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Stage-Gate modified for Lean PD

Master of Science Thesis in the Master Degree Programme, Product Development

Yashar Aslanzadeh
Ali Davoodi

Department of Product & Production Development
Division of Product Development
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden, 2014.

Abstract

This thesis is based on a systematic literature review, which examines how the principles of Lean could bring value to the organizational processes, through modification of the Stage-Gate model to incorporate lean product development principles. Stage-Gate includes the total process of idea to launch in a number of pre-determined steps or stages. In each stage a number of cross-functional and parallel activities are undertaken. At the end of each stage the activities are reviewed at a gate by management in which a **kill/go/re-do** decision is made. Lean is the elimination of waste and the application of practices that contribute to reduction in cost and labor while improving performance of products and creating value for end customers. Processes, procedures and working methods that are unable to create value are considered as wasteful and are thus targeted for potential elimination. With the consumer in focus, "value" is defined as any action or process that the customer would be willing to pay for.

Important organizational factors in the implementation process are examined through literature reviews and semi-structured interviews in a qualitative manner. The research outlines the challenges when changing an organizational business model towards implementing a new one.

The conclusions are based on the information drawn from the literature review, interviews and the current best practice of Stage-Gate. Guidelines are proposed for the design of a suggest systems to support lean product development practices.

The result from this study indicates that visual planning is the preferred method to start with when working towards lean transformation. Also, it was revealed that there are some difficulties in understanding and applying set-*based engineering*, as well as how to distinguish differences between *trade-off* and *limit curves* that literature perceives as critical lean principles. Management methods like *agile*, *portfolio management and change management* are important project management methods that are utilized in synchronization with lean practices and need to conform with the framework in order to achieve a successful implementation.

Key words: *Stage-Gate, Lean Production, Lean Product Development*

Acknowledgement

Firstly, we would like to thank our supervisor Dr Göran Gustafsson for introducing us to the topic of lean, for his patience, trust, and guidance throughout this thesis at Chalmers University of Technology.

In addition we would like to thank Ms Azadeh Fazl Mashhadi, Ms Anna Sandberg, Mr Mats Espling, Mr Thorsten Martinsson, Mr David Haglund and Mr Magnus Thordmark for allowing us to take part of their time. Without their knowledge and experience this thesis would not be possible.

And finally

To my parents Dadash and Nasibeh for their unconditional support and love, you are the ones giving me meaning and purpose in life. To my sisters, Solmaz and Sevim for your guidance, support and always beeing there for me, you are my inspiration in all things I do.

Yashar

I would like to thank my family for their support - my parents for putting me through school and believing that I could get through this, my sister for her advice, and my partner for giving me Motivation.

Ali

Contents

1. Introduction

With rapid emerging technological progress, global communication and increased competition, methods of yesterday may not be sufficient today and can no longer present the same results if they are not able to respond to the fast changing situation. The success of companies depends upon on their ability to react, adjust and conform to change. Staying competitive requires looking for and finding ways of reducing costs and increases the capability of company processes.

NASA introduced the concept of phased development in the 1960s with its phased project planning methodology. The phased review process arranged the development process into a series of phases that could be reviewed in sequence. At the end of each phase a management review was held In order to decide whether the project had met the targeted criteria and could continue to the next phase of the project. NASA's phased review only took into consideration development activities. The complete process of idea-generation to launch was not incorporated and marketing activities was also neglected (*Verworn & Herstatt 2002).*

Coopers Stage-Gate process established a standardized approach for development projects. His model resembles NASA:s phase-review-processes with some additional features. The process is broken into stages of activities and end with a gate. The gates are decision points determining on the continuation of the project. Coopers Stage-Gate-process integrates the engineering and marketing viewpoints. Multifunctional teams make the decisions at the gates according to well-defined go/kill criteria. Also the process covers the whole innovation process from idea generation to launch and activities are carried out in parallel in order to speed up the tasks and reaching the market more rapidly (*Cooper 1994).*

The lean framework is at present considered to be one potential approach for improving organizational performance. Many researchers suggest that it is this framework that is the reason for Toyotas and other Japanese companies successful development practices. Developed as a production system with the aim of eliminating wastes at Toyota Motor Corporation in the 1960's, lean has evolved into a management approach that helps the ever continuing process improvement efforts of developing organizations *(Womack et al.1990, Liker 1998).*

1.1 Purpose

Since Stage-Gate is so widely used in the industry, lean product development approaches must be able to co-exist with this framework if widespread adoption is to be expected. The purpose of the thesis is to investigate best practices of the Stage-Gate model and suggest approaches towards the Stage-Gate framework that supports the principles of lean product development. The study was made through extensive literature review and semi-structured interviews at several large scale development companies in Sweden. An interview was also conducted at Swerea IVF,a Swedish research institute focusing on innovation, product development and production.

1.2 Research questions

In order to fulfill the purpose and aim of this thesis, the following research questions were identified:

Q1. What adaptions to Stage-Gate are required to support lean product development processes?

Q2. How do companies in the industry apply lean principles in their product development processes?

Q3. What product development frameworks /project management methods are critical to consider when applying lean to product development processes?

1.3 Delimitation

Due to the potential wide scope of the research, delimitations are necessary. The data collection and literature study information may be not sufficient enough. Subsequently, the analysis and discussion based on them may not be deep and rich enough. Also, because of limited personal knowledge and experience of the subject, the study cannot exploit and expand into all lean product development issues and challenges. Neither has any extensive mapping of the processes or activity specific evaluation been made. The analysis and discussions of lean and Stage-Gate have been carried out on an overall level. The sample of interviews is also limited and may not accurately give comprehensive enough data, making the study difficult to generalize.

One problem when conducting semi-structured interviews is that the flexibility of the interview may decrease the reliability. The open ended questions make the analysis and comparison of answers difficult.

1.4 Outline of the thesis

2. Methodology

The methodology chapter describes the study methods used in order to acquire information and data in order to accomplish the aim of the thesis. This section discusses the Data collection methods, research approach and the credibility of this thesis.

2.1 Research process

"The choice of methodological approach is strongly based on the information investigated, the problem identification, the purpose and finally the research questions" (Holmes & Solvang 1997).

Depending on the objective and aim of the study, qualitative or quantitative approaches can be used. Quantitative methods are characterized by being highly structured and depend on statistical information, which is used to find out the relationships between different variables.

