite of learning and operations competencies that the firm may accumulate over time (Brown 1996). Rather, the capabilities can only be achieved by combining skills, technologies, know-how, processes and alliances with other players, brought about by strategies in place. Moreover capabilities are characterized as unique and idiosyncratic processes that emerge from unique and path dependent histories of individual firms (Barney 1991, Pandza et al. 2003). The external environment does not simply influence the process of capability accumulation in terms of selection; it also influences the parallel process of generating knowledge about the capability (Pandza et al. 2003). As Hayes and Upton (1998) actually say, such capabilities take a long time to develop, and can "come together" quite suddenly, giving a company its competitive power. But how firms actually develop them is not very clear. It is accepted that the evolution of capabilities is influenced by market dynamics, while the question of how an external environment influences this and why, remains largely unanswered (Pandza et al. 2003).

In his article Williams (2001) defines learning as the only sustainable source of advantage. The learning organisation, with a vision of, and a plan for, the future, would be leveraging capabilities by acquiring knowledge (Noble 1997). The absorptive capacity refers to the phenomenon whereby individuals, as they learn, increase their future ability to assimilate information. A firm's investment in learning may facilitate the firm's future ability to acquire knowledge, to develop technologies and search for new practices by increasing the firm's absorptive capacity (Cohen and Levinthal 1990, Schilling 1998, Hayes and Upton 1998). Therefore, manufacturing strategy is not just about aligning operations to current competitive priorities but also about selecting and creating the operating capabilities a company will need in the future and to be able to create a long term advantage (Hayes and Pisano 1994). As

researchers (Hayes 1985, Hayes and Pisano 1994, Schroeder and Flynn 2001) claim, a truly sustainable competitive advantage - one that is difficult for its competitors to imitate – requires long term development, where a period of five to ten years is not sufficient to do so. On the other hand, in the "hyper-competitive" environment the performance advantage could only last a few months (Williams 1992). These markets are characterized by dynamic price and cost pressures, fast profit margin compression, and accelerated rates of capital depreciation. D'Aveni (1994) also used the term "hyper competition" to describe the condition of rapidly escalating competition characterizing many industries where demands for flexibility, delivery speed and innovation are ever increasing. To maintain a dynamic resource fit, these organisations must master competitive routines associated with quick time-to-market, "fast-cycle" businesses. Timing and know-how are the source of advantages, rather than simply competing on cost and quality. Therefore, sustainable competitive advantage is achieved by continuously developing existing and new capabilities in response to rapidly changing market conditions. However, Hill (2000) warns of the danger of manufacturing becoming so used to reacting that it becomes the norm and every crisis thereafter is viewed as a temporary situation in which the need to review strategies fundamentally is neglected and which could bring the business into serious competitive disadvantage.

In addition to response it seems that competitive advantage is not sustainable unless companies are proactive in creating change in rapidly changing environments – innovating new products, new processes and new markets (Courtney 2001, Hammer 2004). Success comes by creating the ability to respond quickly and effectively to current market demands, as well as by being proactive in developing or shaping future market opportunities – that are vital in the modern era (Teece and Pisano 1994, Courtney et al. 1997, Eisenhardt and Martin 2000). Shapers will play a leadership role in establishing how the industry operates (Courtney et al. 1997). Of course shaping strategies can fail, so the best companies supplement their shaping bets with options that let them change course quickly, i.e. strategic flexibility. Helfat and Peteraf (2003) argue that while some capabilities may deal specifically with adaptation, learning, and change processes, all capabilities have the potential to accommodate change. The term

‘capabilities’ emphasises the key role of strategic management in appropriately adapting, integrating, and re-configuring internal and external organisational skills, resources, and functional competences toward the changing environment (Teece et al. (1997). Competencies are the glue that binds existing businesses, but also the engine for new business development (Prahalad and Hamel 1990). Far-reaching transformation of manufacturing capabilities is possible when competencies are enhanced or changed; the mission of the business could be altered or refined (Swamidass et al. 2001). Eisenhardt concludes that long-term competitive advantage lies in the resource configurations, not in the dynamic capabilities themselves (Eisenhardt and Martin 2000).

2.2.3 Manufacturing’s strategic role

Hayes and Wheelwright (1984) presented the four-stage progression of roles that range from a passive, non-contributing strategic role to one of driving strategy:

1. INTERNALLY NEUTRAL
   Minimizes the “negative effect” of manufacturing
2. EXTERNALLY NEUTRAL
   Achieves parity with competitors
3. INTERNALLY SUPPORTIVE
   Provides support to the business strategy
4. EXTERNALLY SUPPORTIVE
   Manufacturing contributes significantly to competitive advantage

This model provides a framework to evaluate the strategic role of manufacturing within a company and clearly states that manufacturing’s strategic role can vary from company to company. However, there has been little evidence to illustrate how firms actually line up within this four-stage process over time and how, precisely, manufacturing strategy links with the corporate strategy process (Hum and Leow 1996, Brown and Bessant 2003, Spina 1998). Leong et al. (1990) suggest that the

manufacturing strategy literature has not produced a well-organized paradigm due the three reasons: first, a lack of cohesive theory-building efforts on the part of manufacturing strategy researchers; second, a shortage of survey-based empirical work; and third, a lack of effort to integrate manufacturing strategy ideas with established concepts and theories developed in related disciplines. According to Brown and Bessant (2003), although manufacturing strategy lacks agreement about its specific linkages with business strategy, its influence on many important specific areas (e.g. to mass customization efforts within the firm) is considerable.

Mintzberg's (1978) definition of strategy as "a pattern in streams of decisions" is a view later used by Hayes and Wheelwright (1984) in their definition of manufacturing strategy as the "patterns of decisions" in manufacturing's decisions areas. From this viewpoint the strategy a firm "realized" (or implemented) could "emerge", apparently informally, as well as being "indented" or formally planned in advance (Mintzberg 1978). The purpose of thinking and managing strategically is to gain competitive advantage, implying an attempt to mobilize manufacturing capability to help to gain a competitive edge or even having significant contribution to the competitive success of the organisation. Hayes (1985) also argued that the ends should not always determine the means, as is commonly assumed, but that sometimes the means should determine the ends. Building operations competence, the means, as a basis for strategy is especially effective in environments that are changing or difficult to forecast. Manufacturing should, therefore, seek to influence corporate strategies and develop and exploit manufacturing capability proactively, as a competitive weapon (Wheelwright and Hayes 1985, Voss 1995).

Manufacturing's strategic role is to provide manufacturing processes that provide a company a distinct advantage in the market place. In the words of Voss (1995) it is competing through capabilities by aligning capabilities of manufacturing with the competitive requirements of the marketplace. The second way is to create a situation in which manufacturing is able to support, better than its competitors, the dominant performance criteria of the market place in order to win orders. Both order-qualifiers and order-winners are, however, essential if companies are to maintain existing shares

and grow (Hill 2000). Voss (1995) uses the term contingency-based approach, based on internal and external consistency between the business and product context and the choices in the content of the manufacturing strategy. He also adds a third approach based on the need to adopt a "Best practice", for example "World Class Manufacturing". Voss (1995) concludes that each of these three paradigms has strengths and weaknesses and partially overlaps the other and none is, on its own, sufficient for the effective development of manufacturing strategy over the long term.

2.3 Theory of life cycle

Both research questions addressed the theory of life cycle; first how do manufacturing capabilities and performance change in different phases of business life cycle, and secondly, how can manufacturing provide a competitive advantage in different phases of business life cycle. Chapter 2.3 will assess how the life cycle and the company's value propositions are linked. The theory of product-process matrix is investigated as well as innovation along the life cycle.

2.3.1 Technology adoption life cycle

The technology adoption life cycle has been known since the 1950s in social research and illustrates how communities respond to discontinuous innovations. Foster's depiction of technological progression through a series of S-curves suggests that technological change follows a cyclical pattern, where 'dematurity' can in effect set back the clock and revert an industry from a specific to a fluid state. A series of S-curves suggests that an industry evolves through a succession of technology cycles. Each cycle begins with technological discontinuity. Discontinuities are breakthrough innovations that "advance by an order of magnitude, the technological state-of-the-art which characterizes an industry" (Foster 1986, Anderson and Tushman 1991). Ranta (1993) also discusses a paradigm shift where within an industry sector the so-called mature industry evolves again and provides a basis for new growth and a renewal process. Both product and process innovations may either enhance or destroy existing

competencies, but product innovations normally affect more links in the value chain than do process innovations.

Rogers (1995) presented an S-shaped innovation diffusion curve for interactive adoption of innovation (figure 2). When the critical mass in the rate of adoption of an interactive innovation is reached, the percentage of all the individual network partners takes a sudden jump, triggering a much more rapid rate of adoption. Truly discontinuous innovations are new products or services that require a drastic change of past behaviour on the part of the end-user and the marketplace, with the promise of gaining equally dramatic new benefits (Moore 1998). The technology adoption rate hence determines the growth rate of the industry and the market.

2.3.2 Product life cycle

The life cycle model has had a central role in describing the evolution of a product from introduction through growth and maturity to decline. Wasson (1971) was among the earliest to suggest that firms should be using different marketing strategies at different stages in a product's life cycle to obtain a competitive advantage. The product life cycle model was originally developed in order to understand the dynamic of the evolution of a single product and thus to also support innovation and product management (Abernathy and Utterback 1975, Hill 1983/2000, Ranta 1993). Buffa (1984) mentioned that as a product goes through its life cycle, the production system should follow with a process life cycle of its own. Ranta (1993) also claimed that it could be used as a framework to analyze production paradigm shifts as well and be extended to describe the evolution of an industry or a branch of industry. Moreover, it is necessary to widen the concept so that the influence of the social and economic (i.e. business environment) factors can be taken into account. Also, as Mensch et al. (1985, 1986) pointed, real life is different from the model: product innovations dominate even in mature industries. As previously mentioned, in a fast changing industry the product life cycle is understood more as a product type life cycle that includes several individual product life cycles and not as a single product's life cycle.

Hill (1983) presented the product life cycle with phases of introduction, initial growth, maturity and eventual decline in sales (figure 3). These stages outline the phases through which a product or product type may pass as it moves into and out of the market. New products and services are required to replace those already in the cycle, no matter how extended the timescale may be. This emphasises the idea of shifting competitive priorities as a product or product type matures. The discontinuities usually come from outside the company and may be weak signals (Hayes and Wheelwright 1979). Competitors may come out with product innovations or with new process innovations (e.g. Zara and IKEA). In the dominant design phase the production 'machine' is efficient – but when radical innovation begins there will be a burden 'discontinuity'. Ranta (1997) also concluded that in the first phase of the product (or industry) evolution seems to obey the classical life cycle model, but after reaching the maturity phase both market and product innovations lead to market segmentation and product diversification, which in turn result in a highly dynamic interactive system. As an example he mentions the automobile industry and innovations in production by Japanese companies.

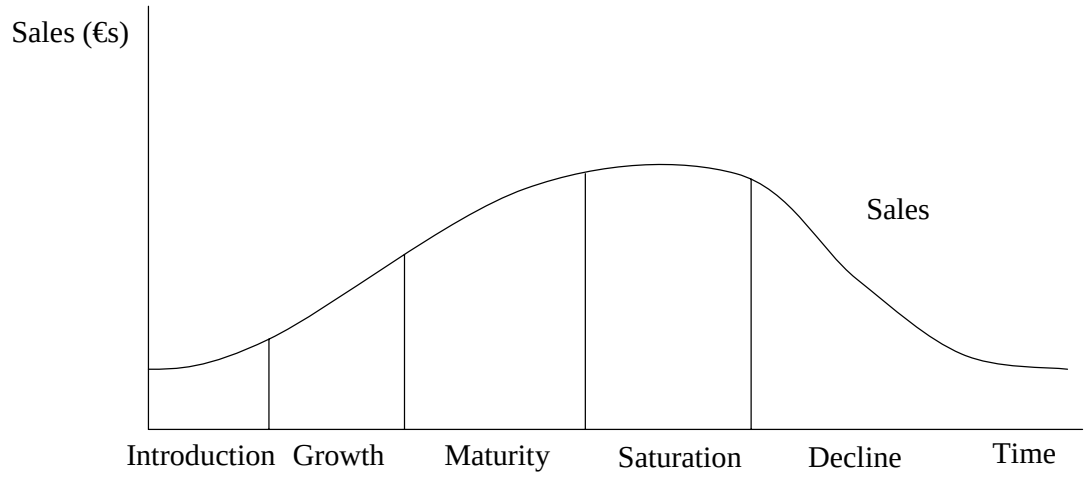


Figure 3. The generalized product life cycle (Hill, T. Operations Management, 2000)

2.3.3 Business life cycle

The life cycle curve can typify any product, organism, company, or society from introduction through growth and maturity to decline (Forrester 1964), but life cycle concept alone does not furnish us with an easily read roadmap to profitable strategy. Rather, the life cycle model provides a framework of expectations – a set of patterns of the types of developments a company needs to be aware of and needs to plan in advance (Wasson 2000).

In this study life cycle model is defined as business life cycle, because a product life cycle was thought to be too narrow in scope. The business life cycle is defined as the growth rate of the company in sales (Forrester 1964, figure 1) of a certain product or service (e.g. mobile phone). The business life cycle is linked to the market growth rate but it does not directly determine the company's growth. For example, a company can have declining sales even though the overall market is growing, or vice versa. Market growth rate is determined by the diffusion of a certain technology, product or service. A company's business life cycle development is rather complex as there are number of interacting forces that link different life cycles, such as product, product technology and process technology. As Prabhaker (2001) mentioned, the connection between the technology diffusion curve and the product life cycle has never been established in literature, conceptually or empirically.

A business life cycle can contain several superimposed series of product and technology life cycles (see figure 4). These products have certain common technologies and functions (e.g. hand portable mobile phone), and share common capabilities required to produce them. This is especially true in fast changing industries where an individual product life cycle lasts only months or a few years and is frequently replaced by newer versions. Continuous technological development can lead to an S-curve type of sales growth because performance of a product or process is improved over time.

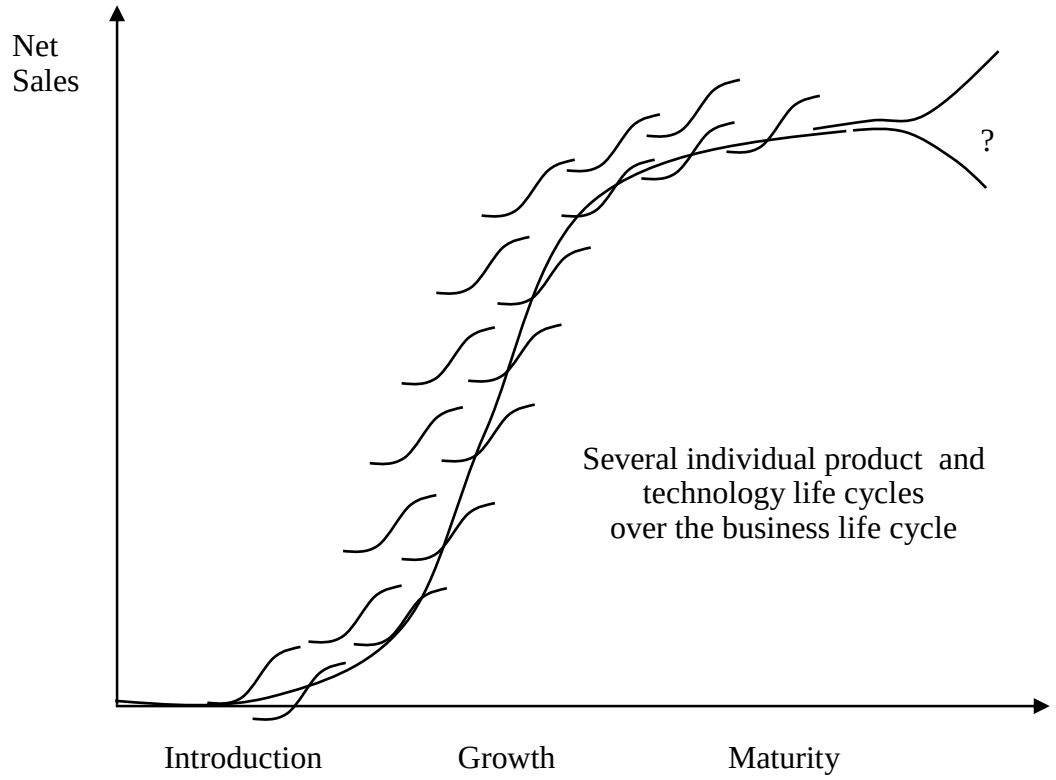


Figure 4. One business life cycle can contain several product and technology life cycles

2.3.4 Capability life cycle

Helfat and Peteraf argue that while some capabilities may deal specifically with adaptation, learning, and change processes, all capabilities have the potential to accommodate change (Helfat and Peteraf 2003). Like the product life cycle, the capability life cycle describes recognizable stages, such as introduction, growth, maturity, and decline. Along their evolutionary paths, capabilities may support a sequence of products or multiple products simultaneously (Helfat and Raubitschek 2000). The entire capability life cycle provides an explanation for the emergence and sustained heterogeneity of capabilities (Helfat and Peteraf 2003).

The capability life cycle identifies three initial stages of a capability life cycle: founding, development, maturity and followed by possible branching into six additional stages (Helfat and Peteraf 2003). The founding stage begins when a group of individuals organizes around an objective requiring or centrally involving the creation of a capability. During the development stage the capability develops through

the team's search for viable alternatives for capability development, combined with accumulation of experience over time. The maturity stage entails capability maintenance involving exercising the capability, which refreshes organisational memory. If exercised regularly, the capability becomes more deeply embedded in the memory structure of the organisation. The branches of the capability life cycle are as follows: retirement (death), retrenchment, renewal, replication, redeployment, and recombination (Helfat and Peteraf 2003).

2.3.5 Linking value propositions and life cycle

The idea of value propositions is introduced here to understand the link between business strategy and manufacturing strategy, since to develop a successful and sustainable strategy alignment is needed between an organisation's internal activities and its customers' value proposition (Treacy and Wiersema 1993). According to Treacy and Wiersema (1993, 1995) there are three 'value disciplines': product leadership, operational excellence and customer intimacy.

Product leadership means offering customers leading-edge products and services that consistently enhance the customer's use or application of the product. This strategy would require a leading-edge innovation process that creates new products with best-in-class functionality and brings them rapidly to market (Treacy and Wiersema 1993, Kaplan and Norton 2000).

Customer intimacy means segmenting and targeting markets precisely and tailoring the offering to exactly meet the demands of those niches. This strategy requires excellent customer management process such as relationship management and solution development. The innovation process would be motivated by the needs of targeted customers, focusing on those new product developments and service enhancements that contribute to better customer solutions (Treacy and Wiersema 1993, Kaplan and Norton 2000).

Operational excellence means providing customers with reliable products or services at competitive prices and delivered with minimal difficulty or inconvenience. This

strategy emphasises measures of the cost, quality, and cycle time of the operating process, excellent supplier relationships, and speed and efficiency of supply and distribution processes (Treacy and Wiersema 1993, Kaplan and Norton 2000).

Achieving superiority in any one of these domains typically involves compromising the other two. Since no company can succeed by trying to be all things to all people it must choose a value discipline in which to excel. The selection of a value discipline is a central act that shapes every subsequent plan and decision a company makes, affecting the entire organisation. In Demand Supply Chain research Fisher (1997) argues that functional products should be delivered through an efficient supply chain "focusing almost exclusively on minimizing physical costs", but for innovative products, the concern should be to "respond quickly to unpredictable demand in order to minimize stock outs and obsolete inventory". According to Kaplan and Norton (2000) companies must excel in one process that has the maximum impact on its customer value proposition. The other two are supportive (see figure 5).

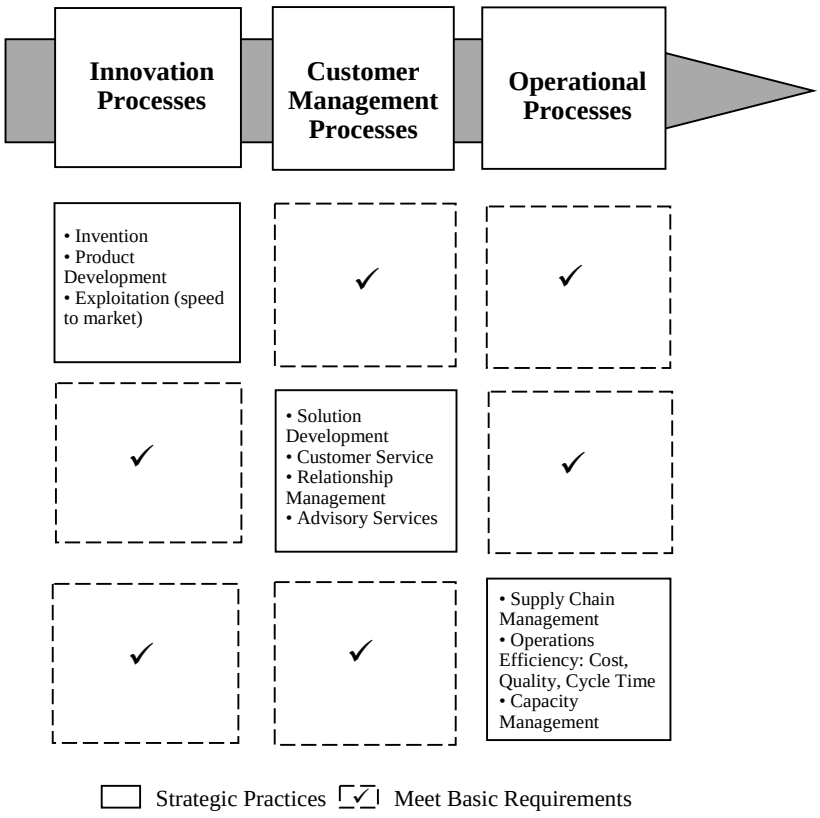


Figure 5. Identifying strategic internal business processes (adopted from Kaplan and Norton 2000)

However, according to Moore, in the case of high-tech marketing, the dynamics of rapidly maturing life cycles forces one to take a more complex approach. The claim made is that the life cycle itself dictates which variables are critical at any given point. Moore (1998) combined the framework of Technology Adoption Life Cycle and the theory of value disciplines as presented by Treacy and Wiersema (1993). Moore's framework (figure 6) was particularly focused on the fast changing high-tech industry. In his book Moore discussed how discontinuous innovations or paradigm shifts will affect marketing strategies. These shifts begin with the appearance of a new category of product that incorporates breakthrough technology, resulting in unprecedented benefits. Moore introduced the idea of the "chasm", saying that whenever truly innovative high-tech products are first brought to market, they will initially enjoy a warm welcome in an early market made up of technology enthusiasts and visionaries but will then fall into a chasm, during which sales will falter and often plummet. If the products can successfully cross the chasm, they will gain acceptance in a mainstream market dominated by pragmatists and conservatives (Moore 1998).

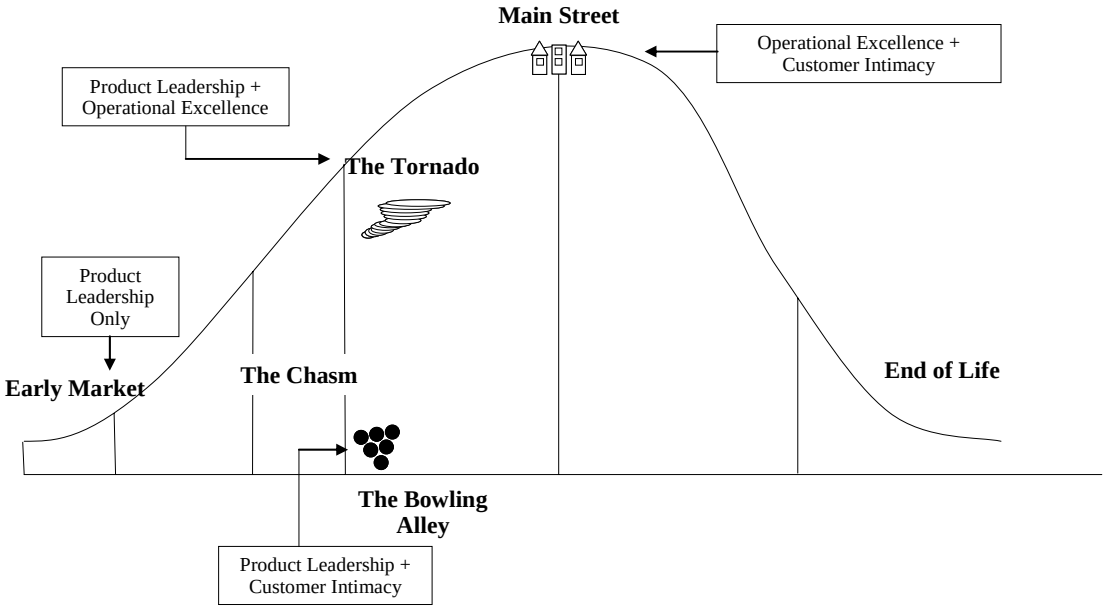


Figure 6. The landscape of the technology adoption life cycle (Moore 1998)

Moore's framework divides up the landscape into six zones, which are characterized as follows (Moore 1998):

1. *The Early Market*, a time of great excitement when customers are technology enthusiasts and visionaries looking to be first to enjoy the new paradigm.
2. *The Chasm*, a time of great despair, when the early market's interest wanes but the mainstream market is still not comfortable with the immaturity of the solutions available.
3. *The Bowling Alley*, a period of niche-based adoption in advance of the general marketplace, driven by compelling customer needs and the willingness of vendors to craft niche-specific whole products.
4. *The Tornado*, a period of mass-market adoption, when the general marketplace switches over to the new infrastructure paradigm.
5. *Main Street*, a period of aftermarket development, when the base infrastructure has been deployed and the goal now is to flesh out its potential.
6. *End of Life*, which can come all too soon in high tech because of the semiconductor engine driving price/performance to unheard of levels, enabling wholly new paradigms to come to market and supplant the leaders who themselves had only just arrived.

2.3.6 Product-process matrix

Hayes and Wheelwright (1979) point out that by matching stages of product and process life cycles, an organisation can choose from among its various manufacturing and marketing alternatives (product-process matrix) and they discuss the implications for corporate strategy (figure 7). However, they recognize that external forces are often set to change a company's position on the product-process matrix, whether or not the company makes any changes to its own product or process structures. Ranta (1997) also proposes links between product, production and life cycle theory. Manufacturing can choose from a number of alternative processes in order to make the product. There are five conventional processes that can be adopted (project, job shop, batch, assembly line and continuous flow) together with a number of hybrids (Hayes and Wheelwright 1979, Hill 1987). Each option embodies a set of distinct trade-offs

for a business, which need to be understood when considering the major investment decisions. As Buffa (1984) says, it is important to position the production system to match the market requirements. The way in which orders are won in the market place varies from product to product and is also different for a single product over its life cycle, therefore plants cannot be set up and then forgotten (Hill 1987, Anderson et al. 1989).

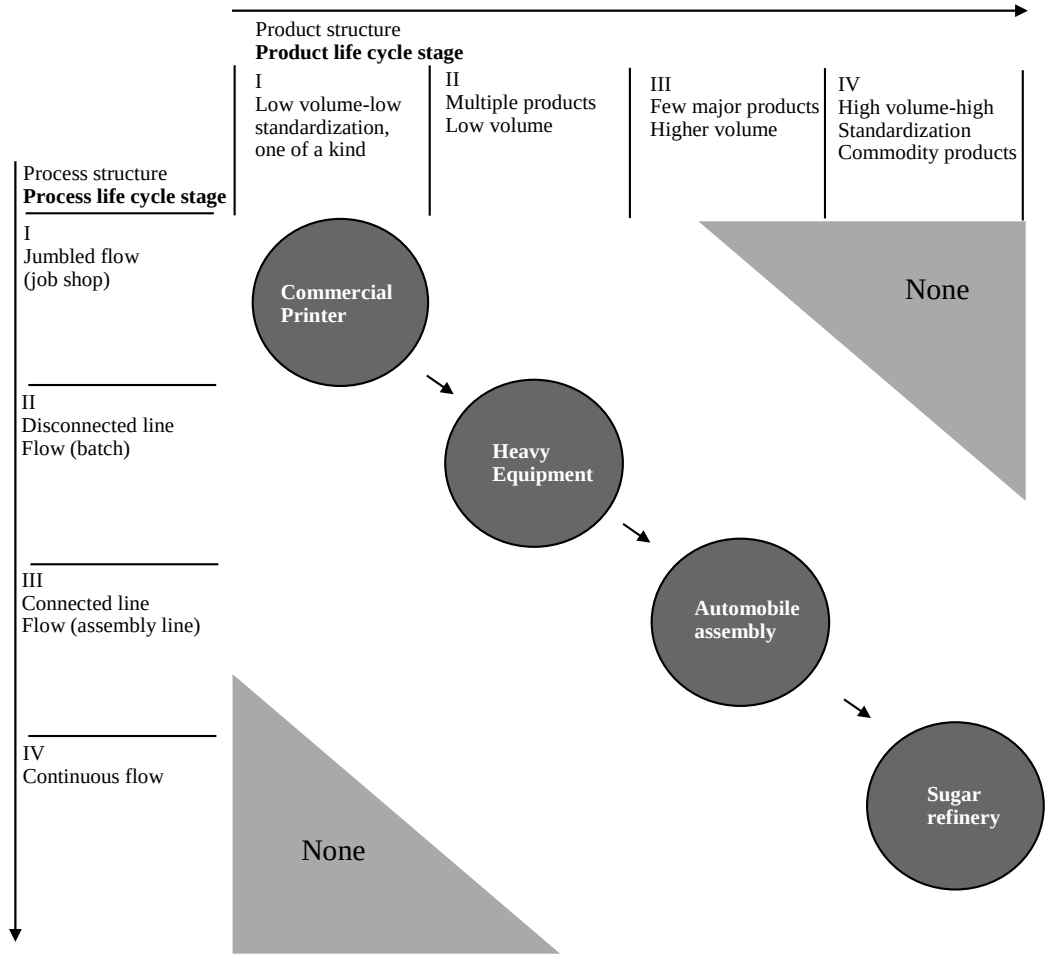


Figure 7. Matching major stages of product and process life cycles (Hayes and Wheelwright 1979)

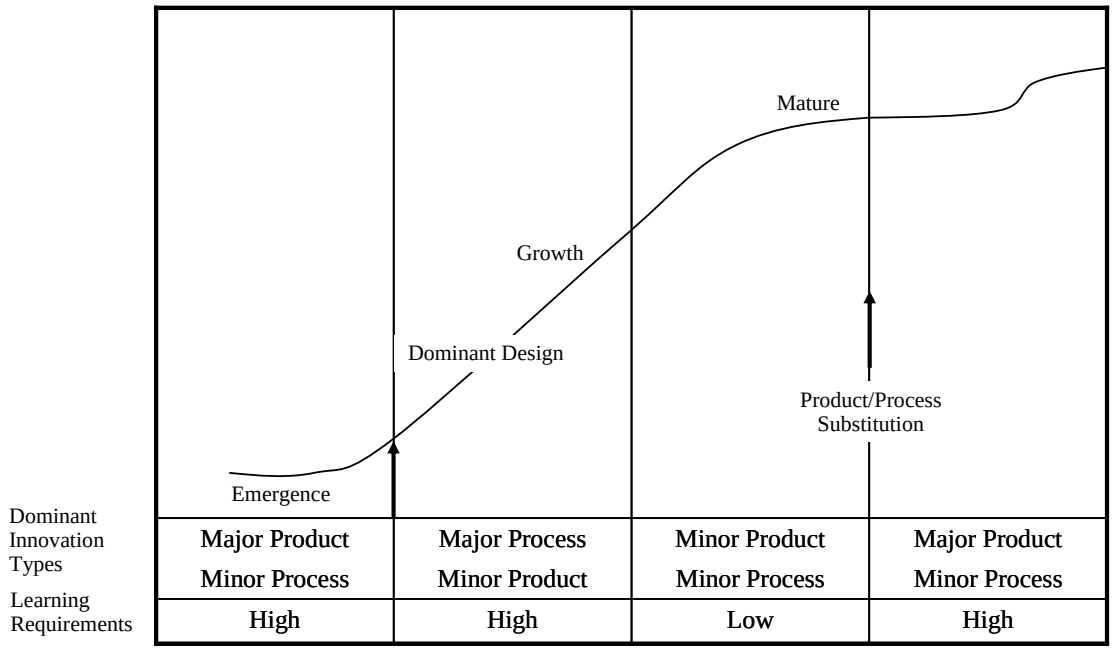
Corbett and Wassenhowe (1993) challenged the Hayes and Wheelwright model with their concept of a competitive dimensions life cycle, where the dividing line between qualifying criteria and order-winning criteria changes along the product's phase in its life cycle. They state that flexibility could be achieved before low-cost and that flexibility could become a qualifying criterion before cost. The flexible technologies would allow firms to reach points closer to the bottom-left (continuous flow, low

standardization) corner of the product process-matrix, providing high responsiveness and low-cost production simultaneously (Corbett and Wassenhove 1993, Dermott et al. 1997). They indicated that the Hayes and Wheelwright model lacked support for the responsiveness to customer needs and did not completely capture the dynamics of the competitive environment. Furthermore, the study of Dermott et al. (1997) demonstrated that the Hayes and Wheelwright model would better describe the industry, rather than explain relative strategic positions. They did not, however, provide any empirical evidence nor set criterion to define the level of flexibility and efficiency or define what high volume vs. low volume on the matrix is. It is assumable that one could also improve efficiency without moving forward along the diagonal within the given set. Hence, one cannot really argue exactly where on the matrix the products should be placed nor define what qualifies as being on the diagonal or off the diagonal.

