Master Thesis in Operations Management
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# Lean Product Development in Swedish Industry

- An Exploratory Study

## ABSTRACT


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Purpose — This thesis serves to answer what lean product development consists of, as practiced by Swedish firms, and what are the implications for management of the experiences made. The underlying purpose is to produce academic insight which can help managers adapt research and development activities to the ever-more globalized and competitive business landscape.

Method — This thesis is an exploratory investigation of the concept of lean product development in Swedish industry, performed through a case study and a complementing interview survey.

Theory — A theoretical framework, starting from innovation theory and positioning the role of product development in innovation and business strategy, is provided. The existing literature on lean product development is surveyed, starting from its origins in lean concepts developed for manufacturing.

Findings — Lean product development practices, inspired locally by Scania, are spreading fast in Swedish industry. Methods to create *cadence,* notably tools to visualize processes, command a remarkably prominent position not reflected in existing literature. Formalized cadence models appear promising with regard to e.g. predictability and transparency, and may indirectly improve concurrency and cross-functionality in product development work. However, Swedish lean product development does not address long-term product development strategy, which managers should thus assess independently.



Key Words — Cadence, Innovation management, Lean product development, R&D Productivity, Visualization

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# 1. INTRODUCTION

## 1.1 Problem description

### *1.1.1 A changing landscape*

This thesis began in a general discussion between us and the faculty at the Centre of Innovation and Operations Management, at the Stockholm School of Economics, about the notion that research and development (R&D) activities in industry are coming increasingly under pressure of productivity demands. Is that the case, and if so, what are the implications?

Stories abound of the overwhelming changes facing corporations today. The combined effects of several interconnected forces – including globalization of production systems and markets, rapid IT development, increasing global competition, the threat of commoditization in many industries, ever-more flexible production systems etc. – make the whole business landscape a moving floor.[1] These forces cut the life-cycle times for new products to fractions of years, and a creative approach to new product development becomes increasingly necessary to escape the commodity trap. Under the impact of these global business challenges, firms are being forced to seek ways to quickly identify and adapt to new market trends, shorten their lead times for development of new products and increase efficiency in all sorts of internal process to stay competitive.

Thus, the recipe for firms on how to handle this cannot just be sought primarily in cost reductions anymore. According to a study by management consulting group Bain & Company, managers increasingly turn to improved innovation as the answer to the competitive challenges: 86 percent of them think that innovation is more important than cost reductions in the long term.[2]

### *1.1.2 Managers face a challenge*

Turning to a textbook, we find "innovation" defined as "theoretical conception + technical invention + commercial exploitation".[3] This definition is typical for today's professional view on innovation, with its emphasis on the commercial dimension.[4] One of the most obvious sources of firm innovation is the firm's own research and development organization, and more explicitly the new product development, which

[1] Schilling, Melissa A., *Strategic Management of Technological Innovation*, p. 1, 2005.
[2] Bain & Company's 2005 Management Tools & Trend survey.
[3] Trott, Paul, *Innovation Management and New Product Development*, p. 12, 2002.
[4] A similar definition is provided by the Organization of Economic Co-operation and Development, OECD (1981): "Technological innovation is the transformation of an idea into a new or improved salable product or operational process in industry or commerce."

typically takes place largely within a dedicated function of the organization.[5]

Surprisingly, searching for "productivity" or "efficiency" in connection with "research and development" we seemed to be finding a lot less than we had expected; it appeared that the management community was still absorbed in the question of effectiveness, i.e. how research and, more explicitly, product development activities can be aligned with the firm's strategy. Eventually, however, we came across a concept partly new to us: *lean product development*. We found it presented as a possible new way to answer to the mentioned business challenges, of market orientation, shortened lead times, and efficiency of internal processes. Naturally we asked ourselves: *what is this*?

### 1.1.3 The emergence of lean product development

What we found showed that throughout the last five years, the concept of lean product development seemed to have crystallized as the dominant discourse in relation to the efficiency of product development activities in firms. The use of the word lean is helping to conceptually position the issue as a natural next step, after the common efforts in industrial companies from the early 1990's onwards to implement so called lean techniques in manufacturing.[6] The relatively abstract and uncertain nature of product development, however, has meant that it is far from self-evident what practices should be denoted as lean in this new context, and what should not. In the literature, it varies what is meant by lean product development, although virtually all accounts share the trait that they view car maker Toyota and its practices as their unquestioned norm.

### 1.1.4 Lean product development in Sweden

So what does all of this mean for Swedish companies? Apparently a lot. On 31 March 2006 around 330 people gathered for a seminar in Gothenburg on the subject of The Toyota Product Development System, led by Professor Jeffrey K. Liker, author of *The Toyota Way* and one of the leading gurus in the field. The event was hosted by the Swedish Industrial Research and Development Corporation, IVF, which also coordinates a dedicated Lean Product Development network for interested companies. Our study apparently coincided with a point in time when the gospel of lean product development seemed to be exploding on Swedish industry.

Not only did we find this a very exciting topic of study in itself. From our viewpoint this could also provide a focal point of the broader discussions, with the faculty, which we started from. If we could help develop an understanding of the concept of lean product development, in its Swedish form, this would provide a contribution to the answers on how firms could front the ongoing changes in the business landscape.

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[5] Schilling, Melissa A., *Strategic Management of Technological Innovation*, p. 20, 2005.

[6] A background on lean manufacturing and lean thinking in general, is given in the literature review section.

## 1.2 Purpose

Our over-arching purpose is a rather practical one: we wish to produce academic insight which can *help managers organize R&D activities to adapt these to the emerging business landscape*. As we discuss in a separate section, on concepts, in our method chapter, we are convinced that reasonably well-defined concepts are important for efficient collaboration in practice. Also, we want to make it possible for managers to learn lessons from other companies' experiences where possible.

## 1.3 Research questions

1. What does lean product development consist of, as practiced by Swedish firms?

2. What are the implications for management of the experiences made?

## 1.4 Delimitations

Starting from a situation where the concept of lean product development is not at all clearly defined, we could not meaningfully aim at a complete survey of who does what in Swedish industry. We approach only firms who have made documented references to lean product development. While trying to catch appearances of lean product development, *we thus do not produce evidence for statistical generalizations about Swedish firms*.

Further, due to the immature state of the concept studied, the reader must expect that *we do not boil it down to a definite list of components*, however convenient that would be. It is through the rich empirical stories that the concept gets its nuances.

While we do discuss managerial implications of what we find, it must be recognized that *we do not aim at producing an implementation guide for lean product development techniques*.

Finally, *we do not investigate the role of social factors*, such as class and gender, in our study of the construction of the lean product development concept. We do not touch on power relations in relation to the discussion on changes in work content for engineers; indeed we do not interview any non-manager design engineer at all. This is not to say such factors are not important, but we hope that others could do this more easily after our conceptual exploration.

## 1.5 Outline

Our text begins with a methodological discussion, focusing on such issues as exploration, concepts, and the case study method, which are central to our work. We then turn to background, consisting of two main parts: firstly a theoretical framework starting from innovation theory, and positioning the role of product development in innovation and business strategy with some basic models; secondly a literature survey leading from

the origins of the lean concepts, in manufacturing, to today's theory on lean product development.

Our empirical data consists in interviews, presented firm by firm, from eight companies, plus an introductory interview with Thomas Sigemyr who manages the Lean Product Development network under IVF. A large part of the empirical account is from our case study firm Leine & Linde, which follows after an interview from lean trendsetter Scania. It is through this detailed empirical account that the complex concept of lean product development in Sweden emerges, providing a platform for our analytical section. The analysis is performed in two parts, focusing on each of the two research questions. Finally we sum up our findings, and discuss the theoretical contribution and possible topics for further study.

### *1.5.1 The use of company names and some concepts*

For the simplicity of the text we often use, throughout this thesis, the surveyed companies' names interchangeably with the names of the individuals whom we have interviewed. This should not be seen as implying that we assume the views of the individuals to be unproblematically aligned with the interests of the entire firms. Also, we sometimes refer to parts of companies by the name of the group to which it belongs. The extension of the units discussed should be evident from our empirical accounts.

A further comment on language is that organizational concepts – such as the R&D function, the technology organization and the product development process – could easily be confusing to a non-practitioner. Our use of these concepts largely conforms to the use at Leine & Linde, described in section 5.3.2. The most important aspect to bear in mind is that the product development process is cross-functional in the sense that it involves activities by people working in various functions, typically including marketing, production technology, purchasing and, confusingly, often a specific function called R&D or product development.

# 2. METHOD

## 2.1 Exploratory survey including a case study

Our research questions, *What does lean product development consist of, as practiced by Swedish firms?* and *What are the implications for management of the experiences made?*, put us on a track of exploration. What we are exploring is a concept, that of lean product development, and we are exploring it as it appears in relation to Swedish firms. We will be discussing the methodological aspects of exploration, concepts etcetera further down, but let us first sum up how our study was performed.

Our research design can be said to consist of three main parts: a review of the literature on lean product development, an interview survey and a case study. The survey part, conducted primarily through interviews via telephone, seeks to capture views and experiences of people who have shown interest in the industrial application of lean product development, mainly development managers of relevant firms. To a lesser degree we complete this with secondary data, found in newspaper articles and where so done this will be explicit from footnotes. Our sampling has targeted firms which have shown explicit interest in the concept.

The case study part looks closer at one firm, Leine & Linde, which claims to have employed a lean product development model entirely according to a blueprint offered by a consultancy firm (Parmatur, where we have interviewed Ulla Sebestyén for background without explicit report in our text). This offers a fuller picture of one instance of an allegedly lean product development system than could possibly be reflected through a survey, and therefore contributes to a more systematic understanding of the concept studied. Data for the case study was collected mainly during a full-day on-site visit during which we had very good access to people we wished to interview.

### *2.1.1 Qualitative research strategy*

While the survey part has been conducted partly to indicate what themes from the theory of lean product development seem more or less emphasized by the practitioners, it is nevertheless important to note that the sample is too small and arbitrary to support any form of statistical conclusion. In terms of research strategy our study stays firmly in the qualitative realm as opposed to the quantitative.[7] According to Bryman (2004), qualitative research obviously tends to be concerned with words rather than numbers, but also shows three other particularly noteworthy features: "an inductive view of the relationship between theory and research, whereby the former is generated out of the latter; an epistemological position described as interpretivist, meaning that, in contrast to the adoption of a natural scientific model in quantitative

[7] Bryman, Alan, *Social Research Methods, Second Edition*, p. 266-, 2004.

research, the stress is on the understanding of the social world through an examination of the interpretation of that world by its participants; and an ontological position described as constructionist which implies that social properties are outcomes of the interactions between individuals, rather than phenomena 'out there' and separate from those involved in its construction."

Bryman (2004) uses the following graph as a generic map of the qualitative research process.

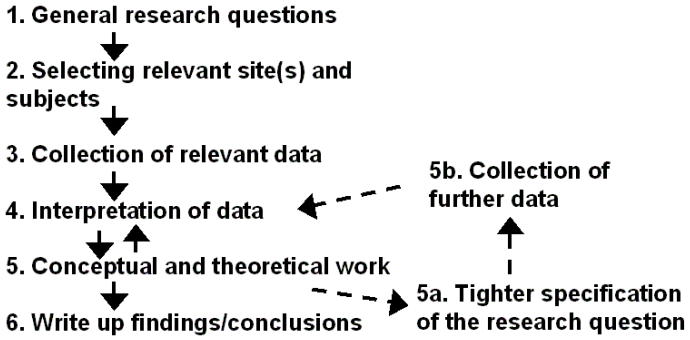


**Figure 1: An outline of the main steps of qualitative research. From Bryman (2004)**

As is evident in the figure above, qualitative research is not a matter of a linear process, but rather one of reiterations between the conceptual/theoretical work and the interpretation of data, both repeatedly developing in the light of each other. There is also a possible reiteration path leading through tighter specification of the research question and the collection of more data.

### *2.1.2 Inductive versus deductive*

Our approach is mainly inductive, rather than deductive, in that we let the concept evolve from our data.[8] However, we do indeed provide an innovation theory framework and a review of existing lean product development literature which we see as

- guides to provide us with enough pre-understanding to delimitate the area of study,
- sets of data and theory to which our findings can be related, for the purpose of strengthening validity, in terms of what Yin (2003) refers to as analytical generalization. (See section on the dilemma of the case study as method further down.)

The literature also constitutes an important component of the environment in which Swedish lean product development is emerging.

[8] Bryman, Alan, *Social Research Methods, Second Edition*, 2004.

### 2.1.3 Interpretivist versus natural scientific epistemological position

A natural scientist can make statements about objects and their relations regardless of how those are interpreted by other people. Often in social sciences, however, it is only through other people's interpretation that phenomena receive their meaning and by consequence it is through their interpretations that the phenomena are best studied.[9] The latter position is clearly the departing point of our study, and our interview-oriented design follows. We do not see how the meaning of lean product development could be sensibly studied without departing from the interpretations by the people it is supposed to mean something for.

### 2.1.4 A constructionist ontological position

Features of what is referred to as lean product development could appear in firms without anybody necessarily being aware of the concept. However, our study centers on the concept. It focuses on what is thought of as lean product development by different persons rather than what fulfills some objectified standard. That is not to say lean product development could mean anything. It does have a meaning, even if that meaning does not have sharp boundaries. Yet the departing point for us is that it receives this meaning through people's application of the concept and its components in their interaction with their social world. This is what makes the ontological position of our study constructionist.[10]

### 2.1.5 An exploratory purpose

Andersen (1998) refers a list of six categories of purposes in social science research.[11] These are descriptive, exploratory or problem identifying, explanatory or understanding, diagnostic, problem solving or normative, or intervention oriented. The category of exploratory and problem identifying studies serves to explore circumstances or phenomena which are less known or possibly entirely unknown, according to Andersen (1998).[12] The purpose of exploratory studies can be to produce interesting questions which can later be examined closer. It can serve to formulate hypotheses or assumptions which can later be subject to testing. In more specific cases, such as those faced by consultants in organizations with felt but unarticulated problems, the consultant's first task is to identify and define more precisely the most important problems.

### 2.1.6 Concepts

In most academic work the development of concepts is crucial. The researcher must make sure that used words are intelligible to others, and

[9] Bryman, Alan, *Social Research Methods, Second Edition*, 2004.
[10] Ibid.
[11] Andersen, Ib, *Den uppenbara verkligheten*, p. 18, 1998. referring to: Borum, Finn, (1990) *Om valg af organisationssociologisk metode*, 1990.
[12] Andersen, Ib, *Den uppenbara verkligheten*, p. 18-19, 1998.

must therefore constantly develop the language.[13] Andersen (1998) draws a parallel to sailing, where quick exchange of specialized but unambiguous words is a prerequisite for efficient navigation and safety. Sailors must agree what to call a specific sail.

In our study, concepts have double importance. Not only are they tools at our disposal. Also, it is a concept, that of lean product development, that is the object of our study. Reaching as deep an understanding as possible of what it means in a specified setting is the purpose. By the same logic as with sailing, we reckon that such concept development of Swedish lean product development can make it easier to apply ideas within the concept, and that it can decrease the risks of various forms of failure.

But can we hope to reach an unambiguous definition? We start methodologically from an assumption that the answer must be no, and let us refer to Blumer for arguments.[14] According to Blumer (1954) it is not meaningful in qualitative research to think about concepts in the same way as in quantitative research, where concepts are traditionally preferred to be "definitive". Once developed the concept becomes fixed through the elaboration of its indicators. Blumer saw this as providing a straightjacket on the social world, and argued that social researchers should stay constantly open to variety in the phenomena which the concept is supposed to subsume. Concepts should thus be "sensitizing", in that they provide "a general sense of reference and guidance in approaching empirical instances".[15] Bryman (2004) points out that while this tends to chime well with the world view of many social researchers it is also problematic. Writes Bryman: "It is not at all clear how far a very general formulation of a concept can be regarded as a useful guide to empirical enquiry. If it is too general, it will simply fail to provide a useful starting point because its guidelines are too broad; if too narrow, it is likely to repeat some of the difficulties Blumer identified in relation to definitive concepts."

Let us produce a figure to illustrate the issue of concept definition in our work.

[13] Andersen, Ib, *Den uppenbara verkligheten*, p. 78-79, 1998.
[14] Blumer, 1954, as referred by Bryman, Alan, *Social Research Methods, Second Edition*, p. 271, 2004.
[15] Blumer, 1954, as directly quoted by Bryman, Alan, *Social Research Methods, Second Edition*, p. 271, 2004.