Qualitative methods are characterized with more flexibility, and are conducted when a deeper understanding is desired within a research area. With reference to the aim and purpose of this thesis, a qualitative methodology has been chosen; deeming that relevant information could best be gathered through a qualitative method as a research approach, see Figure 1.1 (*Holmes & Solvang, 1997,Bryman & Bell 2007).*

	Qualitative Research	Quantitative Research
Objective / purpose	• To gain an understanding of underlying reasons and motivations • To provide insights into the setting of a problem, generating ideas and/or hypotheses for later quantitative research • To uncover prevalent trends in thought and opinion	• To quantify data and generalize results from a sample to the population of interest • To measure the incidence of various views and opinions in a chosen sample • Sometimes followed by qualitative research which is used to explore some findings further
Sample	Usually a small number of non-representative cases. Respondents selected to fulfil a given quota.	Usually a large number of cases representing the population of interest. Randomly selected respondents.
Data collection	Unstructured or semi-structured techniques e.g. individual depth interviews or group discussions.	Structured techniques such as online questionnaires, on-street or telephone interviews.
Data analysis	Non-statistical.	Statistical data is usually in the form of tabulations (tabs). Findings are conclusive and usually descriptive in nature.
Outcome	Exploratory and/or investigative. Findings are not conclusive and cannot be used to make generalizations about the population of interest. Develop an initial understanding and sound base for further decision making.	Used to recommend a final course of action.

Figure1.1-Qualitative vs. Quantitative research (snapsurveys 2010)

2.2 Literature review

The literature review conducted was based on the purpose of the thesis and the research questions. The literature was chosen to assist in better understanding the concepts and principles of Lean Product Development and the framework of Stage-Gate. Other adjacent fields of project/process management were also studied to better understand the correlation between frameworks and the potential overlap between principles. However, most of the content is focused on lean product development principles, tools and methods .The reasoning behind the decision to concentrate more heavily on lean principles were the desire to gain more knowledge about how these methods are used to improve performance in developing companies, understanding how implementation and transformation is carried out in product development organizations, and what critical factors must be considered when implantation has begun.

Information was gathered from articles, books, E-books and other internet sources. The selection of literature was largely based on the amount of quotations. Reference lists of the works found in the initial literature search were used to identify the most distinguished titles and authors to support our research in to the subject.

2.3 Interviews

In qualitative research, interviews and observations are proper methods of gathering data. Additionally the flexibility of qualitative interviews allows the interviewer to adjust in response the interviewee. The main focus is acquiring detailed and rich answers from the respondent's perspective on the subject. The interviewer is able to deviate from any prepared questionnaires being used and new questions may arise due to the respondent's replies, and the order of the questions may be revised during the interview *(Björklund & Paulsson 2003, Bryman & Bell 2007).*

Unstructured and semi-structured are two different interview approaches that can be used in qualitative research.

2.3.1 Unstructured interviews

During an unstructured interview the researcher does not use prearranged questions. The interview starts with a question, the respondent talks freely allowing for questions to develop spontaneously as the interview progresses (*Bryman & Bell 2007).*

2.3.2 Semi-structured interviews

A semi-structured interview follows an interview guide with topics and questions that need to be covered. The respondents have the opportunity to develop their views and the method allows new ideas to be brought up during the interview without constraining respondents to a structured interview method *(Darmer 1995).*

The method of interview chosen for this thesis is semi-structured interviews. The reason for choosing this method is to encourage the interviewees to freely discuss their thoughts and share their expertise on the subject. Additionally the authors of this thesis felt that having this approach would allow the acquisition of deeper knowledge of how to apply lean principles to product development processes, the value of tools and methods, as well as the effects of the framework on P.D processes. Using open-ended questions allows adjusting the questions depending on the characteristics of the

specific company and the attributes of problems they face. The interviews serve as primary data combined with the literature review to answer the research questions.

2.4 Reliability and Validity

Questions concerning reliability and validity are measurements associated with the level of trustworthiness and credibility of the researcher's data collection and analysis. They reflect whether research methods used ensure that the gathering of data is accurate and data interpretations are empirical and logical *(Bryman & Bell 2007).*

The trustworthiness of the study is evaluated based on its credibility, transferability, dependability and conformability, as proposed by Guba and Lincoln (1994).

To secure the **credibility** of the study and restrict the influence of personal perceptions and interpretation of the interviews, the interviews have been approved by the interviewees. This was done in order to secure facts, erase possible misunderstandings in communication and to confirm that the answers given were understood correctly. Written transcripts of the interviews have been sent to the participants by email for validation, giving the respondents the opportunity to correct misinterpretations and misunderstandings *(Bryman & Bell 2007).*

The transferability of the study refers to what extent the results of the research are possible to generalize or transfer to other contexts or settings *(Bryman & Bell 2007,Lincoln & Guba 1994).*

The limited number of interviews makes it difficult to generalize the findings to the whole engineering industry. In an effort to increase the transferability of the study, all interviews followed the same line of questions and the data collected has been documented through recordings and transcriptions.

The dependability relates to contextual factors and how they might have an impact on the results, i.e. carelessness or mistakes in the analysis of the study, data collection, interpretation and report of results *(Bryman & Bell 2007).*

The literature used for the study was written with the purpose to support organizational transformation towards lean. The literature tends to be very positive of the lean principles, which to with our limited knowledge about real cases in the industry could have had an effect on the authors' perception of lean. To minimize this, research articles of lean with a more critical view, were also studied also, though critical articles of this nature were rather scarce. The data collected is largely based on information provided by the interviewees, and is thus dependent on the respondents personal views. However with the exception of Volvo Penta, the interviews are recorded and transcribed allowing the possibility to access them if required.

The Conformability refers to objectivity of the authors when handling data and results in the study *(Bryman & Bell 2007).*

The questions during the interviews have been of an open character to avoid leading the participants to any particular literature theory and in order to avoid personal views interfering with the data. The

authors have also listened to the recorded interviews several times and have had discussions in order to avoid any subjectivity with regard to interpretation and analysis of the data.

The authenticity relates to whether the study has delivered a sufficiently fair view of the opinions and views of the interviewed participants *(Bryman & Bell 2005)*.

All interviewees are familiar with the framework of lean and have been working with the concept. Nevertheless, the participants were all managers. There was no opportunity to interview people in non-managerial positions, thus making the findings to be more of a managerial perception than an overall view of practices.

3. Literature review

This Chapter gives relevant background information to the subjects of this thesis, The most relevant principles, methods and authors are presented

3.1 Stage-Gate

The first-generation of frameworks for new product development processes was developed by NASA in the 1960's. NASA's phased project planning divided the development into phases. Review points at the end of each phase were held in order to decide whether the project had met the targeted criteria and could continue to the next phase of the project. The approach of NASA was very engineering driven and dealt with technical development activities, neglecting any marketing activities (*Verworn & Herstat, 2002).*

To overcome this deficiency of NASA: s Phase model, the second generation Stage-Gate system was developed. *Coopers* model takes into account and integrates the engineering and marketing viewpoints. Multifunctional teams make the decisions at the gates according to well-defined go/kill criteria. Coopers Stage-Gate-process covers the whole innovation process from idea generation to launch and activities are carried out in parallel to speed up the tasks and reach the market more rapidly *(Cooper 1994).*

The framework of Stage-Gate is a template or roadmap for driving new product projects from idea to launch by breaking the innovation process into stages. Each stage comprises a set of parallel and cross-functional activities. Between stages there are gates. These gates are go/kill decision points for projects and specific criteria must be met in order to move to the next stage. Gates are in essence quality check points for the project where senior management reviews the project, and decides whether to continue to release funds and resources or not *(Cooper 1995).*

Cooper (2008) claims that the Stage-Gate system is ideal for new product development since it increases efficiency of the innovation process, allows for faster times to market and boosts the effectiveness in terms of new product success rate.