2.3.7 Types of innovation over product life cycle

According to Tushman and Nadler (1986), in order to compete in an ever-changing environment, companies must adopt innovation as a way of corporate life and that effective innovation requires the synthesis of market needs with technological possibility and manufacturing capabilities. There are two kinds of innovation: product innovation, a change in the product it makes or in the service it provides; and process innovation, a change in the way a product is made or the service is provided.

According to Tushman and Nadler (1986) there are predictable patterns in the amount and degree of innovation over the product life cycle (figure 8). In the introductory stage, there is a substantial amount of product innovation, leading to the emergence of a dominant design. In the next stage, major product variation gives way to competition based on price, quality, and segmentation (i.e. process innovation rather than product innovation). During the mature state of a product life cycle the emphasis is on incremental innovation, until some external shock, such as deregulation, technological change, or competition, triggers a new wave of major product innovation.



Dominant Innovation Types	Major Product Minor Process	Major Process Minor Product	Minor Product Minor Process	Major Product Minor Process
Learning Requirements	High	High	Low	High

Figure 8. Types of innovation over product life cycle (adopted from Tushman and Nadler 1986)

Innovation is, however, a complex and uncertain endeavour shifting over time and that requires the close collaboration of R&D, marketing, sales and production. Smeds (1994) also discussed the possible implications of "lean manufacturing" as a radical process innovation bringing an addition to the classical life cycle: in the maturity phase a new upturn in sales is created by the combination of radical process innovation and incremental product innovations. Lean manufacturing has changed the rules of competition and has caused a "post-maturity" growth phase (Smeds 1994). Hammer (2004) also defines operational innovativeness by achieving a capability to offer lower prices and better service than competitors. He makes a distinction to operational improvement or excellence, which, according to him, is achieving high performance via existing modes of operations. Courtney et al. (1997) also made a distinction between shaping the future and adapting to the future. Operational innovation means coming up with entirely new ways of filling orders, developing products, providing customer service, or doing any other activity that an enterprise performs, such as the Dell Business Model and Toyota Production System.

2.4 Conclusion of theoretical constructs

Chapter 2.4 concludes the learnings from the literature review. The findings are further elaborated in the case study.

2.4.1 Manufacturing capabilities and performance

The first research question asked *how do manufacturing capabilities and performance change in different phases of business life cycle?* To better understand the nature of the capabilities and how they are measured the first question was divided into three sub questions:

1A. What are manufacturing capabilities?
1B. How is manufacturing performance measured?
1C. What is the link between manufacturing performance and business performance?

The theoretical construct's purpose is to ground the study in previous work and indicate the theoretical approach to the phenomena being studied. In order to understand the link between manufacturing capabilities and performance a theoretical framework (figure 9) was modified from the strategy process model of Leong et al. (1990). This predominant process model of manufacturing strategy compiled together the learnings from Chapter 2.1 and 2.2.

Even though the capability is organisation specific, to be internally developed (Swink and Hegarty 1998, Makadok 2001) and may not even be easily recognized or categorized, the categorization is proposed in terms of competitive priorities (Kim and Arnold 1992), such as those presented in figure 9.

Literature review on manufacturing capabilities and performance was summarized into a framework (figure 9) where:

- Manufacturing capabilities could be categorized by competitive priorities (1A)

- Manufacturing performance could be categorized by time, quality and cost (1B)
- Manufacturing performance and business performance is connected (1C)

This framework will define the empirical data collection in detail and help to analyze the competitive priorities and capabilities in the case company.

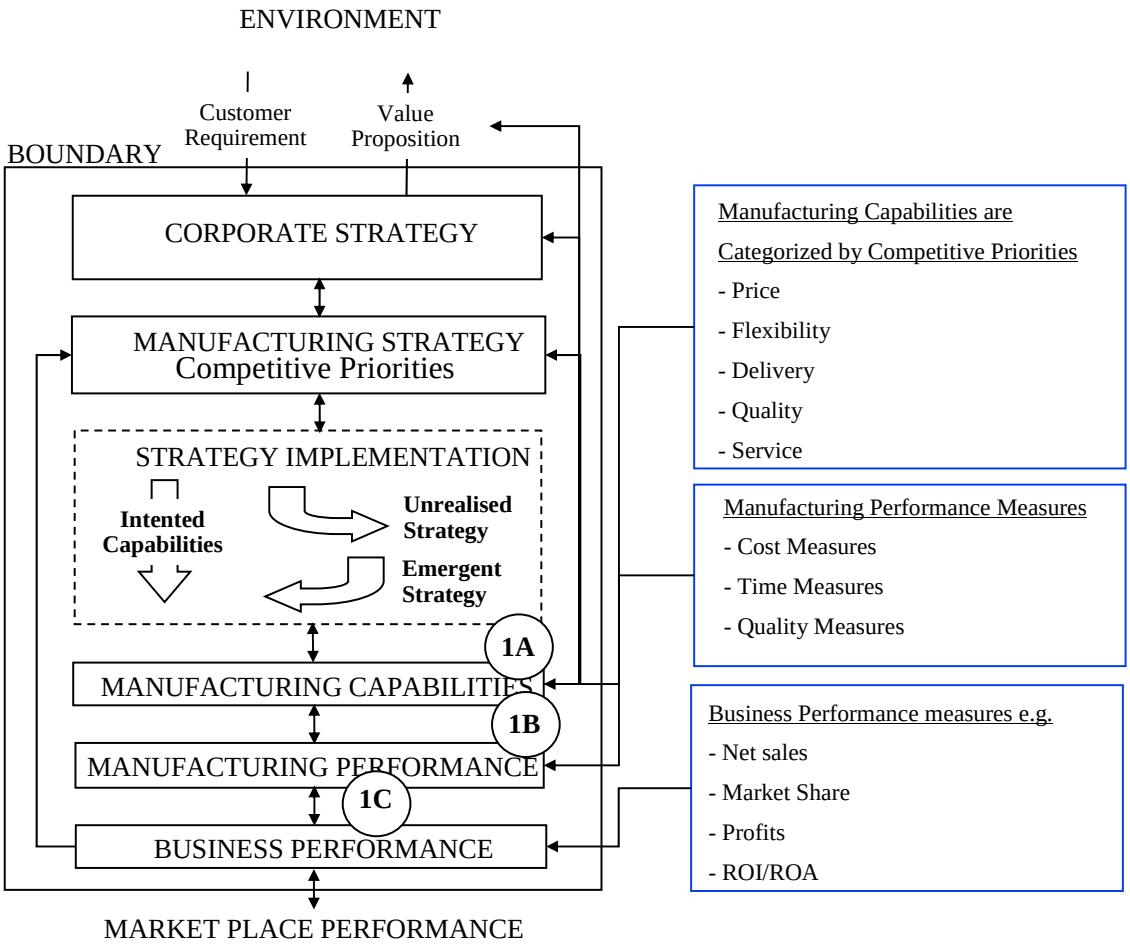


Figure 9. Predominant process model of manufacturing strategy (modified from Leong et al. 1990)

In the model, corporate strategy and company's value propositions determine an appropriate pattern of functional strategies, with feedback on capabilities provided throughout the process. The functional strategies, such as manufacturing strategy, themselves consist of the process of strategy formulation and implementation. Capabilities may result from strategy formulation and implementation if the strategy is realized. However, this model does not preclude the possibility that capabilities may

also result from unplanned patterns of activities rather than a strategic plan (Mintzberg 1978, Leong et al. 1990). In addition, the functional capabilities should, in an uncertain and unstable environment, drive corporate strategy (Hayes 1985). Mintzberg (1978) differentiated between the strategies an organisation planned or "intended" and the strategy it actually implemented or "realised". Differences between these strategies arose over time from the loss of some "intended" strategies, which were termed "unrealised" and the gain of unintended or "emergent" strategies. This was not evident in Leong's original framework. The actual manufacturing and business performance metrics, used in the case company, are validated through the case. Furthermore, how the capabilities and the performance actually change or do not change is investigated through the case study. The other functional strategies or performance measures, such as marketing, are not included here, even though they do affect business performance as well.

2.4.2 Competitive advantage and strategic role of manufacturing

In this Chapter the second research question, *how can manufacturing provide competitive advantage in different phases of business life cycle,* was elaborated in more detail. The second question was divided into two sub questions:

> 2A. Can manufacturing provide a competitive advantage?
> 2B. If so, do manufacturing capabilities providing competitive advantage change along the business life cycle? In other words, what is the sustainability of the competitive advantage in the changing business environment?

To conclude, the literature study shows that many researchers believe that manufacturing can contribute to competitive advantage and positively affect business performance (Skinner 1969, Hayes and Wheelwright 1984, Fine and Hax 1985, Clark 1996, Hayes and Pisano 1996, Berry et al. 1999). As Berry et al. (1999) conclude, strategic options in marketing can be connected with strategic options in manufacturing and vice versa and debate should influence the market position decisions. The key to competitive advantage seems to lie in differentiation amongst

competitors, by doing things differently (competence development, unique manufacturing technology, unique practices) or by doing things more efficiently (predicting new technologies, efficient implementation of new processes and practices, efficient execution and coordination) (Ketokivi and Heikkilä 2004). To develop a successful and sustainable strategy, alignment between an organisation's internal activities and its customer's value proposition is needed (Treacy and Wiersema 1993). Value is what customers are willing to pay, and superior value stems from offering lower prices than competitors for equivalent benefits, or from providing unique benefits that more than offset a higher price.

A company has competitive advantage if

- Profitability (relative position) is above the industry average (Porter 1998, Hayes 1985)
- Market share is high (Prahalad and Hamel 1990)
- Value to customer is high (Porter 1998, Barney 1991)

Understanding the strategic role of manufacturing requires an understanding of the demands of the market place, since the strategic goals can be different (Voss 1995). The purpose of thinking and managing strategically is to gain competitive advantage, implying an attempt to mobilize manufacturing capability to help gain a competitive edge or even significantly contributing to the competitive success of the organisation (Mintzberg 1978).

Manufacturing has a strategic role (i.e. provides competitive advantage) if

- Alignment between manufacturing capabilities and a company's value proposition is high (Hayes and Wheelwright 1984, Porter 1998, Treacy and Wiersema 1993, Voss 1995);
- Alignment between manufacturing capabilities and corporate strategy is high (Hayes and Wheelwright 1984, Skinner 1985);

- Capability development is proactive toward the customers, competition and markets (Wheelwright and Hayes 1985, Stalk 1988, Anderson et al. 1989, Collis 1994, Hayes and Pisano 1994, Voss 1995, Brown 1996);
- A company is able to respond quickly (Teece and Pisano 1994, Courtney et al. 1997, Eisenhardt and Martin 2000);
- Capability development is simultaneous and cumulative (Meyer and Ferdows 1990, Noble 1997);
- Manufacturing provides a combination of unique resources and capabilities (Hamel and Prahalad 1994, Prahalad and Hamel 1990, Pandza et al. 2003, Ketokivi and Heikkilä 2003);
- Manufacturing is more efficient than competitors' (Ketokivi and Heikkilä 2003);
- Manufacturing performances impact on business performance is high (Hayes and Wheelwright 1984, Swamidass and Newell 1987, Roth and Miller 1992, Swink and Hegarty 1998, Hill 2000).

Manufacturing strategy is not just about aligning operations to current competitive priorities, but also about selecting and creating the operating capabilities a company will need in the future and to be able to create a long term advantage (Hayes and Pisano 1994, Teece and Pisano 1994, Eisenhardt and Martin 2000). Long-term success requires that a company distinguish itself from its competitors by offering something unique and valuable to customers (Prahalad and Hamel 1990, Hamel and Prahalad 1994, Hayes and Pisano 1996, Pandza et al. 2003, Ketokivi and Heikkilä 2003). Furthermore, some organisational capabilities can be very valuable sources of sustainable competitive advantage in certain industries at certain periods of time, but they are not generically valuable to all industries at all times (Collis 1994).

Competitive advantage is sustainable if (Porter 1998, Barney 1991)

- The entry of new competitors is low;
- The threat of substitutes is low (unique or imitable offering);
- The bargaining power of buyers is high;

- The bargaining power of suppliers is low;
- The rivalry among the existing competitors is low.

Furthermore, some believe that manufacturing would provide new business opportunities and the link between manufacturing and corporate strategy should work both ways (Hayes and Wheelwright 1984). The results from this Chapter were evaluated empirically in the case study.

2.4.3 Life cycle model and manufacturing capabilities

Both research questions were related to life cycle model, since the goal is to examine how capabilities and competitive advantage change along the life cycle. The life cycle model originated from product innovation studies (Abernathy and Utterback 1975), but it can also be used to describe the evolution of processes and of an industry or a branch of industry (Porter 1980). The business life cycle is defined as the growth rate of the company in sales (Forrester 1964, figure 1). The main findings from the literature are summarized in table 2 by means of life cycle phases.

The basic idea of the life cycle theory is that the product or a product type and the industry evolve through different stages. Each stage has its own characteristics and a life cycle model can hence provide a framework of expectations. Whether the life cycle model could actually provide a framework of expectations for the planning and preparing of capabilities is assessed through the case study. Furthermore, does the manufacturing's strategic role change as the business moves along the life cycle towards the maturity and what are the implications for a company, particularly from the competitive advantage point of view? The ideas of Moore, linking the technology adoption life cycle and value propositions, are also studied through the case in order to understand whether a link between customer value proposition and capability development, in order to create competitive advantage provided by manufacturing, exists.

Table 2. Characteristics of different business life cycle phases (Summary based on the literature review)

Phases	**Introduction**	**Growth**	**Maturity**
BUSINESS ENVIRONMENT			
Product (Hayes and Wheelwright 1979, Ranta 1997 and Smeds1994, Comstock and Johansen)	New paradigm, one of a kind Major product innovations	Dominant design, few major products Minor product innovations	Commodity and standardized products or segmentation and customized products Minor or Major Product
Volumes (Hayes and Wheelwright 1979)	Low volumes, but growing	High volumes and growing extensively	High volumes (can still be growing but decline is seen)
VALUE PROPOSITIONS			
Main value propositions (Moore 1998, Treacy and Wiersema 1993)	*Product Leadership*	*Product Leadership+ Operational Excellence*	*Operational Excellence+ Customer Intimacy*
COMPETITIVE PRIORITIES			
Competitive priorities capabilities (Hill 2000, Moore 1998, Hayes and Wheelwright 1979, Utterback and Abernathy 1975, Brown 1996)	Flexibility	Delivery	Price, flexibility, quality, delivery, services
CAPABILITIES			
Main needed manufacturing capabilities (Hill 2000, Moore 1998, Hayes and Wheelwright 1979, Utterback and Abernathy 1975, Brown 1996, Fisher 1997)	Ability to make rapid volume changes (bowling alley or tornado) Ability to introduce new products	Ability to deliver efficiently (fast and on-time)	Ability to deliver efficiently in volumes, ability to profit in price competitive markets, or ability to customize product and services to customer needs
Process life cycle stage (Hayes and Wheelwright 1979, Utterback and Abernathy 1975, Brown 1996)	Jumbled flow (job shop) or Batch (‘organic’ and responds easily to environmental change, but is ‘inefficient’)	Connected line flow (assembly line, price order winning criteria, designed for efficiency)	Continuous flow (Productivity, more capital intense, more integrated process with more commodity type of products) or Flexible manufacturing system
Process innovations (Tushman and Nadler 1986, Smeds 1994, Hammer 2004)	Minor Process	Major Process	Minor or Major Process

3 RESEARCH METHODOLOGY

Chapter 3 presents the selection for research approach, research methodology, case selection and data used in this study.

3.1 Possible research approaches

3.1.1 Selecting research approach: quantitative or qualitative

Research design consideration leads directly to consideration of the relative strengths and weaknesses of qualitative and quantitative data. Qualitative methods permit the researcher to study selected issues, cases, or events in depth and detail; the fact that data collection is not constrained by predetermined categories of analysis contributes to the depth and detail of qualitative data (Patton 1987). Quantitative methods, on the other hand, use standardized measures that fit diverse various opinions and experiences into predetermined response categories (Patton 1987). Quantitative approaches are based on post-positivist knowledge claims (i.e. cause and effect thinking, reduction to specific variables and hypotheses and questions, use of measurement and observation, and the test of theories) while qualitative approaches are based primarily on constructivist perspectives (i.e. multiple meanings of individual experiences, socially and historically constructed, with an intent of developing a theory or pattern). Creswell (2003) lists as alternative strategies of inquiry for quantitative research, *experiments* and *surveys*. For qualitative research he lists *ethnographies, grounded theory, case studies, phenomenological research* and *narrative research.* A quantitative approach fits if the problem is identifying factors that influence an outcome, the utility of an intervention, understanding the best predictors of outcomes or testing a theory. But if a concept or phenomenon needs to be understood because little research has been done on it, then a qualitative approach is appropriate (Creswell 2003).

In contrast to research questions, research hypotheses are a statement of tentative answers to these questions and imply individual opinions and are based on individual

theory and experience. According to Maxwell (2005) there really is no difference whether one calls the outcome of the research propositions or hypotheses. In his view there is no problem with formulating qualitative research hypotheses. The difficulty is partly a matter of terminology and partly a matter of the inappropriate application of quantitative standards to qualitative research hypotheses (Maxwell 2005). The distinctive characteristics of hypotheses or propositions in qualitative research is that they are grounded (Glaser & Strauss 1967) in the data and are developed and tested in interaction with them, rather than being prior ideas that are simply tested against the data (Maxwell 2005).

In qualitative research grounded theory and case study traditions have similarities: as what is called open coding in grounded theory is similar to the categorical aggregation in case study research (Creswell 1998). The intent of the grounded theory is to generate or discover a theory (Glaser and Strauss 1967, Creswell 1998). In grounded theory the researcher attempts to derive a general, abstract theory of a process, action, or interaction grounded in the views of participants in a study. This process involves using multiple stages of data collection and the refinement and interrelationship of categories of information (Strauss and Corbin 1990, 1998). Two primary characteristics of this design are the constant comparison of data with emerging categories and theoretical sampling of different groups to maximize the similarities and the differences of information (Creswell 2003). The researcher uses systematic procedures, such as open coding and axial coding, and they represent the relationship among categories with a visual model. In case studies the researcher explores in depth a program, an event, an activity, a process, or one or more individuals. The case(s) are limited by time and activity, and the researcher collects detailed information using a variety of data collection procedures over a sustained period of time (Stake 1995, Creswell 1998). In other words, in the case study the theory is based on the researcher's summary of interpretations and claims, including the researcher's own personal experience of the case, called "naturalistic generalizations" (Stake 1995), while in grounded theory the researcher hopes to discover a theory that is grounded in information obtained from participants (Strauss and Corbin 1998).

Another research approach could have been the action research, which aims at solving specific problems within a program, organisation, or community. Action research explicitly and purposefully becomes part of the change process by engaging the people in the program or organisation to solve the problems (Patton 2002). However, there was no particular problem to be solved and the time span used was too extensive for this approach.

3.1.2 Designing a case study: single or multiple cases

Case studies can be used for different types of research purposes such as exploration (uncover areas for research and theory development), theory building, theory testing and theory extension/refinement. Case research has consistently been one of the most powerful research methods in operations management, particularly in the development of new theory (Eisenhardt 1989, Voss 2002 et al.). Case studies use multiple sources of information such as observations, interviews, documents, and audiovisual material.

According to Eisenhardt (1989) theory-building research is begun as close as possible to the ideal of no theory under consideration and no hypotheses to test. Investigators should formulate a research problem and possibly specify some potentially important variables, with some reference to extant literature. However, they should avoid thinking about specific relationships between variables and theories as much as possible, especially at the outset of the process (Eisenhardt 1989, Voss et al. 2002). The theory building research strategy from multiple cases, as described by Eisenhardt (1989), was an optional research approach for this study. When multiple cases are chosen a within-case analysis is followed by a cross-case analysis (Eisenhardt 1989). In the case of multiple in-depth longitudinal cases this would require an extensive amount of time and access to several companies over several years. Unfortunately, this sets resource limitations when conducting a dissertation.

On the other hand, Yin (1994) mentions that existing works may provide a rich theoretical framework for designing a specific case study. The use of theory, in doing case studies, not only is an immense aid in defining the appropriate research design and data collection but also becomes the main vehicle for generalizing the results of

the case study. The type of analysis can be a holistic analysis of the entire case or an embedded analysis of a specific aspect of the case (Yin 1994). According to Yin (1994), the single-case design is eminently justifiable under certain conditions: where the case represents a critical test of existing theory, where the case is a rare or unique event, or where the case serves a revelatory purpose. On the other hand, one may argue that a single case is not enough for providing reliable and generalizable data. However, the researcher believes that this longitudinal study will provide valuable insights as to theory building, since the longitudinal approach requires extended commitment over several years and it is not a commonly used approach in operations management research (Leonard-Barton 1990). Also, the chronological and longitudinal approach, as in this study, works best when events unfold and follow a process (Yin 1994). Therefore, the longitudinal case supports the idea of investigating different phases of life cycle. Moreover the design of qualitative study does not begin from a predetermined starting point or proceed through a fixed sequence of steps, but rather involves interconnection and interaction among the different design components (Maxwell 2005). A continuous assessment of how the design is actually working is needed during the research to make adjustments and changes in order to accomplish what is wanted (Maxwell 2005).

3.2 Qualitative longitudinal case research methodology

The research methodology chosen for this research was qualitative and based primarily on a single longitudinal case. As mentioned, the qualitative research approach is complex, involving fieldwork for prolonged periods of time, collecting words and pictures, analyzing this information inductively while focusing on participant views, and writing about the process expressively. Reducing the data into small categories or themes comes next, as does storing them and representing them for the reader in the narrative (Creswell 1998). The methodology chosen for this study is suited for exploration and hypothesis generation, i.e. theory building rather than hypothesis testing. Theory in qualitative research provides an explanation for behaviour and attitudes, and it may be complete with variables, constructs, and hypotheses (Creswell 2003). In this study, theory is the end point and it is an inductive

process of building from data to broad themes to a generalized model. The theory can assume the form of a narrative statement (Strauss and Corbin 1990), a visual picture, or series of hypotheses or propositions (Creswell and Brown 1992, Creswell 1998). The logic of the inductive approach used in this study is shown in figure 10 (Creswell 2003). Additionally, as in many traditional operational research studies, literature review and theoretical constructs were created in the beginning of the study to help information gathering on the case.

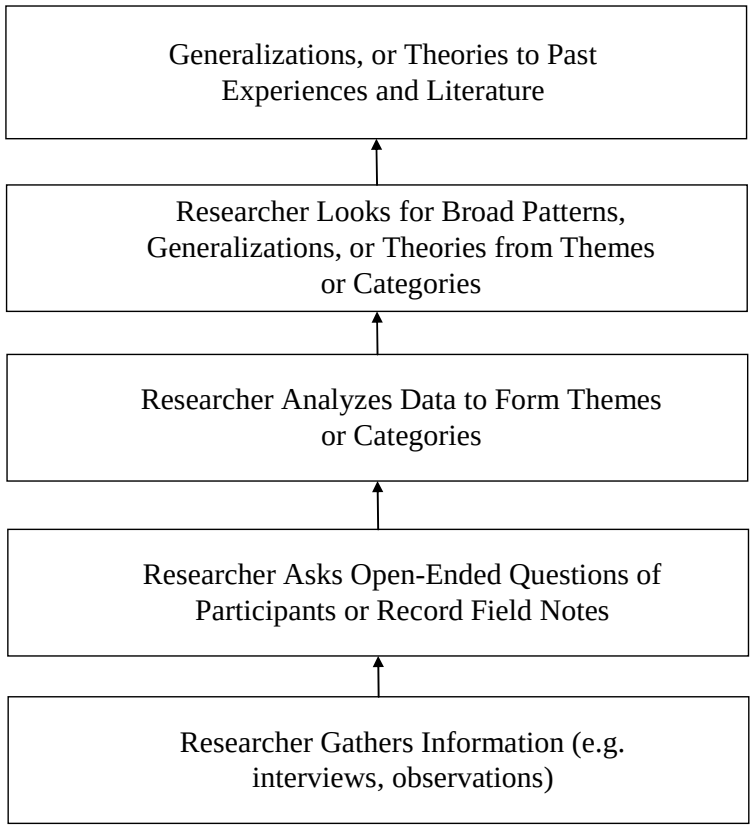


Figure 10. The Inductive Logic of Research in Qualitative Study (Creswell 2003)

A case study consists of making a detailed description of the case and its setting. Creswell (1998) recommends using multiple sources of data to determine evidence for each phase in the evolution of the case. In categorical aggregation (Creswell 1998), the researcher seeks a collection of instances from the data, looking for issue-relevant meanings to emerge. In direct interpretation the researcher looks at a single instance and draws meaning from it without looking for multiple instances. The researcher also

establishes patterns and looks for a correspondence between two or more categories. In the final step the researcher develops generalisations about the case, in terms of patterns, and how they compare and contrast with published literature. Since a single case study is subject to limits in generalizability and several potential biases, the triple comparative research design proposed by Barley (1990) was used to verify and validate the results (see figure 11).

3.3 Case selection

The criteria for the case in this study were to look at an industry where the high growth and strong industry dynamics have been experienced. In order to be able to analyse the life cycle through introduction, growth and maturity, the case had to be within a high-clockspeed industry (Fine 1998). This follows the ideas of Fine (1998) by speeding up the research by finding and studying the industrial fruit flies. As he states, some industries like telecommunication, computers, and the like, undergo changes rapidly, whereas others seem to advance at a more leisurely pace. The information and communication industry did experience rapid growth throughout the 1990s and then phased through a slow-down at the turn of the millennium. The automotive industry has traditionally been the target of many operation management studies but for this particular research it was a too mature and slow-paced industry. However, the automotive electronics industry might have been interesting study subject. Biotechnology is one example of a set of emerging technologies that have the potential to contribute to economic growth, but the full economic and social impacts of new developments in biotechnology have yet to be realised (A Survey of the Use of Biotechnology in U.S. Industry 2003).

The case was selected within the telecommunications industry. The case company is a global manufacturer of consumer electronics products, Nokia Corporation, being the world's largest mobile phone producer. Nokia, in its mobile phone business, was both rapidly growing and changing from one phase to another and therefore provided excellent data for a longitudinal study. Nokia’s strong market leader position further justified the case selection.

In the 1990s the Nokia Corporation underwent several major changes. It was transformed into a focused telecommunications company from a multi-branch firm of electronics, information systems, paper, rubber, mobile phones, and telecommunications. Until the beginning of the year 2000, the company was growing very fast and it gained a considerable market share. However, in the last few years the growth rate has decreased. Today, the telecommunications industry is moving from voice to more diverse technologies and services such as picture and video messaging. An important criterion for the case selection was that the growth shape of the company follows the one presented by Forrester (1964) (figure 1). Another important criterion for the case selection was that the manufacturing was seen as a competitive advantage for the company (Nokia, Kallasvuo 2003). During the manufacturing strategy development, the company therefore faced several questions relating to the industry changes and how manufacturing contributes to business performance. Furthermore, the company's above average performance supports Porter's idea of competitive advantage, where the fundamental basis of above-average performance in the long run is a sustainable competitive advantage (Porter 1998).

The researcher has worked for the case company for over eleven years and has in-depth knowledge of manufacturing development within the company. The case study research approach is inductive and utilises both qualitative and quantitative data. The researcher had excellent access to strategic materials and performance data over the years, which is not always the case for an external researcher. In this single, in-depth longitudinal study case research can be particularly valuable. The longer the period over which the phenomena are studied, the greater the opportunity to observe at first hand the sequential relationship of events (Voss et al. 2002). Moreover, there can be multiple levels of analysis within a single case study (Yin 1994, Barley 1990). In this particular case study it will provide an understanding of manufacturing capability development in three different phases of life cycle growth (diachronic view). By longitudinal (1993-2003) examination of the case company the changes in business environment can be seen from slow growth to high growth and to slow down phase when entering the maturity.

Very interesting possible parallel cases to compare against would have been, for example, Nokia's direct competitors. However, access to data in such depth would have been practically impossible for one researcher. Therefore the parallel comparison cases chosen were Cisco, Dell and SonyEricsson. Cisco and Dell were selected based on the fact that they are representative of the electronics industry and have experienced the similar growth curves as Nokia. SonyEricsson was selected to illustrate a company within the same industry and a competitor, but clearly not enjoying the same level of success and competitive advantage on the market. Important criterion for selecting these parallel cases was that there was enough publicly available data for the comparison.

3.4 Research design and data analysis

The challenge in qualitative research can be an overwhelming corpus of descriptive data or, on the other hand, having insufficient data for making strong claims. According to Barley (1990), by utilizing a comparative research design and by actively attempting to systemize sustained observations, researchers increase their odds of accumulating a body of field notes amenable to orderly analysis (figure 11). He presented the triple comparative design using three distinct viewpoints called *synchronic*, *diachronic* and *parallel*. According to Barley, the synchronic, the diachronic, and the parallel represent three distinct axes of comparison that, when used in combination, allow researchers to examine explicitly the spatial and temporal boundaries of their claims. Synchronic analysis is particularly useful for making statements that generalize across members of a class of events, objects, persons, or activities. In contrast, diachronic analysis is crucial for explaining the etiology of the differences. Parallel studies allow one to generalize synchronic and diachronic findings across similar social settings (Barley 1990) and test whether the generality of particular findings from a single longitudinal case study are present in other cases studied (Leonard-Barton 1990).

To systematize the data collection and further analysing it, a strategy (Laiho and Vehtari 2003) chart was created from the case based on the life-cycle curve (appendix D). In the strategy charting the most important topics from the internal material were posted on the growth curve of each year from 1993 to 2003. Also, the main topics found in the external materials were posted on the chart by years under the relevant categories. On the matrix, synchronical strategies and events were easy to compare. The strategy chart also proved to be very useful for collecting diachronic information. The life cycle curve proved to be useful as an overall framework for collecting and analyzing the data. The strategy chart allowed a systematic charting of the events, roles, and relations associated with each event (Barley 1990). Based on the strategy charting it was confirmed that the case company had clearly experienced three different life cycle phases from introduction to high growth and to maturity, following the S-curve describing industry growth (Forrester 1964) and interactive innovation (Rogers 1995). The categories for sorting the data (Barley 1990) were selected based on the theoretical framework and constructs created in literature study (figure 9). These categories were used as 'bins' for sorting the data for analysis. Strauss and Corbin (1998) described this process as conceptual ordering, where data is organized into discrete categories according to their properties and dimensions and then using description to illustrate those categories. This procedure is primarily found in grounded theory research (Strauss and Corbin 1990), where researchers relate categories and develop analytic frameworks. But, contrary to the grounded theory, where categories are selected based on the interview material; the initial categories for data analysis were selected based on the theoretical constructs created in the literature review:

- Business environment
- Value proposition
- Competitive priorities
- Capabilities
- Manufacturing and business performance
- Competitive advantage

The written case description helped further to understand the changes over the life cycle, since processes are themselves composed of events with antecedents and consequences, and when these are understood and connected in the form of a story or historical narrative, an understanding of the process is often the result (Huber and Van de Ven 1995). Maxwell (2005) emphasises that reading and thinking about the interview transcripts and observation notes, writing memos, developing coding categories and applying these to the data, and analyzing narrative structure and contextual relationships are all important types of data analysis. The theoretical constructs presented in Chapter 2.4 will be used as the basis in each step to guide the data-analysis.