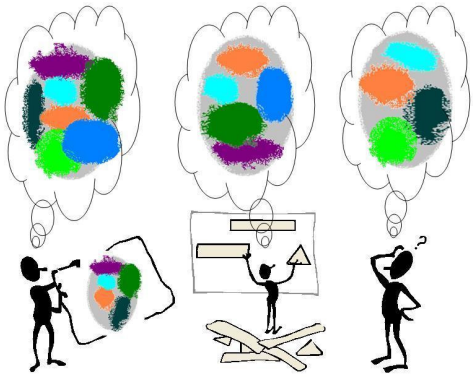

**Figure 2: A visualization of concepts and their components**

Let us see the colored spots in the figure above as the components of the lean product development concept. There is no final authoritative norm of which components are, or are not, part of lean product development, though there will be more or less significant parallels between different persons' interpretations. But even if two persons agree that a certain phenomenon should be seen as a component of the lean product development concept, e.g. visualizations of project flow (let's say this is symbolized by one of the spots that occurs in all persons' images) they may still differ in their understanding of its form, its role in relation to the lean product development concept as a whole, and its possible overlap with the other components. And even so, each person is unlikely to have a mental image of a clear boundary of each component's meaning – this lack of definition is represented by the fluffy edges of each spot. Note also that a component can partially fall outside the full area, representing that it may be perceived as partially falling outside the lean product development concept.

### *2.1.7 The dilemma of the case study as method*

The case study has long, if not always, been one of the absolute favorite methods of researchers in the social sciences, not least in business and management. Not least with regard to research questions of "how" and "why" does it often provide the straightest path to a sense of understanding.[16] Paradoxically, then, its scientific merits have been seen as problematic. As Yin (2003) sums it up: "The case study has long been (and continues to be) stereotyped as a weak sibling among social science methods." Yin (2003) cites three main types of criticism against the case study method:

- that case studies are often characterized by lack of rigor; "Too many times, the case study investigator has been sloppy, has not followed systematic procedures, or has allowed equivocal evidence or biased views to influence the direction of the findings and conclusions."

[16] Yin, Robert K., *Case Study Research: Design and Methods,* chapter 1, 2003.

- that case studies provide little basis for scientific generalizations, and
- that they take too long and result in massive, unreadable documents.

Yin counters the critique on all three accounts. As for the first and the third point, we interpret Yin as meaning that they should be viewed as criticisms of the investigator rather than of the case study method as such. As for the middle point of critique, however, he goes into somewhat complex reasoning. He agrees that case studies (which, as he points out at a different point in his book, cover more points of interest than data points) do not represent a "sample" and thus do not lend themselves to attempts to enumerate frequencies (statistical generalization). However, he argues that case studies can support what he refers to as analytic generalization: "… case studies, like experiments, are generalizable to theoretical propositions and not to populations or universes. … [I]n doing your case study, your goal will be to expand and generalize theories …" All this said, however, the abundant criticism of the case study approach seems to fall relatively lightly on it in relation to studies of exploratory purpose, such as ours, since the purpose is then not so much to draw generalized conclusions as it is to provide the concepts pre-required for such generalizing studies to be performed by others in the next step.[17]

### *2.1.8 Triangulation*

So far the case study method, used with Leine & Linde. But how about our interview survey method with representatives at other companies? Indeed we would argue that its merits and weaknesses can pass under the same discussion as for the case study method above. While structured interview surveys of broad samples can be basis for statistical inferences ours is both too small and too little structured to pass for statistically generalizable. Rather, in our attempts to give a good broad-scale picture of lean product development in Swedish industry, one can see the survey interviews as a form of triangulation in relation to our case study results and to each other, i.e. an approach to shed light on a subject from different angles by using e.g. multiple methods of investigation or sources of data.[18] The reasoning can be further extended to our literature survey, which, in addition to tentatively framing the concept as we have discussed above, also can be seen as a source of further triangulation on our whole set of data from Swedish industry.

[17] Yin (2003) refers to a "common misconception" that various research strategies should be arrayed hierarchically, with case studies being appropriate only for the exploratory phase of an investigation, surveys and histories for the descriptive phase and that experiments are the only way of doing explanatory or causal inquiries.

[18] For a background and discussion on triangulation in qualitative research, see Bryman, Alan, *Social Research Methods, Second Edition*, p. 275, 2004.

### *2.1.9 Eight firms, found through "snowball sampling"*

We have interviewed representatives of eight firms, one of which is our case study object Leine & Linde. At Scania, Ericsson and Leine & Linde we visited in person for interviews, while representatives of ABB Robotics, Haldex, Kongsberg Automotive, Sandvik and Bahco Tools were interviewed via telephone. Further telephone interviews were done with representatives of IVF and consultancy firm Parmatur.

We perceive this sampling method to be a consequence of our desire to frame the concept of lean product development, and of our described methodological considerations; simply, it would be quite ridiculous for us to approach firms who had never heard of it. Starting with a search for references on productivity and efficiency in R&D, we first met the concept of lean product development in connection with an early meeting with Scania's chief technology officer (CTO) Hasse Johansson. This led us to IVF's network on the subject, which had several participating firms listed on their web site, and whose manager Thomas Sigemyr kindly provided us with several names of people to contact.[19] Web searches also led to Parmatur, a consultancy firm, which recommended us to approach the firm of one of its most successful cases, Leine & Linde, for a case study.

This can be seen as a case of what Bryman (2004) refers to as the snowball sampling method, the results of which will depend on (and possibly be biased by) social relations between those covered, and therefore gives no basis for statistical inference, yet can work as a starting point for development of theoretical hypotheses.[20]

## 2.2 Strengths and weaknesses of the method

With industrial relevance being a leading star for our work, we try to give a rich, broad picture of lean product development as practiced in Sweden. It is by relating data on several abstraction/generalization levels, and putting these in the light of innovation and product development theory that this big picture is produced.

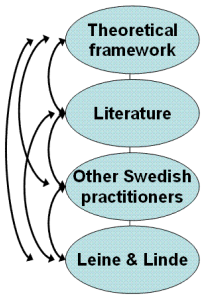


**Figure 3: Data and theory on different levels shed light on each other.**

[19] The following firms are examples of participants in the lean product development network: Scania, ABB, Haldex, Kongsberg Automotive, Sandvik, SNA Europe (owner of Bahco Tools) and Volvo Bus Corporation.

[20] Bryman, Alan, *Social Research Methods, Second Edition*, p. 100-102, 304, 2004.

While our text certainly provides rich detail on many matters, it should yet be clear that these details are not a purpose in themselves, but rather serve to add nuances to the big picture. We have not had the resources to double-check and question all data given to us, a fact that may be seen as problematic in that for most firms we rely on single interviews. Another problem stemming from this is that there may be little, if any, calibration of what different persons mean for example by saying they have come far or just started, done little or done much. Thus our data does not provide basis for quantifications, benchmarking, or any form of assessment, and we try to refrain from such temptation.

A further weakness on an even more detailed level might be the fact that we recreate quotes from more or less cursory notes, taken during the interviews. Given the big-picture purpose, we perceive that the value of word-by-word correctness if we were to use tape recorders would not exceed the cost to interview flow, work efficiency and interviewee integrity. This said, we have double-checked our written interview summaries with most of the interviewees who have only found reason to propose minor corrections. Language may further have been distorted in our translation from Swedish to English, which is done for the purpose of making our text potentially accessible to a broader audience. Thus our data may not lend itself to detailed language or discourse analysis.

We have intentionally spiced our text with many quotes, as we think this is crucial to let the reader continuously micro-test the reliability of data in our text (and our double-checking of the interviews serve to further strengthen reliability in that step).

# 3. THEORETICAL FRAMEWORK

In our introduction we discussed how the concept of innovation, as used in innovation theory today, typically includes a commercial dimension. According to a 2001 survey by the European Commission, the Innovation Scoreboard, EU businesses were spending money equivalent to 4 percent of their sales on innovation (EU means figure).[21] Sweden is particularly interesting, as it tops the list at 7 percent. According to the 2005 update of the same survey, Swedish business R&D expenditure, at 2.93 percent of GDP in 2003, was more than twice the European average.[22] The long-term trend in Sweden, as in the rest of the world, in terms of business-funded R&D as a percentage of GDP, is steadily rising.

The following background on innovation theory serves to position product development in general, and lean product development in particular, in its historical and theoretical context. Discussion starts in business strategy, and the role of innovation in it, and then narrows down into product development. Finally, we go through some recent critical perspectives.

## 3.1 Frameworks for understanding innovation management

Innovation strategy, just like business strategy in general, originated in the 1960s, largely in *rationalist*, militarily inspired, linear models of thinking.[23] From such a perspective a firm should first analyze its environment, then determine a course of action, and finally act. Part of the manager's task is to make sure that enough attention is given to long-term planning under the pressure to concentrate on the day-to-day. This rational view has become increasingly questioned, however, under the pressure of environment complexity and rapid change as well as of lacking knowledge of what goes on inside the organization itself. The pendulum has thus shifted for more non-rational, *incrementalist,* views, which assume that change should be implemented in small steps with constant reevaluation and adjustment. Increasingly, strategy (and innovation management with it) has turned to more systemic (rather than linear) views, which model and investigate under which conditions firms tend to thrive. The implications for managers, according to Tidd et al (2005), is e.g. that they should explore implications of a *range* of possible future trends, that they should ensure broad participation and informal channels of communication, as well as multiple sources of information, debate and skepticism. Successful strategies are contingent on national and competitive environments, and can thus never be directly copied between

[21] The 2001 Innovation Scoreboard, referred by Trott, Paul, *Innovation Management and New Product Development*, p. 23-27, 2002.
[22] http://trendchart.cordis.lu/scoreboards/scoreboard2005/Sweden.cfm.
[23] Tidd et al, *Managing innovation: Integrating technological, market and organizational change. Third edition,* chapter 3, 2005.

firms. The following figure is one example of such systemic models emphasizing gradual and firm-specific knowledge build-up, through activities linking the organization to aspects of its environment:[24]

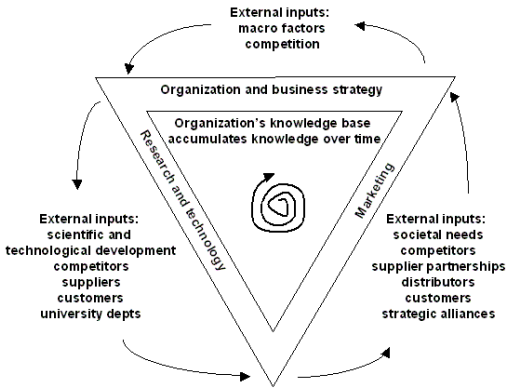


**Figure 4: Innovation management framework.**

Rothwell, as referred by Trott, puts the development of innovation models in a chronological context, leading from models of technology push (1950/60s) to market pull (1970s), coupling models (in 1980s, emphasizing on the integration of R&D and marketing), interactive models (1980/90s) and most recently network models, emphasizing external linkages.[25]

### *3.1.1 Radical versus incremental innovation*

One of the primary dimensions used to separate types of innovations is the parting between radical and incremental innovation.[26] Most innovations can be categorized as incremental, innovation that makes a relatively minor change or adjustment to existing practice. Trott (2002) notes that it is incremental improvement, of existing products, that make up the overwhelming part of firms' product development activities.[27] Sony is mentioned as an example, with 80 percent of all new product activity undertaken to modify and improve the company's existing products. However, at some stage there will also be radical steps in innovation, creating ideas or technology that is new and different to prior solutions. Such developments often create substantial changes to the existing market, reformulating the roles of companies. While established firms can typically predict sales of incrementally new products quite precisely, they are surprisingly often taken by surprise by more radical technology shifts.[28]

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[24] Trott, Paul, *Innovation Management and New Product Development*, p. 21, 2002.
[25] Rothwell, R. 'Successful industrial innovation: critical factors for the 1990s'. *R&D Management* (22) 3, p. 221-39, 1992. as referred by Trott, Paul, *Innovation Management and New Product Development*, p. 20, 2002.
[26] Schilling, Melissa A., *Strategic Management of Technological Innovation*, p. 38, 2005.
[27] Trott, Paul, *Innovation Management and New Product Development*, p. 210, 2002.
[28] Utterback, James M., *Mastering the dynamics of innovation*, chapter 7, 1996.

## 3.2 The role of new product development in innovation management

The position of most day-to-day product development in a firm's portfolio of R&D activities can be understood by looking the model by Wheelwright and Clark below.[29] It describes four types of development projects, ranging from advanced R&D projects, via breakthrough and platform projects to derivative projects. The major part of work is done in the latter two. These are characterized by low degrees of change both in product and process.

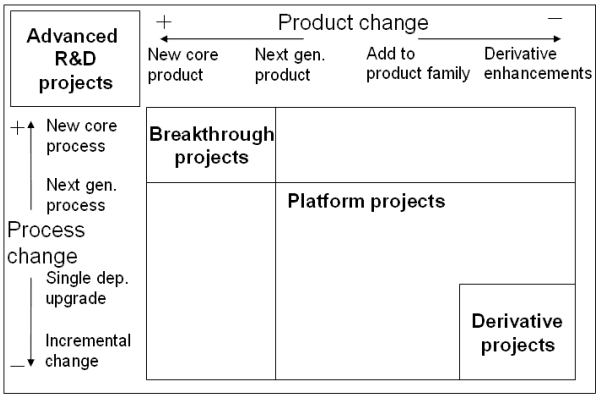


**Figure 5: The Project Map, by Wheelwright and Clark.**

While the more strategic considerations of innovation management may seem abstract to many, most industrial companies have very hands-on activities for incrementally improving their products. Typically, devoted product development engineers are employed in a specific R&D function. Trott (2002) describes the relation between innovation management and new product development as follows:[30]

> "Managing innovation concerns the conditions that have to be in place to ensure that the organization as a whole is given the opportunity to develop new products. The actual development of new products is the process of transforming business opportunities into tangible products. […] New product development concerns the management of the disciplines involved in the development of new products."

[29] As referred by Schilling, Melissa A., *Strategic Management of Technological Innovation*, p. 130, 2005.
[30] Trott, Paul, *Innovation Management and New Product Development*, p. 200, 2002.

Trott (2002) uses the following figure to illustrate the role of new product development in innovation management.


**Figure 6: The role of new product development in innovation management.**

The notion of "new" in "new product development" should be interpreted broadly. It could mean anything from a surprising new-to-the-world product based on hitherto unexploited technology, to a slightly re-targeted market offer of an existing physical product, requiring no engineering. We thus refer to this simply as "product development" throughout this thesis. Our focus is on technology intensive firms, and we therefore use the terms design, engineering and product development interchangeably, as they tend to overlap.

### *3.2.1 Product development models, from departmental to conversion-process*

The organizational activities undertaken by industrial companies in the process of product development have historically been represented by, as well as influenced by, numerous different models. These models have attempted to capture the key activities involved in the process, from idea to commercialization of the product. Similarly to the more general innovation models discussed in a section above, these product development models too started out as simple and linear, moving more recently towards a view of product development as a simultaneous and concurrent process with cross-functional interaction. According to Trott (2002) it is possible to classify the existing models into several distinct categories:

- **Departmental-stage models.** These represent the early form of product development models, based on a linear view of innovation where each department is responsible for a certain task. The category is also referred to as the "over-the-wall" models, so called because departments would carry out all their tasks before throwing the project over to the next department. Today, it is widely accepted that this view of the process hinders

the development of new products as it leads to a great deal of reworking and consultation between functions.

- **Activity-stage models and concurrent engineering.** Although similar to the departmental-stage models, these models enable iteration of activities through the addition of feedback loops. More recent activity-stage models have highlighted the simultaneous nature of activities within product development, hence emphasising the need for a cross-functional approach. The term concurrent engineering, or simultaneous engineering, was first used by the Institute for Defence Analyses in 1986. In the late 1980s many companies adopted this systematic method of concurrently designing the product, its production process and supporting processes.[31]
- **Cross-functional models.** This approach targets the limitations which stem from poor communication in organizations. These are dealt with by forming project teams with people from all functions. This puts issues of project management in focus.
- **Decision-stage models**. These models present the product development process as a series of decisions that need to be taken in order to progress.
- **Conversion-process models.** The conversion-process models view product development as a "black box" into which there is a defined set of inputs. Output is assessed on its functional performance rather than its technical details. Reducing the necessary amount of detailed planning and control is a central purpose in this view.
- **Network-models.** According to Trott (2002), these represent the most recent thinking on the subject of product development. Network models emphasise the external linkages coupled with the internal activities of product development. These models suggest that product development should be viewed as a knowledge-accumulation process that requires inputs from a wide variety of sources.

## 3.3 A critical perspective: Uncertainty is inevitable

One strand of recent research on project management in product development tries to reconcile the surrender to the non-rational nature of the process with the organization's continued need for structured management. One example of this is Engwall (2003), who points, through a set of case studies, to the dangers of applying traditional project management logic onto product development processes which involve

[31] Trott, Paul, *Innovation Management and New Product Development*, p. 216, 2002.

uncertainty on many levels.[32] The message seems to be that under such circumstances the goal of the process cannot be determined in advance, but must be allowed to shift as discoveries are made along the way. Here, the dimension of knowledge build-up, discussed earlier, is thus emphasized, at the expense of rationalist planning. Engwall (2003) summarizes the managerial implications in six imperatives:

- **Act early.** Rather than "planning ahead" one should "act first, in order to understand later". This helps build a practically based joint understanding of the project.
- **Perform visualization together.** (Visualization here refers mainly to products, while our interviewees in later sections mainly refer it to project flow.) This enables communication beyond words, which have not yet been given joint definitions.
- **Be prepared for learning.** Stage-gate decisions should be seen as hypotheses rather than strict limitations.
- **Structure for flexibility.** Like an ice-hockey team, the product development team should have structure, but structure itself cannot have the upper hand in relation to the task, which can be expected to shift.
- **Respect different worlds of ideas.** One reason the hand-over from project to permanent organization can be problematic is that the receivers are not given time to develop their own understanding of what the new product should mean to them.
- **Deviate tactically from the stipulated development plan.** This is risky but sometimes necessary for success.