3.1.1 The stages and gates

Stages are the part of the project where research and technological development are performed. In each stage the tasks consist of gathering information to move the project through to the next gate. The number of stages and gates in the Stage-Gate model are dependent on the company or division, but usually consist of between four to seven stages and gates *(Cooper 2008).*

(**G1) The first gate** decides whether resources should be allocated to it. The criterion for decision at this point is usually qualitative and few. The gate consists of *strategic alignment, technical feasibility*, *competitive advantage* and *opportunity*. Each gate has a predefined set of requirements that must and should be met *(Cooper 1990).*

The idea then goes to **Stage 1** in which the idea is reviewed and includes preliminary technical and market assessments. The idea then moves to Gate 2 *(Cooper 1990).*

Moving to the **second gate** (**G2)**, the criteria here tend to be more rigorous than in Gate 1. The meticulous criteria at this point is due to the fact that more resources will be required to be allocated for development efforts if a "GO "decision is given

Often at this point a measure of aspects ranging from *market requirements*, *competitive situation*, *product advantage* and *revenue potential* are made to decide whether there is any incentives to continue *(Cooper 1990).*

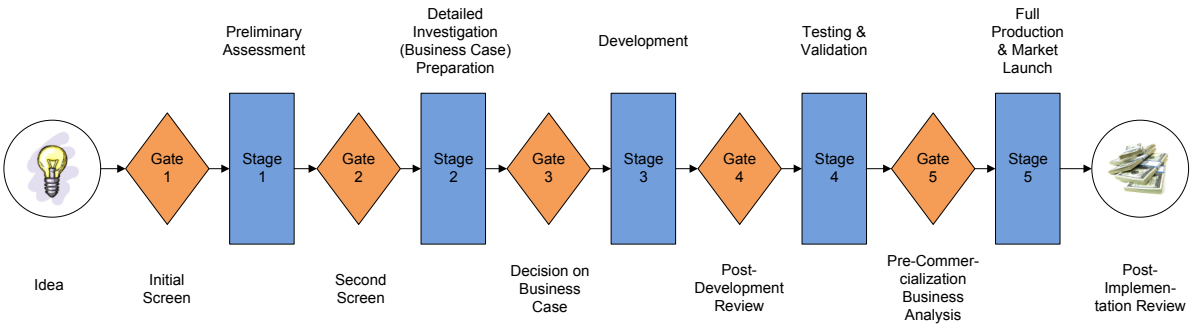


Figure 3.1 - Model of the Stage-Gate (Cooper 1990)

Going through to **Stage 2**, here the business case is developed and the need for the product in the market is established before releasing more funds for further development of the product at the next stage. Stage 2 activities include: research into the customer needs and desire, determining the ideal product in the context of the end-user desires, competitive analysis, technical and manufacturing assessments, legal assessment, patent issues, and a detailed financial analysis *(Cooper 1990).*

At **gate 3(G3**), decision on the work that is done in stage 2 is made. It is the final gate before the development stage. The criteria for a pass are often hard and include critical financial reviews and risk assessments. **Stage 3** emphasizes parallel tasks between technical, marketing and manufacturing activities. Customer opinion should continuously be sought as the product develops. Detailed market test, launch programs, manufacturing and production plans should be developed *(Cooper 1990.)*

Gate 4(G4) is the review done post-development in order to validate the project. Areas that will be evaluated include if there still is a market demand, quality issues, and verification for the next stage is decided upon. In **Stage 4** tests and validation on the product is undertaken, customer approval, field trials, and financial analysis are carried out to determine expected market shares and revenues *(Cooper 1990).*

Gate 5(G5) is usually the final gate and is where pre-commercialization analysis is conducted in order to take the product into full commercialization. Market launch and production start-up are detailed and decided on at this gate. Gate 5 is the last event at which the project can be terminated if deemed unviable. Criteria to pass the gate are based on quality issues, the feasibility of production, launch plans, and on product profitability. Finally this stage involves putting the launch, production and operations plans in motion *(Cooper & Kleinschmidt 1993).*

3.1.2 Critique of the Stage-Gate model

Product development is an environment full of uncertainty and risk. Stage-Gate as a management framework allows for organizing the product development efforts, quantifying them and managing them in order to achieve proper decisions while simultaneously avoiding financial losses and missed opportunities. However the framework has received plenty of critique over the years.

Buggie (2002) claims that the model is not suitable for new product development and that it can only be used as a milestone control point. The author also argues that a critical error in the model is that the gates focus on searching flaws thus excluding radical ideas and potential innovations.

Critique has also been aimed towards the linear approach of the model to innovation. *Tomke (2003)* argues that rapid feedback is essential for businesses with market cycles. Stage-Gate does not have a feedback system, which is regarded as a major problem. Tomkes critique is shared *by Kline and Rosenberg (1986)* whom also emphasizes the need for feedbacks throughout the innovation process. Cooper has however recognized the critiques and has published two articles discussing how the model could be optimized to accommodate these issues *(Cooper 2002).*

Becker (2006) also addresses these critiques and states that if the model is interpreted narrowly. Then suboptimal result should be expected. He argues that the gates are in place so that the proper business choice can be made and to prevent the wrong product from getting to market. He also argues that much like any other system a correct implementation of the Stage-Gate is critical to achieve success. The author also states that it is due to the improper use and implementation that many of the problems the critiques address occurs.