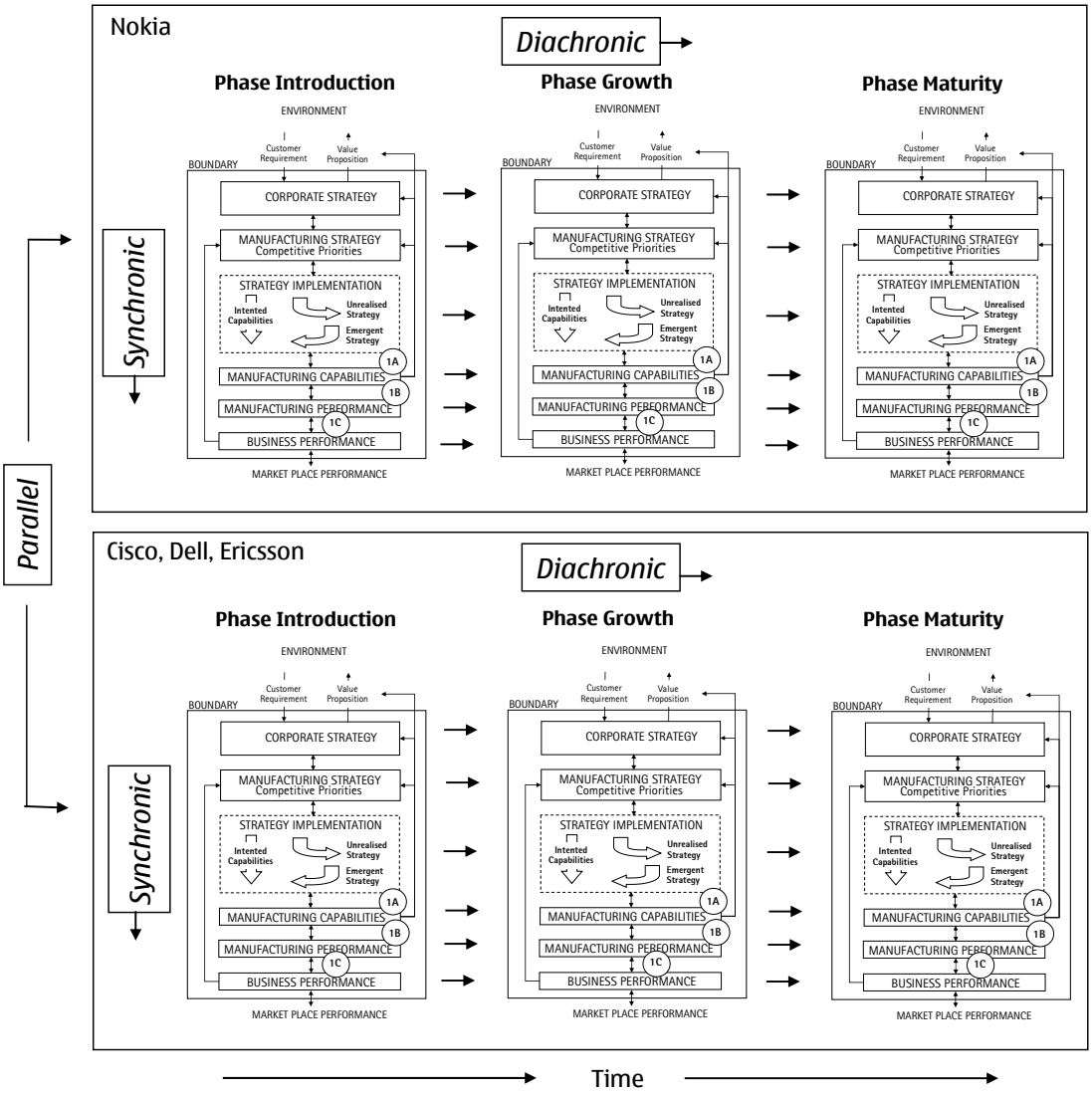


Figure 11. Triple Comparative Design (adopted from Barley 1990)

3.5 Data collection and reliability

3.5.1 Data collection

Guided by the theoretical constructs both qualitative and quantitative data were collected from the case company and is presented in Chapter 4 as case description (see also appendix D). Externally available materials were Nokia's annual reports and presentations to investors, other external communication material such as reports created by external institutions, published articles and news. Internal material used included business, manufacturing and supply chain strategies, process descriptions, information about development plans and actually realized projects, as well as performance assessments and performance measure data.

In addition, data was extended and confirmed by interviewing personnel responsible for manufacturing and demand supply network development or running the operations. The participants were chosen based on their ability to contribute to an evolving theory (Miles and Hubermann 1994, Creswell 1998). The individuals interviewed had a long work history within Nokia's manufacturing environment, either in the factories or from global process and technology development organisations, or both (appendix A). All participants had experienced the phenomenon of the high growth over the life cycle. These unstructured interviews with open-ended questions were carried out in order to obtain a good understanding of the constructs and the events that took place. Each interview lasted 1-2 hours on average and was based on an interview guide sent to informants prior to the interview (appendix B). The topics in the interview were the manufacturing capabilities and performance in different phases and their relations to business environment and performance. Special emphasis was placed on understanding the difference between intended and realized capabilities. Most of the interviews were conducted together with the other researcher. Since case facts are open to interpretation, it is best to have at least two researchers, who can challenge each other's observations (Leonard-Barton 1990). Strategy charting was performed together with the other researcher working on the closely related topic during the fall of 2003 (Laiho and Vehtari 2003). According to Eisenhardt (1989)

multiple investigators have two key advantages: first, they enhance the creativity potential of the study, and second, the convergence of observations from multiple investigators enhances confidence in the findings. Each interview was recorded in written format. Memos were sent by email to interviewees for corrections and amendments. Finally, the case description from strategy charting was updated and validated based on the information obtained through the interviews (Laiho and Vehtari 2003).

In addition, an in-depth case study that was carried out in a case company in the fall of 2003, studying how increased diversity of products impacted manufacturing operations, was utilised in this study (Appelqvist and Vehtari 2004). The case study results were further validated during 2004 through additional in-depth interviews and data analysis of delivery data. These findings were reported in an internal summary report and in a conference paper (Appelqvist and Vehtari 2004). These findings were utilised to verify the results from the strategy charting and interviews.

The cases of Cisco, Dell and SonyEricsson were studied to compare and strengthen the findings from the main case (parallel view in figure 11). The data for the parallel cases was collected from publicly available sources from articles, annual reports and company websites. One of the interests of this study was: has the importance of different manufacturing capabilities changed along the life cycle? Moreover, what are the ways to enhance performance before the expected change and during the actual change to meet new challenges that are required by the business?

3.5.2 Reliability of the data

In this study, data collection, data analysis and theory building were closely linked. Multiple sources of data on the same phenomenon, such as internal archives, interviews, questionnaires, and observations or from publicly available records, increased the reliability of the data. The evidence was both qualitative and quantitative. By multiple data collection and study methods (triangulation) stronger substantiation of constructs and hypotheses are provided on the phenomenon.

Triangulation is a powerful solution to the problem of relying too much on any single data source or method that thereby undermines the validity and credibility of findings due to the weaknesses of any single method (Patton 1987). This study utilised four different types of triangulation (Patton 1987):

1. Data triangulation – use of variety of data sources (internal strategy and project materials, process descriptions, performance metrics data, annual reports, presentations to investors, other external communication material such as reports created by external institutions, published articles, cases and news);
2. Investigator triangulation – the use of several different evaluators (two researchers creating the strategy chart and performing the interviews, two researchers studying mature phase in more detail, use of internal readers to validate the written case and the outcomes);
3. Theory triangulation – the use of multiple perspectives to interpret a single set of data (strategy charting, triple comparative design);
4. Methodological triangulation – the use of multiple methods to study a single problem (interviews, observations, participation and documents).

However, there are always problems with historical data. For example, participants may not recall important events and may be subject to bias. Similarly, what is described in archived data, such as minutes of meetings, may not reflect the whole truth, and difficult or controversial items may not be recorded (Eisenhardt 1989, Voss et al. 2002). Barnes (2001) also points out that not all planned strategy is realised and not all realised strategy is planned. The strategy may arise from a combination of the intended and emergent and not all managerial intentions are expressed in formal plans, and that those intentions may or may not be subsequently realised (Barnes 2001, Mintzberg and Waters 1985). As Hayes and Wheelwright (1984) cautioned “it is the pattern of decisions actually made that constitutes a function’s strategy, not what is said or written in annual reports or planning documents”.

On the other hand, the researcher’s in-depth involvement with the organisation over the years meant having good access to gather the data required and to provide support

for the research being conducted. Barnes (2001) mentions that the qualitative approach has its origins in anthropology, and requires deep involvement on the researcher's part within the organisational setting. The attraction, according to him, lies in its ability to generate extensive, rich and detailed data. Of course, when the researcher has worked for the company for an extensive period of time, intersubjectivity can be a risk as well as an objective liability towards external validity. The written case description and a case summary table were also proofread by colleagues to verify that events and the findings were correctly captured. These selected colleagues had worked for several years with the manufacturing and demand supply chain issues in the case company.

4 LONGITUDINAL CASE STUDY

The case study focuses on understanding the manufacturing capability and performance changes involved with Nokia's mobile phones manufacturing from 1992 to the end of 2003. Focus is also on how manufacturing contributed to the overall business performance and to the competitive advantage of Nokia. The case description and analysis was guided by the strategy charting and data categorized by selected categories based on the literature review**.** In addition to manufacturing capabilities, demand supply network and other cross-organisational capabilities related to manufacturing were studied in order to capture all essential capability development (Eloranta et al. 2001 and Lewis 2003). Each business life cycle phase also includes a short description of the business environment and the main products and value propositions. The case analysis is presented in Chapter 4.5.

4.1 Introduction of the case

4.1.1 Introduction of the case company

The history had already shown several cycles of technological discontinuities and growth periods in the electronics industry before the 1990s in Finland (Lovio 1993). However, this case study will focus on the changes of the Finnish based global player Nokia Mobile Phones from the beginning of the 1990's to the year 2003. This business life cycle also started with slow growth and continued into high growth and continues into slower growth in 2001-2003 (figure 13).

Since the beginning of the 1990's Nokia has concentrated on mobile terminals and networks businesses. In 2003 the company comprised three business groups: Nokia Mobile Phones (NMP), Nokia Networks (NET), and Nokia Enterprise Solutions (NES). Supporting groups were Nokia Ventures Organisation (NVO), Nokia Research Centre (NRC) and Nokia Business Infrastructure (NBI) providing business groups with the processes and tools to run their businesses. In 2003, Nokia's net sales were

29.5 billion euros, with an operating profit of 5.0 billion euros (Nokia annual report 2003).

In 2004 Nokia Mobile Phones was divided into three business groups as Mobile Phones, Enterprise Solutions and Multimedia to better support the more divergent market requirements. The supporting functions in 2004 were Customer and Market Operations, Technology Platforms, Business Infrastructure, Operating Resource Sourcing, Nokia Research Centre and Nokia Ventures Organisation. Customer and Market Operations include Nokia's sales and marketing organisation as well as manufacturing, logistics and sourcing. The Networks business group continues to have its own dedicated sales and marketing, logistics, manufacturing and sourcing activities.

Nokia Mobile Phones became the world's largest phone manufacturer in the 1990s. In 1991 Nokia was Europe's largest manufacturer of mobile phones and the second largest in the world. Economically the year 1991 was the Nokia history's worst year, particularly because profitable sales to the Soviet Union ended and there were discussions of sale to Ericsson (now SonyEricsson). However, Nokia and Europe's second largest mobile phone manufacturer Technophone, were united in 1991. During 1991-2000 the company's number of employees doubled, net sales grew ten-fold and operating profit grew a hundred-fold (Häikiö 2001), (figure 14). The growth of Nokia's operations has been extensive as well. In 1994 the estimation of the volume growth was from 7 million to 60 million by 2000 (Nokia Strategy 1994 Challenge of Volume Growth). The actual number of phones sold ended up being 115 million in the year 2000. In the year 2003 Nokia produced, in nine factories globally, half a million phones per day, the equivalent of seven phones per second. Each phone contained 300-350 components, adding up to over 60 billion components total in one year. For the full year of 2003, Nokia volumes reached a record 179 million units, leading to an estimated market share slightly above 38%. Nokia Mobile Phones broadened and revitalised its product portfolio by launching 40 new products during 2003 with an emphasis on more advanced devices, CDMA technology, entry-level phones and market localization. The Demand Supply Network Management, including operational

efficiency, has been one of the three strengths in Nokia alongside Brand and Product (Internal Strategy Material).

4.1.2 Nokia's mobile phone factories

The mission of Nokia's Operations and Logistics organisation is to deliver Nokia brand promise to customers through innovative, flexible, and efficient Demand Supply Network (www.nokia.com). In 1993 most of the manufacturing took place in nine facilities owned by Nokia, with less than 20 % of production outsourced to three-selected global contract manufactures. By locating three plants in each of the three geographical regions, Nokia has ensured that manufacturing takes place close to customers (see figure 12). The nine factories in 2003 were globally located in Salo (Finland), Bochum (Germany), Komarom (Hungary), Beijing (China), Masan (Korea), Dongguan (China), Alliance (Texas), Reynosa (Mexico) and Manaus (Brazil).

Figure 12. Nine mobile phone factories in Nokia

Through localized factories Nokia is able to provide its customers higher product variety, improve responsiveness to customer preference, and provide fast order fulfilment (Stanford Case 2004). However, Nokia relies on transhipment of

subassemblies across regions to ensure cost efficiency and high rates of demand fulfilment. In this study mobile phone manufacturing facilities (e.g. factories) within Nokia are viewed as one manufacturing unit, i.e. performance measures are combined global averages.

4.1.3 Characteristics of the growth phases

The mobile phone industry was a very rapidly growing industry in the 1990s. Figure 13 illustrates the whole mobile phone industry growth with market shares of the main competitors. This figure illustrates that Nokia was able to win and hold the clear market leader position from 1998 to 2003, while the biggest competitor Motorola was loosing the market share throughout 1994 to 2000.

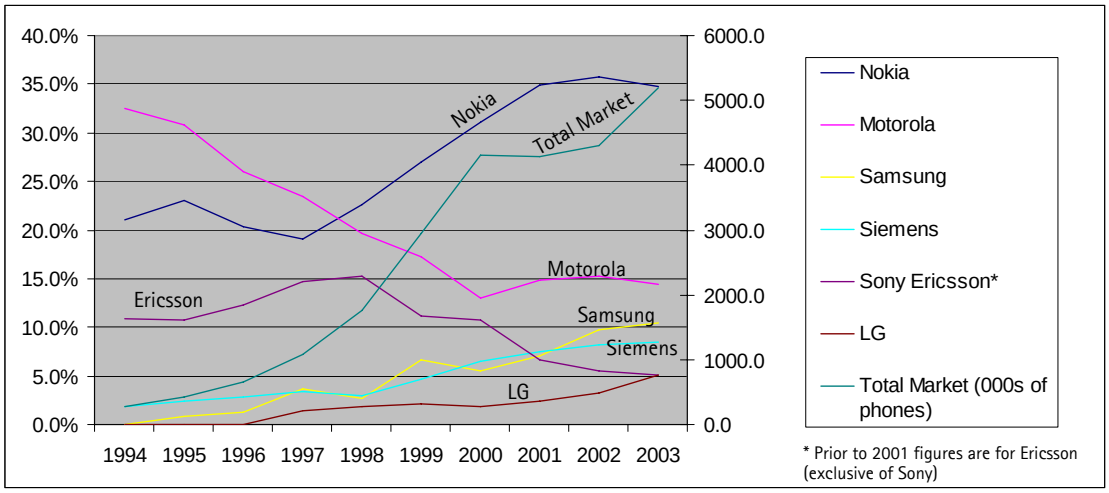
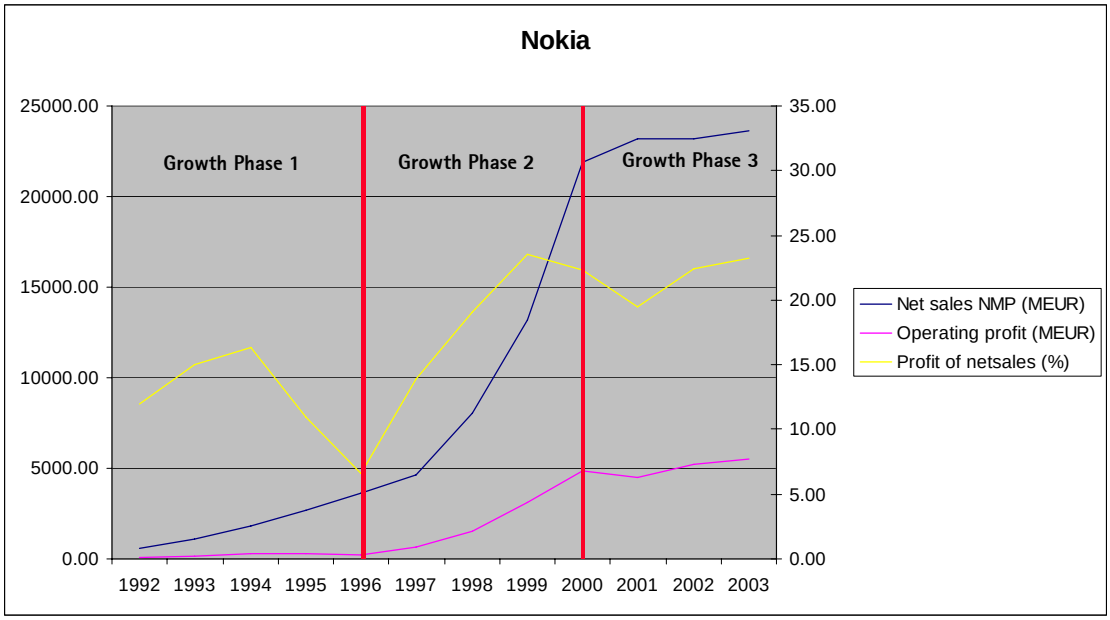


Figure 13. Industry growth by thousand of phones and market shares (Gartner 2004)

The strategy charting confirmed that the company had clearly experienced three different life cycle phases from introduction to high growth and to maturity following the S-curved (Forrester 1964, Rogers 1995). The strategy chart helped create a baseline understanding of the environmental requirements and competitive priorities set for manufacturing. The charting indicated the shifting of value propositions and capabilities in different phases of life cycle (Moore 1998, Tracey and Wiersema 1993). The S-shaped growth curve and growth rates were divided into three growth

phases: introduction (1992-1996), growth (1997-2000) and maturity from (2001-2003) (figure 14).



	Growth phase 1	Growth phase 2	Growth phase 3
Nokia	1992-1996	1997-2000	2001-2003
Compound Annual Growth Rate of Nokia sales	43	47	1
Compound Annual Growth Rate of profit	27	66	7
Average annual growth rate of sales	57	58	3
Average annual growth rate of profit	46	116	4
Compound Annual Growth Rate of volumes	46	57	9

Figure 14. NMP net sales, operating profit and profit of net sales in % (Nokia annual reports)

Growth phase 1: Introduction

According to Moore (1998), in the introduction phase customers are technology enthusiasts and visionaries looking to be first to enjoy the new paradigm. The paradigm shift begins with the appearance of a new category of product that incorporates breakthrough technology enabling unprecedented benefits. Following the introduction period is “the Chasm”, a time of great despair, when the early-market’s interest wanes but the mainstream market is still not comfortable with the immaturity of the solutions available (Moore 1998). In the mobile phone business GSM breakthrough occurred during 1994-1995 and market growth accelerated when mobile phones became available for big masses. This required a global infrastructure standard for the market to start growing rapidly. In addition, the pricing of the mobile phones

needed to reach reasonable levels for the mass markets. In this phase the compound annual growth rate for Nokia was 43 %, which was already a high growth rate. This caused problems towards the end of the phase in component supply and end product stock management, but was solved by reorganising the logistics (Nokia annual report 1996). 2.

Growth phase 2: Growth

The second growth period was characterized by even higher volume growth. Moore (1998) describes this as “the Tornado”, a period of mass-market adoption, when the general marketplace switches over to the new infrastructure paradigm. In this phase demand dramatically outstrips supply, and a huge backlog of customers appears. The significance of this period is that once customers settle on a particular vendor, they rarely switch. In the words of Moore (1998): “It is important to attack your competitors during the tornado instead of serving your customer”. Another important lesson is to expand distribution as fast as possible. Moore (1998) said this is the time to “just ship”. Once the high growth is over, markets are very price elastic. The transition from value-based to commodity-based pricing occurs during high growth, and leveraging that transition is the key to capturing market share, especially in the tornado’s later stages. This means pursuing the next lower price point, which puts emphasis on the cost structure development.

The compound annual growth rate for Nokia was 47%, but the total volumes produced were significantly greater than in the previous phase. During 1998 Nokia won the market share fight against Motorola and became number one in the world (figure 13). The key strategic cornerstone in 1999 was to grow fast in order to achieve maximum economies of scale, while maintaining fast volume growth and managing the growth in the entire demand supply network. The slowdown of the growth was not yet visible, but Nokia targeted to a lean growth to be prepared for sudden changes in market demand.

Growth phase 3: Maturity

According to Moore (1998), the typical transition to maturity phase (Main Street) begins catastrophically. In this phase price erosion leads to a decline in net revenue. The end customer and mass customization strategies became important. On the other hand, the assumption is that as one reaches the top of one S-curve, one should be looking to transition into the bottom of the next curve.

Even though the Nokia's compound annual growth had slowed down to 1% and the market share started to slightly decline in 2003, Nokia did not face any dramatic shortfalls in revenues and profits. On the contrary, an interesting aspect is that when market growth saturated and started to slow down in 2000, the Nokia market share continued to grow until 2002. Nokia was also able to improve net sales profit by a few percent points.

4.2 The first growth phase 1992-1996: Introduction

4.2.1 Business environment 1992-1996

In the beginning of 1990s Nokia's vision was to be the end-user recognized leader in cellular terminals. In 1994 the challenge of volume growth was recognized and the anticipation of customer needs and quick response to market requirements was seen as vital for global players like Nokia. In mid 1990 the mobile phone business faced growth pains. During 1995 Nokia introduced substantial new production and distribution capacity, while hiring a significant number of new employees in order to meet the expected demand. Consequently, the business group experienced certain difficulties in bringing up this production and logistics capacity to optimal levels (Nokia annual report 1995). Nokia's operating profit dropped, remaining however strongly profitable, which is highlighted by profits in percent of the net sales (figure 14).

The main challenge was caused by the market dynamics. Towards the end of the 1990s the risk of price erosion and technological obsolescence of products and

components grew. It was difficult to forecast the fast changes in demand and operations were not well adapted to these fast changes in the demand. Some other issues were caused by supplier quality and with product mix (Häikiö 2001). In 1996 Nokia faced more rapid growth, component supply and end product stock management problems, but with an efficient reorganisation of logistics and new products the profitability had already improved by the second half of 1996 (Nokia annual report 1996).

GSM (Global System for Mobile Communications) technology enabled Nokia to enter new markets from the beginning of the 1990s. The GSM breakthrough occurred during 1994-1995 and accelerated market growth when mobile phones became available for the population at large, mostly in Europe and Asia. In 1994 the 2100 family was launched and became a classic. The original target was to sell 400 000 units, but in the end a total of 20 million phones were sold. The product range also included data services, car phones and supporting software. In 1996 the first communicator (Communicator 9000) was launched and more diverse categories emerged, such as the Nokia 8100 family in the premium category and the Nokia 1610 in the basic category. Already in 1990 half of the mobile phones were sold through big operators. Nokia's strategy was to target end-customer requirements and create a demand that would drive operators to sell Nokia phones. User friendliness and design were the biggest selling arguments (Häikiö 2001). Stronger focus on Nokia Brand development started in 1991, but phones were sold under multiple brands, in the United States, for example, where Technophone was used until 1995.

In the 1980s, in the US markets, analog AMPS dominated the market and the digital TDMA standard (often known as D-AMPS) offered the evolutionary path from analog AMPS. The growth in the US during the 1990s did not experience the same growth as in the European and Asian markets and resulted in delays in establishing digital mobile services such as CDMA and GSM.

4.2.2 Capabilities 1992-1996

4.2.2.1 Development of Demand Supply Network 1992-1996

In the early 1990s the manufacturing and logistics organisations were functional and immature, lacking end-to-end process management. Growth in volumes doubled and tripled in 1994 – 1995 but the growth was not always well managed, being more of an ad hoc development (Interviews). The effort to meet the rapidly growing demand was great and Nokia faced several major obstacles along the way (Stanford case 2004).

All five factories (Salo, Alliance, Bochum, Hong Kong and Masan) increased production in 1994. Flexible working arrangements in the factories had a positive impact on the goal to increase productivity and improve operations (Nokia annual Report 1994). Regional plants focused on serving regional markets and supporting other sales areas if necessary. The products and processes were planned to be flexible in order to facilitate manufacturing of different products to customer orders. In the sourcing area the local partner vendors were set for supplying critical parts, whereas global vendors were set to supply best technology/cost. In 1996 Nokia's joint venture for mobile communications inaugurated the manufacturing of mobile phones and base stations in China (press release April 17, 1996).

In 1995 rapid growth continued, but component supply, end product stock management and disintegrated demand supply network processes, together with an annual price erosion of 25%, created difficulties. Nokia was left with huge inventories of the wrong items in the wrong places, while simultaneously still being unable to deliver some products due to shortages of certain critical items. Thinner margins, coupled with market turbulence and an increasing number of variants, pointed to the need to decrease inventories, to reduce cycle times and manufacturing to order. The shape-up began in 1995-1996 with an efficient reorganisation of logistics and through the implementation of new processes in product creation, delivery process and management process. A global organisation was created to provide more visibility, set common processes across all regions and take charge of a global planning. A SAP

Enterprise Resource (ERP) system was implemented across all plants (Stanford case 2004). The logistic shape-up introduced new measures such as *Inventory Days of Supply* (DOS) and *On Time Delivery* (OTD). It was only in 1996 that the Days of Supply improved from 154 days to 68 days (figure 15), smaller inventories released 2.5 billion FIM (0.4 billion EUR), raw material DOS improved from 86 days to 26 days, cash flow was 4.6 billion FIM in 1996 compared to 3.2 billion in 1995, and warehousing costs decreased from 200 FIM (33 EUR)/phone to 100FIM (17 EUR)/phone (Häikiö 2001, internal metrics documents).

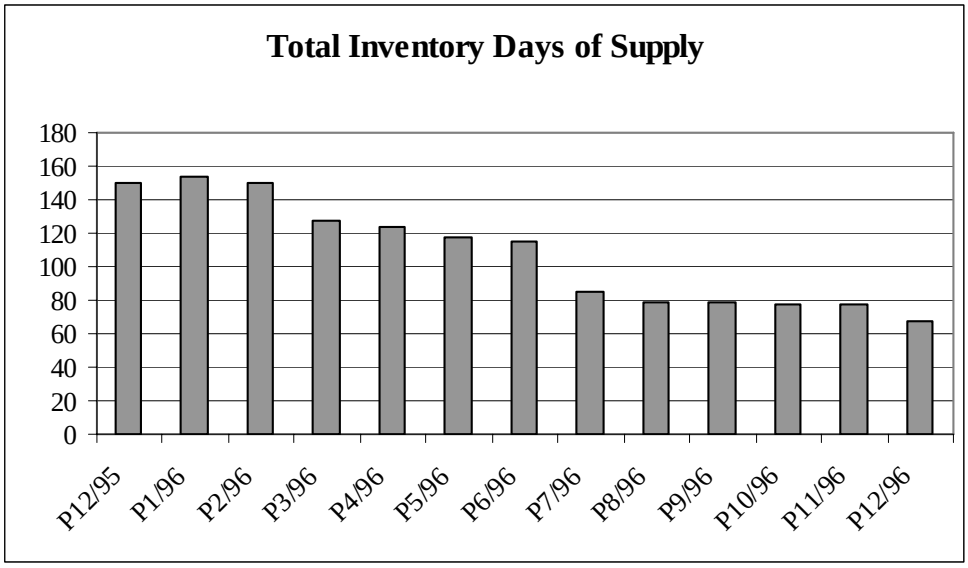


Figure 15. Improvement of inventory Days of Supply in 1996 (Nokia internal material)

4.2.2.2 Development of Manufacturing Capabilities 1992-1996

At the beginning of 1990, the most critical capability was to produce products when production technology was not a commodity (i.e. the ability to introduce new products), meaning that many the processes and equipment had to be developed from the beginning. Current production technology and process designs were mainly introduced through the introduction of the GSM products 2110 and 6110 during 1994-1996 and were copied during the high growth years. Production ramp-up time was measured in months and the goal was to reduce it to one month (Interviews).

The focus in the operation strategy was on the improvement of concurrent engineering (CE) processes, use of Design for Manufacturing (DFM), global manufacturing and sourcing. The cooperation between product creation and factories was not very mature, as is typical in any new type of business. CE process development work started in 1992 and was in place by 1994, enabling a good start for the DFM work. The concurrent engineering process and design for manufacturability improved the ability to introduce new products. Towards the end of the era good manufacturability of the products also helped in the shape-up and fast growth. The cooperation between product creation (CE) and manufacturing (DFM) was practiced along the 2100 product family and it was at a good level prior to the final volume explosion of the 5100 and 6100 products. Design for Manufacturing was criticised at the beginning, but through the 2110 product family, and particularly through the 5110/6110 products, benefits were clear (Interviews). In 1994, Design for Manufacturing (DFM) metrics were introduced including hand time, test time and component count that affected the efficiency of manufacturing (figures 16 and 18). The other targets were to decrease part count from 900 to 400 (products 5110, 6110) and less than 200 parts in subsequent generations

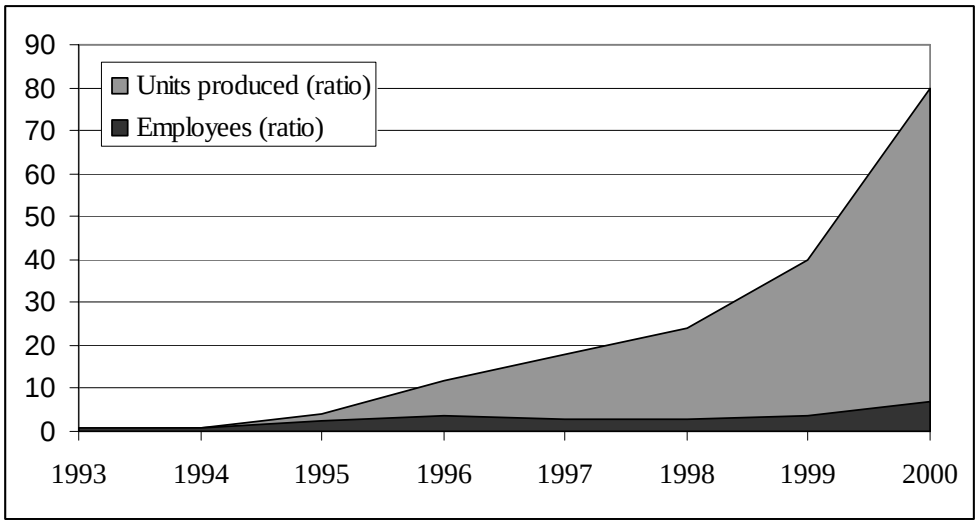


Figure 16. Volume / labour in Europe 1993-1999 (Nokia Internal Material)

4.2.3 Competitive advantage in 1992-1996

Throughout the first era of 1992-1996 product leadership with brand and end-user recognition was the most important value proposition (Nokia strategies). Manufacturing was not the main competitive advantage, even though continuous improvement was important in all three competitive priority areas (cost, time, quality). From the operations point of view the most important manufacturing capabilities were the ability to introduce new products and manufacture according to specification. Later on, the ability to shape-up and grow fast became important as well. Cost was not the most important criteria and quality mattered as and order qualifier.

In 1996-1997 the strong profitability improvement in Nokia was due to further development and integration of logistics processes and efficient management of working capital. Focus, as stated in the 1997 strategy, was on reliable, responsive and cost effective logistics. In practice, this meant focusing on product availability, on-time delivery, and inventory reduction. Renewal of the product range and continuous cost improvements also had an important contribution to profitability. The improvements brought results and the profitability of the company turned into high growth. The organisational renewal resulted in a more efficient operation and sales system. Nokia Mobile Phones became fundamentally better in terms of efficiency, which led to an increase in sales and faster improvement of profitability compared to its competitors (Häikiö 2001, Nokia annual Report 1997).

4.3 The second phase 1997-2000: Growth

4.3.1 Business environment 1997-2000

The rapid growth period was anticipated at Nokia, but not to the extent that it did occur. Already by 1998 Nokia had produced a hundred million phones. In 1998 alone Nokia sold 40.8 million phones and became the world leader in the mobile phone market. Its market share grew 15 percent, from 21 to 36 percent, while Motorola’s dropped from 37 percent to 26 percent. The challenge of high growth highlighted the business environment:

> *"The high demand for our products, the excellence of operations and favourable market conditions with lower than anticipated price erosion led to an exceptional level of profitability." (Nokia Annual report 1998)*

Around the strong market growth period, product availability was the main factor for successful business, but also meeting the demand of different customers segments became rather more important. At the same time Nokia further developed the value proposition towards the trade customers, stating that the key benefit for Nokia's customers is increased revenues and profitability through product availability, high asset rotation, visibility and ease of doing business with Nokia. At this stage, supply chain management started to become a value-adding factor for Nokia. Similarly important were varying logistic needs of different customers in terms of location, frequency and timing of deliveries, product offering and product-related value-added services. Nokia increasingly started to offer trade customers customised products without a significant increase in price. The driver was increased awareness of brand value also among telecom operators, Nokia's major customer group.