## 3.4 "Efficiency" could be ceremonial

Another critical take on the rationalist view underpinning so much of business management in general, and not least project management, is that which comes from the so called neo-institutional (or just "institutional") perspective.[33] Managers are forced to be efficient. But, goes the thought of the neo-institutionalists, in society today this force presses harder on what you say and how you act, than on how you actually perform your work in the organization. This distinction explains why many business phenomena, which are introduced in the name of efficiency, may appear at a closer look to be mainly ceremonial. (For example, a consultant preparing a decision will be expected to produce numbers, even if board members will in reality make their subsequent decision based more or less solely on gut feel. Though the numbers do not add to the efficiency of the decision they are crucial for its legitimacy.) Brunsson and Olsen (1997) have studied what appears to be an

[32] Engwall, Mats (editor), *Produktutveckling bortom kunskapens gränser: Mot en osäkerhets grammatik*, 2003.
[33] The outline of neo-institutionalism in this section builds largely on the key article by Meyer & Rowan (1977), yet for a more easily digested introduction to the field we can recommend the book by Brunsson & Olsen (1997) from which we quote below.

imperative for regular reform in many organizations, concluding that "[r]eforms are the results of attempts at modernization, shifts in administrative fashions, the existence of insoluble administrative problems in organizations, and the organizational tendency to forget previous reform experiences."[34] The valuable point in this context is that even if organization members are convinced that a reform is good for efficiency it may well be that it has not brought increased efficiency at all. Other factors still easily make us think so.

One topic discussed within neo-institutionalism is the spread of managerial ideas, and the mechanisms in such spread, but also how these can subsequently fall out of grace with firms. As one example of such discussion, Forssell[35] looks at organization models in terms of "fashions", a view from the assumption that organization models, once popularized and spread among companies, can be rejected on the basis of rumors between organizations, not only on the basis of the firms own experiences. Spread and rejection are thus social processes. Note that fashionable is not the same as widespread.

[34] Brunsson, Nils, Olsen, Johan P., *The reforming organization*, 1997.
[35] Forssell, Anders, *Organisationsmodeller som moden, Uppsats till Nordiska Företagsekonomiska Ämneskonferensen i Helsingfors 1999,* p 2-18, 1999.

# 4. LEAN PRODUCT DEVELOPMENT IN THE LITERATURE

Over the last fifteen years, the Japanese-inspired gospel of "lean" has taken manufacturing industries in the rest of the world by storm. By using the word in the concept of lean product development, a set of allegedly productivity-increasing techniques for product development are positioned as a further step along the line. However, in no way does the label itself define what practices should be included and the concept can perhaps be best understood as a hybrid of new and repackaged ideas. The following literature survey attempts to show how the current lean product development discourse has developed from that of lean manufacturing. Starting with the sources and principles of lean thinking, it leads forward, through early discussions of the problems with applying these to product development, and finally up to today's attempts at developing more mature theory. The reader can not expect a consistent definition – if there were one there would be no need for our investigation – yet our literature survey should help frame the topic.

## 4.1 The spread of lean production

### *4.1.1 Started at Toyota in the 1940's*

The origins of "lean" are found in the Toyota Production System (TPS) initiated by the Toyota chief engineer[36] Taiichi Ohno and Shigeo Shingo. In the years following the Second World War, Japanese industry in general and Toyota in particular struggled with how to rebuild a shattered manufacturing base without the resources and economies of scale available to Western companies.[37] With the constraints given, Ohno and Shingo started developing the ideas in the late 1940's and early 1950's, and by the end of the 1960's they had fully developed their basic principles of lean production.[38] Ohno's view on production was summarized in three principles: *build only what's needed, eliminate anything that does not add value,* and *stop if anything goes wrong.* The Toyota Production System was also claimed to be rooted in a set of values: *the respect of those engaged in the work, the strive for full utilization of workers' capabilities* and *the placing of authority and responsibility for the work with those doing it*. While these

[36] The chief engineer role is in principle the same as what many firms call product manager. It is ideally a heavyweight person whose work is to communicate perceived or imagined market requirements on an overall level so that these become actionable for the engineers on the project. While this must be based in a realistic understanding of what is technically possible, it is often said to be a matter of communicating visions rather than technical detail. Cusumano (1998) has studied this deeply.

[37] Badr, Haque, Moore, James, *Applying lean thinking to new product introduction*, 2004.

[38] Womack, James P., Jones, Daniel T., and Roos, Daniel, *The machine that changed the world*, 1990.

ideas were commonly applied in Japan it wasn't until the aftermath of the oil crisis in 1973 that any significant impact on Western industry could be seen. Toyota and other large Japanese companies had expanded into Europe and America and these would soon end up dominating several industries, putting local industrial giants such as Ford and GM behind.[39]

### 4.1.2 Beginning to change the world

On the initiative by the so called International Motor Vehicle Program at MIT, James Womack, Daniel Jones and Daniel Roos wrote the influential book *The machine that changed the world* (1990). The focus of the book was the production system of Toyota, and although other American writers had already touched on the Japanese practices it was through Womack and Jones that the concept of lean production (manufacturing) gained widespread attention from a more general corporate audience. The objective of the book was to illustrate the performance gap between Toyota and other car makers and to show alternative ways to organize and manage customer relations, the supply chain, product development and the production operations.[40] Extending the concepts of lean production across the enterprise, the concept of lean product development was thus introduced, although vaguely. While the focus was kept on the assembly line, the authors discussed a number of techniques for lean product development in cursory terms. The main techniques presented were *a strong project leader with total control over functional resources, teamwork, early and controlled communication* and *simultaneous development*.[41] Some of these techniques where previously known, but were now gathered under the common heading of lean.

### 4.1.3 The principles of Lean

Following their 1990 book, Womack and Jones looked to expand and concretize the concept of lean by developing a more comprehensive lean philosophy. In their book *Lean thinking: Banish waste and create wealth in you corporation* (1996), they defined five principles of lean thinking, which according to them could be applied to the entire enterprise and not just to manufacturing. They described their approach as a whole new way of thinking about the roles of the firms, directions, functions, order-to-delivery, customers' role and how to channel the flow of value from product concept to market launch.[42] The five principles of lean thinking, formulated as imperatives for concrete actions, have since been a strong inspiration for all work within the concept of lean. Womack and Jones started from Taiichi Ohno's definition of waste as "any human activity which absorbs resources but creates no value", as well as Ohno's

[39] David, Harvey, *Lean, Agile*, 2004.
[40] Womack, James P., Jones, Daniel T, *Lean Thinking, banish waste and create wealth in your corporation*, 1996.
[41] Badr Haque, Moore, James, *Applying lean thinking to new product introduction*, 2004
[42] Womack, James P., Jones, Daniel T, *Lean Thinking, banish waste and create wealth in your corporation*, 1996.

definition of the seven types of waste: *defects* (in products) or mistakes which require rectification, *overproduction* of goods not needed, *inventories* of goods awaiting further processing or consumption, unnecessary *processing* with steps not needed, unnecessary *movement* of people, *transport* of goods from one place to another without any purpose, and *waiting* due to upstream activities not delivered on time.[43] By further adding an eighth type, *the design of goods and services which do not meet the customers' and users' need*, Womack and Jones (1996) helped open the door for Japanese-inspired manufacturing thinking to influence also non-physical processes such as product development. Their basic definition of lean in this context was grand rather than specific: "Do more and more with less and less – less human effort, less equipment, less time and less space – while coming closer and closer to providing customers with exactly what they want." However, the breakdown into five principles urged concrete action:

- **Specification of value.** Value can only be defined by the end customer, and understanding value is the critical starting point of lean thinking. Value for the customer should be understood in terms of central features of a product (a good or a service) which are required in order to meet the needs of the customer as well as the specific price a customer is willing to pay for a product. Womack and Jones (1996) put it this way: "One should define value in terms of specific products with specific capabilities offered at specific prices through a dialog with specific customers." According to Womack and Jones (1996), the way to do this is to rethink firms on a product-line basis with strong, dedicated product teams. This also requires and includes a redefinition of the role of the technical experts in a firm from inward looking to outward value seeking.[44]
- **Identify the value stream.** The value stream is the set of actions required to bring a product through what Womack and Jones (1996) call the three critical management tasks of business: *the problem solving* task which runs all the way from concept through detailed design and engineering to product launch, *the information management task* including order taking, scheduling and delivery, and *the physical transformation task* running from raw material to finished product. Identification and understanding of a product's value stream and its waste constitutes this second principle.[45]
- **Flow.** In order to create flow firms need to reorganize departments and functions in so that they enable continuous movement and value creation throughout the value stream. The value creation process for the product (or its raw materials, components or sub-assemblies) should never have to be interrupted.

[43] Womack et al. *Lean Thinking, banish waste and create wealth in your corporation*, 1996
[44] Ibid.
[45] Ibid.

- **Pull.** A pull approach means that nothing is made unless the customer has ordered it or wants it. This ensures that there is no build-up of work-in-process inventory, which would disturb the synchronized flows. This is seen as yet another aspect of minimizing waste.
- **Perfection. W**ays to increase value provision should be continuously identified. By tracking non-value adding activities, and reducing the costs of necessary but non-value adding activities, it is possible to remove layers of waste as they are uncovered in existing activities.

Nevertheless, despite the authors' efforts to apply the concept to the whole enterprise, the book and its ideas were heavily biased towards manufacturing and assembly environments. This is evident from the examples used in the book. Consequently, the five principles have mainly been applied specifically in manufacturing. Explicit application of the five lean principles to product development has been lacking, both in industry and in academic research.[46]

## 4.2 Beginning to glance at product development

The rest of the 1990's and early years of the next decade saw a veritable explosion of lean practices in manufacturing.[47] Japanese companies had now for some time been perceived to be outperforming those of the West, and Western companies showed hunger for further ideas from the East. Although most of these attempts were still focused on manufacturing techniques, some also took aim at product development.

### *4.2.1 A difficult path: Karlsson & Åhlström*

But how was the adaptation from manufacturing (concerned with physical things) to product development (concerned with information) to be done? By now it was obvious that the question was not trivial. One little-known, but early and today illuminating, article on the difficulties is *The difficult Path to Lean Product Development* (1996), where Karlsson and Åhlström list and discuss the difficulties and concerns with implementation of lean product development. The key message of their study was that implementing one or a few techniques would not be sufficient for achieving lean product development.[48] Instead, as Karlsson and Åhlström (1996) make explicit, the emphasis should lie on a coherent whole. The article is also interesting because of the authors' definition of what techniques they include in the concept of lean product development – such summary definitions are rare still today. These techniques where:

[46] Badr Haque, Moore, James, *Applying lean thinking to new product introduction*, 2004.
[47] Hines, Peter, Holwe, Matthias, Rich, Nick, *Learning to evolve: A review of contemporary lean thinking*, 2004.
[48] Karlsson, Christer, Åhlström, Pär, *The difficult path to Lean product development*, 1996.

- **Supplier involvement.** Suppliers are involved from the beginning of a new project. Usually suppliers develop complete modules without detailed specifications. Requirements of desired functions replace specification of technical detail.
- **Simultaneous (or concurrent) engineering.** The different functions involved in the development process perform their work in parallel. An example described is that development of the product and the tools for producing it take place simultaneously.
- **Cross-functional teams.** Teams consist of members from different functional areas in the organization (e.g. marketing, development, production, purchasing) in order to incorporate all functional aspects of the product from the start.
- **Integrated rather than coordinated functional aspects.** Instead of coordinating activities and personnel from different parts of the firm they work together. Direct contact and meetings replace special coordination functions.
- **Heavyweight team structure.** A project manager who has access to, and is responsible for, all the work of those involved.
- **Strategically managed.** Projects are managed by visions and objectives instead of detailed specifications.

The authors are clear on the fact that some of the techniques presented were previously known but were now placed under the concept.

### *4.2.2 The multi-project complement: Cusumano & Nobeoka*

While for several years little new was reported on the lean product development front, ways were sought to come around the problem. An important contribution came in the form of the book *Thinking Beyond Lean* (1998) by Michael A. Cusumano and Kentaro Nobeoka.[49] It was the report of a very ambitious study of project management in the product development processes of international car makers, not least Toyota. They argue that existing management theory, including that of lean principles, over-focuses on single projects, while they see the key to success largely in the spread of knowledge between projects. Developing a framework for, amongst other things, discussing the value of concurrency versus sequentiality between projects, the book helped popularize the concept of multi-project management. Although multi-project management is positioned in the book as a complement to lean thinking, the book's title may have helped to conceptually position it as a component of it.

[49] Cusumano, Michael A., Nobeoka, Kentaro, *Thinking Beyond Lean: How Multi-Project Management Is Transforming Product Development at Toyota and Other Companies,* 1998.

### 4.2.3 Reinertsen, before lean

*Developing products in half the time* is the name of a book, first published in 1991, by consultants Donald G. Reinertsen and Preston G. Smith.[50] More than anything it is a toolbox to achieve what the title promises. Looking back today at the second edition of the book, from 1998, it is evident that many tools which are today filed under lean product development were then already in the minds of product development managers: *using product specifications to communicate customer needs, visual schedules, leaving excess capacity* etc. However, although Donald Reinertsen has later become one of the absolutely most prominent proponents of lean product development, the word does not appear in the 1998 issue of the book. This may be seen as support for the notions that lean is, more or less, a new label on old ideas.

## 4.3 Approaching maturity

### 4.3.1 The input from software development: Poppendieck

What appears to be an important contribution to the increasing maturity of lean product development was eventually to come from the sphere of software development: the handbook *Lean Software Development: An Agile Toolkit* (2003) by Mary Poppendieck and Tom Poppendieck.[51] Starting from seven lean principles they line out 22 thinking tools to help, as it says on the back of the book, "customize the right agile practices for any environment". The book's authors argue in their introduction that these lean product development practices are already tried and proven in the automotive industry, and that they should just be adopted by the software industry too. We find this excessively humble, however, as it appears that the Poppendiecks are contributing strongly to the progress of lean product development, rather than just hooking on, by way of their degree of concretization in applying lean principles to non-physical practice.

### 4.3.2 Queues and flow: Reinertsen after lean

As mentioned above, Donald G. Reinertsen has adopted lean rhetorics quite recently, although he is an old proponent of many ideas now carried under the flag. Recently his focus has turned to queues and flow, and he describes lean product development as a unique opportunity to establish flow in product development processes. Although stating that techniques from lean manufacturing are to a high degree transferable to product development he highlights the importance of differences between these two domains. Below is a figure listing central differences.

[50] Reinertsen, Donald G., Smith, Preston G., *Developing products in half the time*, 1998.
[51] Poppendieck, Mary, Poppendieck, Tom, *Lean Software Development: An Agile Toolkit*, 2003.

| Differences between Product development and Manufacturing | | |
|---|---|---|
| | Development | Manufacturing |
| Scope of work | Unbounded, expandable | Bounded, constrained |
| Requirements | Adjustable | Fixed |
| Starting point | Adjustable | Fixed |
| Ending point | Adjustable | Fixed |
| Task sequence | Nonsequential | Sequential |
| Information arrival | Continuous | Concentrated at start |
| Decision making | Continuous | Concentrated at start |
| Queues | Invisible | Visible |
| Risk taking | Necessary | Unnecessary |
| Variability | Adds and destroys value | Destroys value |
| Work content | Repetitive and nonrepetitive | Repetitive |

**Figure 7: Differences between product development and manufacturing, Reinertsen (2005).**

According to Reinertsen these dissimilarities change how lean principles should be applied. He argues that lean principles may even be more useful in product development since they show how to maintain flow in the presence of variability. Product development creates recipes for products, not the actual products, and if the same design is created twice no value has been created the second time. One must change the recipe and add value by creating something new, although this implies risks of uncertainty and increased variability. Hence, variability in product development actually exists in two forms, one form of variability destroys economic value (unnecessary repetition of mistakes is one such example), while the other form adds economic value; some risk taking is always required to develop new solutions.[52]

Reinertsen (2005) presents five key methods for achieving lean product development.

- **Queue management.** Inventory in manufacturing is easy to identify, as it is physically and financially visible. As stated in the table above, inventory in product development is invisible. The "product" of engineering work is information, which, although not visible, creates queues waiting for overloaded resources. The queues develop when processes with variability are operated at high rates of capacity utilization. Yet, simple tools such as controlling the number of projects permitted in the pipeline can produce significant benefits to cycle time. Another management tool is to give precedence to projects with a high cost of delay instead of only focusing on return on investments.
- **Batch size reduction.** One of the most powerful ways to reduce variation in process flow is batch size reduction. Early deliveries of small batches provide opportunities for transferring requirements needed for quicker next-stage decisions. Moving away from the stage-gate processes is one of the ways to reduce

[52] Reinertsen, Donald, *Let it flow: How lean product development sparked a revolution,* 2005.

batch sizes and thus minimize the variance in when work arrives, the size of queues and the cycle time through the process.