3.2 Next-Generation Stage-Gate

Coopers third-generation Stage-Gate model emphasizes more process flexibility with stages and the gates being less strict. They should be viewed as guidelines to speed up the product development process and overcome delays due to the perceived sequential nature of previous Stage-Gate models. Parallel activities and cross-functionality are emphasized and regarded as critical to reduce development time *(Cooper 1996).*

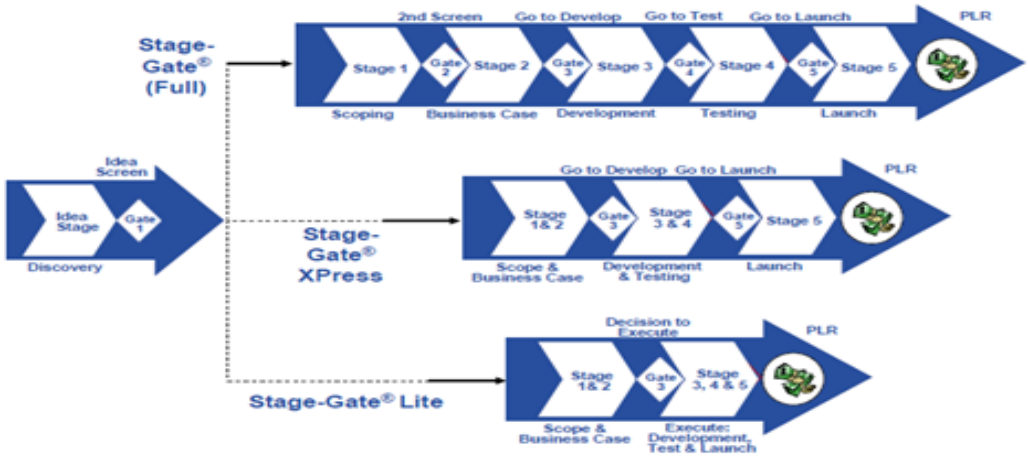


Figure 3.2 - Next-generation Stage-Gate (Cooper 2001)

In order to respond to various types of projects the next-generation Stage-Gate framework has been designed to accommodate projects depending on the risk levels. Figure 3.2 illustrates the different models. All development projects begin at the first gate and go through an early screening process assessing the levels of uncertainty and risk. Depending on the type of project it is, the proper version of the model is chosen. Each project is perceived as unique and has its own scalable process. Gates are not required to be passed nor are all the stages required. The level of risk and uncertainty defines which type needs to be executed. Major new development projects go through the full five-stage process, moderate ones with less risk and uncertainty, such as platforms, modifications, and improvements, use the 'Xpress' version, and projects with minor modifications use the "Lite" process *(Cooper 2001,2008).*

The next-generation framework has also developed adaptability through a set of spirals which incorporates agile principles allowing the development process to establish connection to the marketing endeavors through continuous customer feedbacks, *see Figure 3.3*.

Cooper has also addressed gate-keeping problems by suggesting the use of scorecards based on a number of criteria that must be met in order to facilitate better decision-making. The scorecards are filled out by all involved gatekeepers, then the team working on the project and the gate-keepers, analyze the status of the project, discussing their different point of views at the gate-reviews. The project benefits from this by having everyone involved reflect on different issues prior to the gate-

reviews, thus making the gate review meetings more useful, effective and making more knowledgeable Go/Kill decisions *(Cooper 2008).*

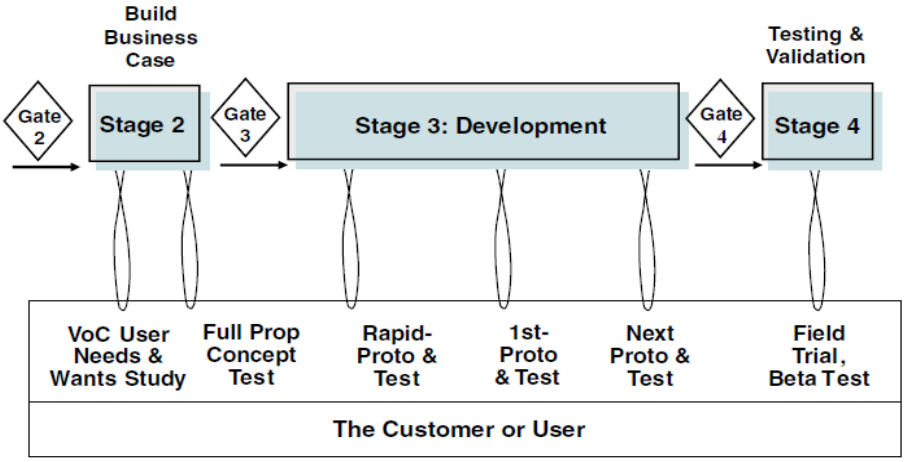


Figure 3.3 - Spiral Development (Cooper 2008)

The smartest way to remove waste in the different part of Stage-Gate is having a process that is lean. One way to achieve that is using *value stream mapping* from lean manufacturing. Value stream mapping is a process used to identify and document value streams. It is used to identifying value added and non- value added activities. Value stream mapping is a vital tool to improving the idea to lunch process. In a typical project all stages, gates and key activities should be mapped out *(Cooper2008).*

The mapping process allows for finding answers to four key questions. These questions are:

1. What work gets done at this step, stage or activity?

2. How well do we execute this activity? How long does it typically take?

3. Is this step or activity really needed? If so, how can it be made better?

4. How can it be made faster?

3.3 Lean

3.3.1 A brief history of Lean

The Concept of Lean is rooted in Toyotas production System (TPS). The ideas of TPS were developed at Toyota Motor Company by Taiichi Ohno and Shigeo Shingo following the visit of Eiji Toyoda at the Ford Rouge factory in Detroit. At this time mass production was to a large extent implemented among the majority of the manufacturing companies in the western world. Upon his return back to Japan, Eiji and Toyota chief engineer Taiichi Ohno came to the conclusion that mass production was not an option for Toyota who faced the challenges posed by the aftermath of WWII. The post war Japanese market place was small and required small quantities of cars to be produced in many varieties, and the strained economy did not allow for large investments in the latest manufacturing technologies *(Dennis 2002, Nicholas &Soni 2006).*

The Toyota production system was created out of need and taking advantage of necessity. These obstacles created the flexibility, increased production efficiency, continuous improvements and waste elimination philosophy that is synonym with TPS today. It took roughly thirty years for Ohno to sharpen this system. As the present days economic crises reveals, Ohnos system is just as relevant today as it was then *(Dennis 2002).*

Albeit the building blocks of TPS began in late 40s and early 50:s, it was not until 1973-1975 with the emergence of the oil crisis that TPS began to spread to other Japanese companies. When the capacity and gains became noticeable to firms outside of Japan the system became the subject of studies, and efforts were made to put the system into use across many industries.