> *"In 1998, we became the world's largest supplier of mobile phones. During 1999, we were able to continue to strengthen our global market position. The mobile phone market grew by over 60% during 1999. We estimate that about 275 million mobile phones were sold worldwide during the year, compared to about 168 million in the previous year. Nokia's sales volume growth exceeded that of the market with sales during 1999 of 78.5 million units, up 92% on the previous year's 40.8 million." (Nokia Annual Report 1999)*

In 1999 strong growth continued with a high operating profit margin, but preparing for sudden changes had started at Nokia, which helped to overcome the problems in entering the maturity phase. The year 2000 was a complicated year for component demand. The mobile phone industry faced a severe component shortage in the first half of 2000. On the other hand, companies ended up with huge amounts of inventory

at the end of the same year. One of the most important reasons for this was the unrealistic plan of each mobile phone vendor. Each vendor had exceeded sales of 600 million units annually; yet actual production quantity was 410 million units annually (Nomura Research Institute 2001). Several reasons can account for this position, ranging from promising demand forecasts to a good economic situation in the United States. In the end, the material availability crisis led to improved cooperation with suppliers to ensure component availability.

The mobile phone products were getting smaller, dividing into different user segments, and the different functionalities increased (Nokia annual report 1998). One of Nokia's success criteria said to be a wide and diverse product range combined with efficient mass production. Nokia was a trendsetter in the design and renewal of the products, which was seen to be as important as production efficiency (Häikiö 2001). In 1998, a total of 17 new products were introduced. However, one should bear in mind that the implementation of new products usually started in Europe and the business development was slower in other markets.

4.3.2 Capabilities 1997-2000

4.3.2.1 Development of Demand Supply Network 1997-2000

The logistics shape-up (i.e. the ability to shape up and grow fast), triggered by the 1995 logistics crisis, led to improved operational efficiency and effective production, which then enabled the high growth. Simultaneous risks of price erosion, heavy volume growth together with obsolescence of products and components emerged. In 1997 the key objective in global logistics process strategy was to build and operate an integrated supply chain. The basic principles were to 'Plan for Capacity' and 'Execute to Order'. This meant that logistics planning captures market demand data and ensures that the correct production and materials capacity is implemented to meet the demand (figure 17). The challenges were growing product range with customization, evolving distribution channels and shortening product life cycles. The target was to maintain a

25-35 percent net sales growth target, which led to challenges in continuing to manage growth and excel in operations (press release July 24, 1998).

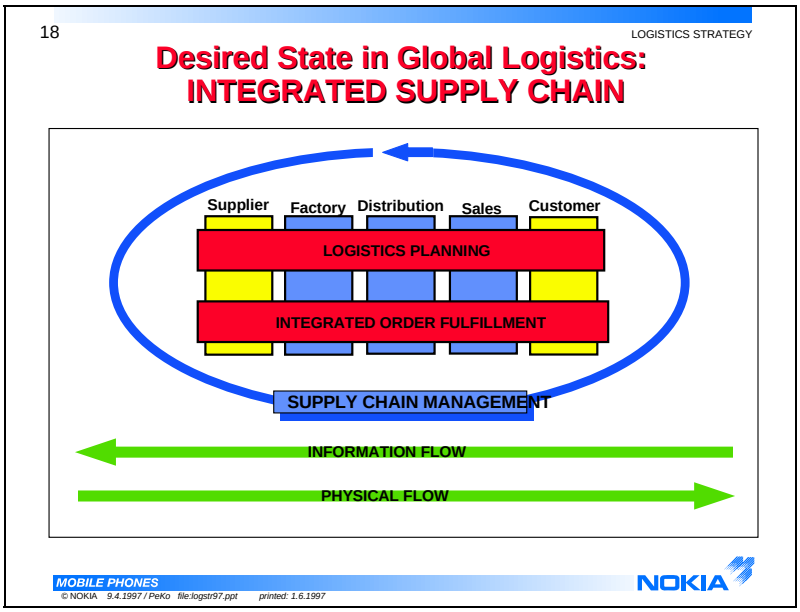


Figure 17. Plans for integrated supply chain (Nokia logistics strategy 1997)

Nokia decided to expand mobile phone production through major investments in Finland and Hungary. A new manufacturing centre was to be built in Hungary (press release July 27, 1998). When the factory was opened in 2000 Jorma Ollila, Nokia Chairman and CEO stated:

> *"In the rapidly growing mobile phone industry, efficient and flexible logistics processes and manufacturing capabilities are an important success factor, and the significance of the new Komárom site within Nokia's global logistics structure is very high. Today, in Komárom we are celebrating the opening of Nokia's 10th mobile phone factory." (Nokia Press release May 05, 2000)*

In 1998 the integration continued, with customers and suppliers, emphasising demand supply visibility to whole chain, integrated planning and "make to demand". A key strategic cornerstone in 1999 was to grow fast in order to achieve maximum economies of scale, but also to manage growth in the entire demand supply network.

In addition, the implementation of SAP R3 enabled for visibility and improved planning, as one company also enabled process standardization and integration. At the same time, together with growth scenarios, there was the initiative to develop a readiness to change with agile and lean growth. Nokia's target was not to build more factories nor increase its number of employees. Limiting the number of factories being built ended up being a very crucial decision. Instead, the capacity increase was achieved by improving design for manufacturability, improving processes, increasing flexible automation, outsourcing and orchestrating the demand supply network.

The material availability crisis of 1999 and 2000 led to improved cooperation with suppliers to ensure component availability. The strategy was to have a global supply network and capacity with global volume planning, priority to suppliers that would be easier to manage and offer Nokia better component availability than its competitors. Cooperation with sub-contractors and outsourcing was to leverage risks, but also to ensure the production efficiency and quality. The outsourcing strategy was not to outsource the customization of final product, but strategic outsourcing 20%-25% was used to balance volume fluctuation in engine manufacturing. The target was high capacity utilization in engine manufacturing and responsive final assembly to customer order. The primary role of Nokia was to be the orchestrator of the demand supply network. At Nokia, Orchestration meant managing the entire chain and outsourcing selected activities to demand supply chain partners: suppliers, contract manufacturers, logistics service providers and channel partners. In the demand supply network, capabilities and resources are combined into flexible networks without the ownership of all activities (Nokia Term bank). The renewal of the demand supply network was to be achieved by eliminating non-value adding activities and re-evaluating the ownership and partnership positions within the network.

The Inventory Days of Supply (DOS) measure became important after the logistics crisis. Inventory Carrying Cost was formed from interest cost, obsolescence, price erosion of procured components and warehousing cost. The other logistics measures On Time Delivery (OTD) and Order Fulfilment Lead time (OFLT) increased in importance. Cost measures as cost per produced phones became important and the

extensive growth and economies of scale helped cost reduction and efficiency improvement.

4.3.2.2 Manufacturing Capabilities 1997-2000

By 1997 Concurrent Engineering (CE) process had become a critical capability as well as Design for Manufacturing (DFM). The use of design for manufacturing simplified the production process and improved efficiency (figure 18). Design for Manufacturability also extended to cover the whole end-to-end demand supply network by introducing the Design for Demand Supply Network rules and taking a closer look at the number of Assembly to Order (ATO) variants and cost of variable parts.

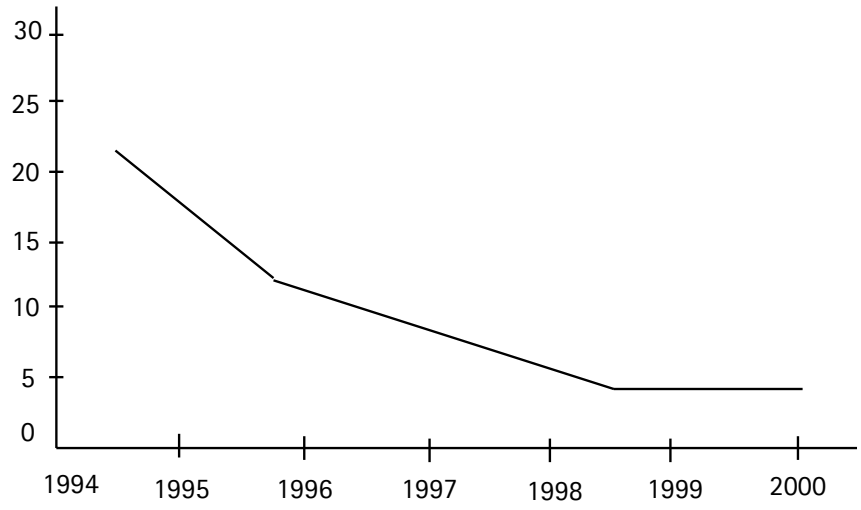


Figure 18. Development of hand time (minutes, Nokia internal material)

Integration of order fulfilment processes, begun in 1996, was the first step towards manufacturing to order and was mostly in place by the end of 2000 in the form of Assembly to Order (ATO) (figure 19). Subassemblies (engines) are built to stock in a process that has higher capacity utilization. The same engine can be used for a wide variety of final products. The more labour intensive final assembly is postponed until after customer orders are received, in order to allow Nokia to better address the high fluctuations in demand and the hundreds of sales variances per model. The ATO process results in high efficiency in internal operations (i.e. the ability to deliver

efficiently in volumes) and saves the burden of holding finished goods inventories (profit in the price competitive market) (Stanford case 2004).

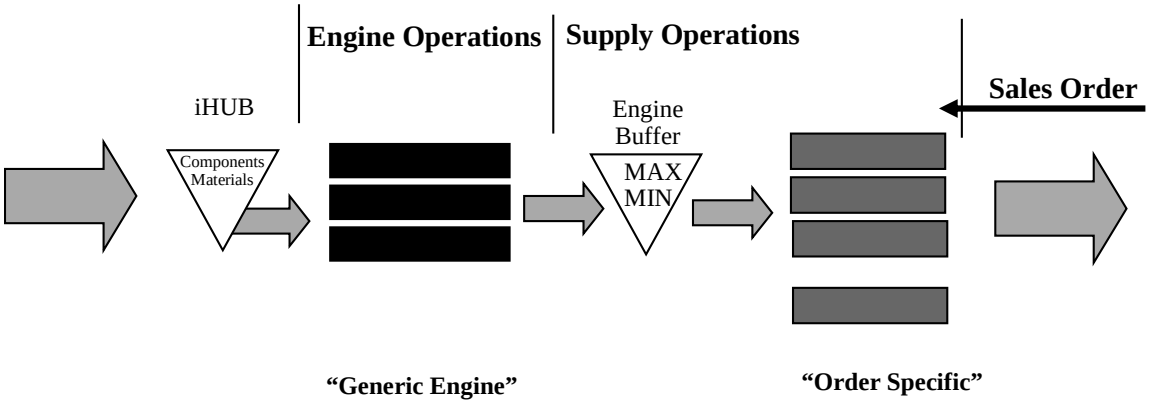


Figure 19. Nokia's ATO manufacturing process

Automation possibilities in final assembly area were looked at extensively, but finally it was decided that they would provide little benefit. The planned high volume and high automation line were found to be too expensive an investment and too inflexible to fulfil increasing customer requirements. The need for different, more diverse manufacturing capabilities was already seen in 1999; based on the more diverse product mix e.g. basic-mid products, more cost efficient products and more quality critical high-flagship products. The high utilisation of production lines was not as important as cost tied to working in process or into inventories. Towards the end of the era, volume change and product mix change became even more important, due to a wider product line and the need for dependable deliveries. In 1998-99 the importance of ramp-up capability also increased.

The processes implemented in the factories were not identical, since the foremost priority was to meet the volumes. At the time of fast volume growth, adapting the operations to the new situations was continuous and changes were implemented quickly (interviews). The huge growth, which Nokia experienced during the late 1990's, did not allow enough time to ensure all the required competences in all the sites. Also when phones and components were getting smaller and layouts tighter, it introduced new challenges to repair quality. This created an opportunity for Nokia in

the area of quality improvement. Manufacturing Failure Rate (MFR) and Field Failure Rate (FFR) became important quality measures.

4.3.3 Competitive advantage in 1997-2000

Throughout the second era of 1997-2000, operational excellence with superior product availability and efficient manufacturing process were the important value propositions (strategy materials) along with product leadership. Customer intimacy also began to be a significant concern and focus shifted from end-users to trade customers. Nokia's mobile phone business was very profitable and had a price advance based on its huge volume. Nokia was strong both in high-end and low-end models. In particular, the main models that supported Nokia's enormous growth were the 5100 series and the 6100 series (Nomura Research Institute 2001). Competitive advantage was provided by the ability to deliver efficiently and by the ability to slow down. The ability to profit in a price competitive market also became important when reaching the maturity phase.

During this time, the capability to grow and meet the demand requirements was important from the manufacturing point of view:

> *"The operations helped to meet the challenging delivery requirements through superior demand supply network, volume flexibility capability and scalable production that others did not have. Nokia was able to stop the growth on time and not having a huge amount of extra inventory. Since during the fast growth demand exceeds offering, the winner is whoever can deliver and increase capacity fast enough and improve the efficiency. The companies that are not prepared to high growth will suffer … Nokia succeeded in translating strong brand, product offering, industry-leading execution and operational efficiency into highly profitable results." (Nomura Research Institute 2001)*

This would not have been possible without the operational innovation that took place in the years 1996 and 1997. Continuous improvement was important in all three competitive priorities, but in this phase continuous improvement was also achieved through high volume growth providing economies of scale. Nokia was able to produce and deliver products better than anyone else leading into close to 40% of market share and high profitability. The interviews further strongly emphasised that without the fundamental logistics shape-up and the improvements through systematic work on Design for Manufacturing (DFM), which had already started in the previous era, there would not have been any gains.

Upon reaching the highest growth rate in the end of the 1990s, it was clearly stated in the manufacturing strategies that Nokia should not build more factories in the near future. Everyone should be prepared for sudden changes (i.e. the ability to slow down). The specific strategic statement was “No More People”. If growth were to continue it should be handled through improved efficiency, not by increasing workforce. Furthermore, the products were excellent in their manufacturability as compared to their competitors. This strategy proved to be an excellent one that assisted the transition from high growth into industry slow-down and into the maturity phase. A flat, networked organisation combined with speed and flexibility in decision making that are characteristics of the “Nokia way” also aided the transition. Nokia’s managers emphasised the importance of understanding the market and turning foresight into correct action at the right time (Interviews and Masalin 2003).

4.4 The third phase 2001-2003: Maturity

4.4.1 Business environment 2001-2003

The year 2001 was characterized by intense competition, extreme volatility and a weakened global economy. The mobile handset marketplace faced the first downturn in unit sales since it began, particularly in the GSM world, as sales declined from 407.9 m (2000) to 385 m (2001) units (ARC 2003). There was, however, solid growth and a return to stability in the industry as the year progressed. This was driven mainly

by the worldwide rollout of an array of compelling products with new technologies (such as handsets with colour screens, camera phones, MMS-capability, polyphonic ring tones, etc), which helped to speed up the increasingly important replacement market. Until 2000, the handset industry operated with virtually no inventory build-up, but inventory build-up was a problem for the industry in 2000. It had an impact on the 2001 market by forcing slow growth as operators cleared old stock (ARC 2003).

Even in this environment, Nokia achieved significant market share gains maintaining excellent profitability in the mobile phone business. Nokia increased its full-year market share in mobile phones for the fourth consecutive year, reaching approximately 37% — almost twice the 19% achieved in 1997 (Nokia annual report 2001). In fact, Nokia grew faster than the market, as illustrated in figure 13. However, in June 2001 Nokia saw a slower market growth affecting second quarter results. In 2002 there were further gains in the mobile phone market share, which raised both sequentially and year on year to over 38%. The economic conditions in the latter part of the year continued to be hard, but Nokia's profitability outlook remained very strong, reflecting the company's execution and operational efficiencies and strong product mix (Nokia annual report 2002). While the world economy had an inevitable impact on Nokia's top line growth, the overall profitability and market position were excellent and Nokia ended the year with the highest ever net cash position of EUR 8.8 billion. Mobile Phones saw a record sales volume of 46 million units in the fourth quarter. Nokia also shipped a record number of 33 new mobile phone products for the full year (Nokia annual report 2002).

At the beginning of 2000, the business environment was shaping up due to a maturing industry, growth slow-down, horizontalization, extreme volatility and uncertainty. The business was not just about competing with other manufacturers, but handset manufacturers still wanted to make profits after the initial handset sale. According to Gartner this will have complex implications for enterprises, mobile operators and consumers (Gartner research 2002). Mobile phone manufacturers were looking for both new sales channels and products that would generate income, even if the networks could not roll out new technology on time. They particularly needed annuity

revenue —money made from follow-on sales of products and services to a customer who had already bought a handset. The industry had become more mature, resulting in stiffer competition and shrinking profit margins. This change in the market environment forced mobile phone manufacturers to shift their focus from growth to financial performance and to adopt a more targeted approach towards customers (Stanford Case 2004). During the last quarter of 2003, Nokia sold 55.3 million phones, which was 20% more than in 2002. All this was done during the major restructuring of operations. Total volume for 2003 was 180 million, 18% more than in 2002. Sales revenues also increased 4% year-on-year in the fourth quarter.

Mobile phones used to be about talking – anytime, anywhere. Now they are devices used for sending and receiving data as well. Market segmentation by lifestyle has also been a growing feature of Nokia's product range since the late 1990s to the beginning of 2000. By producing handsets designed specifically for particular market segments, with associated applications, functionality and brand value, Nokia was enticing subscribers to upgrade their handsets or move onto data-enabled next generation networks. Operators, as well as handset manufacturers, were increasingly expected to provide combinations of these additional services as a means of differentiating their products. It is important to note that with the increased complexity of devices, and the desire for added functionality and features, comes an increased Bill of Materials (BOM). The importance of the software was increasing in addition to the number of ramp-up's and variants through customization requirements. Lot sizes continued to become smaller and lead times shorter. The uncertainty of demand continued to grow, especially in new product concepts. Design was a key parameter in the mobile handset market as vendors strove to make their devices easier to use and more appealing to the eye. In Europe, the mono-block form has been the most popular, being the cheapest design style to produce, and consists of a single unit. In Asia Pacific the clamshell design has been the most popular, where the screen and keypad are located on separate blocks that fold on top of each other. This allows for a larger screen and protection from breakage. The trend of miniaturisation seen in mobile handsets is set to continue. Components have become smaller and increasingly integrated, although the rate at which they are miniaturising has relented. In Europe, 90% of handset transit is via an

operator-controlled warehouse while most devices in China and India, for example, transit via independent distributors and operators who have little control over the process (ARC 2003, Nokia annual reports). What is interesting is that by 2003 Nokia was no longer seen as the trendsetter of the industry. Their basic design had not changed since the end of 1997, while customers were expecting and coveting more clamshell-type products (Nomura Research Institute 2001).

In November 2001, Nokia launched a total of nine new products: six mobile phones, including Nokia's first imaging phone, and three models targeted specifically for Asia Pacific, the fastest growing market, and three Bluetooth accessories. Product range became wider than before, spanning from low cost basic phones to wireless multimedia devices. It was Nokia's strategic intent to create 'Total Product Offering' running from terminals and accessories through to applications and services, hence an emphasis on appropriate applications (ARC 2003). In 2002 Nokia Mobile Phones was divided into business units focusing on different market segments with different business models. The main focus became to drive for profitable growth and focusing on different market segments through different business models (Nokia annual report). For the full year 2003 Nokia launched more than 35 new products, for a total of 80 products in production. The range of Nokia devices in 2003 are presented in appendix C. At the top of the extensive product range there is an enormous amount of customer variants. For example, let us take the 3510i variants: two assemblies to order engines, one hundred and sixty custom transceivers, and two hundred and sixty sales package variants (see figure 20).

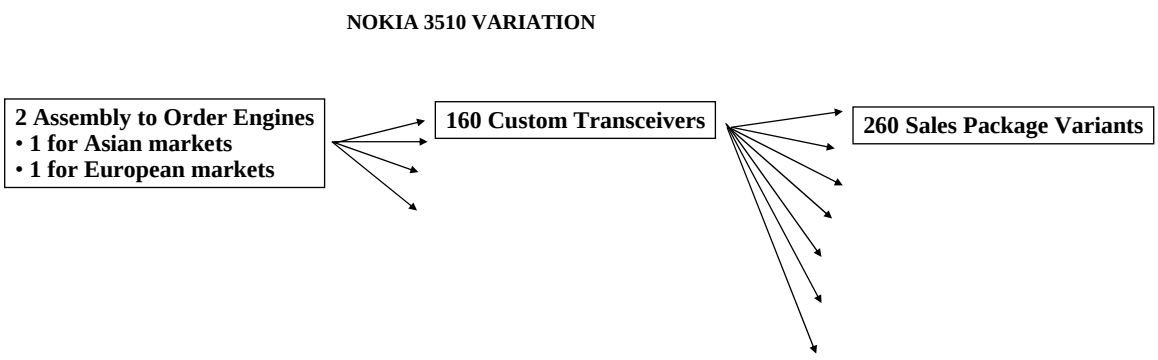


Figure 20. An example of product variation (Nokia, Kallasvuo 2003)

4.4.2 Capabilities 2001-2003

4.4.2.1 Development of Demand Supply Network 2001-2003

Changes in manufacturing trends and the handset vendors' pursuit of reducing costs have meant a massive shift in the preferred regions for global production and capacity management. This means an increasing trend to move mobile phone manufacturing plants away from higher cost regions to new facilities in areas with cheaper labour and lower costs of production, such as China, Korea, and South America. Manufacturers are now leaner, more efficient and far more aware of costs, both in production and marketing. Return on investment is paramount and the average unit selling price is becoming the key performance indicator for the industry (ARC 2003). ARC survey of 2003 showed that manufacturing costs are expected to fall dramatically over the next five years, for both high-end and low-end handsets alike.

The strengths in 2000 were seen as scalable, efficient, and with global volume manufacturing network having strong support from suppliers and the industry's best inventory rotation (figure 25). This was, however, average compared to world-class (see figure 28). The same principles from the end of the 1990's still applied: plan for capacity, execute to order, end-to-end integration, information visibility and replace inventories with information. The key business drivers for 2003 were once again increasing number of products and variants, smaller lot sizes, shorter lead times and cost pressure in the end-to-end chain. Even more emphasis was seen on Total Product Offering (TPO) and intensifying competition through higher quality and customer satisfaction and collaborative planning with channel collaborations offering (i.e. the ability to customise products and sources to customer needs). To avoid diluting Nokia's efficiencies in manufacturing and sourcing, the operations and logistics group were kept as common to all new business units.

Strong development was also implemented on the sourcing side where there was strong pressure for material cost reduction through strategic partnerships and limited number of suppliers (figure 21).

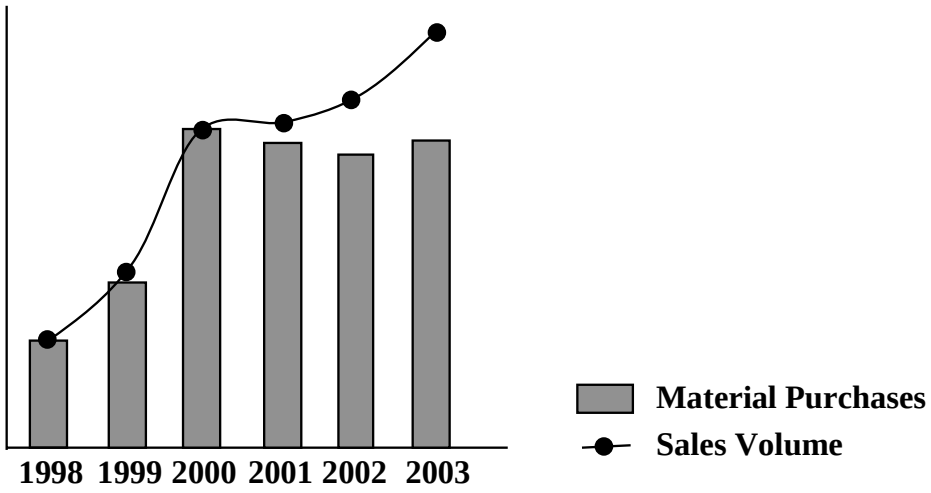


Figure 21. Material purchases (Nokia, Kallasvuo 2003)

While until 2001 the demand-supply network activities focused mainly on upstream integration with suppliers, in 2002 the focus shifted downstream, into the market. The target included improvement in on-time delivery and reduced order fulfilment lead time for Nokia, and increased planning accuracy and lower inventory levels for the customers (Stanford case 2004).

4.4.2.2 Manufacturing Capabilities 2001-2003

At the beginning of 2000, the core areas in manufacturing development were the enhancement of manufacturing practices towards leaner manufacturing, better manufacturing integration to Demand Supply Network, and achieving generic capacity and ramp-up capabilities.

Development of flexible and modular manufacturing concepts was seen as important towards the fast adaptation to the new business requirements. Instead of Design for Manufacturing more emphasis was placed on Design for Demand Supply Network and logistics capability. There was no major improvement in DFM metrics or in

efficiency mainly due to the increasing complexity of the transceivers. Therefore, volume growth created a need for increased capacity. In addition, there were some indications that strong DFM rules were limiting the innovative designs and form factors required by the markets.

In process design assembly-to-order (ATO) had become the critical capability to fulfil customer requirements and an increased number of product changes (i.e. the ability to customise products and sources to customer needs). ATO capability was systematically mentioned as one of the strongest enablers for increased flexibility.
Even more flexibility was required from existing old production equipment but no new major investment in production technology was necessary. Ramp-up target for a new product was seven days or less, in best cases only 2-3 days. Improved test times were better than the competitors', providing a competitive advantage. The harmonisation of processes and network of uniform manufacturing technology creating generic capacity became important.

The manufacturing costs per phone metric became more critical since the high cost pressure continued, but it was not the primary driver in all business models. The slowdown of the growth also triggered development of new business models looking for growth opportunities and led to a more divergent product portfolio (the ability to support new businesses). Cost was extremely important but not for all business models. There were products in different phases of life cycles with different business models. For example, the N-Gage gaming device was in the early market and not so cost constrained, while low category basic mobile phones in main street business were very cost driven. The average price for Nokia had fallen from 152 euros in 2002 to 130-133 euros in 2003. However, due to efficiency improvements, in 2003 Nokia still profited made a profit of 20-25% no each phone sold (*Helsingin Sanomat* 10.09.2003).
In achieving better quality, the Manufacturing Failure Rate (MFR) and the Field Failure Rate (FFR) measures became even more important, since low yields create more rework, scrap, lost sales opportunity and high warranty costs.

In the case study by Appelqvist and Vehtari (2003) the effects of new divergent manufacturing requirements were discussed in the scope of how to maintain operational efficiency. The current assembly-to-order (ATO) manufacturing concept is optimized for high-volume production of products in many variants, but with a small difference between different products and different variants. More diversified product portfolios are expected to require changes in manufacturing (i.e. the ability to support new businesses). The challenge lies in how to distinguish oneself from the competition and meet customer requirements, while at the same time achieving a clear cost benefit, i.e. providing value at the lowest cost. Customers enjoy low prices, but they also demand choice, even at the lower end of the market (Interviews).

> *"Altogether, we were manufacturing four products at the time we moved to the new Salo Factory at the end of 1994. Now we operate on up to twenty products and their numerous variants simultaneously. Earlier the markets took what we had to offer, and everything was sold. Now we produce what our customers want," Nokia manager explains. Fulfilling the customers' needs is the key." (OL Newsletter, Nokia)*

4.4.3 Competitive advantage in 2001-2003

In the third era of 2001-2003 customer intimacy increased in significance to become the most important value proposition. Operational excellence still remained strong and providing value at the lowest cost possible became even more important than in the previous phase (the ability to profit in price competitive markets). Product leadership also remained strong in the form of design and product renewal. The readiness for sudden changes and lean processes helped the company slow down in 2001, since if a whole supply chain cannot be slowed down at the right time, all phases will build up with inventory. The key points were whole demand supply network orchestration, networking and speed.

The economies of scale were also seen to create a competitive advantage in Demand Supply Network. The strategic focus areas were: fast adaptation to trade customer and

consumer needs, global capacity management and manufacturing flexibility and scalability to business needs. Manufacturing flexibility and scalability were achieved through strategic outsourcing and a flexible workforce. According to Nokia's top management manufacturing, logistics and sourcing is one of Nokia's competitive advantages: Kallasvuo (2003) said cost leadership comes from design for manufacturability, sourcing, cost efficient in-house manufacturing and effective sales and distribution providing cost benefit of 25 % compared to competitors, while the interviews emphasised that Design for demand-supply network is the foundation for industry leading profits. Regarding in-house manufacturing one of the interviewed respondents said "this production machine cannot be built in the short term nor be easily outsourced because we would then lose the efficient production and especially good cooperation between product creation and production". These comments were also supported by an AMR research report that names the top 25 companies embracing supply chain best practices and technologies - Nokia scored second best in the world (Reilly, K. (2004) AMR Research Supply Chain Top 25).

According to Nokia Strategy 2004, the business drivers that manufacturing and demand supply network directly impacts are quality, customer satisfaction and cost pressure. Strong impact was also felt in the diverse product range with various business models, an increasing number of customer variants, smaller lot sizes and shorter lead times. However, during this period there was inefficiency in meeting all diverse customer requirements, although there was a strong focus in improving the customization capabilities (Nokia ATO meeting in Beijing 2003.)

4.5 Synchronic and diachronic case analysis

The synchronic and diachronic case analysis was based on the triple comparative design adapted from Barley (1990) (figure 11). A synchronic analysis is particularly useful for making statements about capability development and comparing how capabilities are developed within each phase of the life cycle. In each phase relevant capabilities and measures were identified according to the theoretical framework literature review explained in Chapter 2.4 (figure 9). The use of a clearly defined

theoretical framework helped understand the changes in strategy and competitive priorities along the business life cycle, as well as how competitive priorities are linked to capabilities and performance. This improved the likelihood of an accurate and reliable theory, that is, a theory with a close fit to the data. Diachronic analysis helped to understand the capability and competitive advantage development over different life cycle phases and the chronological order of the events. Parallel analysis with comparison cases is explained in Chapter 5.

4.5.1 Manufacturing capabilities

The first research question was how do manufacturing capabilities and performance change in different phases of business life cycle? The case confirmed the assumptions made in the theoretical framework that manufacturing capabilities can be grouped by competitive priorities (price, flexibility, delivery, quality and service) and manufacturing performance can be grouped by time, quality and cost. On the other hand, capabilities are somewhat difficult to categorize, since they affect several competitive priorities at the same time and develop cumulatively. The summary of the main findings in each phase is presented in table 3. This table was built based on the case description, interviews and the strategy charting created during the case study (a more detailed table can be found in appendix D). The table was then compared to the summary table (table 2), based on the literature review. During the case analysis, the transition phases in particular, emerged as important phenomenon from introduction to growth and from growth to maturity.

Table 3. Summary of the Nokia case (based on case description, interviews and strategy charting)

Business Life cycle Phases	**Introduction 1992-1996**	**Growth 1997-2000**	**Maturity 2001-2003**
BUSINESS ENVIRONMENT			
Product	New paradigm –dominant design (hand portable GSM phones) Major product innovations	Customization, Product segmentation Minor product innovations	Different market segments with different business models Minor and major product innovations
Volumes	Low volume, but high growth	High volume and high growth	High volume, but slower growth
VALUE PROPOSITIONS			
Value propositions	*Product Leadership* (Technology leverage and integration, brand and end user recognition, product innovations)	*Operational Excellence* (Superior product availability, efficient process, economies of scale, focus on supplier management) *Product Leadership* (Design and renewal of products) *Customer intimacy* (Focus on trade customer needs starts)	*Customer Intimacy* (Total Product Offering, segments and tailored offering) *Operational Excellence* (Extreme cost – providing value at the lowest cost, able to differentiate) *Product Leadership* (Design still important)
COMPETITIVE PRIORITIES			
Competitive priorities	Flexibility	Delivery, price, flexibility, quality	Increased demand in price, flexibility, quality and delivery, additional services
CAPABILITIES			
Main Mfg and DSN capabilities	Ability to introduce new products -> Ability to shape up and grow fast	Ability to delivery efficiently -> Ability to meet sudden changes, to slow down and ability to profit in price competitive markets	Ability to profit in price competitive market -> Ability to support new businesses
Mfg Process life cycle stage	Disconnected line flow (batch) to connected line flow (assembly line)	Assembly to Order partly implemented in factories globally	Assembly to Order
Innovations	Major process innovations (Operational Innovation)	Minor process innovations , focus in implementation (Continuous Improvement)	Minor process innovations in manufacturing, some in DSN level (e.g. iHUB, clusters) (Continuous Improvement), Major process innovations still missing, but need identified

Value propositions and competitive priorities

Each phase had a main value proposition. In the introduction phase it was product leadership, in the growth phase it was the operational efficiency, and in the maturity phase it was customer intimacy. There were also supporting value propositions, particularly in the growth and maturity phases. In the maturity phase, the product range only became more diverse in the search for revenue growth. It seemed to agree more with Kaplan and Norton's theory (2000) in that the other two were important as supporting value propositions (table 3 and figure 22) and not so much with Moore's statement saying that two of the three value propositions were important in different stages.