- **Cadence.** The use of a regular cadence, popularly more often referred to as pulse, represents a powerful tool in product development. By conducting project reviews at fixed-time intervals, e.g. every week, all review dates become completely predictable, rescheduling is eliminated and the amplification of variance goes away. You actually process information with a regular takt time. Moreover, the use of cadence in testing, with daily testing as an example, synchronizes the behaviour of coding and testing.
- **Rapid local adjustments.** Reinertsen describes that the speed of adjustments is particularly important in queuing systems. A loss of capacity can build queues much faster then regaining capacity shrinks them. This means that rapid response to local variation brings disproportionate benefits.
- **Waste elimination.** Adopting the same broad view of waste as in manufacturing is equally useful in development. Quantifying and reducing the various components of waste is an important issue. Reinertsen provides a list of notable sources of waste: *bad architecture, expanding work, expensive changes, inefficiency, inflexibility, sequential tasks, low reuse of knowledge, queues, slow learning* and *unnecessary work*.

### *4.3.3 Toyota revisited*

As evident by now, Toyota is the absolute norm on how to work with lean, ever since *The machine that changed the world* came out. The most recent bestseller book on the subject is *The Toyota Way* (2004) by Jeffrey K. Liker. This book is still based in production, but goes further in tying in the other activities with it. Touring with a seminar specifically on Toyota's product development system the author is now promoting an upcoming book which he has written on the subject (with James Morgan): *The Toyota Product Development System: Integrating People, Process and Technology*. Given the interest shown in his Gothenburg seminar in March, this may well become something of a bible for Swedish practitioners, but let us see it released first. In the meantime one can turn to a five-page article summing up what is known on the apparently quite heavily studied subject. In their article *Lean Development* (2005) Freddy Ballé and Michael Ballé present a review of Toyota's product development processes.[53] Among other things they touch on the following four main features.

- **Customers in focus.** Toyota deposits significant amount of effort in making sure its engineers care about the customers view on their products. This involves both creating a strong vision for the future product and communicating the vision to everyone involved in the development process.

[53] Ballé, Freddy, Ballé, Michael, *Lean Development*, 2005.

- **Limiting late changes.** Toyota ascertains that its development process limits late engineering changes. According to Ballé, Toyota has perfected a process that avoids almost all late changes. Once drawings are set there is no room for additional changes.
- **Mastering the flow.** Drawings, tool elaboration and processes are "industrialized" in order to increase overall effectiveness. Having largely solved key design issues early on, Toyota focuses on precise, tightly scheduled production of actual drawings. Also, Toyota reduces variability by relying on the standardization of skills, processes and the design itself. This eliminates rework and waste, and paradoxically strengthens flexibility in capacity.
- **Efficient development process.** Toyota accomplishes an efficient development process largely due to the strong focus on quality and cost in production itself. Excelling in its expertise on lean manufacturing, Toyota closely examines all aspects of the manufacturing process in order to create a strong link to the development process, stating that waste reduction starts at source.

### *4.3.4 The Swedish take*

Not so much is yet published in Swedish on lean product development, though the Swedish Industrial Research and Development Corporation (IVF), and Ulla Sebestyén at consultancy firm Parmatur, deserve mentioning. IVF's Lean Product Development group spreads its lean gospel through various channels. An article it has written in the periodical for industrial sub-suppliers can serve to illustrate the ideas conveyed.[54] The principles it lists are the following:

- a holistic view on product development,
- creating value for the customer,
- a front-loaded process,
- built-in learning and continuous improvement,
- synchronized and parallel work,
- a high degree of standardization, and
- encouraging engineers to monitor production in person.

The book by Ulla Sebestyén, which we have read in a draft version, is still to be published, so content is preliminary.[55] Yet it builds on material distributed to companies that she has supported as a consultant, such as Leine & Linde which we study closely in a following section. While mainly a very instrumental handbook, lining out exact blueprints for organizations to implement, it is simultaneously surprisingly rich on the philosophy and context of lean product development. Perhaps the strongest focus, however, is on the role of cadence, as evident from the book's title: *Create Pulse in the Projects*.

[54] IVF, *'Lean produktutveckling används av fler och fler företag', Underleverantören.* Vol. 3, p 30-31, 2005.
[55] Sebestyén, Ulla, *Skapa Puls i Projekten,* 2006.

# 5. LEAN PRODUCT DEVELOPMENT IN SWEDEN

This chapter builds on meetings and interviews with people at eight Swedish companies, presented firm by firm. As an introduction to these we first present our interview with Thomas Sigemyr, at IVF, who gives a picture from a position of overview. We then turn to Scania since it is often seen as a benchmark for other Swedish firms when it comes to implementing Toyota-inspired practices including lean product development.

On that follows our case study, a detailed account of a visit to Leine & Linde, a medium-sized firm developing and producing so called optical angle encoders. Last autumn Leine & Linde entirely remodeled its product development organization according to what is allegedly a blueprint for lean product development, and perceives the results as very promising so far. A visit to Ericsson's development of its 3G network is next, with a description of its "design machine" which produces a new, fully functioning, version of its network every five weeks. Complementary insights from five further firms then serve to somewhat broaden the overview of lean product development practices in Swedish industry today.

## 5.1 IVF's Lean Product Development network

### *5.1.1 An explosion of interest*

On 31 March 2006 around 330 people gathered for a seminar in Gothenburg on the subject of The Toyota Product Development System, led by Professor Jeffrey K. Liker, author of The Toyota Way and one of the leading gurus in the field. Almost all attendants were product development practitioners from Swedish industry, though large groups had also come from neighboring countries. It thus appears safe to talk about an exploding interest in the subject.

The event in Gothenburg was coordinated by the Swedish Industrial Research and Development Corporation (IVF). Among its projects, it runs a network called the Lean Product Development network, managed by Thomas Sigemyr. "The big question is where you want to go. The major problem in Swedish companies is that they lack clear product strategies. There is too much gut feel and too little analysis. They don't even communicate their target vision in their organization and make sure there is consensus on it. That is where the inefficiency starts," he says. Thus, when Thomas Sigemyr positions his notion of lean product development he does so in the context of management by objectives, or management by means, which means a focus on continuous improvement and employee participation.

**Problems with established methods**
- Heavy administration
- Excessive control of details

Thomas Sigemyr himself has a solid background in Swedish industrial R&D management, having spent 10 years at Alfa Laval, 17 years as

technology manager at ABB Refrigeration in Norrköping and a stint with motor development at United Sterling in Linköping. Since six years he works with these issues at IVF. "The industry has come to insight that rethinking is needed. We put on more and more administration, and tools for remote control of details. It got increasingly heavy without faster product development. We started to think of some own way of making these processes better, but then this lean thing came up. Overall we thought it fitted with our thoughts so we switched to it quite soon. We have worked with this 'lean product development' stamp for around three years now. We have been three people working on it and we are now training another three to four." The activities are largely self-financed, through sale of the tools produced.

### *5.1.2 A different paradigm from detail planning*

Thomas Sigemyr sees lean thinking as being largely an opposite paradigm to that of extensive, typically computerized, detail planning. "This computerization is obviously part of the development but first you need to have a goal oriented manual process which functions correctly. If you computerize a poor process the risk is that you stop reflecting on it. You must, in an almost scientific manner, persistently ask yourself if you have the right methods. There has been too much easy-fixing, which has made [companies] quite inefficient." As a role model Thomas Sigemyr mentions how extensive resource planning systems have been replaced by simple so called kanban systems in manufacturing. He recognizes that it can be more difficult in an abstract process such as product development, which in his terms serves to produce "elimination of the uncertainty inherent in the original bright ideas." Yet one key is to break down large scale detail planning to components with defined deliverables. If the old model was a machine meant to be perfect, with all problems predicted at the outset, the new model can rather be perceived as an intelligent machine, with dynamic qualities, explains Thomas Sigemyr. It is capable of creating its own solutions underway.

**Some mentioned aspects of lean product development**

- Breaking down large-scale detail planning
- Chief engineer role
- Reducing the number of go/stop decision gates
- Reducing the number of projects
- Set-based engineering
- Structured analysis of current situation
- Visualization

One of the chief things to learn from Toyota in this context is their "chief engineer" role (described in a footnote in our literature review chapter above). "It is a person who has [her/his] own six months' experience of selling cars, and who paints a target image of what the car should feel like to drive when it is finished, says Thomas Sigemyr."

Reducing the number of go/stop decision gates in the process is also a concern for Thomas Sigemyr, keeping those where the project can truly be stopped and throwing out those that are only ceremonial. These do harm by stopping the flow of activities, forcing people to wait unnecessarily. Reducing the number of projects is also crucial to improve flows, he says and refers to author Donald Reinertsen as well as to his own experience of a case in the domestic appliances industry. Further, Thomas Sigemyr puts set-based engineering high on his list of potent tools, also following Toyota practice: "You take several ideas quite far [on

the sub-system or component level]. That means you have several possibilities to choose from on the system level. … Else you are forced to do many iterations at late stages. It often turns out that a prototype doesn't work so you have to take steps back. Doing it this way is sometimes compared to cheating at the horse races: You bet a little on all horses but you don't have to place your final bet until close to the finishing line."

The most common question from the development managers who approach Thomas Sigemyr is "How do we get started?", he says. As an answer, IVF has developed a method for analyzing the current situation. "We do maybe two half-days in a cross-functional group of 10-15 people. First there is some lean brainwashing, then participants fill in their outlook on the current state. That leads to an action plan. We tell them not to pick more than three action items but it often becomes ten because they don't listen to us." Visualization is often their favorite first step, being easy to implement and generating quick results. "What would be needed long-term is more roadmapping, imagining product development going forward so that it can be adapted [for the future]. Else technology development activities fall into product development and it gets messed up, yet another uncertainty factor in product development work."

## 5.2 Scania

### *5.2.1 The pulse*

A short meeting, around 30 minutes in length, attended by managers from departments within the development, production, marketing and purchasing functions, is held every Monday morning. This is Scania's new way of working in order to keep the truck development on the road at steady speed. "Everybody is there so no one can hide" says Hasse Johansson, Scania's head of R&D.

When he first started at Scania, five years ago on the day of our interview, the cross-functional meetings were held with three-month intervals, he says. Two weeks before the meeting the attendees started to compile the necessary information for the meeting, but during the larger part of this three-month period there was no complete picture of what was going on. Managers did then not have the necessary information for making decisions. Questions tended to be left pending; groups who had not delivered on time passed on the blame to others on whom they depended. When the introduction of the new generation of trucks had been put off several times, all together more than a year, Hasse Johansson reacted by introducing a much more structured and regular way of organizing the work. By introducing the "pulse meeting" on a weekly basis all issues could now be solved in a much shorter time and on a regular basis.

### 5.2.2 Keeping the pulse

All work is done according to the "pulse", a formalized pattern for what should be done and when, and on Monday mornings the weekly pulse meeting is held accordingly. Another example of the built-in regularity in the work is the telephone conference held every morning between all representatives of the geographical markets. During the meeting all known deviations are reported, discussed and classified. One day later the development department reports back on what measures they are taking on each of all reported deviations. "We love deviations, employees who find deviations are rewarded, even if they have caused them themselves. To find a deviation means that we have a chance of correcting it before it reaches the customer," Hasse Johansson says.

The discussion during the "pulse meeting" is centred around a big whiteboard, showing every ongoing development project. At this point in time there are 128 ongoing projects, sorted by columns, where the rows represent the different departments. Hasse Johansson estimates there are around 30 to 40 departments, which would give a matrix of about 4000 squares. To support the sense of overview, different squares are marked in different colours, green for projects which are working according to plan, yellow and red if there are deviations. In order for the meeting to work, a set of rules has been set. Only deviations are up for discussion, and only the administrative aspects of how concerned managers are planning to handle these deviations, Hasse Johansson says. According to him the meeting is over in about 30 to 40 minutes, implicitly having covered all 128 projects.

**Some aspects of Scania's "R&D Factory"**

- A weekly "pulse meeting" covering all 128 projects, at an all-covering whiteboard.
- Strict cadence, e.g. daily telephone conference with representatives of all geographical markets.
- Focus on deviations.
- Standardization of processes and methods.
- Viewed as part of broader "management-by-means" approach.

### 5.2.3 Inspiration from the manufacturing line

"The R&D Factory" is what Hasse Johansson calls his model for the changes in Scania's development department. The department now works under a steady beat, much like the manufacturing line. He has also been through a process of standardizing the development work, something that was met with scepticism from the engineers in the beginning.[56] He says that the name "R&D Factory" has contributed to the acceptance of this new way of structuring the work and that it helped make more concrete what his ideas stand for. According to Hasse Johansson it is the well-known ideas from Toyota's manufacturing that have been the foremost source of inspiration. Principles, continuous improvements and careful timing are some of the more central concepts. "We have been working closely with Toyota since the beginning of the nineties," he says. The

[56] To engineering weekly "*Scania höjer pulsen på FoU*" Ny Teknik, 14 June 2005, Hasse Johansson says: "We work as efficiently as possible and we have a process oriented development organization. Systematization is very important since both development and research are to a high degree routine work. If we can make the work more systematically organized we will have more time for the creative work.".

different approaches and concepts originally from Toyota are thus strongly integrated in large parts of the Södertälje activities.

## 5.3 Leine & Linde

### *5.3.1 Friday morning at Leine & Linde*

It is just past 8.30 Friday morning at the small technology company Leine & Linde in Strängnäs, an hour's drive south-west from Stockholm, and six men are kicking off the weekly "Pulse meeting" in one of the office passages. One wall of it is taken up by a whiteboard, possibly seven or eight meters long, filled with activity lists, synchronization plans and other details of the five or so most important projects currently running. The participants stand at the opposite wall, some leaning against it. The passage leads from the staircase to the kitchen/cafeteria, so every now and then somebody scurries in front of them with a cup of coffee.

The meeting is led by development manager Ulf Thorsander, with product manager Per-Johan Ahlström regularly chipping in questions and comments about expectations from customers. Focus of discussions is whether time frames seem possible to keep. Generally they do at this week's pulse meeting, although for one project the market commitments seem a bit too demanding on lead time.

"We've had production evaluation for the bill encoders," says Håkan Eriksson who is a product development engineer and the manager of the project currently discussed. He is now asking the others at the meeting whether he should pass on parts of the design to production engineering as they get ready, or whether it is better to wait until all evaluation results are clear. "We have received an order for 20 units in week 19," says product manager Per-Johan Ahlström. "It is all a little bit Just-In-Time," he says, notably referring half-jokingly to a much-spread lean manufacturing concept when indicating that he sees a risk of a delivery problem. Håkan Eriksson and the others seem to smile recognizingly. Development [function] manager Ulf Thorsander chips in: "There is hard time pressure. What we could do is add some resources?" With the exchange of some quick nods he gets confirmation from the project managers that some engineers ought to be able to temporarily shift projects. Product manager Per-Johan Ahlström says he has communicated to the sales force that delivery time is now 12 weeks for related types of product: "There are already 69 orders, on 27 detectors." Apart from delivery times for the circuit boards there are no problems in the project, says project manager Håkan Eriksson, so as soon as those boards arrive the project can be subject to a daily form of the pulse meeting: a cross-functional meeting for those directly involved in this particular project. He says components have been ordered and that he will give a shout if issues turn up underway.

**The Pulse Meeting** ("Pulsmötet") at Leine & Linde takes place weekly is attended by

- development manager,
- production manager,
- project managers of projects discussed (three at our visit),
- the two product managers (representing the marketing function),
- managing director (passively observing).

Development manager Ulf Thorsander asks if the production engineering function is up to speed on the project: "Have they received

specifications and those things?" Normally the head of production engineering will be present at the weekly pulse meeting but for some reason he is absent today, and thus unable to respond to the question. Project manager Håkan Eriksson says he presumes they have them. "So, any other questions on this project?" checks Ulf Thorsander. "Ok, lets go on," he says, and discussion skips to the next project.

### *5.3.2 The heart of a new product development model*

The whiteboard, together with the regular meetings held at it, is the heart of the firm's new product development organization, developed in cooperation with the small consultancy firm Parmatur which was also involved when Scania first implemented its similar system. At Leine & Linde the people involved generally seem very positive with the changes made. The changes are not seen as directly connected with quality management, but rather as a way to improve and predict lead times. The "Pulse board" serves to visualize the status of all project activities and their interdependence in terms of timing and resources. The weekly meetings, about half an hour long, provide the main forum for communication between the firm's product managers on one hand, representing the marketing function, and on the other hand the project managers and the two functional managers of the technology organization, which consists of product development and production engineering, each employing about ten engineers.[57]

### *5.3.2 A grip on the whole organization*

Leine & Linde implemented its new development organization about half a year ago. Ulf Thorsander claims to have followed the consultancy firm Parmatur's model, in principle exactly by the book. He says he had been on the outlook for this type of concept for several years without success before he came across Parmatur's models some two years ago. The most common approach to project efficiency in practice, as he perceives it, is that a small group of people are sent to a course to learn project management tools. Coming back to the same organization they are still unable to produce broad change. The advantage that Ulf Thorsander sees in Parmatur's model is that it takes a total grip on the organization, specifying roles for everybody from top management to each single engineer.