Womack, Jones and Roos (1990) conceived the phrase *'Lean Manufacturing'* to describe TPS when they published their results from a five-year study that chronicled the history of the automotive industry and comparing assembly and manufacturing practices of Japanese, American and European manufacturing processes in the now famous book "*The Machine That Changed The World"*. This book was followed by "*Lean Thinking: Banish Waste and Create Wealth in Your Corporation"* by *Womack and Jones in 1996.*

The fundamental purpose of Lean is to continuously reduce waste in order to maximize the flow and create value for the end customer *(Seth &Gupta 2005).*

Processes, procedures and working methods that are unable to create value are considered as wastes and are targeted for potential elimination. With the consumer in focus, "value" is defined as any action or process that the customer would be willing to pay for *(Womack & Jones 1996).*

The lean concept has mostly been used within production and often been referred to as *Toyota Production System (TPS) or Lean Production* as it has come to be known outside Toyota and Japan. However Toyotas systems are more than just their production system; it is a chain of different connected systems linking the different processes and operations together. It consists of four interacting sub-systems, *Toyota Development System (TDS), Toyota Marketing and Sales System (TMSS), Toyota Production Systems (TPS*) and *Toyota Management System (TMS)*. The interaction of the systems can be seen in *Figure 3.4.*

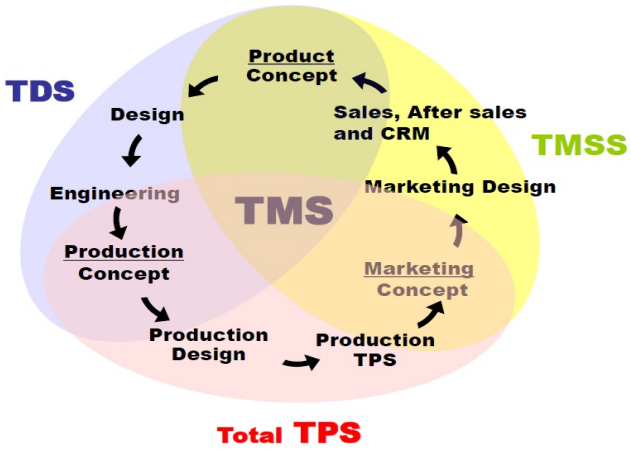


Figure 3.4-Toyotas different operations seen as one system (Holmdahl 2010)

The systems are linked together, and all operations are lead and managed by *the management system TMS*. The *marketing* aspects of Toyotas business are administered by *TMSS*. *The product development* side is handled by *TDS* and the production system is managed by *TPS (Holmdahl 2010).*

As the principles of *Lean* continue to gain momentum in the industry, the methods, tools, and principles are beginning to spread beyond just manufacturing. Lean methods and principles are being implemented to logistics, distribution, construction, and product development. Indeed, lean thinking is now truly beginning to take form among managerial practices across the industry.

3.3.2 Lean product development (LPD)

Today's market place has become increasingly competitive. Consumers have become more aware and expecting new and better ways of support and service. This in effect forces industrial companies to continuously improve their products and themselves in order to stay in business. Gaining new customers and retaining existing ones requires the unrelenting pursuit of improvements in all aspect of business. If companies fail to prioritize improvement in their business model the risk of disastrous results and failure will ultimately jeopardize the organizations future existence.

Morgan & Liker (2006) state that conventional product development is full of waste; wastes in P.D processes are activities that consume resources without adding value to the final customer. This reality is the reason for the advancement of *lean product development*. Product development is a field with high potential for recognizing the benefits of lean. Product development plays a key role in defining the customers' wishes, determining the appearance and material of products, thus largely impacting several areas such as *cost, quality* and *lead-time* throughout an organization *(Morgan & Liker 2006).*

Lean product development aims towards addressing these challenges through standardizing, managing and creating development and operational value streams in the PD processes, which are continuously improved. This in effect results in maximized customer value and value oriented product development process with reduced waste, which is pulled by the customer *(Ward 2007, Womack & Jones 1996, Morgan & Liker 2006).*

To this end authors and researchers have studied Product development systems and processes, in particular the Toyota P.D system. These studies have put forth a number of components, methods and principles that address the problem areas of product development in an effort to achieve a high performance Lean product development system.

3.3.3 Approaches towards Lean

Womack and Jones (1996) described lean based on five principles that could be applied to the entire enterprise. These principles are:

1. **Specify value** – defining value from the end customers' point of view in terms of product capabilities, appropriate price and at the right time.
2. **Identify the value stream-** identifying the entire value stream for each product/product family and eliminate the wastes. "From concept to launch, order to delivery and raw materials into the hands of the customer".
3. **Value flow-** make the value creating activities along the value stream flow, "from design to launch, order to delivery and raw materials into the hands of the customer with no stoppages, scrap or backflows".
4. **Allow the process to be pulled-** provide what the customer needs only when the customer demands it. The process must be pulled from downstream to upstream. "Nothing is produced upstream unless a need is signaled by the downstream customer"
5. **Pursue perfection-** striving for perfection by continuously removing waste (muda) along the value stream

Liker (2004) published the book "The Toyota Way." In his book he summarizes Lean in 14 principles.

The first principle involves management decisions with a long-term philosophy rather than for short-term gain. It emphasizes the need for purpose amongst employees to find motivation and establish goals. The first seven principles concentrate on process and quality. Work processes are redesigned and improved in order to eliminate waste through continuous improvement *(kaizen).* The eight types of waste (muda) are identified by *Liker (2004*) as:

1. **Overproduction**- considered by *Taiichi Ohno* as the root cause of other muda. Producing products when there is no demand/orders. This results in other kinds of wastes such as overstaffing and excess storage resulting in higher transportation costs because of excess inventory.
2. **Waiting (time on hand)-** Workers waiting for delivery of materials, for tools, or process to starts etc.
3. **Unnecessary transport or conveyance-** Carrying work in process (WIP) between different processes, long distances that must be covered during work, inefficient transport system, Obviously materials must be moved, thus making this a necessary muda, however it must be minimized as much as possible
4. **Over processing or incorrect processing**- doing more than what the customer requires poor tool and product designs leading to inefficient processes, enabling unnecessary motion and product defects.

Excess inventory- This muda is related to keeping excessive raw materials, or finished goods causing higher lead times as well as higher storage costs, and delay. This accumulated inventory also makes it difficult to detect production imbalances, suppliers that fail to deliver in time, defects, equipment failures, and setup times that take longer time than they should.

Unnecessary Motion- Any unnecessary motion performed by employees during work, such as looking for, reaching, twisting, walking due to long distances between tasks, poor ergonomics leading to straining motion is also a waste in this category.

Defects- Producing defective parts leading tore-work and repairing,

Unused employee creativity- missed opportunities and learning potential due to loss of knowledge flow by not listening to employee and their ideas.

Principles *nine* to *eleven* put focus on people and the development of employees. The essences of these principles are that they must be intrinsically rooted in the minds the employees in order to be fully utilized and beneficial. **Principle nine** mainly highlights the role of the leaders as the promoter and teacher of the corporate philosophy. **The tenth principle** relates to need of developing individuals and work teams who follow and endorse the company's philosophy. **Principle eleven** puts focus on business partners and the establishment of a reliable and mutual beneficial relationship. Toyota treats their suppliers like they would their own employees, with respect and continuously helping their suppliers to improve and become better, valuing long-term partnership and common understanding rather than just short term financial gains.