Competitive priorities in the first era (introduction) were mostly in the area of flexibility (e.g. the ability to introduce new products and increase volume) (Kim and Arnold 1992, Utterback and Abernathy 1975) (figure 23). Continuous improvement in other areas was important as well, but was not the major order-winning criteria. In the second era (growth), delivery and price were the main competitive priorities and therefore the new measures such as Days of Supply (DOS) and On Time Delivery (OTD) became important. The importance of flexibility grew (e.g. the ability to make rapid product mix changes and to offer wider product line together with high growing volumes) (Kim and Arnold 1992), but so did the ability to slow down, even more so. In the third era (maturity), in addition to previous competitive priorities, service increased in importance through the ability to customise products and services to customer needs (Kim and Arnold 1992). Price with cost and efficiency measures were even more important because of cost pressure from the mature markets. Quality seemed to always be more of an order qualifier than an order winner criterion, however continuous improvement was needed along the life cycle (interviews).

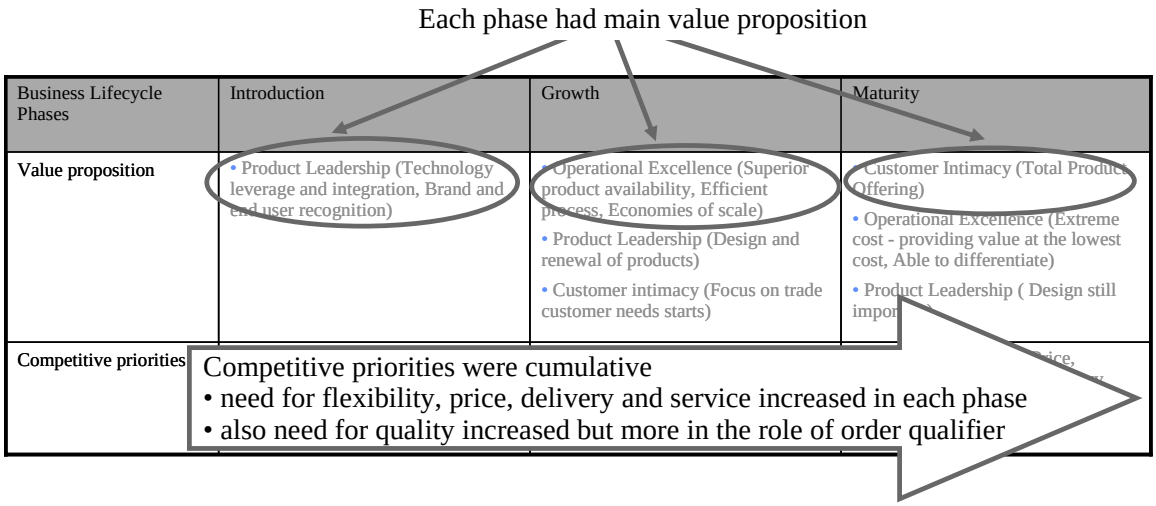


Figure 22. Value proposition and evolvement of competitive priorities in life cycle

Capability development and transition phases

The demand supply network and manufacturing capabilities developed over time before they fully started to contribute as value adding capabilities (Helfat and Peteraf 2003) (see figure 23). However, in such a fast paced industry, a development period of five to ten years, as suggested by Hayes (1985), Hayes and Pisano (1994), Schroeder and Flynn (2001), is simply not feasible. The main capabilities found in each phase fit well under a certain topic. In the introduction phase the main capability topic was the ability to introduce new products, in the growth phase the main capability topic was the ability to deliver efficiently, and in the maturity phase it was extremely price driven, but capabilities also turned towards a greater ability to support new businesses and customer intimacy.

A major new finding was the significance of the transition phases (figure 24). The finding was that capabilities development began in the previous phase before transferring to the next phase. It was interesting to see how the capabilities had already shifted during the phases, as shown in summary table 3. The first major process shape-up began before the first transition period and eased the transition into high growth. The preparation of sudden changes and simplifying processes (lean processes) also occurred before the slow down actually took place. In the maturity phase there were no radical changes in processes, rather the change consisted more of incremental

process improvements, as required by product diversification and segmentation. However, there were indications for a need of radical process improvement in order to keep up the market share or market share growth, or even entering the new S-curve, and to support new products and services. It is important, in developing the capabilities, to understand that in their introduction and development phases they contribute as order winners. In their maturity phase, when competitors have the ability to catch up, capabilities change more into order qualifiers. Stalk (1988) emphasised: the competitive advantage is a constantly moving target and the most successful ones know how to keep moving and always stay on the cutting edge. Continuous improvement was mentioned, important in all phases, but its importance increased towards the maturity phase when cost pressure was more intense (figure 23). One should also note that the capability to introduce new products is quite different in the introduction phase than in the maturity phase. The introduction phase is more of a "job shop" work phase that forgives mistakes, while the maturity phase has huge volumes and a wide product range with very short life cycles.

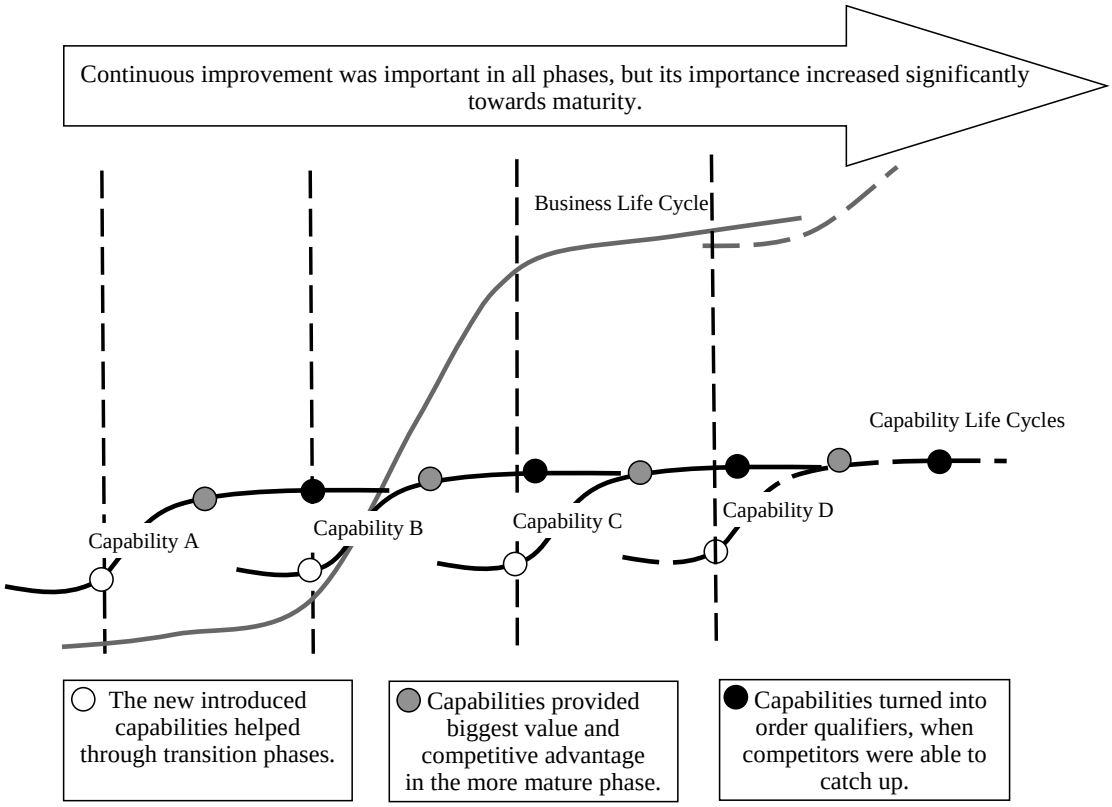


Figure 23. Capability life cycles and the their relationship to business life cycle

The main capabilities built over the years were either cross-functional or across companies. Figure 23 also indicates that the capabilities were built cumulatively and simultaneously, as suggested by Ferdow and Meyer 1990 and Roth and Miller 1992. In addition, they affected more than one area of competitive priorities (price, flexibility, delivery, quality and service). For example, design for manufacturing (DFM) and modular product structure were not just capabilities within the manufacturing function, but required capabilities built both in manufacturing and product creation. Integration of processes was a cross-functional exercise and extended over the demand supply processes and not just within manufacturing. The integration of processes and shape-up that took place in 1995-1997 could be categorized as operational innovation (Hammer 2004) (figure 24). A good example of capabilities across the companies was the improvement in sourcing process to ensure the availability of the components (interviews).

Manufacturing process life cycle stages and innovations

The manufacturing process did not follow the classical stages of Hayes and Wheelwright's (1979) model from one end to another (see figure 24). In the process development there was slight shifting from batch flow to connected flow when moving from the introduction phase to the maturity phase. The product in this case was a mobile phone, which evolved through a new paradigm to a dominant design. When the mobile phone products moved towards maturity, they started to have more customer specific variants and market segmentation. So the closer they reach the maturity phase, the greater the number of product types and variants only grew, as well as different services for customers. This required flexibility from the manufacturing system. Already in 1920, Sloan, the then-CEO of GM (General Motors), challenged Henry Ford with the idea that given alternatives, consumers would not prefer a uniform product. In Nokia the processes were planned to be flexible so as to facilitate the manufacturing of different products to customer orders already from the beginning of the introduction phase. Low price was not the main sales argument, but it was an important order qualifier.

Even with many products and many variants, the differences between the products and variants were quite small, such as colour and software variants, during the growth phase. The product structure consisted of a common body (engine) along with interchangeable variable components (Salvador et al., 2002). These mainstream products were well supported with the assembly to order process and never reached the lower right hand corner in the product-process matrix (Appelqvist and Vehtari 2004). However, there were indications that the setup was not ideal in the future for more complicated products based on new technologies or lowest cost, or more simple products. Making these products ATO-compatible has the danger of restricting innovativeness and design options, as was seen in the case company to a certain extent. The emerging, more diverse product groups would require different capabilities from each other and new ways of manufacturing, indicating a need for operational innovation (Appelqvist and Vehtari 2004). Furthermore, customisation of products was becoming more complicated and was assumed to require major process changes, figure 24.

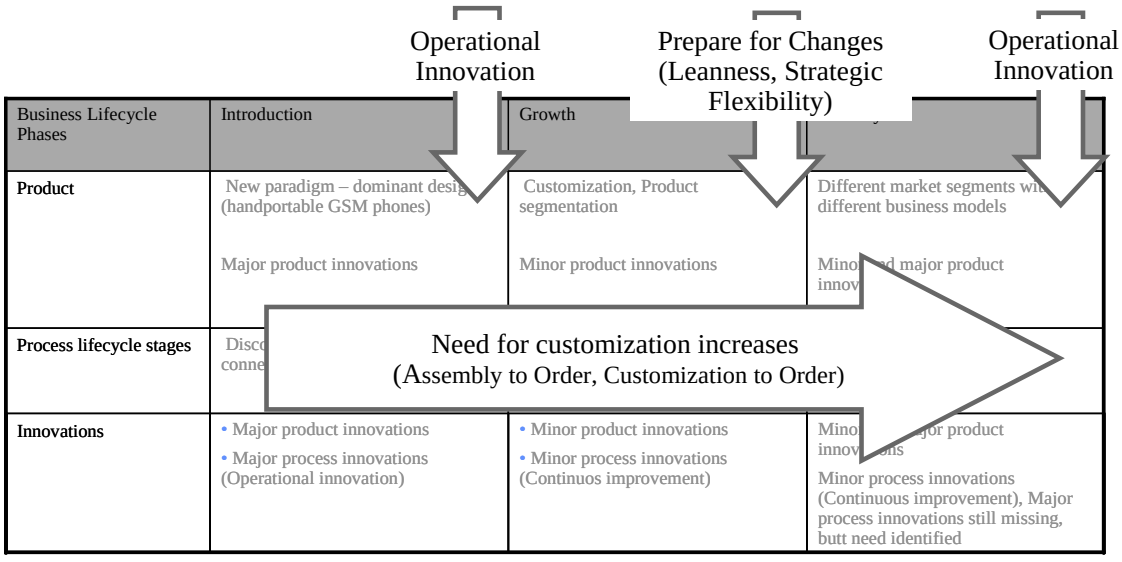


Figure 24. Product and process development

As predicted, the manufacturing technology did not follow the life cycle model and did not show major changes over the period of 1993-2003. There was an initial introduction of new technologies during the product introduction, but over the years only incremental technology improvements occurred in manufacturing equipments. Of

course, updating process equipment to newer versions improved process performance, but this was more of a steady, continuous improvement rather than a sudden change. The production technology development continues, since new products are introduced with new technologies. At Nokia, new product technologies and new production technologies are developed jointly. Nokia had plans for high volume automation but never realized them, since the flexibility of semi-automation and manual workforce proved to be more important in an environment where new products are constantly introduced with a high number of customer specific variants (Appelqvist and Vehtari 2004).

Innovations followed what Tushman and Nadler (1986) indicated: first, there is a substantial amount of product innovation that leads to the emergence of a dominant design. In the next stage, major product variation gives way to competition based on price, quality, and segmentation (i.e. process innovation rather than product innovation) (figure 24). Innovation is also a complex and uncertain endeavour, which shifts over time and requires the close collaboration of R&D, marketing, sales and production.

4.5.2 Manufacturing and business performance

There was evidence that manufacturing performance and business performance is connected, as indicated by the theoretical framework. The capabilities' greatest impact on performance occurred during the 'growth' phase (see table 4).

Most of the main performance measures in use today were introduced during the shape-up project in 1996. The performance metrics clearly show improvement in all areas (cost, time and quality) and were linked to business performance improvement. However, the direct link between individual competitive priorities and particular objectives was difficult to establish, since a higher emphasis on quality objectives does not necessary mean less emphasis on cost reduction (Kim and Arnold 1996). There was also no simple cause-effect relationship between single improvement

programs (Meyer and Ferdows 1990) (table 4). Since the figures are weighted averages of regional figures, each individual factory may have behaved differently.

The greatest improvements took place in the cost metrics of Days of Supply (DOS) and cost per phone. The deep cost performance improvement curves slowed down when volume growth slowed down. This was partly because, during the growth phase, economies of scale were achieved through volume growth and sufficient volume allowed costs to go down rapidly and then decline.

> *"The massive production volume, well over 500,000 phones per workday, helped Nokia to enjoy economies of scale and substantial research and development (R&D) resources." (Mawston 2003)*

This is in line with the Ketokivi and Heikkilä theory (2003), namely, that at the manufacturing level it is difficult to affect to scales benefits, since they are more company-level decision or environment-driven issues. But it can also be said that the largest gains occurred at the beginning of the introduction of new capabilities, such as better supply chain management and introduction of processes. Compared to the wireless OEM competitors, Nokia's inventory days of supply were an industry benchmark (figure 25).

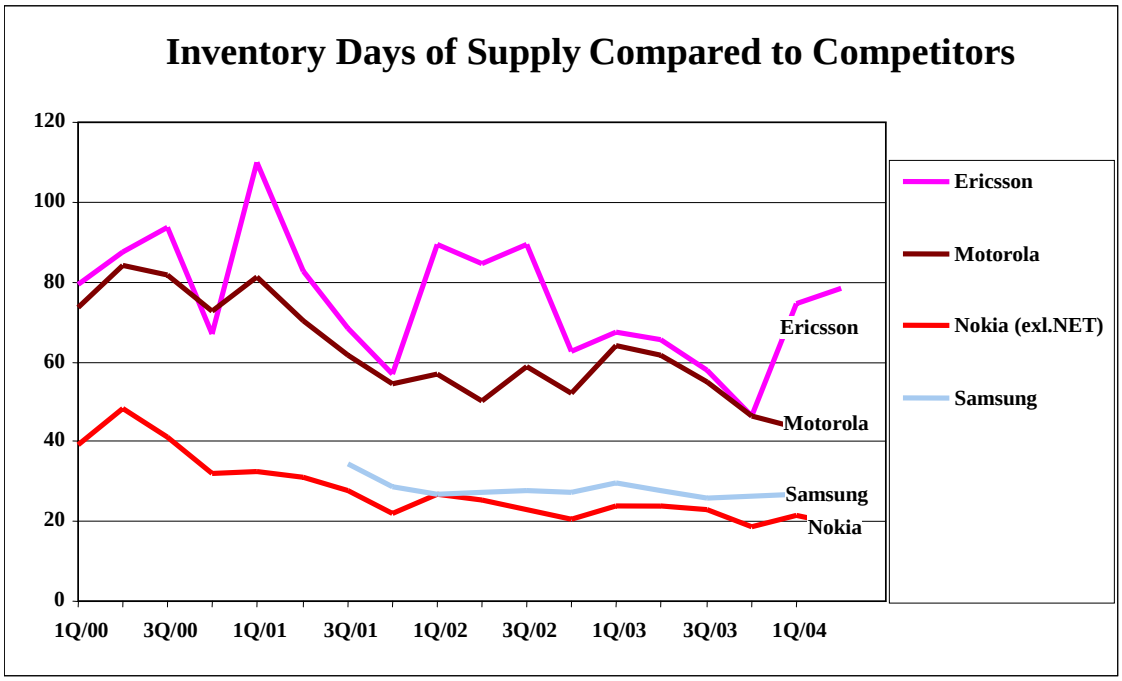


Figure 25. Inventory Days of Supply compared to competitors (quarterly reports)

The time metrics On Time Delivery (OTD) indicated that the greatest improvements occurred in 1999-2001 when the slowdown had already started. At this point, the demand and delivery capacity began to be balanced, following a period of very high growth. During the high growth period customers were also used to supply shortages, but during the slowdown and faced with more severe competition this was no longer an acceptable situation.

There were no common flexibility metrics available across factories or in the company operation and logistics scorecards, even though this was important from a competitive priority point of view. This confirmed the assumption made in the literature review that flexibility could be measured through cost and time (Kaplan and Norton 1996). Customers were also more interested in when they would obtain the product and the cost of the product rather than in internal flexibility measures. For example, mix flexibility was usually mentioned in that factories needed to have generic production lines for all products, but not as a specific measure of how many products per line. This was due to short product life cycles and frequent introduction of new products.

As reported in the interviews and contained in internal documents, quality was valued in all stages of the life cycle but more as an order qualifier than as an order winner. According to the interviews, Nokia's mindset was more on volume output and not primarily on quality. However there was continuous improvement in quality performance during the second and third phases. Unfortunately, detailed metrics of quality improvements for comparison from the first era and second were not available and are therefore excluded from table 4. In the maturity phase customers are requesting better quality and service. In this phase it is difficult to keep up with improvements in the metrics on account of the frequent new product introductions. It was seen that frequent ramp-ups with too immature products affected performance metrics.

Table 4. Summary of main performance metrics

Business Life cycle Phases	**1996**	**1997-2000**	**2001-2003**
Cost Metrics			
Total Inventory Days Of Supply (DOS)	160->70	60->40	30->
Manufacturing cost per phone (€)	20	10	5
Inventory carrying cost per phone	31.7	n/a	1.83
Time Metrics			
On time delivery (OTD) to 1st confirm (% improved)	n/a	+10 %	n/a
On time delivery (OTD) to customer request (% improved)	+25 %	+20 %	+ 15 %

The business performance measures show an improvement over the years and Nokia has been a strongly profitable company over the years, as previously discussed (table 5). White (1996) proposes that the most direct relationships between manufacturing capabilities and business performance are through decreased cost and, consequently, higher profitability. This was highlighted by the case findings as well. The sales and the volume growth rate were high in both the introduction and growth phases, but not until the growth phase with large volumes, did it became a real challenge to increase these volumes (table 5). There were also some differences among sales areas and individual factories.

Table 5. Summary of main business metrics

Business Life cycle Phases	**1992-1996**	**1997-2000**	**2001-2003**
Net sales (MEUR)	~600->3600	~4650->21900	~23200->23600
Market share	~21%	~21->36%	~35->38%
Profits (MEUR)	74->240	645->4879	4521->5483.00
Volumes (Mpcs)	~2->40	~40->130	~140->180

4.5.3 Competitive advantage

The second research question was how manufacturing can provide a competitive advantage in different phases of business life cycle, and do those capabilities change along the life cycle? The case study confirmed that the company had experienced competitive advantage and manufacturing had contributed to the competitive advantage, as indicated in the theoretical framework. The check lists created in Chapter 2.4.2 enabled us to check whether or not the case company had actually experienced competitive advantage, what the role of manufacturing proving competitive advantage was and how sustainable it was.

Manufacturing had a big impact from the competitive advantage point of view in the transition period (operational innovation), from introduction to growth by enabling cost efficient high growth. The second great impact was during the transition from growth to maturity (ready for sudden changes, lean and control), when it was essential to slow down the whole demand supply chain. The next transition had already started and it seemed that manufacturing and demand supply network would have a strong role (operational innovation) there as well as provide capabilities for new types of products and customer services, in search for the revenue growth.

However, it was not manufacturing alone, but rather how integrated processes aligned with value proposition of the company. As the value propositions shifted their order of importance as well as competitive priorities, so did the need for new capabilities to provide competitive advantage. When competitors started catching up, on manufacturability and cost efficiency, for example, a stronger need for customisation

and services emerged. Consequently, the internal strategy documents, the interviews and the external analysis highlight the importance of a three-dimensional competitive advantage, being Brand – Design – and efficient Demand Supply Network.

> *"The design of the phone (3650) is very clean with considerable attention to ease of manufacture. We believe that Nokia's attention to design and manufacturing detail is a key to its ability to maintain market leading handset-operating margins above 20%. We also note Nokia's fast follower strategy and exceptional brand identity. When this is combined with the company's design methodology, we believe it leaves Nokia in a unique position of offering high end features at mass market price points without endangering margin." (CIBC World Markets, Equity Research, Nokia Corporation Nokia 3650 Handset Analysis, February 28, 2003)*

> *"Nokia was a trendsetter in the design and renewal of the products, which was seen as important as production efficiency." (Häikiö 2001)*

Nokia's competitive advantage

The company's profitability was above the industry average. The company also achieved the market leader position during the high growth period, and value towards the customer was high. However, it is worth mentioning that a company can have great market share without profitability, but in this case both market share and long-term profitability were achieved (see table 5).

Strategic role of manufacturing

Nokia's demand supply network and manufacturing structure had evolved from functional to the integrated process enabling good capacity utilization in the engine manufacturing and responsive final assembly to a customer order. Furthermore, the role of DFM (the ability to introduce new products and ability to profit in price

competitive market) and modular product structure that enabled the assembly to order process (ability to deliver efficiently) were of key importance.

The alignment of manufacturing capabilities and the company's value proposition and corporate strategy was high. The capability development was proactive, particularly in the introduction and growth phases. In the introduction phase, manufacturing had a role in the ability to manufacture new products, and in the growth phase it was the ability to deliver efficiently. However, in the maturity phase, Nokia also suffered from a loss of product and design leadership, particularly on the North American markets. Nokia's design leader position was lost in approximately 2000, when competitors were able to produce innovative product designs. It was mentioned that strong standardization of the manufacturing process and design for manufacturing rules were preventing the implementation of new innovative designs. So, in the maturity phase there could have been a more proactive role in manufacturing capability development. The company was also able to respond quickly during the transition phases and capability development was cumulative and simultaneous. There is evidence that Nokia was a leader in bringing in new capabilities prior to its competitors, design for manufacturing (DFM) capability is one such example (Interviews, Ericsson Case).

Manufacturing highly impacted business performance with a higher level of internal and external collaboration and through a modular product, by reducing its manufacturing costs and inventory levels while improving operational efficiencies across its supply chain, thus also benefiting its customers and suppliers (Stanford case 2004). The competitive advantage created by the demand supply network can be highlighted by the following: ten days of inventories equals to 1 % in profit and that inventory carrying cost has decreased 94 % from 1995 to 2003 (Nokia). Therefore, inventory management has had a significant impact on the end result. Profitability with material costs account for 80% of the total cost of goods sold, and any improvement in inventory management and purchasing cost has also had a significant impact on the end result (Stanford case 2004).

According to the Stanford case (2004), keeping production mainly in-house and using outsourcing only to balance volume fluctuations, has allowed Nokia to retain control of key operations and minimize the risk of loosing key secrets, skills, or technology. Even though growth slowed down, the break for growth was done at the correct time; preparation for sudden changes, such as slowdown, had already started in 1999 (strategy material and interviews). The collaborative initiatives have also provided value to Nokia's business partners (interviews). Nokia's firm control of the key operations and collaborative initiatives were different from the case illustrated by Cisco during the industry downturn.

Sustainability of competitive advantage

The analysis shows that sustainability of the competitive advantage is low, which is an indication of the high clockspeed and instability of the industry. This confirms that sustainability of competitive advantage is highly dependent on the business environment in which the company operates. The entry of new competitors was high during the first phase, less during the high growth phase, but increased again during the maturity phase. The threat of substitutes was not very high during the growth phases but increased during the maturity phase. The bargaining power of the company improved while volumes grew. Competition in this highly volatile environment was high throughout all the phases, although the company's size enabled it to overshadow smaller competitors in the market and ensured the economies of scale.

4.5.4 Life cycle model for capability development

The research questions to be answered were how do manufacturing capabilities and performance change in different phases of business life cycle, and how can manufacturing provide a competitive advantage in the different phases of business life cycle. As it was defined earlier, a theory denotes a set of constructs that are systematically interrelated through statements of relationships to form a theoretical framework that explains some relevant phenomenon (Strauss and Corbin 1998). The case confirmed that requirements (i.e. competitive priorities) for manufacturing

capabilities change along the business life cycle and therefore, it can be used as tool to predict needed change in capability development (table 6).

Manufacturing can provide a competitive advantage if alignment between the manufacturing capabilities, the corporate strategy and the customer's value proposition is high and the capabilities development is proactive, which results in manufacturing performance's high impact on business performance. A company has a competitive advantage if profitability (relative position) is above the industry average and its market share and value to customer is high. The sustainability of competitive advantage can be improved by preventing the entry of new competitors, reducing the threat of substitutes, improving the bargaining power of buyers, lowering the bargaining power of suppliers and reducing rivalry among existing competitors.

Changing capabilities

Capabilities that provide competitive advantage change in the different phases of life cycle and, moreover, manufacturing needs to follow the requirements set by value propositions in order to provide a competitive advantage. The main value propositions seem to follow the order from product leadership to operational excellence and then towards customer intimacy. However, the competitive priorities were cumulative and the requirements towards the maturity phase were increasing (table 6).

Table 6. Life cycle model for capability development

Business lifecycle phases	Introduction	Transition phase 1 (from introduction to growth)	Growth	Transition phase 2 (from growth to maturity)	Maturity	Transition phase 3 (from maturity to growth)
Main value proposition	Product leadership	Product leadership	Operational excellence	Operational excellence	Customer intimacy	Customer intimacy
Main competitive priorities	Flexibility	Delivery	Delivery, price, flexibility, quality	Price, flexibility	Increased demand on price, flexibility, quality and delivery, Additional services	Increased demand on price, flexibility, quality and delivery, Additional services
Main capabilities	Ability to introduce new products *"Continuous Improvement"*	Ability to shape up and grow fast *"Operational innovation"*	Ability to deliver efficiently in volumes *"Continuous Improvement"*	Ability to sudden changes, to slow down *"Strategic Flexibility"*	Ability to profit in price competitive market Ability to customize products and services to customer needs *"Continuous Improvement"*	Ability to support new businesses *"Operational innovation"*

Transition phases

One of the main findings of the case study was that not only do the different life cycle phases matter, but even more critical to the company's success is the management of transition phases (table 6). In the transition phase it was critical to adapt the changes in the business proactively. Being proactive required that the needed capabilities already existed at least in their introduction phase. Capability development needs to be initiated in the previous phase in order for it to assist the company through the transition period successfully and provide a competitive advantage in the next phase. The capability will become more of an order qualifier than an order winner when it reaches maturity in its own life cycle and competition catches up.

Operational innovation, strategic flexibility and continuous improvement

New constructs, operational innovation, strategic flexibility and continuous improvement became very relevant for the study throughout the research process. The model indicates that operational innovation (Hammer 2004) is needed prior to entering transition phases from introduction to growth, while continuous operational improvement is needed along all the life cycle phases in order to keep up with the competition. There were indications that the new operational innovation would be required to enter into a new growth period provided by new diverse business requirements. The transition from growth to maturity gives the company an advantage if it is strategically prepared for change and has strategic flexibility. Being prepared for sudden changes also translated into lean growth and organisation at the end of the growth period, as well as targeting the next lower price point (Moore 1998).

5 PARALLEL CASES

Three comparison cases are presented here to compare the findings from the Nokia case. The case of Cisco will highlight the importance of being prepared for sudden changes in transition from growth to maturity. The case of Dell will highlight the importance of manufacturing supporting the business model and the leanness of the organisation. The case of SonyEricsson will highlight the importance of proactive capability development. Chapter 5.4 presents the summary and the findings that were used to update the life cycle model in Chapter 5.5.

5.1 Cisco

5.1.1 Introduction of Cisco

Cisco Systems, Inc. is the worldwide leader in Internet networking. Cisco Internet Protocol (IP)-based networking solutions are the foundation of the Internet and most corporate, education, and government networks around the world. Cisco provides a broad line of solutions for transporting data, voice, and video within buildings, across campuses, and around the world. Cisco was founded in 1984 by a group of computer scientists from Stanford University. Since the company's inception, Cisco engineers have been prominent in advancing the development of IP—the basic language for communicating over the Internet and in private networks. These technologies include advanced routing and switching, data, voice, and video over IP, optical networking, wireless, storage networking, security, broadband, and content networking (Nokia Annual Report 2001). Similarly to Nokia, Cisco highlighted in the mid-1990s the technological leadership of its products and worldwide brand awareness (Nokia Annual report 1997). In addition to technology and product leadership, Cisco is mentioned as an innovator in how business is conducted. Cisco was among the first companies to use the Internet to communicate with suppliers and customers, automate work flows among trading partners, and to use solutions such as remote product testing, which allowed suppliers to deliver quality results with minimal manual input. Cisco has outsourced the manufacturing of most of its networking products, but works closely with contract manufacturers to select the right locations to support its needs.

Cisco highlighted its development of a virtual supply chain with limitless capacity and its ability to provide extraordinarily high reliability to its customers (Cisco annual reports 2000 and 2001). This emphasises that Cisco considers its management strategic, even though manufacturing is outsourced.

> *"By implementing its own virtual supply chain, Cisco reduced inventory levels by 45 percent over the past six years and decreased the time to market for its products by as much as 12 weeks. "Virtual manufacturing" saves Cisco upward of $175 million in annual operating costs. Cisco will also provide networking products in a quick-start kit for suppliers to give component makers immediate and secure access to the site." (Cisco's Annual report 2004)*

On the other hand, figure 26 illustrates the inventory days of supply benchmark in infrastructure OEMS, where Cisco is higher in days of supply than Nokia.