Ulf Thorsander says that he and the firm's production engineering manager began finding the problems urgently evident when the size of their organization grew from around 5+5 engineers (5 in each of product

[57] Altogether Leine & Linde employs around 90 people. The firm's business is to develop, produce and market a type of product known as optical angle encoders, a component in automation systems in for example paper mills. The customer base is dominated by large long-term customers. The firm's competitive position, according to our interviews, is towards the high-end in its market. It is owned by German encoder group Heidenhain which has given Leine & Linde a group responsibility for developing ruggedness and certain so called field bus electronic interfaces.

development and production engineering) to 10+10, without a corresponding increase in output. He sees part of the explanation in his own having been a bottleneck in the old organization. As in many organizations communication between the marketing and development functions where supposed to be dealt with through the decision-making managers of each. In practice Ulf Thorsander as development manager also doubled as much of a project manager for all projects. The new organization delegates true project management responsibility to one of the engineers on the project, and gives a framework for direct communication between product managers (marketing function) and project managers (technology function) without a need to involve the development manager for details.

### *5.3.3 Product managers take control*

"You get this self-pull, everybody is part of a team that wants to get finished. It used to be that you had to go there and nag and pull," says product manager Magnus Johnson.

Despite the short time that the new system has been in place he is definitely positive. "There has really been a change," he says. Asked to specify what, concretely, causes the change he emphasizes the role of the whiteboard. "You create transparency. It's the visualization that creates it. You see immediately if things are done."

In simplified terms one could say that the marketing function used to specify what should be done, by means of product specifications, while they had little insight into how the work was being carried out within the product development organization, or what resources the work was consuming there. Through the new framework, the marketing function, in the form of the two product managers, actually take over the control of resource allocation in the product development department. The main tool at their hands is the list of project priorities, which they compile in discussion with the managers of product development and production technology and communicate weekly to the engineers. To be able to set such priorities for the technology organization they must match what they know about its work situation against market requirements. And this is where the role of the "pulse" whiteboard and meetings come in. It is through these that the inner workings of the product development process become visible and actionable.

"Now it is visual to everybody, what they should work with first and things like that. Earlier it was all in the dark. We could never report a firm date to the customer," says Per-Johan Ahlström, the other of the two product managers. "It is a real improvement, actually. It is a lot easier to see where we are in the project," he continues. The CEO of Leine & Linde, Björn Zetterlund, also (independently) reaches for a similar darkness metaphor when describing the impact of the changes: "The product development department used to be like a black hole," he exclaims, seeing the new system as a remarkable improvement on the account of transparency.

### 5.3.4 Product managers in the centre

Leine & Linde has had its two product managers also before, but the change in the development organization has given them a considerably strengthened role. As mentioned, they are part of the firm's marketing function but have come to play a key role in the communication between all parts of the company. Based on what they know from their interaction with customers and sales agents they communicate their picture to the project managers at the weekly pulse meetings. Based on information coming in the opposite direction, from product development, they can reevaluate which project should have which priority and give hints of this to the engineers. They are not, however, in a formal position to make decisions on their own. The formal decisions are taken by the "product council", made up of the two product managers together with the development manager, production technology manager, quality manager and the firm's CEO. These meetings are led by the product managers, and will in practice be expected to bring little new information on top of that known from previous pulse meetings.[58]

**Some tools which gain importance**

- "Pulse" whiteboard (visualization)
- "Pulse" meetings (part of cadence)
- Project priorities
- Product specifications
- Synchronization plan

### 5.3.5 A new tool-box

Magnus Johnson notes that different people in the organization probably view the new lean product development system from different perspectives. He refers to a picture of a triangle, apparently discussed with the consultant at some point during the implementation, illustrating that while the top 10 percent or so may focus on *why*, middle management may care more about *what* and the average co-worker may be happy enough to get a clear message as to *how* s/he should apply the new tools.

Clearly, as mentioned before, the pulse whiteboard and meetings are crucial, as are the priority lists. But the toolbox also has several other notable components. First of all it is important to note the significance of cadence (a recurring theme amongst firms applying lean product development, as will be shown later). It is the predictable recurrence of regularly scheduled check-up meetings with the product managers that encourages the teams to finish the tasks on which it has embarked. Secondly, as a result of the visualization and the regularly held meetings, product specifications now enjoy a higher status than before. As product manager Magnus Johnson puts it: "[Under the new system] … you can't as easily over-do anything. So the specifications and goals become a lot more important: without them there is no way you can say you're finished." A third type of tool is the synchronization plan which visualizes how activities interdepend, and which teams are assigned to what activities when.

[58] There is also another forum within the company, called the "program council", with a member set-up strongly overlapping that of the other forums. Since we perceive that information on its exact role and relation to the other forums would not add understanding significant to our context we leave it outside our discussion.

### 5.3.6 Reducing the push

One of the most central parts of what is usually thought of as lean manufacturing, is that "push" logic in the value chain of a firm's operations should be replaced with "pull". Development manager Ulf Thorsander makes the same basic interpretation of "pull" as Ulla Sebestyén of the consultancy firm, Parmatur. By their view, the most important aspect of it is that development activities for each project should be entirely focused on fulfilling the requirements of the market, as instrumentalized by the product managers through the product specifications.

**From push to pull**
- Market pull
- Fewer projects
- Clear priorities
- First-in-first-out

Another aspect of reducing push is to try to keep down the number of simultaneous projects. The visualization, and the unambiguous project priorities set by product managers in discussion with the technology function managers, help make sure that projects started are not forgotten half-way. Before the organization has been relieved of the pressure of current projects, new projects are not introduced in the first place. "We have about ten projects open," says Ulf Thorsander. "You can not check the pulse with more than three or four. The others can be in different phases; they can rest with the customer who needs to report if they fulfill requirements or not, others can be in a planning phase. In companies of our size there can be three to five projects with which you really make progress."

Product manager Magnus Johnson agrees that the attitude to starting new projects has become stricter. "If we have ten customer projects coming up we don't start them all at once. However, you might start those two projects that matter most to the customer, so it is still market driven," he says. Also, Magnus Johnson definitely thinks that the linear progress of the projects has become clearer. "Earlier, things would easily pile up," he says. People involved would tend to give priority to tasks they received recently – being fresh these tasks would tend to be perceived as adding most value. In the new system tasks tend to be completed increasingly in the order they came in, Magnus Johnson certifies.

### 5.3.7 Toward parallel engineering

Most of our interviewees emphasize that it is too early to draw general conclusions from their experiences of the new system, which has only been in place about half a year. However, several of them seem to share an impression that it has indeed helped to lower the functional barriers remarkably. Development manager Ulf Thorsander says the previous, functionally oriented, organization embodied a basic logic which made it difficult for parallel engineering to happen. Product manager Per-Johan Ahlström is on the same track: "I never used to bother about production equipment, for example. ... That's where there was one big flaw earlier: We specified a product, development came up with it – and then there could be chaos in production." It is through the transparency produced at the pulse meetings that risks of such problems can be targeted early, he implies.

The new methods are said to have made work more concurrent

Product development engineer Kjell Löfgren, who also doubles as project manager, also seems certain that parallel engineering has had something of a break-through. "[Product development] is more integrated with production engineering now," he says. "What we have had most difficulty with earlier, generally, is when you change many things at the same time: product features, test equipment, purchasing etc. The new way of working gives a possibility to build in produceability and testability earlier in the project. It has become possible by working together with production engineers in a team."

### *5.3.8 So where does creativity go?*

Several interviewees give the picture, typically in response to our direct question, that the increased focus on delivering quickly to specifications could stifle creativity in engineering. However, different persons take different positions on whether this is a good or a bad thing.

"That is my hope!" exclaims CEO Björn Zetterlund when asked if creativity could suffer. He perceives there has historically been way too much individual effort spent on creativity in the product development department, compared to what would have been optimal for the company. He perceives that some product developers see themselves as artists, who need to wait for their work to be delivered through something of a birth process. "That is a drawback with departments like that: there are too many ideas." He recalls an incident some five years ago, when an engineer, approaching a deadline after about a year's development, replied that he wasn't ready, and needed another several months. Björn Zetterlund talks about this as the day he hit his fist in the desk. The product council was introduced soon after, yet it is only since the introduction of the other lean product development techniques last year that it has found its role, he perceives. "Now we want to get as far in the view on delivery targets in the product development department as we have in production. There they truly put their honor in it." He thinks it is very important to break down activities to small tasks with very regular follow-ups.

So how can the firm be sure not to miss new technology shifts if it only listens to expressed short-term requirements from existing customers? And where should the good engineering ideas go? CEO Björn Zetterlund points to the importance of technology roadmaps and project documentation. Technology roadmaps line out, for the future, which product performance should be achieved, at which point in time, and by the use of which underlying technology. As for project documentation the development engineers should channel their ideas by writing down what could be done better next time, rather than implementing it immediately outside the current product specification.

Also product manager Per-Johan Ahlström confirms that creativity in product development has become more confined. "They used to put on all the bells and whistles they could." He perceives product development

to have come under clearer control, and to have become more customer and market oriented.

Kjell Löfgren, one of the product development engineers doubling as project manager, is mostly positive to the impact of the new system. However, he notes that it is still early to judge, and that the work changes have probably come in his role as project manager rather than as "plain" engineer. "In long projects it is easy to lose focus. This is to shorten the time, so you keep the spark," he says. "I think it is nice, partly in that you become more involved, partly because of the higher tempo. There is more focus in the project. And if there are interruptions they are shown more clearly, so that [the] marketing [function] can re-prioritize if they wish. … The more you know [about each other's work] the less friction there will be." He agrees that there is less room for improvised work now: "The openness means you can't get spaced out ... The concept must be set from the beginning, by [the] marketing [function]," he says. So what could be the drawback of that? We ask Kjell Löfgren to give an example of something done historically that may have been less easy to do under the new paradigm, and he comes to think of a technology shift some years ago, when detectors with a 13-bit resolution were introduced: "That started largely with skunk work[59]," he says. He believes that part of the work on functionality and testability of the 13-bit design would not have been performed if the work had been more tightly controlled. Functions that were developed through skunk work have later proven useful and explicitly desired by customers, he argues.

Although Kjell Löfgren is predominantly positive towards the new system he does to some degree lament the decrease in freedom. "You have become a designer because you like creativity, but it has become more administrative," he says. This shift is specifically due to the introduction of a new database system not directly linked with the lean re-organization. It took long time before the database system, which is an administrative burden, started to provide value by means of the documents from other people lying where they should. But the reorganization adds to the picture. "It is difficult to find a week for skunk work. It easily goes that you download something at home because you don't want to drop the idea. There's a risk you get more administrative than creative work."

### *5.3.9 An extension to the build-to-order system*

Before leaving Leine & Linde, let us just look briefly at the business context, as summarized by CEO Björn Zetterlund. While he holds the lean product development system for development manager Ulf

[59] Skunk work is widely used term for research and development work carried out in organizations without formal approval or resource allocation. It is often discussed as a necessity for firms' long term success, thus firms who try to extinguish it are seen as faced with a dilemma. For a background on the skunk work concept, as well as a discussion on the management of scientific freedom, see the section "Effective R&D Management" in Trott (2002), pages 328-333.

Thorsander's baby, he argues that it seems to lie well in line with strategic considerations. The firm organized its production around a build-to-order system, in the aftermath of a severe crisis in the early 1990's when 35 employees had to leave. A ten day delivery time with high certainty, was the concept. For some time the employees' bonuses where set on the proportion of on-time deliveries. The concept worked fine, according to Björn Zetterlund, and when customers realized they could trust deliveries the order stock decreased. This ability to deliver to order sets out Leine & Linde as unique in its industry, claims Björn Zetterlund, and it is on this customer value that he thinks product development must also try to leverage. This is how the increased transparency of the product development organization connects with the firm's delivery strategy: Being able to shorten the product's time to market and to predict it with accuracy could be very valuable to customers who in turn are designing Leine & Linde's products into automation systems with critical deadlines in themselves. As mentioned earlier, large industrial customers make up a large part of the customer base.

## 5.4 Ericsson

Lars Frank today leads the product development unit for the 3G Connectivity Packet Platform (known as CPP) within Ericsson. It employs around 500 people, mainly at Älvsjö, Stockholm. However, his experience of implementing what we think of as lean product development techniques comes mainly from the radio network controller unit (RNC) where he worked until New Year, and where he led 150-200 people in software coding alone. He is quick to point out that within Ericsson the product development managers make little reference to "lean". Rather, they tend to restate the group's confessions to "leading efficiency" and "operational excellence". Yet the Ericsson group's CTO Håkan Eriksson has publicly credited "lean product development", as performed by Toyota, as one of the main inspiration sources for Ericsson's current ambitions to slice product development lead time by half.[60] And Lars Frank may well be the person who has done most to promote such new organizational measures in the group,[61] though he emphasizes that Ericsson is a world of several product development cultures, varying by division and unit.

As for his RNC unit, it performs its work to the sound of a steady five-week beat, which dictates how often the complete radio network is tested and must be verified as fully functioning in its integrated form. This period is then sliced into single weeks, the interval at which each "node" of the radio network, such as a base station or a network controller, must be working with all new components introduced. These software components, in turn, are verified on a daily basis.

[60] "Håkan Eriksson ökar FoU-takten på Ericsson", *Ny Teknik,* 25 Jan 2006.

[61] Lars Frank believes so himself, it is he who is interviewed on the details in Swedish engineering weekly "Ericsson utvecklar på löpande band", *Ny Teknik,* 25 Jan 2006, and it is to him we are referred when we contact CTO Håkan Eriksson on the matter.

Lars Frank sums up his organizing of the work as a way to tackle three main complicating factors:

- the value of previous investment must be protected. The value of each increment is marginal in relation to the value of the existing product,
- complication caused by parallel software tracks must be avoided, and
- the design work process should proceed without interruptions in the form of mid-way specification changes.

### *5.4.1 Problems are quickly made visible*

The idea behind this is that the introduction of new functionality or performance should never be allowed to destroy any that has existed previously. "What has once worked must always work! That is one of my horses," says Lars Frank who emphasizes that only a minor fraction of Ericsson's research and development work lies in broad technology shifts – almost all daily work is concerned with incremental product improvement on existing platforms. "With a one-week delay you will know if you have destroyed something [on the node level]." Another important aspect, closely connected to the cadence, or "pulse", in the projects, is the visualization of the work in progress. Given the fixed delivering points in the projects – the daily verification, the weekly testing and the five-week completion of new features – everything has become much clearer, states Lars Frank. All people involved in the projects know exactly what is supposed to be included, and more importantly what they should include as well as when it should be included. Moreover, as Lars Frank continues "This method visualizes the work of each engineer. You see immediately if one engineer cannot deliver at the end of the week". The result is that problems in the product development work become visible on a weekly basis as it produces a definite stop during testing. "The advantage when there is a complete stop is that you get a very strong focus on getting it to work," Lars Frank says. By working with this method, the unit has created a better flow in the work process, and as a result managed to shorten the lead times in product development.

**Aspects of Ericsson's "design machine"**

- Strict cadence: full system verified every five weeks, node every week, components daily.
- Aims at slicing lead times by half.
- "One Track" of software.
- Started tasks are always completed.
- Focus on minimizing disruptions.

### *5.4.2 A different type of stress*

One could imagine that the visualization of the work progress and its steady beat could be stressful for the individual engineer, who is now under regular supervision, and whose possible failure in a detail could halt the whole project. Yet Lars Frank does not perceive it to be so. "First we thought the clock would be a stress factor," says Lars Frank, but he now interprets that it rather changed in its nature, and in fact decreased for the single engineer. "There is a different form of stress now." Earlier, the engineers were under stress because they did not know if their code or particular item worked, or fitted with the main code. There could be

weeks before results from testing came back and when they did, and something was wrong, the engineers would already have started working on the next step. This created a strong feeling of uncertainty in the development work, Lars Frank explains. Today the picture is different, he argues: every engineer now knows what (s)he is supposed to do and when it should be finished. Also, testing is performed continuously through the development, and everything is verified before new features are processed. Thus, the stress of uncertainty has changed into stress from exposure.

### *5.4.3 No more parallel versions*

A new feature in the development process is what Ericsson calls "One Track". Earlier, engineers worked on several parallel versions of the code implementing new features and performed separate testing. There could be one old "track" of code working, several others in testing and an even newer set of code in development. As a result, problems occurred when trying to integrate all new features into a complete system; each fix had to be implemented several times, and old bugs could come back after fixing. Today, Ericsson only has one track of code being processed at a given point in time. New features are verified before others are being developed. Lars Frank describes this as a strong tool in protecting the investment already made. Also, given that the department works under a steady beat, having one code instead of several heterogeneous codes becomes almost a necessity.