The final three principles declare the importance of having a problem solving approach. Emphasis is put on thoroughly understanding situations by personally viewing the activities within a process, and seeing them with your own eyes, executing decisions based on consensus and swift implementation and finally acknowledging mistakes and seeking improvement through continuous reflection *(Hansei)* and improvement *(kaizen),(Liker 2004).*

Genchi Genbutsu, **the twelfth principle** *"Go and see for yourself to thoroughly understand the situation" liker (2004)* articulates that managers should personally evaluate and view operations and processes in order to gain firsthand and better understanding of activities and complications.

"*Make Decisions Slowly by Consensus, Thoroughly Considering All Options; Implement Rapidly"* is **Principle thirteen** or, *nemawash*i in Japanese. This principle advocates consideration of all possible solutions by gathering inputs and reaching an agreement thus generating consensus before management makes formal decisions. Once consensus is achieved and decisions are made implementation is executed rapidly people are giving their input and this generates consensus.

The final and fourteenth principle "*Become a Learning Organization Through Relentless Reflection (Hansei) and Continuous Improvement (Kaizen)"* ties together the previous thirteen principles by necessitating that the organization must be a*" learning organization"*, by looking at every part of the organization critically and continuously putting efforts into improvements and reflecting upon on their practices. This allows the organization to become better tomorrow than they were yesterday.

Morgan &Liker (2006) proposed 13 Lean principles that are more product and process development oriented rather than focusing on manufacturing in their book, *"The Toyota Product Development System*". The authors analyze Toyotas product and process development methods, which the authors acknowledge to be to be "*just as refined and powerful as their production system (Liker 2004).*

Morgan & Liker (2006) emphasize that 3 primary elements need to be integrated in order to create a high performing product and process development system. These three elements are *process*, *people* and *tools and technology*. To create a Lean Product Development System the starting point must be to create a *Lean process*. Once *a Lean process* is well established and defined; the implementation of proper *Lean Tools &Technology* can be developed to support the process, and finally recruiting and the training people in the skills needed to work in the process.

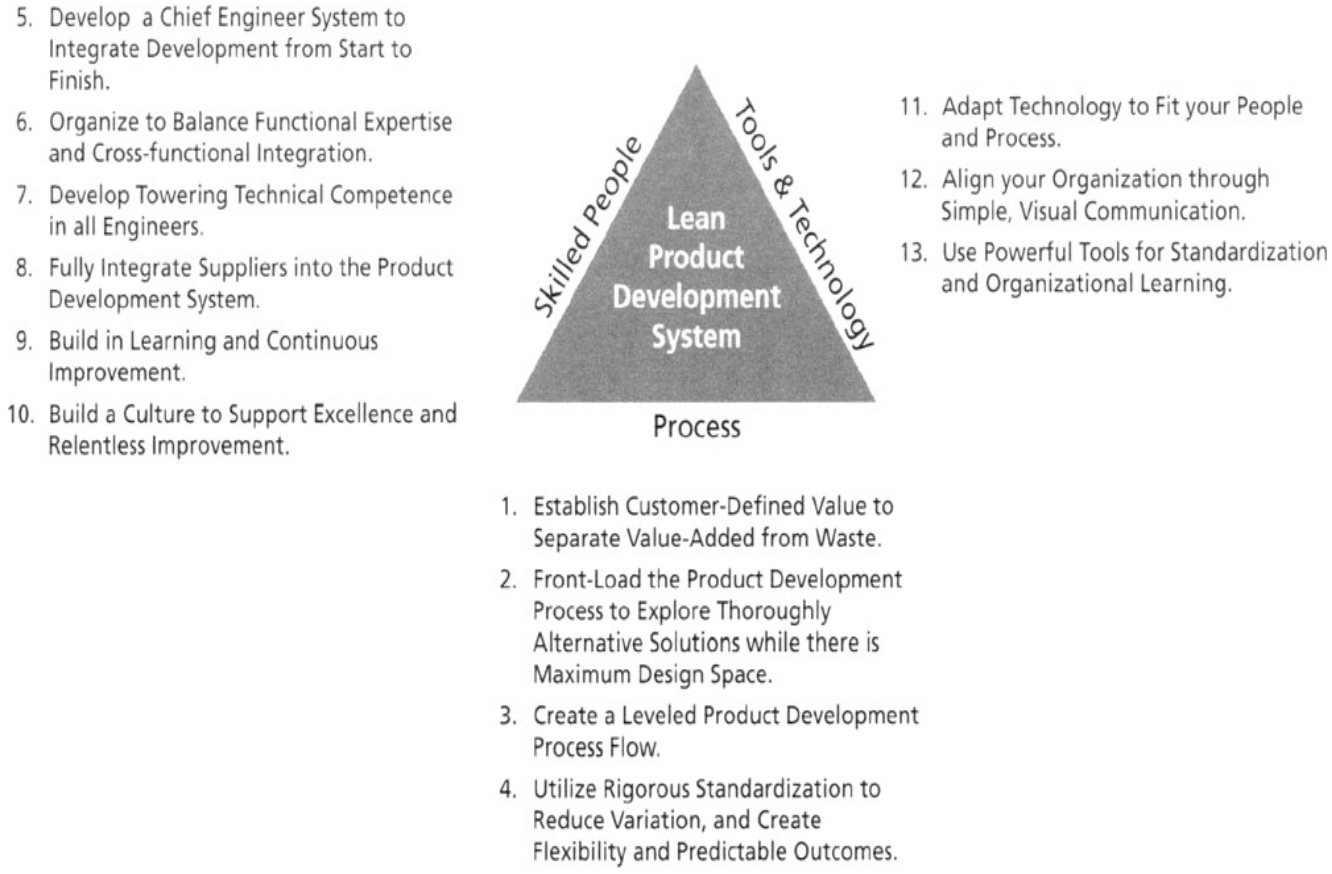


Figure 3.5 - LPD Model and 13 Principles, (Morgan and Liker 2006)

Process

While manufacturing processes are to a large extent repetitive processes, product development processes is more complex and less precise. Despite the differences Product development can take advantage from some of the methods applied to manufacturing to become more refined, eliminate waste, reduce lead time and cost. The process subsystem in Morgan &Likers (2006) model incorporates all the tasks and the work sequences needed to bring a product from concept to production. This is the subsystem that must be investigated when *"the value stream"* is mapped.

1. Establish custom-defined values to separate Value-Added activity from waste

The starting point for any process must always be the customer. Putting the customer first reduces conflict and creates alignment between functions, since all functions (i.e. Design, manufacturing) have the customers need in focus, thus value becomes *customer value*. Waste is defined as anything that expends time, money and resources without adding value from the customer's perspective.

2. Front-load the product development process while there is maximum design Space to explore alternative solutions thoroughly

By front-loading product development and using *set based design* i.e. *exploration of several alternative solutions simultaneously* early in the process increases the chances of reaching an optimal solution and costly downstream development variation and last-minute changes can be avoided.