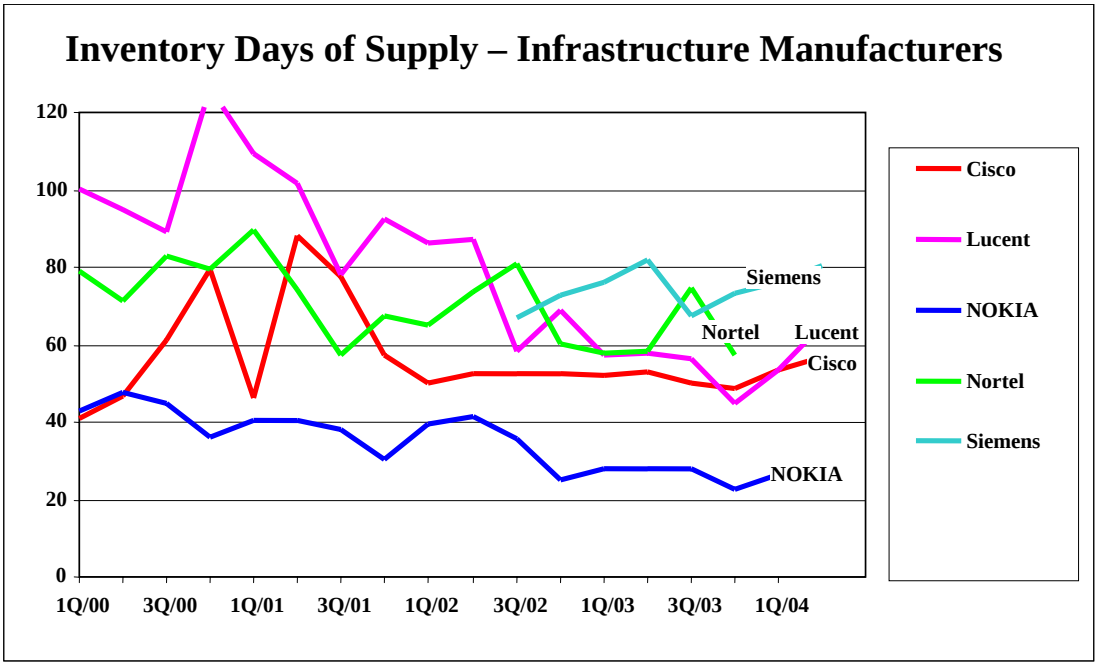
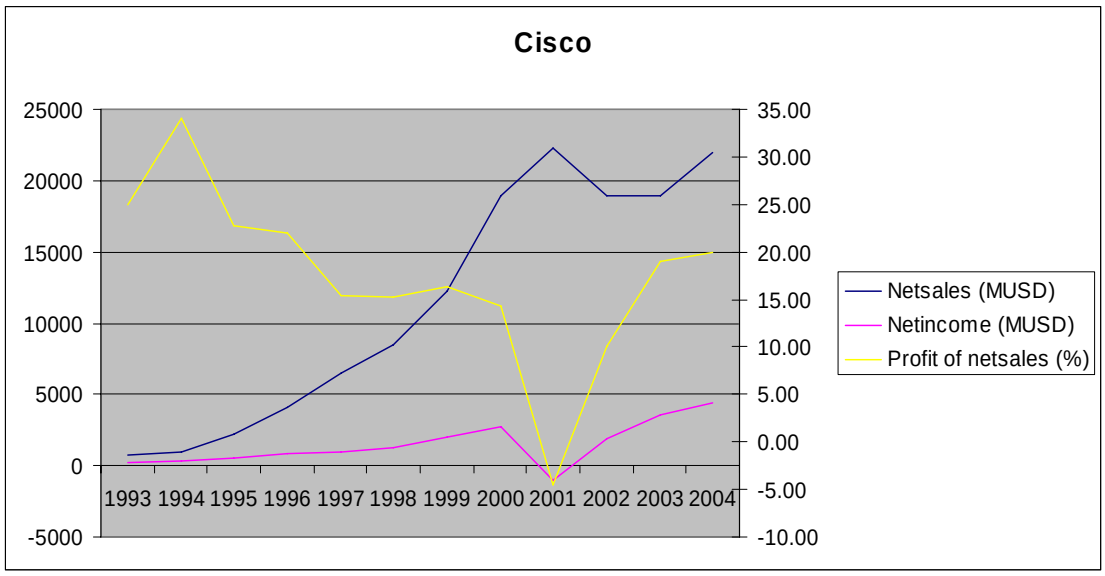


Figure 26. Cisco's inventory Days of Supply compared to Nokia (quarterly reports)

5.1.2 Growth of Cisco

Cisco's net sales and net income over the years from 1994 to 2001 shows a high growth rate similar to Nokia's during the period of 1996-2000, figure 27. By the end of 2000, the telecommunications infrastructure experienced a severe downturn, when customer orders began to dry up and Cisco neglected to turn off its supply chain. When compared to Nokia, Cisco experienced a huge drop in net income and recorded losses during 2001. Luckily, Cisco's virtual networking and outsourcing of manufacturing was able to recover quickly and resumed gaining profits again from 2002 onwards.



	Growth phase 1	Growth phase 2	Growth phase 3
Cisco	1993-1994	1995-2000	2001-2003
Compound Annual Growth Rate of sales	12	43	0
Compound Annual Growth Rate of profit	30	32	86
Average annual growth rate of sales	25	66	5
Average annual growth rate of profit	70	43	66

Figure 27. Cisco's net sales and net income (Cisco's annual reports)

The Harvard Business Review (2004) analysed why Cisco was forced to write off $2.25 billion in inventory. There were several factors at play, but the main culprit was the misalignment of Cisco's interests with those of its contract manufacturers. The contractors accumulated a large amount of inventory for months without factoring in the demand for Cisco's products. Even with the US economy slowdown, contractors

continued to produce and store inventory at the same pace. Finally, Cisco found it could not use most of the inventory of raw materials because demand had fallen sharply. The company had to sell the raw materials off as scrap (Harvard Business Review 2004).

Cisco ended up with a mountain of subassembly boards and semiconductors it did not need due to its supply chain partners' behaviour over the previous 18 months. Cisco does not own production facilities, so it passes orders to contracted manufacturers. These contractors had stockpiled semi-finished products because demand for Cisco's products usually exceeded supply. They had an incentive to build buffer stocks since Cisco rewarded them when they delivered supplies quickly (Narayanan and Raman 2004). Many contractors also boosted their profit margins by buying large volumes from component suppliers at prices lower than that Cisco had negotiated. Since the contractors and component makers had everything to gain and nothing to lose by building up excess inventory, they worked overtime to do so without worrying about Cisco's real needs. When demand declined in the first half of the fiscal year 2000, Cisco found that it could not cut off supplies quickly. Moreover, it was not clear what Cisco had asked its suppliers to produce and what the contractors had manufactured in anticipation of Cisco's orders. Many contractors maintained that Cisco had implicitly assured them it would buy everything they could produce. Since Cisco hadn't stipulated the responsibilities and the accountability of its contractors and component suppliers, much of the excess inventory ended up in its warehouses. The supply chain imploded because Cisco's partners acted in ways that were not in the best interests of the whole supply chain (Narayanan and Raman 2004). Cisco was blind sighted to the possibility that demand might not continue and was not able to scale down as quickly as expected. Apparently Cisco had outsourced manufacturing of its essential components without a full understanding of the changes required in their business model (Lakenan et al. 2001). What they lacked was the ability to react quickly to sudden changes in the business environment. Cross-company problems were more difficult to detect and incentives were not well aligned (Narayanan and Raman 2004).

In 2001 Cisco emphasised moving forward with more focus on customers' needs, market-share gains and growth opportunities in emerging markets as well as profit contribution. As examples of two new growth markets Cisco mentions the IP telephony and security markets (Cisco annual Report 2001, 2004). Cisco saw that its customers' needs changed hence it must move beyond reactive maintenance services and more toward advanced services, such as network optimization (Rossman 2004).

5.1.3 Cisco's capabilities

In the introduction phase the ability to introduce new products and technologies was also Cisco's main focus. In the early 1990s, the problem Cisco faced in its supply chain was scaling up manufacturing operations in times of massive technology and market change. The market was growing very rapidly and Cisco wanted to move to a Build to Order model for customers and developed its virtual factory network. Cisco's supply chain initiatives allowed the company to scale manufacturing operations cost effectively while constantly raising its levels of quality. The Internet and networked applications allowed customers and employees easy access to self-service, users to configure (price and route) and submit electronic orders directly to Cisco (www.oit.umd.edu, www.cisco.com). In the transition phase from high growth to slow down Cisco missed the ability to face sudden changes, but fortunately it was able to recover quickly (table 7).

Table 7. Cisco main capabilities in different life cycle phases

Business life cycle phases	Introduction	Transition phase 1 (from introduction to growth)	Growth	Transition phase 2 (from growth to maturity)	Maturity	Transition phase 3 (from maturity to growth)
Main value proposition	Product / Technology leadership	Product / Technology leadership	Operational excellence	Operational excellence	Customer Intimacy	---
Main competitive priorities	Flexibility	Delivery, Flexibility	Delivery, price, flexibility, quality	---	Delivery, price, flexibility, quality, additional services	---
Main capabilities	Ability to introduce new products and technologies	Ability to grow fast, ability to configure products to order	Ability to deliver efficiently (virtual factory)	*Missed* ability to face sudden changes, to slow down	Ability to recover fast, ability to offer more advanced services	----

5.2 Dell

5.2.1 Introduction of Dell

Michael Dell founded Dell in 1984 on the simple concept of selling computer systems directly to customers. According to Dell, they could best understand customer needs and efficiently provide the most effective computing solutions to meet those needs. Revenue totalled $49.2 billion and the company employed approximately 55 000 team members around the globe in 2005. Dell's product line includes desktop computers, notebook computers, network servers, workstations, and storage products (www.dell.com).

The company manufactures its computer systems in six locations: Austin, Texas; Nashville, Tennessee, Eldorado do Sul, Brazil (Americas); Limerick, Ireland (Europe, Middle East and Africa); Penang, Malaysia (Asia Pacific and Japan) and Xiamen,

China (China). Dell sells its products and services worldwide. Dell has Sales Offices in over 40 countries, distributors in 190 countries and 46,000 employees worldwide.

Much of Dell's good financial performance is said be attributed to its successful implementation of this direct-sales model (Kapuscinski et al. 2004). Dell's direct model enables the company to excel at demand management. The process of selling directly to customers and building product to order creates opportunities for true real-time collaboration and synchronization between manufacturing and sales. By being in direct contact with the market, Dell can quickly identify changes in customer demand. Synchronization (along with the recent shift to a seven-day-a-week operation) then allows Dell to respond faster to customer demand than its competitors can. Additionally, internal collaboration allows for highly accurate forecasts (Fugate and Mentzer 2004).

The ability to adapt quickly to changes in demands is crucial to a good demand management (Fugate and Mentzer 2004). Dell is well known for having a unique corporate culture that complements its aggressive approach to innovations and new ideas. In fact, the company has what has been billed as a "maniacal approach towards execution". The ability to remain flexible is a critical skill for fitting into this culture. According to Fugate and Mentzer (2004), the Dell management team's speed of execution is a result of the team members' flexibility and ability to make fast decisions. In the Harvard Business Review interview (Magretta 1998), Michael Dell also mentions that:

> *"… Looking for value shifts is probably the most important dimension of leadership… "*

Other more traditional PC manufacturers have been locked into their more traditional channel and distribution strategies and are unable to transform. The five tenets of the Dell model are (www.dell.com): Most efficient path to the customer, single point of accountability, build-to-order, low-cost leader and standard-based technology.

Figure 28 shows the superiority of Dell's Inventory Days of Supply when benchmarked against competitors and Nokia. Dell's operating expense ratio to sales is less than 10 percent whereas most of the competitors' is over 20 percent (Dell 2002).

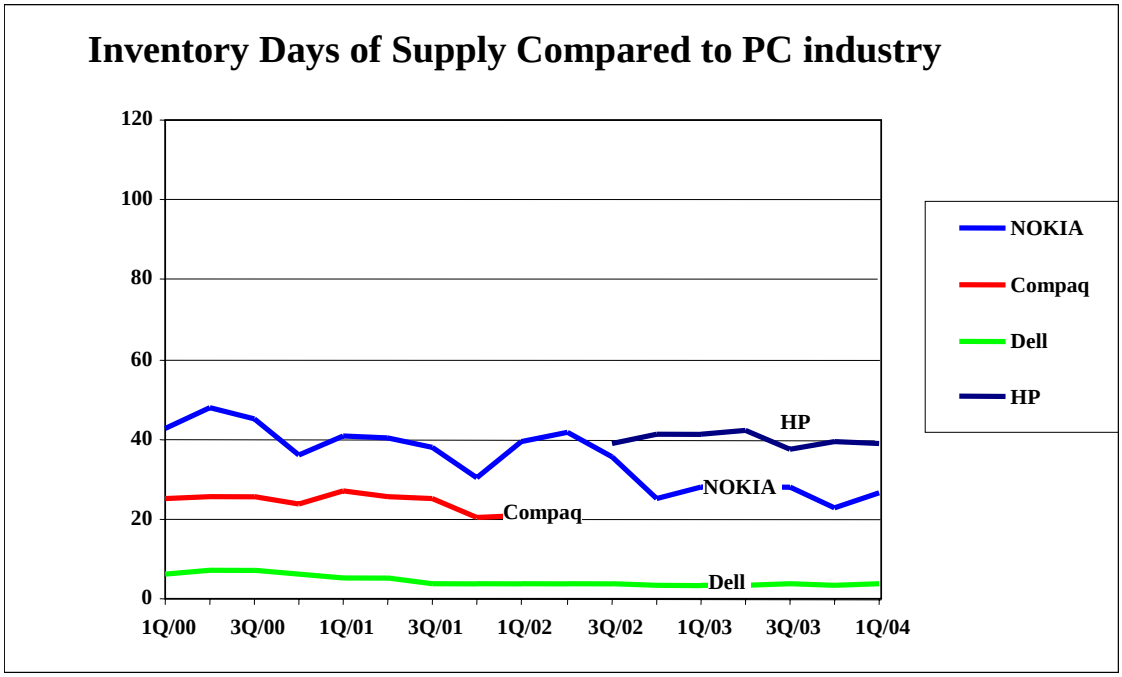
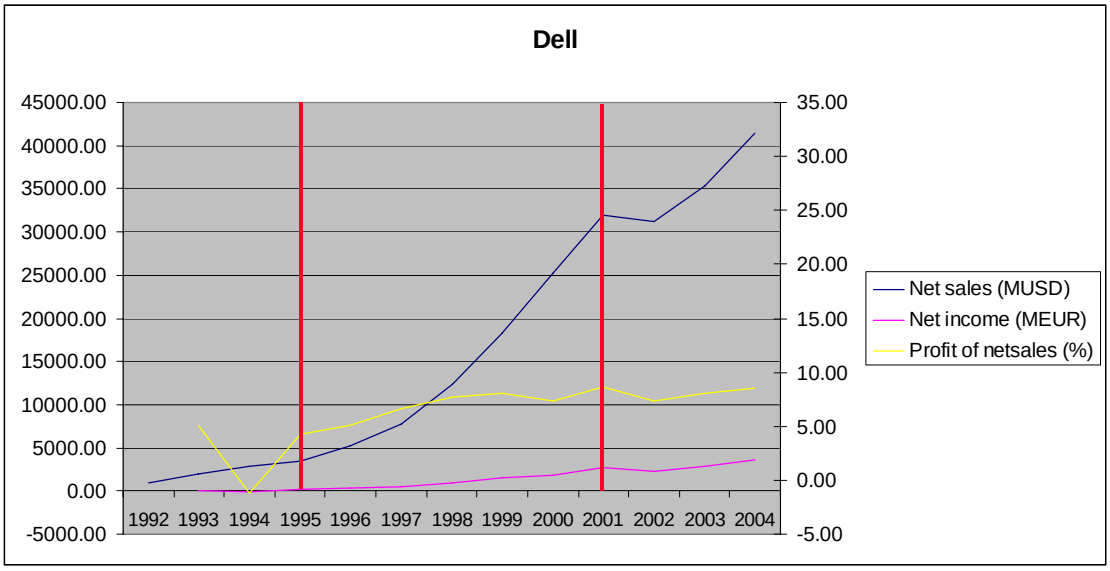


Figure 28. Dell's inventory Days of Supply compared to Nokia and HP (quarterly reports)

5.2.2 Growth of Dell

Similarly to Nokia and Cisco, Dell has clearly experienced three different life cycle phases from introduction to high growth and to maturity, but has also increased its net sales well into the maturity phase (see figure 29 for Dell's sales and profit growth in years 1992-2004). The figures for the years 1984-1992 were not significant for the analysis of this growth. Despite the 2002 "hiccup", Dell's business life cycle does not show any signs of slowing down nor does it indicate the slow growth typical in a saturated market. However, the overall market has profit margins of 10 percent and computers are considered as commodity products, which is typical in the maturity phase.



	Growth phase 1	Growth phase 2	Growth phase 3
Dell	1993-1995	1996-2001	2002-2004
Compound Annual Growth Rate of sales	20	43	10
Compound Annual Growth Rater of profit	14	59	16
Average annual growth rate of sales	22	45	9
Average annual growth rate of profit	23	77	11

Figure 29. Dell growth phases (www.dell.com)

First growth phase 1984-1996

When Michael Dell founded the Dell Computer Corporation in 1984, he had a simple business idea of selling directly to customers and building products to order. This direct business model gave Dell Computer Corporation a substantial cost advantage (Magretta 1998). As a small start-up Dell couldn't afford to create every piece of the value chain, but focused on where it was able to add value. Dell also talks about virtual integration and blurring the traditional boundaries and roles in the value chain (Magretta 1998).

In 1990 the manufacturing centre in Limerick, Ireland, opened to serve the European, Middle Eastern and African markets. In 1993 Dell joined the ranks of the top-five computer system makers worldwide (www.dell.com). However, in 1993 Dell Computer Corporation also reported a stunning setback in its notebook-computer operations and an unexpected drop of more than 48 percent in its first-quarter profits (Hayes 1993). One of the business mistakes Dell made was entering the retail channel in the early 1990s. They took products into computer superstores, because they saw

this as a hybrid of the traditional computer store and Dell's direct model. However, this move was incredibly confusing for the organisation. Although retail appeared to be a way to obtain incremental revenue, it turned out to be unprofitable. Michael Dell said: "We evaluated the decision, agreed that it was a bad idea, and closed down those operations. We learned from that and moved on" (www.dell.com).

In 1994, Dell was still a struggling second-tier PC maker. Like other PC makers, Dell ordered its components in advance and carried a large amount of component inventory. If its forecasts were wrong, Dell would experience major write-downs. Then Dell began to implement a new business model. Its operations had always featured a build-to-order process with direct sales to customers, but Dell took a series of ingenious steps to eliminate its inventories. The results were spectacular. Over a four-year period, Dell's revenues grew from $2 billion to $16 billion, a 50 percent annual growth rate. Earnings per share were increased by 62 percent per year. Dell's stock price increased over 17,000 percent in a little over eight years (Byrnes 2003).

Second growth phase 1996-2001

In his article Byrnes (2003) explains how the new Dell business model developed over a period of time. Profitability management, coordinating a company's day-to-day activities through careful forethought and excellent management were at the core of Dell's transformation in this critical period. Dell created a tightly aligned business model that enabled it to manage away the need for its component inventories. Not only was capital not needed, the change also generated enormous amounts of cash that Dell used to fuel its growth. Dell also led the commercial migration to the Internet, launching www.dell.com in 1994 and adding e-commerce capability in 1996. The following year, Dell became the first company to record $1 million in daily online sales. Today, Dell operates one of the highest volume Internet commerce sites in the world (www.dell.com).

The new business model was phased in, with component inventory dropping from seventy days to thirty to forty days, then to twenty days, then to nearly zero. At the same time, the sales force was trained to "sell what you have." As the new

profitability management system emerged and proved viable, Dell moved aggressively to refine it and to bring the other functional activities into tight alignment. (Byrnes 2003). Dell used the freed-up cash to fuel its growth, chiefly in major corporate accounts. In order to win this business from the resellers, Dell had to convince the accounts that its products were of comparable quality, and that it could meet the necessary service and the delivery requirements. It was widely thought that Dell's build-to-order model could not meet delivery requirements of major accounts. Once Dell demonstrated that it could build to specific customer orders and meet delivery and quality requirements, growth followed. This dynamic enabled Dell to catapult to first-tier status. (Byrnes 2003).

In 1997 Dell shipped its 10-millionth computer system. In 1998, Dell's return on invested capital was 217 percent, and the company had $1.8 billion in cash (Byrnes 2003). That same year the company expanded manufacturing facilities in the Americas and Europe, and opened a production and customer centre in Xiamen, China. In 1999 Dell opened a second major U.S. location in Nashville, Tennessee (www.dell.com).

According to Byrnes (2003), as inventory dropped, lead time performance improved. The reason was that Dell was not simply carrying component inventory against forecasted sales, but rather was aligning inventory and sales, managing profitability on a daily, weekly, and monthly basis. Secondly, as inventory disappeared, the company's returns grew disproportionately. Not only did Dell avoid carrying costs and obsolete stock, but it was also saving enormous amounts of money on purchasing components because the component prices were dropping 3 percent per month (Byrnes 2003).

Third growth phase 2001-2004

In 2001, for the first time, Dell ranked number one in global market share (www.dell.com). Even at the desktop computer level (which most people would consider a commodity), Dell actually has quite a profitable business in the manufacturing of such commodity products, because of being the low-cost provider (www.dell.com).

Though the computer hardware industry was once booming, in recent years the industry has experienced a decrease in profits. Much of this is due to the downturn in the economy and decreased consumer confidence and spending. The decrease in profits also mirrors the consumer's decreased need to upgrade. The technology provided by computers is not growing at the rate tit once was, which means that consumers can continue to use older computers to meet their needs. In 2005 "Dell's efforts remain focused on four strategic initiatives: driving global growth, attaining product leadership, continuously improving the customer experience and enhancing Dell's winning culture" (www.dell.com).

Based on the Michael Dell interviews over the last 10 years, we see that Dell's business has become much broader, growing from PCs to mobility products to servers, storage, and services that are used in the IT world. As the prices of computing systems continue to decrease, there are emerging markets around the world that will be able to afford technology that they once couldn't. China and India are both fast growing markets for Dell and overall, there is enormous market potential over the next five to ten years (Michael Dell Remarks, Round Rock, Texas, in February 2005). The differentiation in products is not tremendously significant from one to another. "There are bigger differences in the business model and service levels, and in the profit Dell is able to generate", Michael Dell remarked in 2005.

> *"I believe the most important factor has been our business model. The way we provide our products and services to our customers is radically different from competitors. We've been able to expand that across a broadening array of products and services and geographies – while continuing to deliver superior value to customers. This has allowed us to grow and return healthy profits to our shareholders at the same time." (Michael Dell Remarks, Round Rock, Texas, February 2005)*

5.2.3 Dell's capabilities

It is said that Dell's success comes from continuous innovation and improvement of its direct marketing formula, as well as the use of the Internet and build-to-order manufacturing (Maglitta 1997). Build-to-order means that Dell does not maintain months of aging or expensive inventory. They provide customers with exactly what they want in their computer systems through easy custom configuration and ordering. As a result, they are able to provide customers with good pricing and the latest technology for those features they really desire. Each assembled computer receives customer address at the end of the assembly line. Customer fulfilment is 2 – 5 days from customer order placement with more than 50% of these orders being placed in the Web (www.dell.com). Since the introduction phase, Dells' targets were efficient delivery, build-to-order, and low cost, based on standard-based technology. This was different from the more product and technology leadership approach of Nokia and Cisco in the introduction phase. It seemed that Dell's main value proposition was customer intimacy throughout all phases. But operational excellence was as important in supporting the business model and in the growth phase. In the competitive priorities (delivery, flexibility, price) there also seemed to be no significant shifts. But a shape-up of the business model and the build-to-order model was required in order to achieve high growth and profitability (table 8). The Dell case also highlights the importance of the ability to make fast decisions. In their search for new growth Dell highlighted the importance of low cost and ability to support emerging markets and different service levels.

Table 8. Dell main capabilities in different life cycle phases

Business life cycle phases	Introduction	Transition phase 1 (from introduction to growth)	Growth	Transition phase 2 (from growth to maturity)	Maturity	Transition phase 3 (from maturity to growth)
Main value proposition	Customer intimacy	Customer intimacy & Operational excellence	Customer intimacy & Operational excellence	Customer intimacy	Customer intimacy	Customer intimacy
Main competitive priorities	Flexibility	Delivery, flexibility, price	Delivery, price, flexibility	*Not known*	Delivery, flexibility, price	Delivery, flexibility, price services
Main capabilities	Ability to build to order	Ability to shape-up and grow fast (Dell Model)	Ability to deliver efficiently configurable products, Ability to profit in price competitive market	Speed of execution, ability to make fast decisions	Ability to deliver efficiently configurable products Ability to profit in price competitive market	Ability to support new emerging markets (low cost) and different service levels

5.3 SonyEricsson

In their article, Comstock et al. (2004) discussed the flexibility and speed of Ericsson's operation (later combined to SonyEricsson). In the early 1990s Ericsson was one of the leaders in the mobile telephone market, based largely on its ability to design and produce some of the most technologically advanced mobile phones in the world (see figure 13). Nokia soon became the market world leader and in 2000 Ericsson had dropped to the world's fourth largest provider of mobile handsets, with a 10% share of the overall market (Ericsson 2000). Nokia had, at the time, introduced a popular series of customized mobile telephones at the entry-level market segment. Ericsson decided to react with a similar product. The new telephone achieved only limited success in the marketplace, with sales far below expectations. One likely

contributing factor to the new mobile phone's poor market reception was its long-delayed introduction on the market; in fact, while new to the Ericsson's product line, the user-changeable covers concept had been introduced by its primary competitor, Nokia, approximately two years earlier (Comstock and Johansen 2001, Comstock et al. 2004).

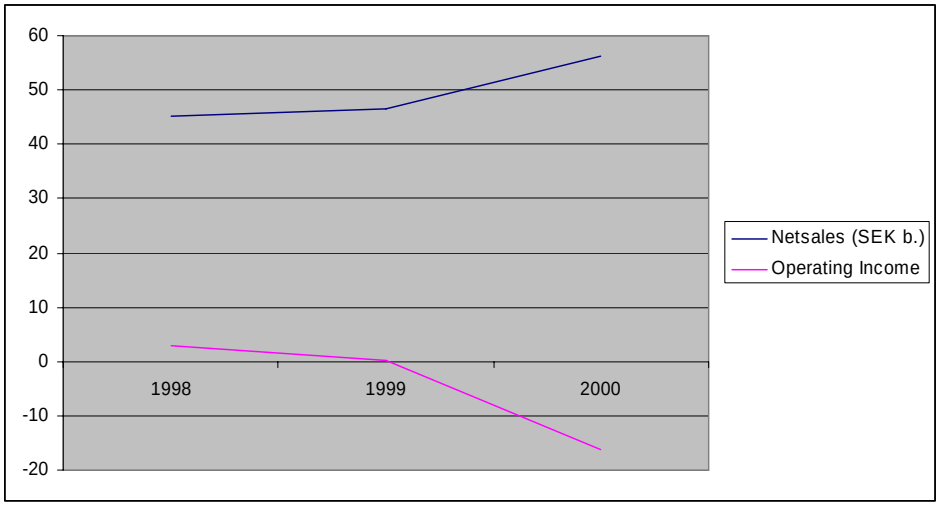


Figure 30. Ericsson Consumer Product's net sales and operating income 1998-2000 (www.ericsson.com)

From 1998 to 2000 Ericsson's net sales grew from 45.2 billion SEK to 56.3 billion SEK (figure 30). The sales growth was 21 percent in 2000. Nevertheless, the operating income turned into losses in 2000. From 1998 to 2000, the amount of its employees increased by approximately 19 percent. At Nokia, the amount of growth in personnel between 1998 and 2000 was 50 percent, but sales growth was an enormous 66 percent. In comparison, Nokia's sale was 0.8 MEUR/person, whereas Ericsson's sale was 0.37 MEUR/person (at the then current exchange rate) in 2000. Consequently, from 2001 onwards, the Ericsson mobile phone business was integrated with Sony, forming a unit called SonyEricsson.

By the end of the 1990s, the level of automation in the company's mobile phone final assembly in high labour cost countries, such as Sweden and the United States, had peaked. At these locations, nearly all of the final assembly and testing processes, with the exception of the packing, were automated (Comstock et al. 2004). In countries

with lower labour costs the final assembly process remained largely manual. During 2001 the company decided to outsource its complete manufacturing function, which signalled a trend backwards to manual assembly. With an external assembler, it is expected that the manufacturing of mobile phones will shift towards low-wage countries, where final assembly is primarily a manual process. This was different from Nokia's strategy, where production flexibility was seen as more important than the cost savings generated from an automated assembly (interviews). At Nokia, even in high wage countries such as Finland, United States and Germany manufacturing was kept in-house and was done mainly manually in order to achieve the needed flexibility.

5.4 Summary of parallel case analysis and findings

The cases of Cisco and Dell similarly followed the Nokia case and supported the viability of the life cycle model for capability development, presented in Chapter 4 (table 6). The case of SonyEricsson also supports the findings of how important it is to proactively develop capabilities. All cases demonstrated a shifting in value propositions and capabilities along the business life cycle. In the cases of Cisco and Dell exact competitive priorities and capabilities with development starting times were, of course, difficult to estimate, since there was no access to internal strategy documents or internal performance measures. But some shifting in competitive priorities and capabilities could be estimated based on the existing literature and the company web sites. Also, in the cases of Cisco and Dell, there was no access to future strategic goals and plans, which made it difficult to validate the transition phase from maturity to new growth. In the case of SonyEricsson only a snap shot of one phase was investigated.

The value propositions clearly shifted in the case of Nokia and Cisco from product leadership, through operational excellence towards customer intimacy. Dell's main value propositions were, since the beginning, customer intimacy combined with operational excellence, although some shifting was seen over the business life cycle towards more intimacy and the need for more diversified services. Nokia and Cisco

presented more clearly the need for shifting capabilities than did Dell. This supports the idea that when value proposition changes the capabilities need to be aligned accordingly. In Dell's case the ability to introduce a new business model was the main capability in the introduction phase rather than the ability to introduce new products. In the growth phase the capabilities were the ability to grow fast and deliver efficiently in high volumes. Therefore, Dell demonstrated that even though the value proposition did not clearly change along the business life cycle the need for capabilities to shift was needed.

In the introduction phase both Nokia and Cisco needed the ability to deliver new types of products and technologies, while Dell relied more on the existing standard technologies. All three cases needed the ability to shape up and grow fast in order to enter the high growth phase. For example, the transformation of Dell's business model had already started prior to the high growth period, similarly to Nokia's process innovation. In the growth phase, all three companies needed the ability to deliver efficiently, but also to maintain the flexibility to achieve configurable products. Cisco and Dell relied on an Internet-based configuration and served better customer specific configurations, while Nokia concentrated more on self-created variants. Nokia did not start until well into the maturity phase to create real configuration capabilities. Nokia and Dell excelled at managing sudden changes, while Cisco failed in slowing down. Both Nokia and Dell also emphasised the importance of supplier collaboration, already in the growth phase. In the maturity phase, all three companies saw tighter cost requirements together with increased service and configuration needs. Dell differed from Nokia in that product differentiation as such was not seen in the maturity phase, even though the products range widened. However, Dell similarly saw new emerging markets and service level differences. Therefore, the flexibility and need to serve different businesses in the manufacturing increased. The case of SonyEricsson highlights how important the proactive cross-functional capability development is, particularly when entering the high growth possibility.

In the process development both Nokia and Dell relied on in-house assembly to order process and with a more cell-type of production. Cisco, on the other hand, did not

have in-house manufacturing, but considered managing the entire supply chain as strategic. SonyEricsson outsourced manufacturing when their mobile phone business was already in trouble.

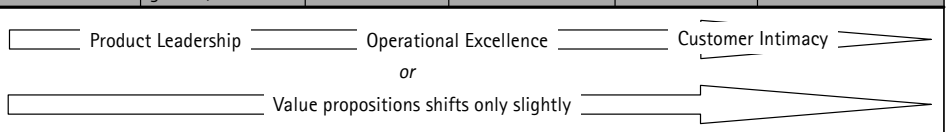
Dell's profit of net sales in the maturity phase was 10 percent, while Cisco was able to achieve 20 percent and Nokia over 20 percent. However, in the computer industry, a 10 percent profit is a great achievement. Compound annual growth rates for sales were over 40 percent in all three companies. Nokia had the largest revenue growth in growth phase 2. Even though Cisco suffered one bad year with big profit losses, it was clearly able to recover best in the growth phase with a compound annual growth rate of 85 percent.

5.5 Modified life cycle model for capability development

Chapter 4.5.4 presented initial ideas for the life cycle model for capability development based on the Nokia case. The conclusion was that requirement (i.e. competitive priorities) for manufacturing capabilities change along the business life cycle and therefore can be used as a tool to predict needed change in capability development (table 6). Table 9 presents the modified model for capability development based on the additional cases presented in Chapter 5. The main change in the table is that while value propositions do not necessarily change significantly, the needed capabilities will shift regardless of whether value proposition changes or not. Of course, manufacturing needs to be well aligned to the company's main value proposition, but its position on the life cycle will also set requirements for the capabilities. There can also be two equally important value propositions, as in the case of Dell. Additionally, the cases confirmed that competitive priorities and capabilities are cumulative and that requirements towards the maturity phase are ever increasing, particularly for low cost and customer service. Both Cisco and Dell highlighted the stronger need for configurability already in the growth phase. Moreover, the cases confirmed that management of the transition phases is critical to the company's success. The capability development needs to be started in a previous phase in order for it to provide a competitive advantage and be of assistance during the transition

period. The additional cases also confirmed the need for operational innovation or industry shaping to ensure growth and continuous improvement between the transition phases, as well as the need for strategic flexibility prior to maturity.