### *5.4.4 A linear design machine*

During the interview Lars Frank continuously refers to the "design machine" as a metaphor for his development department. On his whiteboard he sketches a figure, the main features of which we try to recreate below:

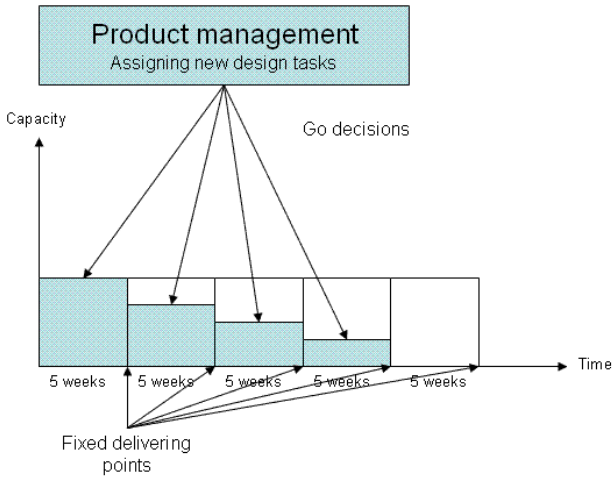


**Figure 8: Lars Frank's model of his "Design machine".**

The unit works with a fixed capacity throughout the development process. As described above, the process follows a steady beat. Fixed delivery points occur every five weeks, producing a fully functional product, ready to be shipped to customers *whether there is one or not*. This produces flexibility towards the market and customers since the product development department will always have a product that is no more than five weeks old. Moreover it provides opportunities for steady and routinely sample deliveries to the customers. Given that the unit works with a fixed capacity, planning becomes more clear-cut. The product management, closely connected to customers and with a strong market focus, assigns new design tasks to the development department, on the same five-week regularity. Each delivery frees resources and creates room for coming assignments, shown as the white rectangles in the graph. When capacity for the coming five-week period is fully occupied, nothing more can be added, but also, notably, no task can be thrown out. Lars Frank refers to these assignments as "the point of no return"; once the product development department has started working on new features these will be finished, regardless of changes in customers' or the market's preferences. This ban on mid-way interruptions serves to emphasize the linear, perhaps assembly-line, character of the process, and Lars Frank states that this provides stability in the work process. If new features become necessary they will have to wait for the next five-week train.

## 5.5 Haldex

Haldex is a Sweden-based industrial group supplying components and subsystems to the automotive industry. Its product development activities are spread, both with regard to geography and product types. Since a couple of years Haldex performs rigorous work on making its operations lean. Its system for doing this, "The Haldex Way", was introduced in 2000 and stepped up in 2002 when a corporate level team was assigned to coordinate its implementation throughout the group. The system conforms strongly to Scania's Toyota inspired production system. Having started with manufacturing, the team now addresses product development too, since around two years. The team's introductory folder adheres almost completely to the classic representations of the lean principles and techniques: e.g. a drawing of a classic chamber orchestra represents the idea that all aspects of the system should be applied in concert. For the method of implementation Haldex makes heavy use of a formalized so called gap model, where each unit fills in where it thinks it is, compared to an ideal state, on a number of parameters.

Haldex has also added an internal certification system, specifying requirements for each unit to achieve increasing ranks from copper, via bronze, silver and gold up to platinum. "When we started out we were hesitant to introduce a grading model," says Urban Fagrell, who covers product development issues for the corporate "Haldex way" team. "Yet when people then understand the use

**Techniques used/ considered at Haldex**

- Complete quality program: "The Haldex Way"
- Formal grading system for sites
- Visualization boards
- Cadence meetings
- Formal priorities
- "Customer project managers"
- Fewer projects
- Rapid prototyping
- Formalized phase model
- Concurrent engineering
- Value stream mapping
- Standardizing reports

we add this [grading system], which adds both competition and a sense of connection between the elements. Many sites are on the copper level now, the first ones are approaching bronze level this coming week." Urban Fagrell has visited Scania in the very week before our interview, and notices that certification levels seem to have played out their role there: "The competition aspect goes away when you are on the top level."

### *5.5.1 A broad set of tools*

Just like Scania, Leine & Linde and others, Haldex has introduced visualization boards and weekly meetings in its product development. Formal project priorities are set in collaboration between the product development and marketing functions. Most development projects are managed together with customers, with customer project managers who functionally belong to marketing but who are physically located together with product development. Product managers existed already earlier, but their role has been strengthened, thinks Urban Fagrell – whether due to the lean initiatives or due to quality standards emphasizing customer demand. As for cutting the number of projects, measures have not yet been taken, though thoughts of the Haldex Way team are beginning to go in that direction: "We do have too high load on the development department as is. I am quite convinced there may be something in it."

Rapid prototyping is seen as important in reducing product development lead time. This is accomplished by identifying specific prototype producers, with other equipment than that optimized for full-scale production, and located geographically close.

Otherwise, the main technique to achieve lean product development appears to be a more formalized phase model, where a true possibility of shut-down at later stages should reversely work to open the door on more ideas in early stages. The idea is that cross-functional considerations must be made at each stage, thus generating concurrent engineering in the various functions. There are five phases: pre-study, planning, concept, design and implementation, with go/stop decisions between each, so far by the same forum in all stages. One current ambition is to develop meaningful key indicators, e.g. the meaning of time-to-market has been defined and is now routinely registered.

### *5.5.2 Translates value stream mapping to product development*

Haldex has tried to transfer the tool of value stream mapping from manufacturing also to product development.[62] "You analyze a value stream. In production it's how material proceeds and where it lies still. You can apply it on information too, you want it to move in opposite

[62] The value stream mapping tool relates to Womack and Jones (1996) who hold it for one of their five lean principles, developed in chapter 2 of their book. Methods have been developed e.g. at the Massachusetts Institute of Technology, by Millard, in relation to a major program known as the Lean Aerospace Initiative, more info on which can be found at http://lean.mit.edu/.

direction to the material," describes Urban Fagrell. The same tool is used in product development as in production. "It is transferable, with some caveats. It is not without its problems. You need to have an open mind. It must be done by somebody who has done it a number of times and who has a positive attitude to doing it." Value stream mapping has also been used in administration, notably on the customer complaints process, where redundant reporting of customer data was reduced. Similar room for standardizing reports could be found in product development, believes Urban Fagrell.

Urban Fagrell can not say for certain why interest in lean product development has exploded just recently, but he believes it may be a logical next step. "I guess [companies] have reached so far in production they have to apply the same thinking in the rest of their activities to reach further. They can't do that unless product development joins in."

## 5.6 Sandvik Materials Technology

Sandvik Materials Technology is a division of the Sandvik group, developing and producing metal alloys. Development cycles for new products are long, often spanning several years.

Like most companies covered, the product development department at Sandvik Materials Technology also covers what it calls its pulse, in a "pulse room" on weekly basis. Magnus Nyström works with the lean-inspired improvement implementation which, he points out, has not yet come so far as to show major effects.

**Some points of focus at Sandvik Materials Technology**

- Formalizing processes
- Value-based sales arguments
- Front-loading
- More cross-functional
- "Production ramp-up"
- Testing installations at customer sites

Magnus Nyström gives a long list of aspects spanned by the current changes. First, a structured process will be implemented, covering the full way from idea to product. Such structure will be new, and currently the organization is being scanned for ideas some of which will be developed to business cases. Secondly, test installations at customer sites will improve product testing, and help in the phase of production ramp-up which will be improved to take a grip on the differences between test-scale and full-scale production. Next, the sales force will be involved, by routinely being supplied with value-based sales arguments well in advance when a new product is launched. Also, there will be increased emphasis on front-loading the process "… to smoke out the problems as early as possible before you start the big things," as Magnus Nyström puts it.

Magnus Nyström thinks a lot needs to be done to get a more cross-functional head start in projects, though projects do contain parallel work processes in product development, process engineering, marketing and other issues such as patent work. "We have recently started having one person as the project manager through the whole cycle from idea to market. Earlier the cycle has been seen as something shorter. Now it may take two to four years, so the individual may need to be exchanged underway, but the function is there," says Magnus Nyström.

It is the product areas that are in control of research and development, and not vice versa, explains Magnus Nyström, and he says this is a change from how it was ten or fifteen years ago. "The problem was [and still is], to be a little sarcastic, that marketing put an order and then stayed away for two years. After that the product development function came back and said 'here's your product'." Thus market insight might be lacking in product development despite a marketing dominated decision structure.

A big challenge with lean product development which Magnus Nyström wants to put light on is the risk of losing out on innovation. "Companies typically start by looking at processes and flows, but when it is mature after some years the question arises how to feed the process with bright ideas. That is the difficult thing, the other issues are more mechanic. The question is how you can be present in the marketplace to pick up ideas."

## 5.7 Bahco Tools

At Bahco Tools, located at Enköping, Mattias Lövemark is the person who manages the firm's contacts with the Lean Product Development network of the Swedish Industrial Research and Development Corporation (IVF). "Since previous New Year [i.e. about 15 months] we have performed a set of experiments within what you could call lean product development – that is a broad concept where you could include many things," he says. When Mattias Lövemark sums up the outcomes, value stream mapping is the tool that comes across as the key to success. "Value stream mapping can be applied to information flows too," he says. Bahco Tools applies it both on project planning and on parts of the product development activity. The positive effect of value stream mapping comes through its combination with reviewed forms of group work. Mattias Lövemark thinks it has led to more cross-functional and focused work, and according to estimations made, it has led to a lead time reduction of around 25 percent in product development, with a preserved level of total resource use. Mattias Lövemark also perceives, based on his experience as a designer and project manager, that the quality of the work has improved, due to more aspects of the design being illuminated simultaneously and early.

**Some points of focus at Bahco**

- Value stream mapping
- Cross-functional "events" using post-it visualization

### *5.7.1 Mapping done in two-day "events"*

"The basic principle is that the cross-functional project group sits in an 'event' for one-and-a-half to two days – as different from normally, where the project manager contacts department by department and sews it together, typically in [Microsoft's project management application] MS Project. Ours is a very visual method. When you are finished you have a wall full of post-it notes," says Mattias Lövemark. The meeting form gives an opening for the product manager from the marketing function to sit and discuss even technicalities, but Mattias Lövemark points out that it is important for the process that the degree of detail is not taken too far. One further advantage of these "events" is that the burden of

coordinating the cross-functional work is lifted from individuals or individual departments.

As for the implementation, Mattias Lövemark seems to see the adoption of value stream mapping in product development as a natural next step from doing it in production where it has been done longer.

## 5.8 Kongsberg Automotive

The weekly cross-functional update meeting at Kongsberg Automotive in Mullsjö is called "The Temp", as in temperature. "The "pulse" was taken by Scania so we had to call it something else," says technology manager Christer Lundh who has previously worked at Scania. Kongsberg Automotive has not been engaged long with lean product development issues, but when IVF's Lean Product Development team proposed participation last autumn Christer Lundh agreed to join. So far, participation in the network itself has not brought about more concrete results than the attendance of some seminars. However, some years ago Christer Lundh himself started promoting principles in which he believed, for the product development organization, directly taken from Toyota and Scania. These principles were continuous improvement, right-from-me, visualization, cadence, and balancing of knowledge and resources (making sure teams have a suitable composition of members in terms of their competences, and that resource allocation can vary with the work load in different project phases). "These principles have a lot to do with lean," Christer Lundh sums it up. "It's in looking at what more is required in my design work to make me able to deliver a finished design."

**Some points of focus at Kongsberg Automotive**

- Visualization boards
- Computer-based simulation
- Increased method standardization

Visualization boards are in use today to show project progress, and a next step will be to have them cover also testing. Otherwise Christer Lundh emphasizes the role of computer-based simulation in slicing product development lead times, as an alternative to physical modelling. As an example, the firm can now measure how much arm force a car driver must apply to change gears, without having to build the gear system physically. Kongsberg Automotive invests heavily in such technology, and Christer Lundh cites Toyota as a source of inspiration on this account too.

Generally, Christer Lundh thinks it would be positive for productivity, and for the firm as a whole, if the engineers could come to work in a more repetitive way in order to perfect their skills in each work element. He acknowledges, however, that there may well be a trade-off with work satisfaction if so done.

## 5.9 ABB Robotics

"Generally one could say that what we implement is pretty much what Scania has managed to implement, as they have come the furthest. They [Scania] are truly devoted to this and they share their work with others. Scania has taken the role as Sweden's own Toyota and they are the

driving force in Sweden," says Thord Porsander, manager of the R&D Strategy department. He thus leaves little doubt that his company gets much of its inspiration from the truck maker, though it also looks at other firms in its own industry to address its product development issues in new ways. In its business ABB Robotics connects with the automotive industry, which constitutes a large customer segment, as well as with Japanese industry which makes up a great part of its competition, and faces incentives and influences to continuous improvements from both of these.

**Some techniques at ABB Robotics**

- Visualization board
- "Pulse meetings"
- Continuous improvements
- Standardizing the product development process

ABB has continuously worked with trying to shorten lead times in development, streamlining processes and finding more efficient ways of performing their work. The importance of this kind of work has increased in later years as competition is fiercer, Thord Porsander explains. "In our work we have been seeking organizations and ideas addressing these issues, which led us to IVF and their initiative on lean product development." He says that the work of IVF on lean product development is one of the most interesting initiatives he has seen to tackle the problems.

"The first thing we have done is visualization, as in adopting Scania's 'pulse-meeting' as well as integrating high level project coordination and evaluation. Today all projects work under a common model, regardless of their nature." The visualization method strongly follows Scania's. "Every Monday we all meet, project managers and line manager, around a large whiteboard. The whiteboard has columns representing projects and rows representing the lines. We use color codes exactly as Scania." Thord Porsander explains that the visualization has definitely given some results. Today ABB Robotics has a better view of its ongoing projects and their product portfolio is more balanced. Also, the allocation of resources and the setting of priorities between projects have improved.

# 6. ANALYSIS

In the previous chapter we turned to practitioners in Swedish industry, to investigate what lean product development consists of from their viewpoint, and to find clues to possible implications for managers. Particularly from our case study visit at Leine & Linde we were given rich insight into one implementation of an allegedly lean product development system, with complementary experiences and views being added from our eight other sources. As was discussed in the method chapter, our research approach builds on the notion that the richness of such data is crucial to a deep understanding of the concept, in our case lean product development. Yet we hope that our further analysis of the data, and consequent summaries, may help the reader get a quicker grasp if desired, and that the models we propose could help understand the phenomenon from more perspectives, to help answer our research questions. For the purpose of structure the analysis addresses the two research questions one by one.

## 6.1 Analysis 1: What does lean product development consist of, as practiced by Swedish firms?

This first research question of ours will be analyzed in the following in two sequential steps, which together capture an answer. Firstly, we review our empirical data in the same order that it has been presented, looking at how the interviewees present the rationale behind their interest – the organizational need they are trying to address in reaching for lean product development. This rationale, in turn, implies a set of roles for lean product development to play. This discussion uses a model representing what we perceive as three categories of such roles: *a label, a philosophy* or *a set of techniques*.

Secondly, we investigate how the Swedish practices relate to the international literature on lean product development. Possibly due to the concrete character of most of both the literature and our data, this part concerns mainly the techniques dimension. In this part the discussion is restructured: we now go through our material technique-by-technique, similarly, though not identically, to the order in the literature review chapter, rather than firm-by-firm as in our empirical part.

### 6.1.1 The rationale behind lean product development in Swedish firms

#### 6.1.1.1 The promoters: IVF and Scania

When examining IVF's take on lean product development we particularly note two things. Firstly, heavy emphasis is put on the role of the concept as a weapon to target fundamental strategic problems, not only to increase operational efficiency; the problem is said to spring originally from fundamental lacks in product strategy and the communication of visions in general within firms. Secondly, IVF describes lean product development as an answer to increased administration and heavy control of details in product development. Today IVF, who has for some time been seeking methods for addressing these issues, actively promotes the concept to Swedish firms. We interpret that for IVF, the label "lean product development" has been important as a source of legitimacy in its work, as it can be presented as a concept with strong connections to long-familiar ideas of lean principles rather than as something untested. Thomas Sigemyr, in our interview, explicitly refers to it as "a stamp".

Moreover, judging by IVF's vision of lean product development as a strategic instrument and a method for viewing the product development from a holistic viewpoint, it appears that to IVF the concept is a broad philosophy not limited to a set of techniques.

Turning to Scania, Sweden's most influential player when it comes to lean development practices, its CTO makes clear that his program to build what he calls the R&D Factory was triggered by a series of long delays in developing the previous truck platform. Thus cutting and predicting lead time was a key reason. Although a frequent participant in the IVF Lean Product Development network, Scania does not internally label its efforts as lean product development. While clear on the fact that ideas, methods and principles are heavily inspired by those of Toyota and by lean practices, Scania puts emphasis on creating its own philosophy, guided by a set of clear principles. Talking to the CTO it becomes clear that there is a strong symbolic value in the ideas and practises related to lean product development at Scania. Much like the Japanese view on lean manufacturing, Scania sees the development as a way of thinking, not just working. Moreover, embedded in the principles we find techniques familiar to those proposed by lean product development spokesmen such as Reinertsen, Womack and Jones.