3. Create a leveled product development process flow

In order to create a product development that is lean it is required that the processes are waste-free for the product to rapidly be introduced to the market. Although Product development might create unique challenges most work that is done throughout development are fairly similar. This similarity allows the PD process to be managed and improved much like any other process. By establishing a specific set of tools and methods it is possible to create a leveled flow in product development processes. Much like Toyota having a strong focus *on learning*; *continuous improvements* and *standardization*, the need for resources at different stages of development can be predicted and anticipated. This means people and other resources can be assigned according to demand, thus enabling the company to level their product development programs.

4. Utilize rigorous standardization to reduce variation and to create flexibility and predictable outcomes

A major PD challenge is to reduce the variation without losing creativity. To achieve this kind of system flexibility lower level tasks must be standardized. Toyota has three standardization categories:

- **Design standardization**- implemented through common architecture, modularity, reusability, and shared components.
- **Process standardization-**accomplished by designing products and molding their manufacturing facilities based on standard lean manufacturing processes.
- **Standardized skill sets for the engineers**-reduces work variation, creates flexibility in task assignments and program planning.

The authors state that through such standardization highly stable and predictable outcomes can be derived in the unpredictable environment of product development.

Skilled People

The people subsystem relates to the organizational culture and structure. It incorporates leadership style, employee development and learning patterns. The structure of the organization must be such that it enables continuous improvements and a problem solving mindset in employees.

5. Develop a chief engineer system to integrate development from start to finish

Usually in developing companies different functional departments are responsible for different parts of Product development endeavors with nobody responsible on an overall level. The concept of Toyotas chief engineer means having an individual with deep technical knowledge and high degree of expertise responsible for the project from start to finish. The chief engineer's role is to be *a "technical architect"* and not just managing people and timing as it is often the case with project managers.

6. Organize to balance functional expertise and cross-functional integration

Balancing functional knowledge within specific disciplines and integrating that knowledge in cross-functional development teams. This is done in Toyota by establishing and empowering a *chief engineer* which represents the customer, having *module development teams* which are cross-functional teams with people from different functional areas gathered around specific development programs, and *Obeya rooms* for communication improvements. In the Obeya room visual management is used and participants have visibility of details, schedules, problems and solutions as all key information of the project is at display across all functional groups.

7. Develop towering technical competence in all engineers

Developing people is fundamental. Large investments must be done when selecting and developing technical competence of all engineers. Toyotas approach to this is that people learn best from a combination of direct experience and mentoring. Through this kind of employee training and development practices organizational culture will also be influenced in a direction that is essential in order to sustain a lean organization.

8. Fully integrate suppliers into the product development system

Getting the suppliers involved in the early stages in concept development, makes it possible to create awareness and learning opportunities as supplier knowledge is brought into the process thus reducing development time and achieving better cross-organizational communication. This in effect will result in better quality and faster development process. Toyota does this by having engineers from suppliers working full-time in as guests, hence creating strong relationship with their suppliers.

9. Build in Learning and Continuous Improvement

Being able to learn and continuously improve is the core essence of lean. Learning and continuous improvement reinforce one another allowing the organization to achieve overall objectives.

10. Build a culture to support excellence and relentless improvement

An organizations culture defines whether it will achieve excellence or not. *It not the destination that matters most in lean, but rather the journey and the lessons learned during the journey. Only implementing* lean tools and principles will not be adequate there must be a culture of understanding of the core values of lean. Only then can excellence and improvements be achieved.

Tools and technology

This subsystem relates to the tools and technologies used to facilitate the development process in order to achieve alignment throughout the organization. Just copying technology and methods will not suffice. Successful implementation of *tools and technology* depends heavily on how the organization integrates and achieves a unique customization suited for their needs .If done poorly acquired technology will not solve any problems in fact it may even cause furthers issues.

11. Adapt technology to fit your people and processes

Technology in itself does not provide a sustainable competitive advantage due to it beeing easily replicated. If new technology is unable to integrate well with the other two subsystems; **process** and **people** it will result in organizational disturbance and loss of valuable time. Tools and technology require large amounts of investments, resources and attention for proper implementation.

12. Align your organization through simple, visual communication

A key aspect of product development is *information flows.* The organizations need to be aligned through simple visual communication. However the organization needs to recognize what constitutes "good communication". Effective and efficient communication must be accurate, targeted and focused on the essentials. Example of tools is "*Obeya" (*Large Room). The "*Obeya"* is a room with relevant information visualized on the walls allowing cross-functional teams of experts to coordinate the development tasks together and taking part of the same information to solve issues. The Obeya room allows product development efforts to be integrated, improving communication, and supporting cross-functional alignment.

13. Use powerful tools for standardization and organizational learning

Successful lean organizations must be able to cultivate *organizational learning* by evolving a culture captures knowledge and transforms it into standards all employees can learn and are able to pass it down to others. Taking advantage of knowledge and know-how is one of the greatest assets and competitive advantages an organization has.

Allen Ward is considered by many to be one of the pioneers in the study and practice of lean product development. His book *Lean Product and Process Development (2007)* was finished posthumously by his students *John Shook* and *Durward Sobek*. Ward emphasizes the value of systems thinking above all else.

Wards Lean principles rest on five pillars:

1. **Value focus**- The importance of establishing consistent and profitable value streams. Wards definition of value stream incorporates both the profits created by the product and the useful knowledge created by the development organization. He promotes the idea that the substantial part of development efforts should be spent on creating useful knowledge and stresses the disadvantages of excessive formal structures.

2. **Entrepreneur System Designers (ESDs)-**Making one person who has the knowledge skills and understanding of an entrepreneur as well as those of a system designer. This person is responsible for the development, design and business success of the product. The ESDs should be empowered and be able to cut across functional boundaries. The administrative responsibilities of ESDs should be very little. Supported by strong functional groups with deep knowledge in special areas the EDSs lead the development efforts and the integration of that knowledge into a successful product.

3. **Set-Based Concurrent Engineering (SBCE)-**Refers to the development of multiple alternatives in parallel. Sets of possible solutions are considered and investigated. Successively reducing the set of possibilities as the weaker solutions are eliminated allows the best solution to emerge.

4. **Cadence, flow, and pull-**Creating a rhythm in the development process by dividing work into smaller sizes and chunks that are easy to work with, and allowing the process to be driven and pulled by the customer.

5. **Teams of responsible experts-**This notion is meant to replace bureaucracy with teams of experts and leaders that are value creating and mission focused. According to Ward this allows the construction of an organization with internal disciplined rather than having the discipline imposed from external structures and centralized control. Ward suggests that such an organization can be created by using people with the proper technical expertise who are empowered to take action when needed.

Ward identifies *knowledge wastes* as the most important wastes in development. These wastes are categorized into **scatter**, **handoffs**, and **wishful thinking**, each with two associated categories (see table 3.1). **Handoffs** are considered to be the most critical waste, occurring when knowledge and responsibility are separated.