Table 9. Updated life cycle model for capability development

Business lifecycle phases	Introduction	Transition phase 1 (from introduction to growth)	Growth	Transition phase 2 (from growth to maturity)	Maturity	Transition phase 3 (from maturity to growth)
Main value proposition						
Main competitive priorities	**Flexibility**	Delivery	**Delivery, price, flexibility, quality**	Price, flexibility	**Increasing demand on price, flexibility, quality and delivery, Additional services**	Increasing demand on price, flexibility, quality and delivery, Additional services
Main capabilities	**Ability to introduce new products or new business models** ***"Continuous Improvement"***	Ability to shape up and grow fast *"Operational Innovation"*	**Ability to deliver efficiently and Ability to configure to order in high volumes** ***"Continuous Improvement"***	Ability to sudden changes, to slow down Ability to profit in price competitive market *"Strategic Flexibility"*	**Ability to profit in price competitive market** **Increased ability to customize products and services to customer needs** ***"Continuous Improvement"***	Ability to support new businesses and new growth *"Operational Innovation"*

6 ENFOLDING LITERATURE

The summary of the main case findings on manufacturing capabilities, performance and competitive advantage, together with a proposal for life cycle model, were presented in Chapter 4.5.4. The modified life cycle model for capability development was presented in Chapter 5.5 based on the parallel case findings. Chapter 6 enfolds how the existing literature on the manufacturing capability development, the manufacturing's strategic role in providing a competitive advantage and the life cycle model supports the findings from the case studies. Other relevant constructs (operational innovation, strategic flexibility and continuous improvement) that emerged during the case study are also discussed in more detail. An essential feature of theory building is comparison of the emergent concepts, theory, or hypotheses with the extant literature (Eisenhardt 1989), whether the literature supports the case findings or not.

6.1 Manufacturing capabilities and performance

The Nokia case supported that capabilities were somewhat difficult to categorise and affected several competitive priorities at the same time (price, flexibility, delivery, quality and service). This is consistent with the theories of Wheelwright and Bowen (1996) and Pandza (2003), noting that capabilities are also unique to each company, and may not even be easily recognised and categorised. As suggested in the literature, companies are more likely to address multiple manufacturing capabilities simultaneously, which supports the rationale behind the cumulative model (Noble 1997, Meyer and Ferdows 1990, Roth and Miller 1992). Furthermore, as Mills and Platts (2002) proposed, the architecture exist in reflecting the collection of individual services, routines, and competences into higher-level competences, which at the highest level are recognized by customers as offering particular levels of performance on competitive factors.

However, the Nokia case confirmed that capabilities can be grouped by competitive priorities (Kim and Arnold 1992) and performance measures by *cost, time* and *quality* (Kaplan and Norton 1996). Surely many other categorization methods will work as well, but it is important to identify the order winning criteria and know the qualifying criteria as well (Hill 1983). Manufacturing's competitive role is to specify these priorities and pursue them through consistent structural and infrastructural decisions (Wheelwright 1984 and Kim and Arnold 1992). The case also complied with Kaplan and Norton's theory (1996) that virtually all value propositions incorporated into measures related to time, quality and price. As previously stated, a direct link between individual competitive priorities and particular objectives may be difficult to establish, since greater emphasis on quality objectives does not necessarily mean less emphasis on cost reduction (Kim and Arnold 1996). Quality seemed to always be more of an order qualifier than an order winner criterion, although continuous improvement was needed along the life cycle. There was also no simple cause-effect relationship between single improvement programs and manufacturing performance, and some action programs became effective only after a fairly long transition period (Meyer and Ferdows 1990).

Since the value propositions shifted in their order of importance as well as competitive priorities, so did the need for new capabilities to provide competitive advantage. When competitors started to catch up on e.g. on manufacturability and cost efficiency, for example, a stronger need for customisation and services emerged. The more mature capabilities still supported the company as order qualifiers when new capabilities emerged more as new order winners (Hill 2000). The capabilities aligned with the main value proposition seemed to provide the greatest competitive advantage, while capabilities supporting the other two value propositions seemed to further help the business performance. This was in alignment with Kaplan and Norton's (2000) ideas of strategic internal business processes. The case of SonyEricsson highlighted the importance of early introduction of new products and capabilities and the consequences of responding later to competitor offerings. It also highlighted the need for manufacturing to have flexibility to support the emerging needs of markets.

The link between manufacturing and business strategy lead to improved business performance (Gupta and Lonial 1998), especially through improved Days of Supply (DOS) and cost per phone. However, in Nokia's case, the deep cost performance improvement curves slowed down when volume growth slowed down. This is in line with the recent studies of Ketokivi and Heikkilä (2003) that at the manufacturing level it is difficult to affect to scales benefits, since they are more of a company level decision or environment-driven issues. Nokia's market share when entering the maturity phase was 35 %, while its next biggest competitor, Motorola, had a market share of only 15 %. The benefit of economies of scale was of tremendous advantage to the market leader. Moore (1998) named the market winner as the "gorilla" and indicated that the market leader position won in the tornado phase (growth) would remain also during the main street phase (maturity). Additionally, the Nokia case highlighted that modular product design also contributes to economies of scale. Economies of scale are gained in materials usage by creating a range of modular systems, which, when combined, make a larger volume, from which customers can choose (Brown 1996). This contributed as a cost advantage but also in providing leanness to the organisation, which became important during the transition into the maturity phase.

6.2 Competitive advantage and strategic role of manufacturing

Following the initial work of Skinner (1969), many agree that the strategic choices in manufacturing need to be competitive, enabling manufacturing to do certain things better than competitors (Clark 1996, Fine and Hax 1985, Hayes and Pisano 1996, Berry et al. 1999) and more so if properly operated and achieving strong performance outcomes (Wheelwright and Hayes 1985, Hayes and Wheelwright 1984). The cases validated that operations can have a significant impact on the bottom line, such as through superior demand supply network, inventory management or product manufacturability. In the Nokia case, manufacturing had the biggest impact from the competitive advantage point of view in the transition period from introduction to growth by enabling cost efficient high growth. The second big impact was during the transition from growth to maturity (ready for sudden changes) when it was essential to

slow down the whole demand supply chain. This was well emphasised when the cases of Nokia and Cisco were compared and it was shown how the companies handled the industry slowdown in 2001. These findings are not found in current literature to this extent; however Moore (1989) indicated that the role of manufacturing should change in different phases of the life cycle.

The case findings are consistent with the idea (Porter 1998, Hayes 1985, Prahalad and Hamel 1990, Barney 1991) that a company has competitive advantage if it is profitable, has a high market share and its value to customer is high. A company with a small market share may, however, have a competitive advantage by serving niche markets and have a relatively high market share compared to the competitors in that particular market area. The cases also proved that in the high-speed environment described by Fine (1998) competitive advantage is not very sustainable (Porter 1998, Barney 1991) since the market situation changes and competitors are willing to catch up. As Stalk (1988) emphasised, the competitive advantage is a constantly moving target, and the best competitors, the most successful ones, know how to keep moving and always stay on the cutting edge.

The purpose of thinking and managing strategically is to gain competitive advantage, implying an attempt to mobilize manufacturing capability to help to gain a competitive edge or even significantly contribute to the competitive success of the organisation (Mintzberg 1978). In the cases of Nokia, Dell and Cisco the alignment between capabilities and company value position was high, thus supporting the ideas of Hayes and Wheelwright (1984), Porter (1998), Treacy and Wiersema (1993) and Voss (1995).

Furthermore, the strategic choices are needed because manufacturing has a limited amount of resources for implementing the required manufacturing capabilities for competitive advantage. Also, according to Brown (1996), process choice is a major strategic decision; no amount of reactive, tactical measures can hope to compensate for inappropriate investment in the wrong processes, which do not match the market requirements in which the firm is competing. It was suggested that in a high-

clockspeed environment, the flexibility of generic manufacturing resources outweighs task similarity benefit of dedicated resources (Appelqvist and Vehtari 2004). The challenge is how to differentiate from competitors and meet customer requirements, while at the same time achieving a clear cost benefit, (i.e. providing value at the lowest cost) (Porter 1980). The case companies faced significant challenges in making the comprehensive system-wide transition to customer responsiveness. The attitude should be that winners will be those that build products according to customer needs and in deference to the customers themselves. Both Nokia and Cisco primarily focused on product technologies and product leadership, but now emphasise the importance of customer intimacy and service offerings in their strategies (www.nokia.com and www.cisco.com).

6.3 Life cycle model for capability development

The case improved the understanding of market value propositions and competitive priorities when preparing for transition from one phase to the next. This was in alignment with the literature that the life cycle model can be used to describe the evolution of processes, and an industry or branch of industry (Porter 1980). The life cycle model emphasises the idea of value propositions and competitive priorities shifting as a product matures. However, not all individual products will go through every phase of the business life cycle and the length of the time will vary for products to stay in a particular point of the life cycle (Brown 1996). Furthermore, not all businesses will necessarily have shifting value propositions. But the case indicated that in order to provide competitive advantage, capabilities must shift along the business life cycle. The life cycle model can be used to predict the need for process innovations, for example.

The Nokia and Cisco cases confirmed that different phases of life cycle have different main value propositions and the manufacturing strategy should be aligned with the company's value proposition to the customer (Moore 1998, Tracey and Wiersema 1993). In the introduction phase the main value proposition was product leadership, in the growth phase it was operational efficiency, and in the maturity phase it was customer intimacy. There were also supporting value propositions, particularly in the

growth and the maturity phases. This is consistent with Kaplan and Norton's (2000) saying that companies must excel in one process that will have the maximum impact on its customer value proposition, while the other two are supportive. Moore's idea (1998) that the value propositions will experience major changes along the life cycle was not supported in the Dell case. Dell's focus was not in product creation or new technology development but in providing direct delivery and adding value to customer starting in the introduction phase. However, Dell seemed to have in its growth phase two equally important value propositions: customer intimacy and operational excellence. This was somewhat indicated by Moore's assertion (1998) that there could be two equally important value propositions while Kaplan and Norton proposed that only one is to be excelled at.

The competitive priorities shifted in all cases, even if the value propositions did not change as significantly. As Treacy and Wiersema (1993) stated, manufacturing needs to be well aligned to the company's main value proposition, but its position on the life cycle will also set requirements for the capabilities. The cases illustrated that in the introduction phase competitive priorities were mainly in the area of flexibility (e.g. the ability to introduce new products or business models and increase volume) (Utterback and Abernathy 1975). In the growth phase, improving cost and delivery times were the main competitive priorities along with flexibility. In this rapidly growing industry growth ensures that firms can improve results just by keeping up with the industry (Porter 1980). In the maturity phase, in addition to the previous competitive priorities, service increased in importance through its ability to customise products and services to customer needs (Kim and Arnold 1992). Cost and efficiency measures were even more important because of increasing cost pressure from the mature markets. D'Aveni (1994) described it as "hyper competition", where demands for flexibility, delivery speed and innovation are ever increasing. The findings in the maturity phase also comply with the conclusions of Ranta (1997) and Smeds (1994), in that evolution in the first phase of the product (or industry) seems to obey the classical life cycle model, but after reaching the maturity phase both market and product innovations lead to market segmentation and product diversification, which in turn leads to a highly dynamic interactive system. As an example they mentioned the implications of "lean

manufacturing" as the radical process innovation, bringing an additional element to the classical life cycle. On the other hand, Tushman and Nadler (1986) discussed process innovation discontinuity over the product life cycle as occurring only in the growth phase and not in the case of a mature industry evolving again through a process innovation. It is also worth noticing that the cases demonstrated that market segmentation, product diversification and especially the need for configured products had already begun in the transition phase from the introduction phase to the growth phase. This is consistent with the findings of Pantzar and Ainamo (2004). In their recent study, Pantzar and Ainamo (2004) compared the breakthroughs of General Motors and Nokia in the "mass-class market" (Sloan 1983) and identified three common dimensions: segmenting a market on the verge of a breakthrough, well-timed introduction of new technological advances, and brand-management skills in sensing, interpreting and representing changes in market circumstances and the broader business environment.

The successful transition from one phase to another also requires proactive capability development or quick response to market changes (Wheelwright and Hayes 1985, Stalk 1988, Anderson et al. 1989, Collis 1994, Hayes and Pisano 1994, Voss 1995, Brown 1996, Teece and Pisano 1994, Courtney et al. 1997, Eisenhardt and Martin 2000). The cases supported the capability development having a life cycle of its own as well as recognizable stages, such as growth, maturity, and decline (Helfat and Peteraf 2003). Along their evolutionary paths, capabilities may support a sequence of products or multiple products simultaneously (Helfat and Raubitschek 2000) and it takes capabilities years to develop and pass from the introduction to the maturity phase. This is consistent with the Hayes and Upton statement (1998) that such capabilities take a long time to develop, and can "come together" quite suddenly, giving a company its competitive power. According to Pandza et al. (2003), capabilities are characterized as unique and idiosyncratic processes that emerge from unique and path dependent histories of individual firms, for example the Dell Model.

Previously, the capabilities development were started in previous phases and prior to transition times (e.g. from introduction to growth or from growth to maturity). This

was not so evident in the literature review, but was a major finding from the case studies. Although Pandza (2003) indicated that capability development is initiated by change in the life cycle, it may already be too late for successful companies to react. Moore (1998) defined the transition phases as going from the “chasm” into “entering the tornado” and then, in maturity phase, seeking for new growth opportunities in mature markets. However, Moore missed the importance of the second transition phase from high growth to maturity. It is important to understand that in the introduction and development phase of developing capabilities, they contribute as order winners, when their competitors have an ability to catch up (in the maturity phase) capabilities change into order qualifiers (Hill 2000). It can be said that the greatest wins occur in the beginning or middle phase of capability development when competitors lack the same capabilities.

As predicted, the manufacturing technology did not follow the life cycle model. In the introduction phase of new type of products building up new non-existing production technologies and equipment is a key. The study of Boyer et al. (1996) indicates that technology itself is not linked with improved performance. Companies that are currently investing in the technologies may not see significant returns on their investment for several years. Even if the impact of advanced manufacturing technologies on performance is small (Kotha and Swamidass1998), it may create new business opportunities. From the company point of view, production technology did not become mature, nor did it become more capital intensive. This complies with the findings of Ranta (1997) that there is a continuous need to develop and change production technology; therefore companies cannot follow the life cycle theory concerning production technology. According to Laugen et al. (2005), high performers implement programmes directed towards updating process equipment, process focus, pull production and equipment productivity. Moreover, according to Baines et al. (1993), an organisation can build upon an existing technology, tailoring the equipment to produce better and cheaper products faster, and then a distinct contribution to competitiveness starts to emerge. The Nokia case supports the importance of pull production through implementation of ATO-process and overall productivity improvements. Updating process equipment was also supported but not so much as a

competitive priority as a continuous improvement. Focused processes were not seen to be at all important in the company, since the mix flexibility was given priority and the processes supported all products. Towards the end of the maturity period the discussion on focused processes emerged due to more diverse business needs. Therefore, it is crucial to understand and achieve the balance between focus and diversification. This would indicate that process equipment updating and productivity improvements are more continuous improvements and are necessary as such, but implementing process focus and pull-production are more operational innovations.

Similarly, manufacturing processes did not follow the classical stages of the Hayes and Wheelwright model from one end to another. The study of Dermott et al. (1997) showed that the Hayes and Wheelwright model would better describe the industry rather than explain the relative strategic positions of a company. According to Hayes and Wheelwright (1979), the process evolution typically begins with highly flexible, but not very cost-efficient process and moves towards highly integrated, high volume production lines. The flexibility of semi-automation and manual workforce proved to be important in the environment where new products were introduced constantly with high amounts of customer specific variants. The flexibility of more manual processes contributed in a generic capacity, serving a wider variety of products. De Meyer and Pycke (1996) also conclude that neither price competition nor fast product introduction seem to rely on automation. The human factor (training, teamwork, and empowerment) is replacing the trend towards automation. The case of SonyEricsson supported this in that they had lost flexibility when automating their production facilities.

6.4 Operational innovation, strategic flexibility and continuous improvement

Hammer (2004) defined operational innovativeness as achieving a capability to offer lower prices and better service than competitors. He distinguishes this from operational improvement or excellence, which, according to him, is achieving high performance via existing modes of operations. Tushman and Nadler (1986) used a similar term to mean process innovation over a product life cycle. Operational

innovation or shaping the industry means coming up with entirely new ways of filling orders, developing products, providing customer service, or doing any other activity that an enterprise performs, for example, the Dell Business Model, Toyota Production System and Zara. As Courtney (2001) puts it, when a company faces a very high level of uncertainty about the variables it can influence, shaping makes the most sense.

The ability of manufacturing companies to adapt is referred to as the strategic flexibility of a company (Beach et al. 2000). Furthermore, an effective strategy should steer companies toward where an industry is heading, not where it is today (Huyett and Viguerie 2005). If organisations wish to respond rapidly, there is a need for increased operational flexibility. In the transition phases change can be fast and even if expected, not entirely predictable. In these situations manufacturing could also play a contributor role as defined by Hayes and Wheelwright (1984). With strategic flexibility, manufacturing is able to significantly contribute to the competitive advantage, particularly in a rapidly changing business situation. Operations will manage unpredictability, when products must be made in various volumes and configurations. Berry et al. (1999) also concluded that strategic options in marketing can be connected with strategic options in manufacturing and vice versa and that debate should influence market position decisions. Moderately diversified companies not only outperform more diversified ones but also perform at least as well as, if not better than, more focused companies (Harper and Vigurie 2002). Adapting is preferable when key sources of value creation are relatively stable or beyond the company's control.

Courtney et al. (1997) also devised a strategic posture for shaping the future and adapting to the future. According to Brown and Hagel (2005) very few companies create significant shareholder value through breakthrough product innovations; most economic wealth comes from more modest changes that accumulate over time. Process innovations may be even more important for building a competitive advantage and generating wealth. In the studied cases, operational innovation seemed to play the largest role when transferring from introduction to growth. Operational innovation when entering the growth phase could be, therefore, also labelled as shaping the

future, while readiness for change could be labelled as adapting to the future or strategic flexibility. Tushman and Nadler (1986) supported the idea that first there is a substantial amount of product innovation that leads to the emergence of a dominant design. In the next stage, major product variation gives way to competition based on price, quality, and segmentation (i.e. a process innovation rather than product innovation). Since new products often require different distribution channels and suppliers from those servicing older products, a company should consider developing competencies that survive technological revolutions, such as flexible manufacturing capabilities or strong distribution channels. An organisation may find at least some help in coping with the high uncertainties imposed by the environment by increasing manufacturing flexibility and by maintaining or ensuring the role of manufacturing managers in strategic decision making (Swamidass and Newell 1987).

According to Voss (1995), the continuous improvement of best practices in all areas of the organisation will lead to superior performance capability, and hence, to increased competitiveness. This does not take into account that best practices may not be best for all companies. The potential influence of factors such as type of industry, company size, processes and products is not considered, nor is the fact that practices, even the best ones, may become obsolete in the course of time, although in their study Laugen et al. (2005) did not find indications that the type of industry would affect the selection of best practices.

6.5 Dynamics of development and competitive advantage

Why was Nokia able to win and hold the clear market leader position from 1998 to 2003, while its biggest competitor Motorola was losing the market share throughout the 1994 to 2000 period? What did Nokia do right, compared to Motorola, in the very difficult management situation of having to implement drastic changes on all fronts? Why was Ericsson, having the advantage of technologically advanced products, not winning market share? Why was Nokia able to retain control of key operations during the industry downturn? Or why does Dell have such a profitable business making

commodity products? These are some of the interesting questions that emerged during the case studies.

In fast changing industries, where an individual product life cycle lasts only a few months or a few years and is frequently replaced by newer versions, one business life cycle contains several individual product, technology and process life cycles. These products share certain common technologies and functions (e.g. hand portable mobile phones), and share common capabilities that are needed to produce them. Yet, at the same time product, process and management technologies evolve forming a series of superimposed life cycles. Many of the capabilities are also not just within manufacturing, but are cross-functional or cross-organisational, which leads to a rather complex model of a company's development as a result of a number of interacting forces triggering and supporting or conflicting with each other. Companies need to be able to concurrently coordinate the development of products, manufacturing and supply chain. This is in line with Fine's idea of three-dimensional concurrent engineering. The Nokia case further highlighted the importance of multi-dimensional competitive advantage of Brand – Design – and efficient Demand Supply Network.

6.5.1 Product and process development

Product and process innovations are complex and uncertain endeavours, which shift over time and require the close collaboration of R&D, marketing, sales and production. First, in order for the electronic business to enter a period of mass-market adoption (tornado), a new infrastructure paradigm is needed (Moore 1998). In the mobile phone business the GSM breakthrough occurred during 1994-1995 accelerating market growth, when mobile phones became available for big masses. This required a global infrastructure standard for the market to start growing rapidly. For examples Nokia was highly involved in the GSM standardization work and development of new technologies. However, technological advance does not guarantee the win, as in case of Ericsson. They had the ability to design and produce some of the most technologically advanced mobile phones, but overlooked the fact that user friendliness and design were the biggest selling arguments. At same time,

Nokia introduced a popular series of customized mobile telephones at the entry-level market segment and became the recognized trendsetter in design and renewal of products, which was seen as being of equal importance as production efficiency (Häikiö 2001). Renewal of the product range and continuous cost improvements by using less numerous or cheaper components also significantly contribute to profitability. Production technology development, as well as product technology development, contributes to the overall success of companies: at first when production technology is not a commodity, and then later by achieving better performance and cost savings over time. It is necessary to develop new product technologies and new production technologies jointly (Ranta 1997), since the development of component technology has an impact to the cost performance of the mobile phones through decreased component and manufacturing costs, for example. In mature markets companies are expected to provide combinations of additional services as a means of differentiating the products. However, it is important to note that increased complexity in devices and the desire for added functionality, and features often increases the Bill of Materials (BOM).

6.5.2 Internally and externally coordinated development

In capability development the key points are the whole demand supply network orchestration, networking and speed. In a period of mass-market adaptation demand dramatically outweighs supply, resulting in a huge backlog of customers. The significance of this period is that once customers settle on a particular vendor, they rarely switch (Moore 1998). An important lesson to apply is to expand distribution as fast as possible. The key is to grow fast in order to achieve maximum economies of scale, while maintaining fast volume growth and managing growth in the entire demand supply network. Nokia’s mobile phone business was very profitable and had a price advantage based on its huge volume, while Dell’s direct model enabled the company to excel at demand management and cost efficiency. Synchronisation and direct contact with the market allows Dell to respond more quickly to customer demands than its competitors. Additionally, internal collaboration allows for highly accurate forecasts (Fugate and Mentzer 2004). Cisco’s supply chain, however,

imploded because its partners acted in ways that were not in the best interests of the whole supply chain, the cross-company problems were more difficult to detect, and incentives were not well aligned (Narayanan and Raman 2004). If the whole supply chain cannot be slowed down at the right time, all phases will build up with inventory.

As previously discussed, manufacturing can significantly impact business performance by means of a higher level of internal and external collaboration and through a modular product and process, thereby reducing manufacturing costs and inventory levels while at the same time improving operational efficiencies across its supply chain. This benefits its customers as well as its suppliers (Stanford case 2004). The whole organisation needs to renew in order to achieve more efficient operations and sales systems, thereby leading to increased sales and faster improvement of profitability compared to competitors (Häikiö 2001). Successful capability development requires cross-functional development in product creation, delivery and management processes. Common process development will provide more visibility and improved planning. At Nokia, orchestration meant managing the entire chain and outsourcing selected activities to demand supply chain partners: suppliers, contract manufacturers, logistics service providers and channel partners. At Dell, the process of selling directly to customers and building product to order creates opportunities for true real-time collaboration and synchronization between manufacturing and sales. Nokia's demand supply network and manufacturing structure evolved from functional to the integrated process enabling good capacity utilization in the engine manufacturing and responsive final assembly to a customer order. The role of DFM (the ability to introduce new products and the ability to profit in a price competitive market) and the modular product structure that enabled the assembly to order process (the ability to deliver efficiently) were important as well. The postponement strategy has become mandatory in many companies in light of the current levels of market globalisation, increasing demand for product variety and customization, rapid technological innovation, shortening product life cycles and intense competition (Yang et al. 2004).

Therefore, manufacturing capabilities alone do not provide competitive advantage, since the competitive advantage ultimately stems from customer responsiveness and manufacturing is only a part of the order-to-delivery process (Holweg and Pil 2004), but rather, it is how integrated processes are aligned with the value proposition of the company. Hence, in the wider perspective, it is not enough to look at only internal manufacturing capabilities but also at cross-functional capabilities, such as Design for Manufacturing or supplier cooperation, in Nokia's case. In order to manage and develop these capabilities cross-functional and delivery network wide development are required and many authors do discuss the management of the entire demand-supply network and innovating business concurrently (Fine 1998, Eloranta et al. 2001, Appelqvist 2005). Companies should also periodically study their supply chains, because even top-performing networks find that changes in technology or business conditions may alter the alignment of incentives, as illustrated by the Cisco case (Narayanan and Raman 2004). But how to actually manage the complex systems and entire networks is not so clear. It should also be noted that operational innovation may be difficult to achieve in an on-going organisation, since this has a greater bureaucratic momentum (Mintzberg 1978). Moore (1998) even warned of the risks of major innovative changes during the high growth (tornado) phase. Well-established companies can often succeed in changing one dimension of their business model, but simultaneously changing multiple dimensions inevitably leads to conflicting constraints (Beinhocker 2006). When implementing the direct sales model, Dell enjoyed a greater degree of freedom than the established players, making it easier for it to create a new business model than it was for the incumbents to adapt theirs. According to Beinhocker (2006), one of the solutions is to reduce hierarchy in a company.

The overall 'fitness' or 'leanness' of the organisation helps during periods of sudden changes, such as entering from high growth to slow down, as in case of Nokia and Dell. By building lower-cost positions earlier and more radically than seems necessary is almost always a beneficial move. Moreover, a healthy cost structure provides the headroom needed to cut prices or to invest in innovative products and business models, should the market require them (Huyett and Viguerie 2005). This is achieved

mainly through continuous improvements, but is not always enough for achieving a competitive advantage. Nokia also emphasised the importance of understanding the market and turning foresight into correct action at the right time (Masalin 2003). According to Fugate and Mentzer (2004), the Dell management team's speed of execution is a result of the team members' flexibility and ability to make fast decisions.

7 CONCLUSIONS AND DISCUSSSION

Chapter 7 concludes the main findings of the study. The theoretical contribution and practical utility of the study are assessed and the quality of the research is evaluated against the criteria set based on the selected research methodology. The implications of the study are discussed and issues for further research are proposed.

7.1 Contribution of the study

7.1.1 Answering the research questions

This study was motivated by better understanding the relationship between manufacturing capability development and life cycle theories and whether the life cycle model could be used for predicting future development needs of manufacturing capabilities. The questions how do manufacturing capabilities and performance contribute to business performance, and will certain competitive advantage be sufficient if a business situation changes rapidly, have inspired this research.

The research questions of this study were formulated as follows:

1. How do manufacturing capabilities and performance changes in different phases of business life cycle?
2. How can manufacturing provide a competitive advantage in different phases of business life cycle?

The research questions were divided into sub-questions to understand the relevant body of knowledge and the initial constructs were set as: *manufacturing capabilities* and *performance, competitive advantage* and *life cycle*. The initial constructs were studied through the literature review and forming a basic understanding of the life cycle theories and capability development. The theories indicated that the capabilities would need to be changed in different phases of the life cycle in order to improve performance and provide a competitive advantage. The theoretical framework and

constructs were created and categories selected to guide the case analysis. The case studies further validated the findings from the literature further and provided additional insight as to how the capabilities actually evolve in different phases of life cycle and how manufacturing can provide a competitive advantage.

One of the main findings from the Nokia case was that not only did the different *life cycle phases* matter, but even more critical to the success of the company is the management of *transition phases*. This was also supported by the Dell and Cisco cases. New constructs, *operational innovation, strategic flexibility* and *continuous improvement* became very relevant for the study along the research process. The concept of *value proposition* was introduced in the literature review in order to understand how to align the manufacturing and business strategies. As predicted Hayes and Wheelwright's (1979) a product-process matrix would better describe the industry, rather than explain the relative strategic positions of a company.

The main contribution of this study is to the operations management theory in the area of capability development. The findings provide a practical understanding on how capabilities need to change along the business life cycle. As previously mentioned, generating theories about phenomena, rather than just generating a set of findings is important to the development of a field of knowledge (Strauss and Corbin 1998). The novelty of this research lies in providing extensive insight into the changing needs of business situations and how companies should adapt or shape their capabilities. The study also provided new findings on the need for operational innovation (shaping), especially prior to the growth phase. Capability development also needs to be initiated in the previous phase in order to achieve a competitive advantage over competitors. The study further validated the need for strategic flexibility (adapting) of the company (Beach et al. 2000). Distinct from Hayes and Wheelwright's (1979) findings, this study focused more on the overall manufacturing and demand supply network capabilities and links with manufacturing performance and its competitive advantage rather than just on the process set-up. The study also indicated that the main value proposition of the company does not necessarily change, as has been proposed by Moore (1998), but there can be more than one main value proposition.

The theoretical contribution of this research and main findings are as follows:

- Capabilities providing a competitive advantage change in different phases of business life cycle;
- Capabilities follow their own life cycles, but they are often initiated by the change in the business life cycle;
- Continuous operational improvement is needed in all life cycle phases;
- Operational innovation and ability to shape the future is needed prior to entering the growth phase;
- Strategic flexibility, ability to adapt and leanness of the organisation is needed prior to entering the maturity phase;
- Operational innovation and strategic flexibility are main contributors to competitive advantage.

As Hayes and Pisano (1994) stated: "By expanding the range of the manufacturing capabilities, they increase their strategic options" and therefore create strategic flexibility. Also, according to Beach et al. (2000), change is now a permanent feature of the business environment and companies that can adapt to the new environments are likely to gain a significant competitive advantage.

7.1.2 Manufacturing capabilities and performance

The manufacturing capabilities were categorized in the case study by the competitive priorities of *price*, *quality*, *delivery*, *flexibility* and *service*, as proposed by Kim and Arnold 1992. For clarity the performance metrics were categorized under *cost*, *time* and *quality*, as proposed by Kaplan and Norton (1996). Flexibility was seen as a manufacturing capability and not as a performance metric, since it can be seen as referring to a means to an end (Hayes 1985). As expected, the direct links between individual competitive priorities and particular objectives were difficult to establish (Kim and Arnold 1996), since capabilities were somewhat difficult to categorize and affected several competitive priorities at the same time (price, flexibility, delivery,

quality and service). Furthermore, the market leader can achieve huge benefits with economies of scale, but the results clearly demonstrated that manufacturing contributes to improved business performance especially through improved Days of Supply (DOS) and decreased cost.

7.1.3 Competitive advantage and strategic role of manufacturing

The cases validated that operations can have a significant impact on the end result, through superior demand supply network, inventory management or product manufacturability, for example, and provide a competitive advantage. In particular, manufacturing was seen to have a great impact in the transition periods (operational innovation and readiness for change). Therefore, the ability to shape the future and strategic flexibility are main contributors to competitive advantage. Also, as value propositions shifted their order of importance as well as competitive priorities, so did the need for new capabilities to provide competitive advantage (see table 9). When competitors started catching up, on levels of manufacturability and cost efficiency, for example, a stronger need for customisation and services emerged. The more mature capabilities still supported the company as important order qualifiers while new capabilities emerged more as new order winners (Hill 2000). The company has a competitive advantage if profitability (relative position) is above the industry average and its market share and value to customer is high. Manufacturing can provide a competitive advantage in different phases of the life cycle if alignment between manufacturing capabilities, corporate strategy and customer's value proposition is high and capabilities development is proactive, which results in the manufacturing performance's high impact on business performance. On the other hand, the analyses show that sustainability of the competitive advantage is low when industry has high clockspeed. The sustainability of the competitive advantage is improved by preventing the entry of new competitors, reducing the threat of substitutes, improving the bargaining power of buyers, lowering the bargaining power of suppliers and reducing rivalry among existing competitors.

7.1.4 Life cycle model for capability development

The research confirmed that requirements (i.e. competitive priorities) for manufacturing capabilities change along the business life cycle and it therefore can be used as a tool to predict the needed change in capability development (figure 31). The value propositions do not necessarily change along the business life cycle. The manufacturing strategy should not be aligned just with company's value proposition to customer (Moore 1998, Tracey and Wiersema 1993), but also according to the company's position on the life cycle.

Capabilities follow their own life cycles, but if reacting to change in the business life cycle, the development starts too late for achieving a competitive advantage. In the introduction and development phase, capabilities provide the greatest value before competitors are able to catch up. Successful capabilities development is initiated in the previous phase. Capabilities are developed either through continuous improvement or through operational innovation. A whole supply chain may need to be reconfigured and, in doing so, greater responsibility might be placed across the entire demand-supply chain (Brown and Bessant 2003, Eloranta et al. 2001).