In summary, we can interpret lean product development as able to appear in any, or several of, three roles: *a label, a philosophy* or *a set of techniques*. We will be referring to this insight going forward.

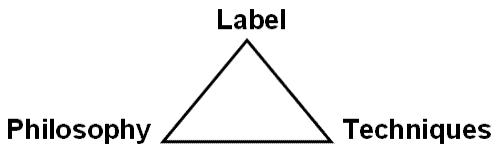


**Figure 9: Lean product development as label, philosophy or techniques.**

#### *6.1.1.2 The case study: Leine & Linde*

Leine & Linde had been seeking ways to improve both their lead times and output in their product development. Coming across the concept of lean product development, as presented by Parmatur, they saw an opportunity to address both issues. Lean product development is described by Leine & Linde as specifying the roles for the whole organization, from top management down to the single engineer. "Lean product development" is used internally as the label of the new organizational reform, and may help legitimize this, but it is not used externally and does not seem to be used in reference to philosophy beyond the ideas behind the local reorganization. We thus find the emphasis on the dimension of concrete techniques in the triangle presented above. Our interviewees, in unison, certify that these techniques have indeed made a significant impact on the product development, as well as the organization as a whole, at Leine & Linde.

#### *6.1.1.3 The survey: A broad set of approaches*

From our data on the other firms in our survey we cannot draw complete conclusions as to what meaning lean product development is taking on in their organizations. We can note, however, that a rather broad range of techniques which could be filed under lean product development are being used. The selection of techniques at various firms is partly divergent, although many of the companies share several similar practices.

We cannot judge how important it is to these firms that the concept can be perceived as trendy, and that this positive image could rub off on those who apply it. Such a suspicion would be close at hand if one looked at it from the neo-institutional perspective outlined in our theory framework. What we can conclude, however, is that many of the firms appear genuinely interested in techniques, and in some cases broad parts of the lean product development philosophy (sometimes as a continuation from their experiences with lean manufacturing, as in the cases of e.g. Haldex and Bahco). At Haldex the work done is not called lean product development but rather "The Haldex Way", so the top-level label differs, yet the content is remarkably similar to traditional representations of lean philosophy. In the case of Ericsson it appears that the term "lean product development" is virtually never used, neither internally nor externally, thus can not be important as a label. Instead, Ericsson focuses around a set of techniques, and a way of organizing the work, which puts strong emphasis on selected ideas also found in lean product development. Ericsson does not credit the lean philosophy for its measures, but explains them as necessary solutions to problems observed internally in the firm.

As to why these firms have started implementing ideas based on lean product development the picture is quite coherent. Shortening of lead times is a shared purpose, as well as getting a stronger market and customer focus in product development. Increased cross-functionality

and concurrency are also regularly mentioned reasons for implementing the ideas.

### 6.1.2 How Swedish lean product development practice relates to the literature

Having analyzed the rationale behind the interest in lean product development in Swedish industry, we now turn to see how the practice matches the literature on lean product development. Let us start in Reinertsen's view of the concept as a unique opportunity to establish flow in the product development processes.

#### 6.1.2.1 Swedish practice related to Reinertsen's lean product development

**Queue management.** According to Reinertsen, one of the methods for establishing flow is queue management, which incorporates e.g. better control of the number of projects in the pipeline and more coordinated capacity utilization. Our empirical findings provide clear examples of techniques such as these: e.g. today Leine & Linde emphasizes the role of stronger project priorities as well as the importance of reducing the total number of ongoing projects in order to reduce pressure in the development work. Similar ideas can be found at Haldex who also uses formal priorities between projects, and looks to a reduction of the total number of projects as a positive possibility for the future. Further examples can be found at Ericsson who has fixed capacity limits strictly determining not only how many projects can be completed (as such limits always do), but also work as a formal limit on the volume of tasks introduced in the organization in the first place.

**Batch size reduction**, as presented by Reinertsen, is a method for moving away from the "over the wall" phenomenon in product development as well as reducing the variance in delivery times. Our case study, Leine & Linde, provides examples of this as they have shortened checkups and delivery time by breaking down activities into smaller tasks. The concept of batch sizes is likely to be less evident in product development, which is non-physical, than in manufacturing where a batch can be seen, but preliminary deliveries of not yet fixed designs can be interpreted as such batch size reduction.

**Cadence.** One of the most noticeable components of lean product development in our empirical data is the use of cadence. Reinertsen sees cadence as a method for eliminating rescheduling and generating predictability in the development work much similar to the views of all our surveyed firms. In Sweden, cadence seems to be the heart of lean product development models, imposing a regular schedule on all of the development work. Descriptions about the value of creating "pulse" or "takt" in product development are not isolated, but are observed more often than not in our studied firms, and mentioned by IVF as a favorite of companies.

**Rapid local adjustments** are yet another technique which appears reasonably simple to understand in manufacturing, but more abstract in product development. While highlighted in the literature as a tool for flexibility and capacity planning, it does not appear explicitly in our empirical data. As shown in the case study of Leine & Linde, adjustments regarding allocation of resources between projects are made easier as a result of more formalized project priorities and better cross-functional communication, i.e. as an indirect result of its cadence and visualization methods. Some firms, e.g. Scania, Haldex, Sandvik and Kongsberg Automotive, further argue that efficiency can be improved through standardization of processes, which should make local adjustments easier.

**Waste elimination** is a central part of the original lean principles, and also constitutes one of Reinertsen's components of lean product development. It should be safe to assume that waste elimination in general is an underlying goal of all studied firms. Of more specific interest in our data, in the context of the waste elimination principle, is the technique of value stream mapping which was proposed but not detailed for product development by Womack and Jones (1996). Both Haldex and Bahco are examples of firms working with value stream mapping, appearing to view application in product development as a natural next step from performing it in manufacturing. However, remaining difficulties in the adaptation for product development can be sensed from Haldex' testimony that an open mind is required by the person who performs the mapping.

#### *6.1.2.2 Swedish practice related to other lean product development literature*

**Customer focus and heavyweight team structure.** A central theme in descriptions of Toyota's lean practices in product development is customer focus. This is listed in Womack and Jones (1996) as one of the lean principles, in the form of "specification of value" which should be done from the customer's viewpoint.

Also Karlsson and Åhlström (1996), in arguing for their holistic approach and pointing to the challenges in translating lean practices to product development, put heavy emphasis on the role of a heavyweight product manager as a carrier of a stronger market focus in product development.[63] Elements of such thinking are clearly reflected at Leine & Linde, Sandvik, and Haldex who have been working to give the marketing function a strong formal position in relation to the product development function. At Leine & Linde the product managers have actually taken much control in the product development work and the resource allocation to it. Today, project priorities are set according to market and customer requirements.

[63] Karlsson & Åhlström (1996) do not use the term "product manager", but talk about "heavyweight team structure" where one person bears overall responsibility. This relation has been touched upon in a footnote found in our literature review section.

**Standardization of processes and tools.** Being an important component of Toyota's practices, as described by e.g. Ballé and Ballé (2005), standardization of processes and tools appears as a widespread measure in Swedish firms. In our data, Kongsberg Automotive, Sandvik, Haldex and perhaps especially Scania all discuss the value of standardizing processes. Scania, with its "R&D Factory", has taken measures to control the processes in ways similar to those on the factory floor, in order to reduce waste, increase predictability and to create flexibility in capacity.

**"Front-loading".** Also prominent in the descriptions from Toyota, is the theme of "front-loading" processes, which come through in our data as efforts to formalize the product development process in terms of phases, for example at Haldex, Leine & Linde, Sandvik and others, or cross-functional kick-off conferences as at Bahco. Moreover, at Leine & Linde, initial product specifications have been given a more prominent role.

**Concurrency and cross-functionality.** Present in Ballé and Ballé (2005), as well as in Karlsson and Åhlström's (1996) list of lean product development components, are ideas of concurrency and cross-functionality in development. Examples of this are found in several of the examined firms. For example at Leine & Linde, parallel engineering is accomplished to a much higher degree today, than before introducing the new model for the product development organization. As Karlsson and Åhlström (1996) highlight, integration rather than coordination, often through direct contact or meetings, increases the cross-functionality and concurrency in the work. This, together with cadence (and visualization which will be discussed further down) is one of the most explicit and reoccurring ambitions expressed in our interviews. All studied firms use weekly, fixed meetings where representatives from several functions are attending, often called "pulse-meetings". Described as bringing increased transparency, cross-functionality and concurrency in development, these meetings appear as one of the strongest and most frequent techniques in Swedish lean product development practices.

#### *6.1.2.3 The main mismatches between Swedish practice and lean product development literature*

**Set-based product development.** One technique that we perceive to be remarkably absent in our studied cases of Swedish practice is set-based product development, promoted by for example Poppendieck and Poppendieck (2003). This technique commands a very prominent position in the accounts from Toyota which inspire so much of the international literature. We have not investigated why this does not occur in our study, though we believe that the technique is simply difficult to grasp intuitively, and therefore difficult to implement in an early phase where employees' understanding of lean product development reforms is still infant.

**The visualization board.** Interestingly, one of the most common techniques in our empirical data does not come across as prominent at all

in the international literature on lean product development. What all firms seem to view as the first and most natural step to take, in order to achieve lean product development, is the visualization of processes and projects. In all cases, with the exception of Ericsson, this is accomplished with such a simple tool as a whiteboard, showing all ongoing projects together with the status of its task components, both regarding priorities and progress. Based mainly on our interviews with Leine & Linde and Scania, we interpret this tool to fill a function as in the following figure.

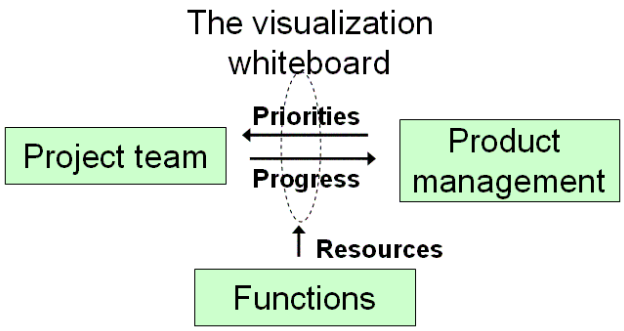


**Figure 10: The visualization whiteboard mediates information about priorities, about project progress and about functional resources.**

While the product development organization may previously have been something of a black whole (this is how the CEO of Leine & Linde describes it), the new visualization method has, according to several sources, created a remarkable increase in transparency as to how the projects progress. This is represented by the right-pointing arrow in the figure above, showing how the whiteboard communicates project progress information from the project teams to product management which assigns the tasks. The work in the project teams are determined by formalized priorities which are communicated back from product management via the same board. General resource supply is communicated from functional managers. In the general cross-functional weekly meeting (and other meetings at their given intervals) in front of this visualization tool, many decisions can be taken immediately. A sense of predictability, cross-functionality and joint understanding throughout the product development process is created as a result.

### *6.1.3 Summary of this section*

We have analyzed what lean product development consists of, as practiced by Swedish firms. The covered firms largely view lean product development as a potential answer to problems which they have long perceived, with regard to primarily

- product development lead time,
- the predictability of product development lead time, and
- lacking customer focus in product development.

With some exceptions we perceive that it is mainly by means of its *techniques*, rather than its philosophy or its label, that the concept of lean product development attracts rapidly growing interest amongst Swedish firms. This is not to say the philosophy or label are unimportant. Especially at IVF, Scania and Haldex we meet holistic argumentation, that the whole philosophy is important. As for the role of lean product development as a label it is difficult to draw conclusions from our data. However, judging by the virtual explosion of interest in the subject recently, we reckon that the packaging of ideas, some old and some new, under a single label may have helped a lot.

The techniques which form the core of Swedish practice are, more than anything, those that make up what most surveyed firms refer to as the "Pulse". These techniques, which appear to be spreading rapidly since they were introduced by Scania in 2003, consist of attempts to achieve *formalized cadence*, mainly through the introduction of a *visualization board* (the "pulse board") and the *weekly meetings* ("Pulse meetings") at it. Strict cadence models, such as at Scania and Leine & Linde, impose a regular schedule on a great part of all work. Notably, the company that seems to be applying the strictest cadence model in our sample, Ericsson, does not center its work around a visualization board and weekly meeting, possibly due to the fact that it so regularly generates the finished product itself. Among the techniques stated by many firms we also find more formalized priority setting, cross-functionality, strengthening the position of marketing, and measures to improve concurrency in development.

Below is a list of what we perceive as important components of Swedish lean product development in practice.

- Formalized cadence
- Visualization (whiteboard) with weekly meeting
- Formal project priorities
- Reducing number of ongoing projects
- Standardization of processes
- Value stream mapping
- Giving marketing a stronger formal position
- Measures to increase concurrency and cross-functionality

## 6.2 Analysis 2: What are the implications for management of the experiences made?

The previous section looked at Swedish practice in the light of international lean product development literature to discuss what components it is made up of. In the following section we broaden the comparison framework. With the purpose of possibly generating new insights on how product development can best be managed, we now turn to analyzing the found practices in the light of preexisting product development theory, as lined out in our theory framework chapter. This will lead us to the managerial implications.

### *6.2.1 Positioning Swedish lean product development in innovation theory*

As summarized by Tidd et al (2005), innovation theory is often analyzed as consisting of two main strands of thought: one rationalist (built on the belief that things are fundamentally plannable), and one non-rational, referred to by Tidd et al (2005) as incrementalist (built on the belief that the world is too complex and fast-changing to allow for successful detail planning). Our perception of Swedish lean product development practice is that it is characterized by aspects of both.

Several sources emphasize the value of linearity, a key trait of rationalism, in the product development process. We perceive Ericsson as the most outstanding example of this, with its "design machine" (a rationalist metaphor in itself), the tasks of which cannot be stopped once started, and which cannot be disturbed with new tasks except at fixed cycles. The linear dimension is emphasized also at Scania, with its factory metaphor, and by several people at Leine & Linde where one interviewee invents the word "self-pull". Another trait which we find remarkable in our data is the following: while the role of market requirements and customer needs are held for absolute leading stars, we observe no self-critical analysis whatsoever regarding the ability of the marketing function (product managers) to translate these into plans in the form of product specifications. It is further assumed that value-creating activities could, through the process of value stream mapping, be more or less unproblematically separated from wasteful activities – a rationalist assumption indeed.

A paradox appears. While the problems targeted (globalization, complexity, shorter product life-cycles, increased competition etc) are fundamentally those which have historically *undermined* the rationalist view, they are now seen as the reason for more of it. The rational "machine" of product development, running at high and predictable pace, is paradoxically seen as an enabler of agility and flexibility in the organization as a whole. Ideally, it becomes something of a necessarily predictable motor when the company model goes from steady tanker to flexible speedboat. Lean product development, as it emerges in our study, is thus seen as a way to create rational stability internally in the product development process, in order to support flexibility externally.

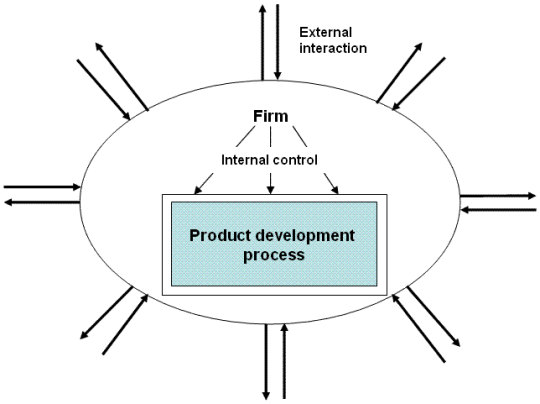


**Figure 11: In lean product development, the concern with external relations is largely separated from the product development process**

The product development process is embedded in the company, increasingly controlled by people from the marketing function but also protected by them from the disturbances of the ever-more irrational world outside. For the company as a whole, a non-rationalist view prevails.

### *6.2.2 Positioning Swedish lean product development in product development theory*

As evident from Trott (2002), product development theory has progressed somewhat in parallel with the rationalist-to-nonrationalist trend in innovation theory. Clearly, the early departmental-stage models do not correspond with lean product development, where departmental borders are assumed to be a main source of wasteful inefficiencies. The thinking behind lean product development lies closer to that of later categories, notably the concurrency models, cross-functionality models, decision-stage models and conversion-process models – so close, in fact, that one could view lean product development as largely a "best-of compilation" of selected components developed under the mentioned types of frameworks. The correspondence with ideas from concurrency and cross-functional models should be self-explanatory. Decision-stage thinking is evident from attempts – in Haldex, Leine & Linde and others – to ascertain that cross-functional work takes place early in the development of each product; this is guaranteed by the use of phases between which a go/stop decision must be taken. Conversion-process models build on the assumption that the product development process can benefit from a simplification of its interfaces with the rest of the organization, so that it can be influenced also by people who e.g. have a lesser knowledge of technology. Such thinking is evidently reflected in the Leine & Linde case where product managers from the marketing function have taken more control, and possibly in Scania, where the rules of the pulse meeting comprise a ban on technical detail. As for network models, the last category of product development models presented by Trott

(2002), we find that evidence of such thinking is lacking in our data. This would be expected if there is truth in our perception, discussed at the end of the previous section and illustrated there with a figure, that the concern with external relations is separated from the product development process and moved up to the firm level.