In the transition phases it is critical to proactively adapt or shape the business. Being proactive requires that needed capabilities already exist at least in their introduction phase. Continuous improvement is essential in all phases of the business life cycle, but provides value through improved efficiency and not as much as a competitive advantage over competitors. The life cycle model in figure 31 summarizes the findings of each phase including transition phases. Manufacturing has great impact from the competitive advantage point of view in the transition phase, from introduction to growth, by enabling cost efficient high growth (operational innovation) and by shaping the future. The second major impact occurs during the transition from growth to maturity (readiness for sudden changes, leanness and control) when it is essential to slow down and control the whole demand supply chain and adapt to the change (Hammer 2004, Courtney et al. 1997). Being prepared for sudden changes equals having lean growth and organisation at the end of the growth period and also targeting

the next lower price point (Moore 1998). In the transition phase, when entering the high growth or maturity phases, the manufacturing can also achieve a contributor role (Hayes and Wheelwright 1984). The next transition will emerge in the maturity phase when new types of products or services are introduced. Manufacturing will have a strong shaper role (operational innovation) there as well, by providing capabilities for new types of products and customer services in the search for new revenue growth. Strategic flexibility in manufacturing significantly contributes to competitive advantage, particularly in a rapidly changing business situation.

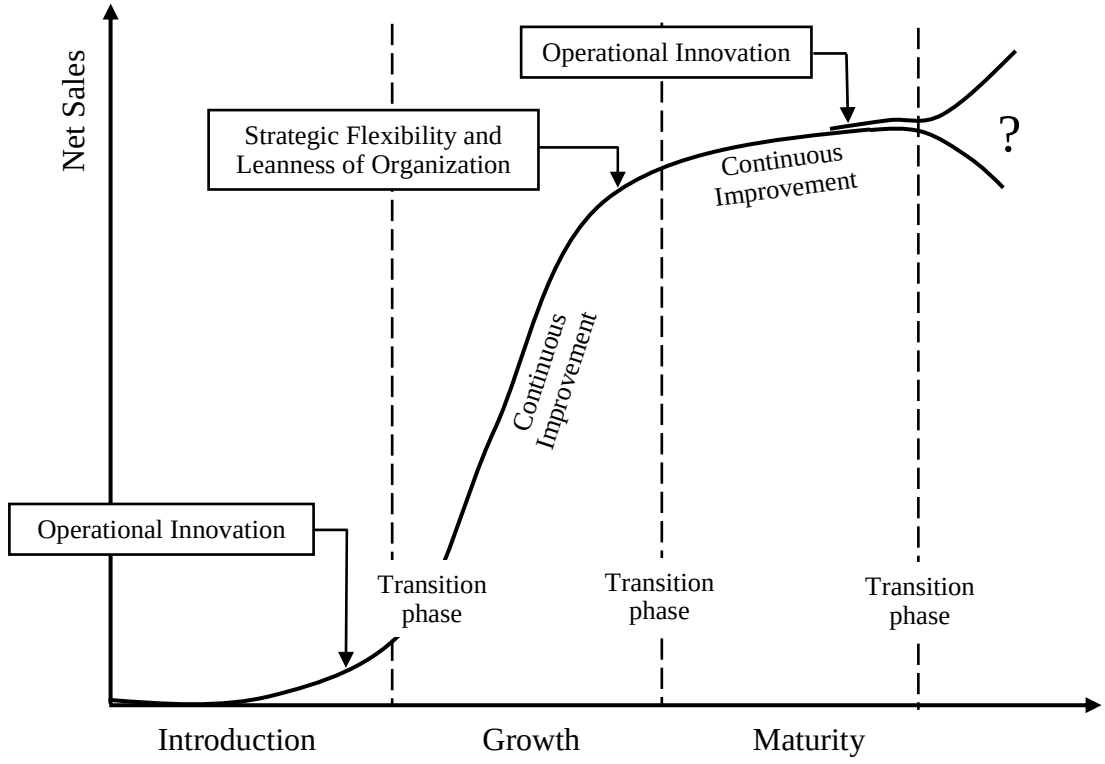


Figure 31. The business life cycle model for capability development

7.2 Managerial implications and relevance of the study

The business life cycle model was proposed for understanding the dynamics of competitive priorities and capabilities when preparing to transform from one phase to the next. As shown in figure 31 and table 9, capabilities providing competitive advantage change in different phases of life cycle and manufacturing must follow the

requirements set by value propositions and life cycle in order to provide a competitive advantage.

Since the practical utility of this research was to provide a better understanding of business dynamics and provide tools for formulating a manufacturing strategy, the business life cycle model provided a tool to predict future capability needs. However, capabilities follow their own life cycles but are initiated by change in the business life cycle. The model also gives operations managers a better understanding of the strategic role of manufacturing and can therefore assist in strategy formulation. The model could also be used to formulate future needs - a strategy charting of previous activities to understand and learn from past behaviours would be a useful tool that can be applied to the model.

However, the business life cycle model does not guarantee winning, but rather provides a framework for thinking about strategic interactions. Using the life cycle model has limitations, as with any theoretical construct. It is important to keep in mind that no single framework can ever address all situations equally well. Another of the model's limitation is the assumption that a product's life cycle is equivalent to a business life cycle. While the two generally move in the same direction, they do not necessarily move at the same rate or to the same extent. This is particularly true when a market splits into price categories, and the products and customers of each major price segment follow separate product life cycles. In such a situation the low-end price segment may move very quickly to the final stage of the product life cycle, whereas the higher price segments may never move beyond the middle stages (Hayes and Wheelwright 198). Anyway it is valuable to scope the current position within an industry's existing structure and then move with speed and agility to recognize and capture new opportunities when market changes (adapting to the future). But more so, as Courtney (2001) mentioned, influencing (shaping the future) the outcome of crucial and currently uncertain elements of an industry's structure is especially important in extremely uncertain environments. Therefore the proposed capability model offers a discipline for thinking systematically about uncertainty.

7.3 Validity and reliability

Tying the emergent theory to existing literature enhances the internal validity, generalizability, and theoretical level of theory building from a case study research. As mentioned earlier, an in-depth case study of an individual company in a specific business environment can lack external validity. When conducting an in-depth longitudinal research study there are practical constraints in terms of time and resources, but it will provide valuable insight over a long period of time. The longer the period over which phenomena are studied, the greater the opportunity to observe at first hand the sequential relationships of events (Voss 2002). External validity was strengthened through a comparative research design (Barley 1990), existing literature, and by searching external knowledge of similar parallel cases, such as the Cisco, Dell and SonyEricsson cases. Internal validity is the extent to which we can establish a causal relationship, whereby certain conditions are shown to lead to other conditions; as distinguished from spurious relationships (Yin 1994). Internal validity was further enhanced by examining a multi-level analysis (synchronic and diachronic) within a single case study (Yin 1994). The different life cycle and transition phases were analysed as the cross-cases to understand if there were similar or dissimilar patterns in each phase. The use of multiple data analysis methods were planned and used in order to answer the research questions and address the threats to validity (Maxwell 2005).

The construct validity was improved by using multiple sources of evidence, multiple data collection methods, and both quantitative and qualitative data. The validity was further increased through interviews that confirmed the findings extracted from written documentation and external analysis of the company. The strategy charting and most of the interviews were done in collaboration with another internal researcher. An external researcher was involved in the single in-depth case study in 2003 and 2004. Several discussions with both these researchers helped validate the constructs and enhance the creativity of this research. According to Eisenhardt (1989), multiple investigators also enhance confidence in the findings. The findings from the initial constructs and case study where validated by further enfolding the existing literature.

The reliability is the extent to which a study's operations can be repeated (Voss et al. 2002). The reliability of the research was increased through documenting the research process (see appendix D) and demonstrating that the study can be repeated with the same results. Reliability was also increased through discussions and cross checking with others working within or with the case company. The conclusions developed in this research are proposed to be generally applicable to rapidly growing and phased industries, such as the electronics industry (Fine 1998). The hypotheses presented may not be applicable in the case of bulk or process type of environment, or when certain cultural preferences or government sanctions change the competitive environment (such as the Chinese practice of giving preference to a local phone manufacturer).

The limitations of this study included being able to use only one longitudinal case company, due to the nature of the study, and also the impossibility of obtaining in-depth access to competing companies or industries. The researcher was a full-time employee in the case company's manufacturing and logistics organisation, which provided excellent access to the relevant data, as well as internal support for the research being conducted (Barnes 2001). However, when a researcher has worked for a company for over ten years, intersubjectivity can be a risk as well as an objective liability towards external validity.

7.4 Future research

The main finding from this research was that the business life cycle model can be used as a tool to predict future capability needs. The model can work as a starting-point to look at where the company is and what might lie ahead, as well as a guide for capability development, but, as discussed in Chapter 6, what is not so clear is how to actually manage the complex systems and entire networks. This would clearly require further investigations. Furthermore, the significance of the transition phases in capability development was a new and significant finding. However, the model needs more extensive evidence and requires future research. As mentioned, it would be interesting for future studies to conduct in-depth cross-case comparisons, investigation whether certain types of capabilities emerge in each phase in different types of growth

industries. It would also be valuable to study other industries to attempt to find support for the findings of this research. The findings can then be validated and generalised if others have similar findings in a different context. The result is often a theory with stronger internal validity, wider generalizability, and a higher conceptual level (Eisenhardt 1998). It would be particularly interesting to see how the model would work in a slower clockspeed industry. Also, under which conditions and in which industry environments would the model be applicable? Further research could cover how manufacturing capabilities and performance could be enhanced to match business changes proactively. Interesting questions for future research would include:

- How should capability development be done in a complex, multi-dimensional environment?
- How much should one proactively invest in capabilities?
- What are the indicators in the life cycle that indicate imminent change?
- What is the degree of focus with limited resources and what is the degree of strategic flexibility that companies are able to create in an ever-changing environment?

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APPENDIX A

All of the informants had several years of experience working for Nokia and most of them through the whole time of 1992-2003. Examples of informants work titles throughout the years 1992-2003 are presented below.

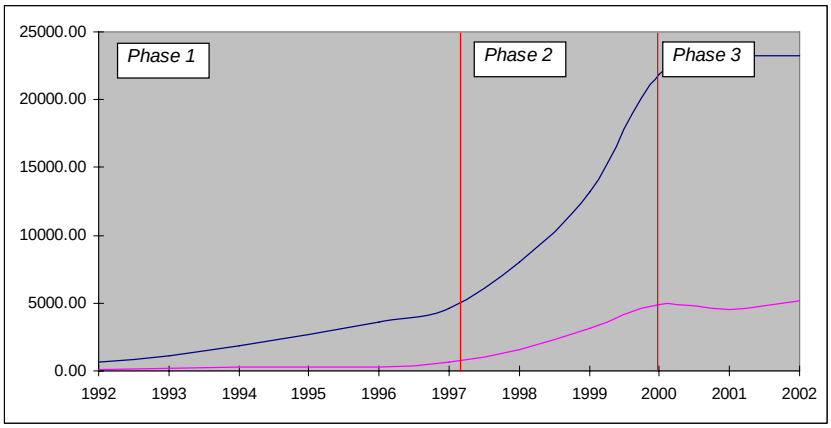
List of informants work titles over the years:

Interview 1: technology area manager, director technology, platforms operations and logistics
Interview 2: operations program manager, site manager, senior manager operations
Interview 3: production manager, plant manager, director operations, logistics and sourcing
Interview 4: production manager, factory manager, director operations and logistics
Interview 5: production manager, logistics manager, director of supply solutions
Interview 6: operations project manager, director of operations and logistics
Interview 7: factory manager, vice president of operations, logistics and sourcing
Interview 8: logistics change integrator, senior advisor

APPENDIX B 1/2

Interview guide

The purpose of this interview is to understand the dynamics involved with manufacturing / DSN capabilities and how capability requirements have changed in different business situations and how they have affected business performance. The time line for the study is 1992-2003.



NMP net sales and operating profit

1. General Information about the Interviewee

   1.1. Interviewee's position in the company today?

   1.2. What were the interviewee's previous positions in the company?

2. Business environment

   2.1. What were the characteristics of the business environment in different years from 1992 to 2003 (growth, profitability, competition)

3. Performance

   3.1. What performance metrics were used to measure manufacturing process performance?

   3.2. Was there any evidence that operations and DSN performance affect business performance?

APPENDIX B 2/2

3.3. Did operations and DSN help meet the corporate objectives?

3.4. Has the importance of operational excellence changed during the different times from 1992 to 2003? Were there changes in the order of importance of the performance measures compared to previous years?

4. Capabilities

4.1. Which were the most relevant capabilities at different times? Which were the capabilities / components actually built? Examples:

Prize	
Price	Ability to profit in price competitive market (Low price)
Flexibility	
Design change	Ability to make rapid changes in design (Design change)
New products	Ability to introduce new products quickly (MPI)
Volume change	Ability to make rapid volume changes (Volume change)
Mix change	Ability to make rapid product mix changes (Mix change)
Broad line	Ability to offer a broad product line (Broad line)
Quality	
Conformance	Ability to offer consistently low defect rates (Conformance quality)
Performance	Ability to provide high performance products or product amenities (Performance quality)
Reliable products	Ability to provide reliable/durable products (Reliable/durable)
Delivery	
Fast delivery	Ability to provide fast deliveries (Fast delivery)
On-time delivery	Ability to make dependable delivery promises (On-time delivery)
Services	
After-sales services	Ability to provide effective after-sales services
Support	Ability to provide product support effectively
Distribute	Ability to make product easily available
Customize	Ability to customise product and services to customer needs

4.2. Were there any ‘disruptive’ points that capabilities were required to change radically? What were these points and when?

4.3. How did the planned capabilities vs. implemented capabilities compare?

4.4. Were there changes in the order of importance of the implemented capabilities compared to previous years?

5. Value proposition

6. How was the operations and DSN aligned to value propositions

APPENDIX C

Nokia Mobile Phones product range 2003

- 2000 series - Entry level, low-end handsets aimed at developing markets, e.g. 2100
- 3000 series – mid-range of handsets, particularly targeted at mass and youth markets, chat, ring tone composer, profiles and screen saver via SMS, Xpress-on changeable covers, e.g. 3330, but now includes MMS, cameras and Symbian OS with launch of 3650
- 5000 series – application specific devices, with appropriate form factor, e.g. 5510
- 6000 series – high-end handsets, with a broad array of multi-role functionality. Long operating times, data capabilities, large memory, phone book and calendar functions. Cameras, Java, WAP and Bluetooth capabilities on some models, e.g. 6310, with enhanced data capabilities, e.g. GPRS, and tri-band. Launch of first WCDMA handset in this series, the 6650.
- 7000 series – mix of fashion and professional consumer range. Colour screens, MMS and cameras feature heavily, e.g. 7650.
- 8000 series – fashion range, designed to be regarded as “status symbols” in a primarily adult and professional user market. Compact and elegant form factors with an emphasis on low physical impact and high aesthetic appeal. GPRS, multimode GSM for intercontinental roaming and WAP functionality, e.g. 8910.
- 9000 series – High-end products for mobile professionals and business users that support a variety of enabling technologies and wireless connectivity features. Email, word processing, presentation viewer, spreadsheets, multimedia, WAP and internet functionality, e.g. 9210 communicators.

Source: ARC (2003), www.nokia.com.

APPENDIX D 1/5

Strategy charting: Data collected from strategies, annual reports, interviews and articles arranged by life cycle phases.

BUSINESS ENVIRONMENT					
Introduction 1992-1996		**Growth 1997-2000**		**Maturity 2001-2003**	
SUMMARY					
1) New paradigm - dominant design (handportable GSM phones) 2) Major product innovations 3) Low volumes, but high growth		1) Customization, Product segmentation 2) Minor product innovations 3) High volumes and high growth		1) Different market segments with different business models 2) Minor and major product innovations 3) High volumes, slower growth	
DATA DETAILS BASED ON SOURCE MATERIALS					
Data	**Source**	**Data**	**Source**	**Data**	**Source**
1) End user recognized leader in cellular terminals	Strategy 1993, Annual reports	3) Rapid growth expected, but not to the extend it took place	Annual report 1998	3) Intense competition, extreme volatility, weakened global economy	Annual report 2001, ARC 2001
1) The technology leverage and integration	Strategy 1993	3) Product availability was the main factor for successful business	Interviews #6, 7	1) Diverge range of products, complexity of products	ARC 2001, annual reports, interview #3
2) GSM breakthrough 1994-1995	Häikiö 2001, Annual reports	1) Growing product range with customization, evolving distribution channels	Press release July 24, 1998	3) Nokia achieved significant market share	Annual report 2001
3) The challenge of volume growth (volumes doupled, tripled, lot of new resources)	Strategy 1994, 1995, interview #4, #3	2) DCT3 products set the standard for manufacturability but also provided variants to customers	Interviews #7, 8,6	3) Extreme volatility and uncertainty with complex implications for enterprises	Annual report 2002, Gartner Research 2002
1) Focus on recognition of brand (Europe's largest mobile phone manufacturer and world's second largest)	Strategy 1994	3) Business challenge continued strong growth and high operating profit margin	Strategy 1999	1) Nokia Mobile Phones was divided into business units focusing on different market segments with different business models. The main focus became to drive for profitable growth and focusing different market segments with different business models.	Annual report 2003
3) Growth pains, difficulties in bringing up the production and logistics capacity	Häikiö 2001, Annual report 1995			1) Business units focusing different market segments with different business models	Strategy challenges 2002
				2) By producing handsets designed specifically for particular market segments, with associated applications, functionality and brand value, Nokia was looking subscribers to upgrade their handsets or move onto data-enabled next generations' networks.	Annual report 2002

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VALUE PROPOSITIONS					
Introduction 1992-1996		**Growth 1997-2000**		**Maturity 2001-2003**	
SUMMARY					
1) Product Leadership (Technology leverage and integration, brand and end user recognition, product innovations)		*1) Operational Excellence* (Superior product availability, efficient process, economies of scale, focus on supplier management) 2) *Product Leadership* (Design and renewal of products) 3) *Customer intimacy* (Focus on trade customer needs		*1) Customer Intimacy* ((Total Product Offering, segments and tailored offering) *2) Operational Excellence* (Extreme cost – providing value at the lowest cost, able to differentiate) 3) *Product Leadership* (Design still important)	
DATA DETAILS BASED ON SOURCE MATERIALS					
Data	**Source**	**Data**	**Source**	**Data**	**Source**
1) "Manufacture according to the specification, technology challenges and technology capabilities in place" "Product specific competition and good products"	Interviews #7, #6, #5, #3	3) Focus towards the trade customers	Annual report 1999	1) The industry had become more mature, resulting in stiffer competition and shrinking profit margins. This change in market environment forced the mobile-phone manufacturers to shift their focus from growth to financial performance and to adopt more targeted approach towards customers.	Stanford Case 2004
1) Issues with supplier quality and product mix	Häikiö 2001	1) Nokia became fundamentally better in efficiency, which lead to increase in sales and faster improvement of profitability compared to competitors	Häikiö 2001, Annual report 1997	3) Nokia no longer was seen as the trendsetter in the industry. The basic design had not changed from the end of 1997, while customers were expecting more clamshell type of products	Nomura Research Institute 2001
1) "The cost was not the most important criteria and the quality was an order qualifier"	Interview #3	2) Nokia was trend setter in the design and renewal of the products, which was seen as important as production efficiency	Häikiö 2001	3) It was Nokia's strategic intent to create 'Total Product Offering' running from terminals and accessories through to applications and services, hence an emphasis on appropriate applications.	ARC
1) "Poor yields were allowed in some extent"	Interview #2	1) "Nokia' cellular phone business was very profitable and had price advance based on its huge volume. Nokia was strong both in high-end and low-end models. Especially, the main models that support Nokia's big growth were 5100 series and 6100 series."	Nomura Research Institute 2001	2) Improve efficiency and master demand-supply network	Key strategy and focus areas 2000
1) End user recognized leader in cellular terminals and technology leverage integration	Strategy 1993, Annual reports	1&3) Success criteria: customer satisfaction, operating profit, RONA, DOS, component count, cost	OLS strategy 1997	2) Effective and scalable manufacturing, fast adaptation to new business requirements	Strategy 2000
1) "No clear manufacruring benefit shown and volumes small"	Interview #6	2) Product range explosion and end user segmentation	Strategy challenges 1997	3) Nokia dominates with brand awareness, perceptions of style and quality	Market strategy 2000
		1) "Production volumes were able to increase faster than competitors, in 2000 fast slow down and no extra capacity" "Also very good ramp-up capability" "No major quality problems do to the manufacturing"	#6	2&1) Success criteria: availability, best service, on-line relationship, asset rotation, scalability, cost	Strategy 2000
		Nokia was leader in each phase on what it focused on	Interview #6	1&3) Sales of complimentary products and services	Strategy 2002

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COMPETITIVE PRIORITIES					
Introduction 1992-1996		**Growth 1997-2000**		**Maturity 2001-2003**	
SUMMARY					
1) Flexibility		1) Delivery, 2) flexibility, 3) quality, 4) price		Increased demand on 1) price, 2) flexibility, 3) quality and 4) delivery, 5) additional services	
DATA DETAILS BASED ON SOURCE MATERIALS					
Data	**Source**	**Data**	**Source**	**Data**	**Source**
1) Flexible processes	Annual report 1994, interviews	3&4) More cost efficiency, quality critical	Strategy 1999	5) It was Nokia's strategic intent to create 'Total Product Offering'	ARC
1) Concurrent engineering and DFM	Strategy 1994	2) Important was ramp-up speed, DFM and DFDS metrics, ATO variants, cost of variable parts	Interview #6	1) Important was manufacturing cost	Interview #6
1) New product families begin	Strategy 1994, annual reports	1&4) Cost reduction and efficiency improvement	Interviews #9, #6, strategies	1,2,3,4,5) The key business drivers for 2003 were once again increasing number of products and variants, smaller lot sizes and short lead times and cost pressure in the end-to-end chain. Even more emphasize was seen on Total Product Offering (TPO) and intensifying competition with quality and customer satisfaction and collaborative planning with channel collaborations offering.	Strategy 2003, interviews #9
Quality, efficiency problems	Interview #4	1) Market driven logistic chain, manufacturing to real market demand, integrated, cross functional processes end-to-end	OLS strategy intent 97	4) "We see clear positive (=declining) trend during the whole year 2003 in inventories measured by Days of Supply (DOS) and we are not far from our challenging target. On Time Delivery (OTD), the most important customer satisfaction measure has not progressed as expected reflecting the extremely heavy load. Let's not, however, forget that customer satisfaction is vital for our future success"	Internal Global Operations, Logistics and Sourcing newsletter, October 2003, Nokia.
		4) "10 Days of DOS equals to 1% profit"	Interview #9	1,2,3,4,5) The business drivers that manufacturing and demand supply network directly impacts are quality, customer satisfaction and cost pressure. Also strong impact is to the diverse product range with various business models, increasing number of customer variants, smaller lot sizes and shorter lead times.	Nokia Strategy Sharing 2004
		1&4) "Significant improvement in working capital, inventory carrying cost that effected profitability"	Interview #8	4) The target included improvement in on-time delivery and reduced order fulfillment lead-time for Nokia, and increased planning accuracy and lower inventory levels for the customers.	Stanford case 2004
		1,3,4)"Product, Process and supply chain all needed to be in good shape"	Interview #8	1&3) Key business drivers quality and drive for profitable growth	Strategy 2002
		1)"Era of growth, volume, capacity"	Interview#6	4) Deliver Nokia Brand promise: perfect demand fulfillment of superior products, creating and orchestrating the most efficient demand supply network in the world	Strategy 2001
				1) ARC survey 2003 showed that manufacturing costs are expected to fall dramatically over the next five years, for both high-end and low-end handsets alike.	ARC
				1) "Era of cost control, cost cutting"	Interview #6
				1) "Nokia achieved a level that nobody would have believed, 25% operating margin"	Interview #5
				2&3) "ATO brought clear competitive advantage"	Interview #4
				2) "The CA has been the fast reaction speed, small order sizes and number of variants. But we not clearly the best in the market as in phase 2"	Interview #9

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CAPABILITIES					
Introduction 1992-1996		**Growth 1997-2000**		**Maturity 2001-2003**	
SUMMARY					
1) Ability to introduce new products -> Ability to shape up and grow fast 2) Disconnected line flow (batch) to connected line flow (layouts, interviews, internal documents) 3) Major process innovations (operational innovation)		1) Ability to delivery efficiently -> Ability to sudden changes, to slow down 2) Assembly to order partly implemented in factories globally (layouts, interviews, internal documents) 3) Minor process innovations (Continuous Improvement)		1) Ability to support new businesses 2) Ability to profit in price competitive market 3) Assembly to Order 4) Minor process innovations (Continuous improvement), Major process innovations still missing, but need identified	
DATA DETAILS BASED ON SOURCE MATERIALS					
Data	**Source**	**Data**	**Source**	**Data**	**Source**
2) Important was yield and DFM metrics	Interview #6, #1	2) "In 1997 clear understanding of manufacturing to order"	Interview #9	2, 4) Manufacturing cost of netsales improved by 4 %	Interview #9
2) Functional and immature organization, no end-to-end process management	Häikiö 2001, strategy materials, , interviews #9, #5	1) Logistics shape-up: to build and operate an integrated supply chain. The basic principles were to 'Plan for Capacity' and Execute to Order'	Strategy 1997	1) Contributor by creating new business opportunities	Strategic intent manufacturing strategy 2000
1) "Production more like preproduction, and like fighting the war to get products done"	Interview #3	3) Continuous improvements also had an important contribution to profitability	Interview #3	1, 4) The importance of design for manufacturing (DFM), verified manufacturing technologies and development of flexible and modular manufacturing concepts were seen important towards the fast adaptation to new business requirements.	Strategies and interviews #1, #6
1) Adhoc development	Interviews #7, #5, #3	1) CE and DFM had become critical capability, resulting in modular product platforms for better manufacturability	Interviews, handtime measure	3) In process design assembly-to-order (ATO) had become the critical capability to fulfill customer requirements and increased number of product changes. (mass customization)	Interview #2, #1
1) "Lot practicings getting new products done, new business to everyone""Not very mature cooperation between factories and	Interview #1	1) "DCT3 products where already good in manufacturability and helped to get volumes up"	#7	1) New diverse manufacturing requirements	Appelqvist and Vehtari 2003
1) "In the beginning it was most important to built the production capability, build against the specification""To get products manufactured when production technology was not commodity"	Interview #2, 1	3&4) Preparing for sudden changes, Readiness for change with agile and lean growth	Strategy 1999	1, 4) Flexibility requirements just grew in maturity phase	Interview #2
3) The effort to meet the rapidly growing demand, several major obstacles along the way	Stanford case 2004	3) "Factory investments were in control in 1999, even some losses because of limited capacity" "it was important decision to limit the number of factories and find the growth from efficiency"	Interview #9, #3	1) "Altogether, we were manufacturing four products at the time we moved to new Salo Factory in end 1994. Now we operate on up to twenty products and their numerous variants simultaneously. Earlier the markets took what we had to offer, and everything was sold. Now we produce what our customers want," Nokia manager explains. Fulfilling the customers' needs is the key."	OL Newsletter, Nokia
1) Flexible working arrangements to increase productivity	Annual report 1994	1&4) Grow fast in order to achieve maximum economies of scale, but manage the growth = Supply chain management	Strategy 1999	2) The readiness for sudden changes and lean processes helped the company to slowdown 2001	Interviews #3
1) Product and processes were planned to be flexible to facilitate manufacturing of different products	Interviews, Annual report 1994	1) Cooperation with suppliers to ensure the component availability (supplier relationship management)	Strategy 1999 and 2000	2) The cost leadership comes from design for manufacturability, sourcing, cost efficient in-house manufacturing and effective sales and distribution providing cost benefit of 25 % compared to competitors.	Kallasvuo 2003
3) Focus in operations was CE processes, DFM and global manufacturing	Strategies 1994, 1995, interview #1	2) The ATO process resulted in high efficiency in internal operations and saves the burden of holding finished goods inventories	Stanford case 2004, interviews	2, 4) Design for demand-supply network is the foundation for industry leading profits.	Pertti Korhonen (2003)
3) Clear benefits for manufacturing through DFM	Interviews #1	3) The strong profitability improvement in Nokia was due to further development and integration of logistics processes and efficient management of working capital	Häikiö 2001	2, 4) "this production machine cannot be built in short term and be outsourced easily because we would then loose the efficient production and specially good cooperation between product creation and production".	Interview #1
3) The shape up started 1995-1996	Häikiö 2001, strategy materials 1995-1996	3) The automation possibilities were looked at extensively, but not realized	Interviews #4, #1, strategy materials	2) Nokia was scored as second best in the world	Reilly, K. (2004) AMR Research Supply Chain Top 25

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1) Challenges rapid growth, component supply and end product stock management problems	Strategy 1996	1) "The high demand for our products, the excellence of operations and favorable market conditions with lower than anticipated price erosion led to an exceptional level of profitability"	Jorma Ollilla, Annual report 1998	1) "A Paradigm shift is required improved customization capability".	ATO meeting in Beijing 12.12.03:
3) I"mprovement needs where seen few years before the volumes exploided"	Interview #7	4) "No more people" the people in NMP factories will not grow	Strategy 1999	1) The need for more diverse manufacturing capabilities	Interviews, strategy 2000
3) With reorganization of logistics and new products the profitability improved on the second half of 1996	Annual report 1996	4) "It was good that Nokia knew how to slow down"	Interview #8	1) Effective and scalable manufacturing, DFM, verified manufacturing technologies, fast adaptation: new manufacturing concepts and modular production process	Manufacturing strategy 2000
1)"Most critical to produce products when production technology was not commodity, meaning that lot of processes and equipment had to be developed from the beginning"	Interview #1	1) "In the rapidly growing mobile phone industry, efficient and flexible logistics processes and manufacturing capabilities are an important success factor, and the significance of the new Komárom site within Nokia's global logistics structure is very high. Today in Komárom we are celebrating the opening of Nokia's 10th	Nokia Press release May 05, 2000	2, 4) Harmonization of global manufacturing processes, Efficiency improvement (High capacity utilization in engine manufacturing and responsive final assembly to customer order, scalable, efficient and global volume manufacturing)	Manufacturing strategy 2002 and 2003, Appelqvist and Vehtari 2003
1) "Current production technology and process designs were mainly introduced through introduction of GSM products 2110 and 6110 during 1994-1996"	Interview#7, #2	1) "Scale benefits as enabler in component sourcing"	Interview #8	2, 4) Upstream integration with suppliers continues	Sourcing strategy 2003, interviews #9, #1
1) Ability to adapt to local needs in manufacturing distribution and channel relationships (local factories), building up the delivery capacity	Strategy 1994	1) "Without fundamental logistics shape-up and the improvements through systematic work on Design for Manufacturing (DFM), which had started already in the previous era, there would have not been any wins."	Interview #1	2) "Cost/phone more important than previously phones/head"	Interviews #5, #3, #1
"Hick up in 1995/1996 woke up to the logistics improvement need" "If only cost cutting had been done, Nokia could not have won Motorola"	Interviews #8, #3	2) Integrated final assembly and packing improved the leadtime from 10 days to 24 hours	Interview #8	1) "Better customer focus and visibility needed, integration to customers and new business models"	Interviews #9, #7
3) "The biggest decisions were made in 1996/1997 for shape-up"	Interview #9	1) Integration with customers and suppliers, demand supply visibility to whole chain, integrated planning and make to demand, capacity increase	Strategy 98 targets		
		1&3) "If no improvement in manufacturing we would have ended up with tens of factories"	Interview #7		
		1) "Network of uniform manufacturing and generic capacity enabled volume changes and product mix changes"	Interview #6		
		1) "Global supply network and capacity plant to plant deliveries"	Interview #5		
		1) "After logistics hick-up there was sourcing hick-up that initiated the sourcing shape up"	Interview #7, #1		
		1) "Ramp-up capability improved significantly"	Interviews #6, 4, 2		
		1) "It was just running after capacity, cost efficiency was not so important as getting deliveries out"	Interview #4		
		3) "High growth hide lot of the problems as well, even high performance seen from the outside"	Interview #2		
		1) Outsoucing mainly submodules, which helped to simplify the manufacturing process" "Nokia did not outsource so much because did not want to loose the control" "Outsourcing was strategical 20-25%"	Interviews #1,#9, #3		
		"The improvement of logistics released money for the company"	Interview #7, 2		
		1) "The operations helped to meet the challenging delivery requirements through superior demand supply network, volume flexibility capability and scalable production that others did not have. Nokia was able to stop the growth on time and not having huge amount of extra inventory. Since during the fast growth demand exceeds offering, the winner is who can deliver and increase capacity fast enough and improve the efficiency. The companies that are not prepared to high growth will suffer … Nokia succeeded in translating strong brand, product offering, industry-leading execution and operational efficiency into highly profitable results "	Nomura Research Institute 2001		