#### *6.2.2.1 Letting the firm learn, and the engineers work*

Engwall (2003) was mentioned in our theory framework chapter as an example of proponents of measures to embrace uncertainty, viewed as inevitable, in the organization, rather than eliminate it. We do not find lean product development to be characterized by the same degree of openness towards appreciating uncertainty. It is the idea of eliminating disturbances, not having to cope with them, that the proponents of lean product development are concerned with. Lean product development serves to shield the everyday work from the persistent wind-shifts of the external landscape, to let the engineers work in peace. Again, it is important to distinguish between the levels of product development, which should be shielded and made factory-like, and the firm as a whole, which is thus enabled to be open and flexible. The ideas of Engwall (2003) thus correspond well with the ideas of how *the whole firm* should be able to act according to lean product development thinking, although lean product development seems much more rigid on *the product development* level. Bringing in the broader perspective of the firm the match thus seems tighter. In fact several proposed measures of Engwall (2003) – of acting early, performing visualization together and structuring for flexibility – can all be seen as very closely in line with those proposed within Swedish lean product development.

### *6.2.3 Swedish practice and the critical perspective*

Our data could possibly be in line with a notion that the "pulse", in terms of the visualization and the infrastructure of related meetings, should be understood to be what Forssell (1999) would call a fashion, in Swedish industry, or at least partly so. This would also be a case of what Meyer and Rowan (1977) discuss: a contribution, in this case a temporary one, to dimensions of legitimacy amongst its adopters more than it to the long-term efficiency of their organizations (although we perceive our data would not be sufficient for any conclusive statement on this). As Brunsson and Olsen (1997) describe, companies in general appear to have insatiable hunger for reforms, and lean product development is one that carries a bold promise. Clearly, lean product development has become fashionable, judging e.g. by the attendance figures at Jeffrey K. Liker's seminar in Gothenburg or the interest in IVF's Lean Product Development network. It is reasonable to believe that talk of lean product development could be perceived as trendy, and rub off on the image of those who talk it, without much necessarily happening behind the scenes.

As mentioned in our Analysis 1 section, the Swedish firms generally appear to focus more on the separate techniques than on coming across

as more or less "lean". Not all have come far in concrete action, though, and in such cases it is difficult to tell the difference between deep and shallow interest. The technology manager of Kongsberg Automotive, for example, has had the firm join the Lean Product Development network, lists lean principles received from Scania, and refers much to Toyota, although it is not evident that this has yet formed basis for practical changes to the product development process in the firm. Also, one could note that outside the range of firms which we have visited in person (Scania, Leine & Linde and Ericsson) we have no data to falsify that the "Pulse meeting" could be but a new name for an ordinary weekly meeting that may have existed since long.

Yet our case study on Leine & Linde indicates that to this firm it has truly been a key component in a system to create a sense of pull and cadence in the product development value stream, benefiting efficiency. Also at Scania and Ericsson we perceive it as clear that cadence models have catalyzed remarkable change (with our reservation that we only have one person at each place, both high managers, as sources); Scania's claims to have extinguished product development delays, and Ericsson's claim to be delivering a fully functional update of its 3G network every five weeks, are both bold.

We therefore argue that it would be stupid at this stage to dismiss lean product development as *only* fashion. Even if it is fashionable, that does not automatically mean that it is not efficient, and vice versa. While fashion may be a good way to describe how it spreads and why, efficiency could still be a good way of saying what it accomplishes.

### *6.2.4 Managerial implications*

#### *6.2.4.1 Look closer at the formalized cadence models*

We just concluded that Swedish lean product development ought not to be dismissed as just talk. More than anything this goes for formalized cadence models, which have been elaborately implemented by several companies in our empirical data. (We are thinking here of Scania, Leine & Linde and Ericsson, the three companies we have visited in person.) While the benefits of cadence are discussed by Reinertsen (2005), these Swedish cases go further than any that we have seen discussed in the literature on lean product development, and notably touch on both large and small firms. Further, these models are reported as having brought remarkable improvement in lead times, predictability and transparency. Before this phenomenon has been investigated further it cannot be dismissed. Rather, we argue that managers and researchers should investigate it further, as *a hypothetically world unique, and industrially very potential, set of management tools for improving the efficiency of product development, which in turn make up the major proportion of business R&D.*

#### *6.2.4.2 The full ideology is not a prerequisite to get started*

It is a common view that the creation of a "lean" organization cannot happen through the selection of a few selected techniques, but that lean thinking comprises an integrated set of ideas forming, as Karlsson and Åhlström (1996) put it, "a coherent whole". Womack and Jones (1996) convey the same idea.

Our data, however, gives evidence for an opposite view. Neither at Leine & Linde, nor at Ericsson – the firms which together with Scania go the furthest in implementing techniques of cadence – is the lean philosophy adopted in general. This implies on one level that firms could approach lean product development as a resource of tools to pick from. This is not the same as saying there is an easy road. It appears that a crucial success factor in all three mentioned companies has been a preparedness and willingness to reshape the whole product development organization, and at all three places do the development managers appear genuinely devoted to the ideas.

#### *6.2.4.3 Concurrency could be improved as an indirect result of cadence*

Indeed, one of the most interesting aspects of the formalized cadence model at Leine & Linde is that increased cross-functional considerations, and more concurrent engineering, are described as having come *as a consequence of* the main cadence tools: the visualization board and the cadence meetings. The implication of this, if generalizable beyond this company, is that cross-functional work and concurrent engineering may not need to be directly promoted by managers, but that these will follow naturally if synchronization points and project priorities are communicated clearly enough to the product development engineers, and review forms are designed accordingly. Let us try to visualize this idea in simplistic models. Hitherto, managers may have worked largely according to the logic shown in the following first graph, trying to promote concurrency and cross-functional work in order to improve product development so that it will produce better or quicker market offers:

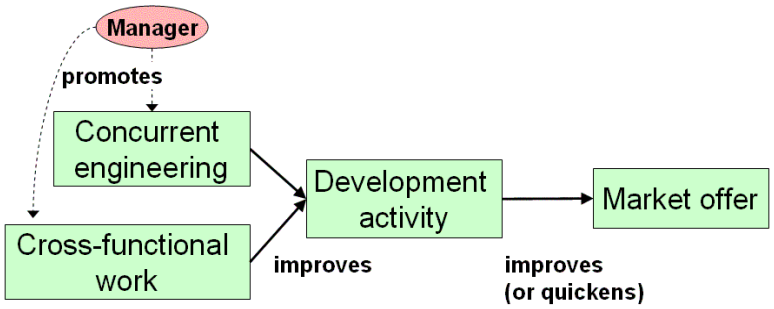


**Figure 12: Direct promotion of concurrency and cross-functional work.**

However, the application of visualization and other cadence tools, as they come across in our study, appear to improve concurrency and increase cross-functional work, not so much because the product development

manager prescribes it, but rather through the encouragement of quick delivery to specification and the visualized follow-up. This is shown in the next graph:

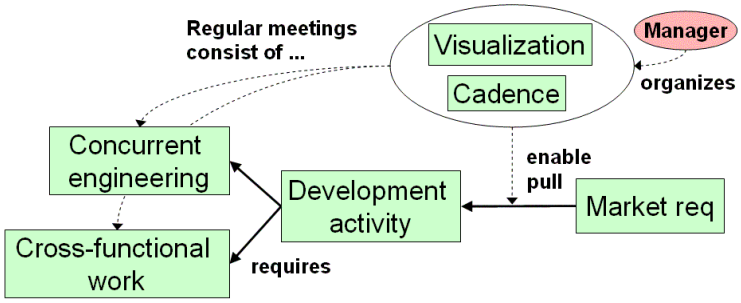


**Figure 13: Lean product development may be better at encouraging concurrency and cross-functional work indirectly.**

Still, the underlying value-chain flows from left to right, but the causal links in terms of work organization (shown as thick arrows) have shifted direction from a push logic (left-to-right) to a pull logic (right-to-left). By mediating communication and priority setting between the marketing and product development functions, new techniques of visualization and cadence will thus enable a sense of pull in the product development organization, which will in turn require more concurrency and cross-functional work simply for the engineers to be able to deliver to specification. One can also note that the "pulse meetings"– although these are short decision-making meetings rather than working meetings – do in themselves consist to some degree of cross-functional and concurrency enabling work. The product development managers' focus now shifts from promoting certain work techniques, to hosting the communication forum where requirements and results are assessed.

#### *6.2.4.4 Product development strategy remains to be assessed*

Leine & Linde is one example of how companies perceive quick results from implementing lean product development techniques, and clearly it is with regard to relatively short-term product development projects that lean product development has its most direct application there. As mentioned by Trott (2002), such incremental improvements, rather than radical innovations, make up the overwhelming part of the product development activities in firms. By conclusion, we believe that many firms would be wise to investigate what lean product development philosophy or techniques could bring for them.

However, we do not see that lean product development in its practiced form brings any valuable input on how more long-term product development should be organized. In our interviews we find one statement (at Scania) that increased efficiency in short-term development automatically frees up resources for more long-term research too, and one statement (by the CEO of Leine & Linde) that product development is simply bad for business unless it targets customer specification. While

such statements may serve a provocative purpose in a given organization at a given time, we argue that they are dangerous for firms if broadly believed. Too carelessly is all established discussion on strategic management of product development swept to the side. As Utterback (1996) has shown, established firms are surprisingly often shaken when radical technology shifts occur. The general lack of explicit long-term discussions in our interviews on lean product development does not automatically imply that the firms are neglecting such issues, but the only explicit comment on such worries in our interviews gives a rather dark impression; it is Magnus Nyström at Sandvik who says as his final point that when firms have worked with lean product development for some years the question arises how to feed the process with bright ideas, and how to be present in the marketplace to pick up ideas. We find these worries supported by the amount of evidence in innovation theory, such as Utterback (1996), on the dangers of radical technology shifts.

We propose that development managers should file lean product development clearly under *operational* considerations rather than *strategic*, thus acknowledging that even if lean product development is introduced, the firm must still answer its own questions of what function its development activities fill in the long term, how it should safe-guard that the firm is not over-taken by technology shifts or competitors etcetera. While the introduction of a lean product development model could be viewed as a *long-term organizational reform*, it should be remembered that it regards a part of the organization that is concerned with relatively *short-term, incremental technology and product considerations*. Let us emphasize this distinction with a simple figure:

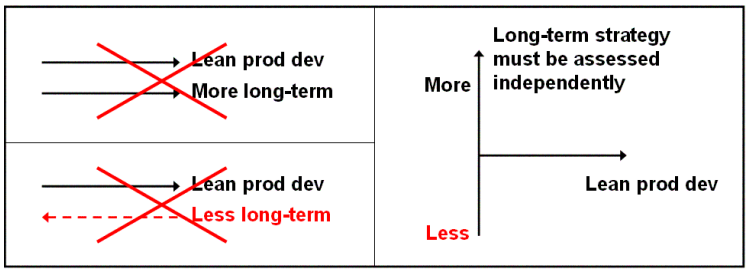


**Figure 14: Long-term product development strategy must be assessed independently of lean product development.**

We argue that implementations of lean product development should not be assumed to automatically have neither a positive nor a negative effect on long-term product development strategy. Our two-dimensional model to the right in the figure above serves to remind managers that long-term product development strategy must be assessed independently of lean product development.

# 7. SYNTHESIS

## 7.1 Summary of findings

### *7.1.1 What lean product development consists of in Swedish practice*

The covered firms largely view lean product development as a potential answer to problems which they have long perceived, with regard to primarily

- product development lead time,
- the predictability of product development lead time, and
- lacking customer focus in product development.

With some exceptions we perceive that it is mainly as *techniques*, rather than as a philosophy or as a label, that the concept of lean product development attracts rapidly growing interest amongst Swedish firms. This goes particularly for tools aimed at imposing *cadence* in the product development process, notably a visualization whiteboard and a short weekly cross-functional meeting held in front of it. This technique has apparently spread rapidly from Scania, which is broadly viewed as a role model in Swedish lean product development. Such cadence models, where strictly applied, impose a regular schedule on a great part of all work, and thereby serve to make product development more transparent and predictable. Next to the mentioned cadence tools, which dominate the picture, we observe an additional broad range of techniques in connection with lean product development in Sweden. Let us recapitulate these as a list (which should not be taken for a necessarily complete list of lean product development techniques used in Sweden):

- Formalized cadence models
- Visualization (whiteboard) with weekly meeting
- Formal project priorities
- Reducing number of ongoing projects
- Standardization of processes
- Value stream mapping
- Giving marketing a stronger formal position
- Measures to increase concurrency and cross-functionality

### *7.1.2 The implications for management*

**Look closer at the formalized cadence models.** The formalized cadence models, which can be said to form the core of Swedish lean product development practice, are described as a source of remarkable improvements where they have been allowed to affect the whole product development organization. These models consequently deserve further attention from managers (as well as researchers), as they hypothetically

constitute a world unique, and industrially very potential, set of management tools for improving the efficiency of product development.

**The full ideology is not a prerequisite to get started.** It appears, opposite to widespread statements, that components from the lean product development toolbox can be successfully applied without adoption of the full concept as a coherent philosophy. However, the success of such selected tools may still depend on the preparedness to let them have radical impact on the whole organization.

**Concurrency could be improved as an indirect result of cadence.** Since long, concurrency between tasks in different functions and true cross-functional teamwork have both been aims of managers. Our case study carries interesting evidence that these could come as a consequence when the organization is reshaped according to a formalized cadence model. If generalizable beyond our investigated case, this proposes a new focus for managers.

**Product development strategy remains to be assessed.** We propose that development managers should file lean product development clearly under operational considerations rather than strategic ones. They would thus acknowledge that even if lean product development is introduced, the firm must still answer its own questions of what function its development activities fill in the long term, how it should safe-guard that the firm is not over-taken by technology shifts or competitors etcetera. Long-term product development strategy must be assessed independently of lean product development.

## 7.2 Theoretical contribution

We find our theoretical contribution to lie primarily in the identification of lean product development as a promising yet almost unexplored new phenomenon within the field of R&D productivity, as well as in our development of concepts related to it and in our tentative identification of what could be some of its most important components. We believe that our empirical data, which is rich especially on the interesting case of Leine & Linde, can contribute significantly to the understanding not only of Swedish lean product development, but to the potential of cadence models in product development in general.

This said, our main purpose is that of industrial relevance, where we hope that our four managerial implications can form valuable input for any manager who considers the implementation of lean product development techniques. Further, the analysis contains tentative proposals for ways to understand aspects of the phenomenon, some in the form of graphical models, and we hope that some of these could be appreciated by either practitioners or researchers.

### *7.2.1 Future research*

- As discussed under managerial implications, the existing knowledge on what we call formalized cadence models does not match the promise such models appear to carry. Further study is deserved. Do they produce improvements? If so, under what circumstances, and by what mechanisms?
- We have argued that long-term product development strategy is not automatically determined by lean product development. This does not exclude the possibility of mutual dependence. Do firms who implement lean product development tend to change their ways of working with the more strategic aspects of product development? Can roadmapping and/or other complementary structured approaches compensate for possible lack of long-term focus?
- How is the professional role for the product development engineer affected by the increased exposure, the seemingly limited room for creativity, and the increased dependence on initiatives from marketing?

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(in order of presentation in the chapter of empirical data)

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Swedish Industrial Research and Development Corporation (IVF)
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Hasse Johansson
Head of Research & Development, Scania
1 February, 2006

Ulf Thorsander
Development manager, Leine & Linde
7 April, 2006 (telephone)
21 April, 2006

Per-Johan Ahlström
Product manager, Leine & Linde
21 April, 2006

Magnus Johnson
Product manager, Leine & Linde
21 April, 2006

Håkan Eriksson
Project manager & product development engineer, Leine & Linde
21 April, 2006

Kjell Löfgren
Project manager & product development engineer, Leine & Linde
21 April, 2006

Björn Zetterlund
Chief Executive Officer, Leine & Linde
21 April, 2006

Lars Frank
Manager for the CPP unit, Ericsson
24 April, 2006

Urban Fagrell
Development manager, Haldex
7 April, 2006 (telephone)

Magnus Nyström
Development manager, Sandvik Materials Technology
6 April, 2006 (telephone)

Mattias Lövemark
Development manager, Bahco Tools
6 April, 2006 (telephone)
10 April, 2006 (telephone)

Christer Lundh
Technology manager, Kongsberg Automotive
7 April (telephone)

Thord Porsander
Manager for Research & Development Strategy, ABB Robotics
28 March, 2006 (telephone)

Ulla Sebestyén
Consultant, Parmatur
24 March, 2006 (telephone)