Table 3.1 - Knowledge wastes (Allen ward, 2007)

SCATTER

- Actions that make knowledge ineffective by distrusting its flow
- Re-organization disrupting communication networks/knowledge through interaction
- More/new members to teams slows the team down, due to new developers knowledge gap of the teams lingo and jargon
- Workload fluctuations and demands for rapid responses causes organizational and personal disruption
- Adding projects at random intervals leads to work environment fluctuations

COMMUNICATION BARRIERS

- **Physical barriers**- distance, incompatible computer formats
- **Social barriers**-corporate "class systems", management behavior that prevents communication
- **Skill barriers**-not knowing how to turn data into usable knowledge
- **Information channels**-multiple, late and conflicting copies of the same data

POOR TOOLS

- Written processes that require the use of inefficient techniques
- Cutting corners leading to copy of old failures
- Increased crosschecks, reports and tasks

HAND-OFF

- Most **critical** and **fundamental** waste
- Occurs when **knowledge, responsibility, Action and feedback** are separated
- Decision makers do not have required knowledge
- Handoffs are destructive Because 70-90% of knowledge transferred is lost during hand-offs

USELESS INFORMATION

- *Information* is useless if it does not contribute to **good decisions, understanding the customer, doesn't improve innovation and operational value streams**
- *Information* is produced to **reassure/impress managers** or **avoiding blame**
- FMEA analysis that does not generate new knowledge

WAITING

- Sequencing work **slows processes** and creates **waiting, one- way** rather than **multi-way information flows**, gives **more power to upstream developers than downstream**, results in **variation in workload** which causes **scatter**
- Creates **push** instead of **pull** in planning and scheduling
- Suppliers are too late, hindering **joint innovation**, and **optimization of systems, processes** and **products**

WISHFUL-THINKING

- Decision making without data/operating blindly
- Decisions are made based on old data
- Setting specifications at beginning of a project
- One single concept is chosen and efforts are made to make it work, making modification if it does not

TESTING TO SPECIFICATIONS

- *Testing to specification* does not ensure quality
- Lean companies should test in order to find *the point of failure* and design to *avoid and eliminate the failures*
- Pass or fail mentality when testing reduces effectiveness

DISCARDED KNOWLEDGE

- Failure to use knowledge acquired during projects for future use
- Focus on finishing and launching products, capturing knowledge less of a priority
- Failure to turn data into usable knowledge

Karlsson and Åhlström (1996) base their approach and interpretation towards lean on observations made during a span of 2.5-year period at an international manufacturing company producing mechanical and electronic office equipment. They also use the principles of *Womack, Jones and Roos (1990)* from *"The Machine that Changed the World"* as a basis for their model. Their model encompasses a number of different functions with associated interrelated *fundamental lean principles*, which are then translated into *specific principles* for each specific functional area. *(See figure 3.6)*

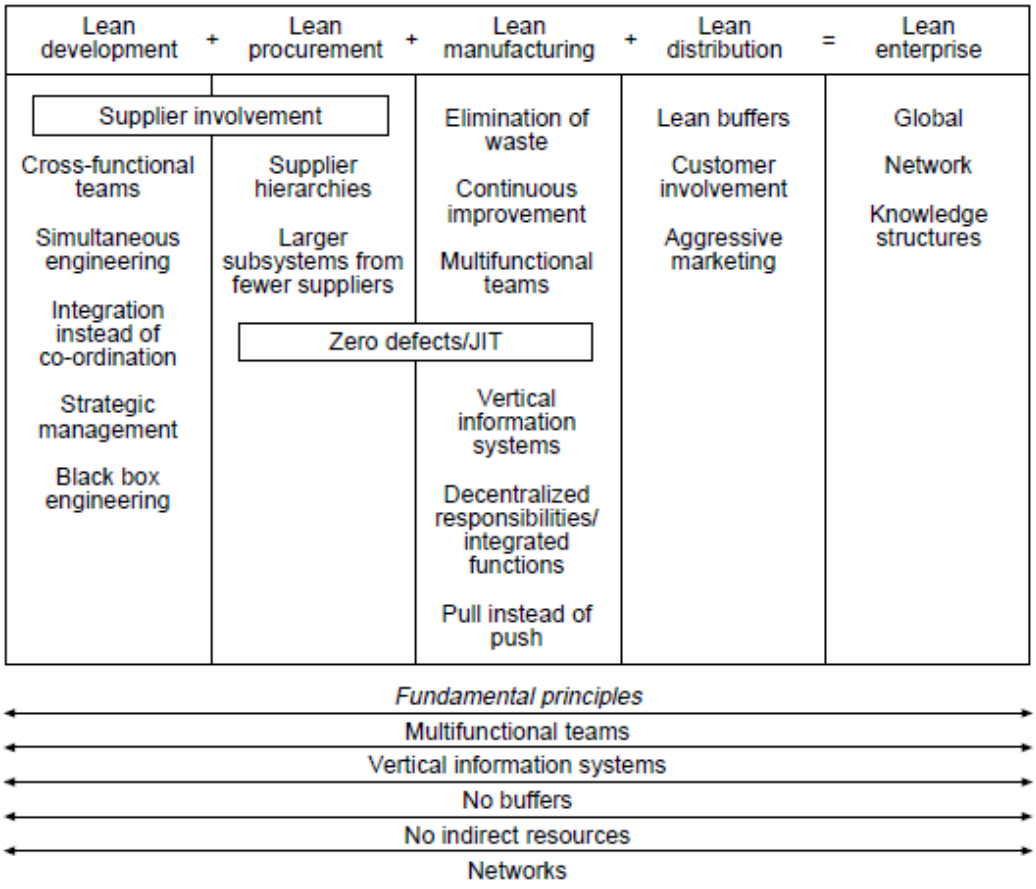


Figure 3.6-Karlsson& Åhlström assessing changes towards lean production International Journal of Operations& Production Management, Vol. 16 No. 2 1996, pp. 26

It is emphasized by the authors that a company does not become lean only through the implementation of some of these techniques, tools and methods. In order to become a successful lean enterprise the authors argue, "*these interrelated techniques must be approached as elements of a coherent whole" (Karlsson & Åhlström 1996).*

The first fundamental principle is *Multifunctional team*. The purpose of having such teams is to develop the employees so that they are multi-skilled. Having multi-skilled team members allows the team to reach better solution and results by adopting knowledge and experience from different functional perspectives, hence allowing most of the problems that occur to be solved within the group reduces the need for external help and supporting functions.

The second fundamental principle in *Karlsson and Åhlström* (1996) model is *vertical information systems.* This principle highlights the importance of information flows. Information must be provided timely, and continuously. Empowering employees makes them able to act on the information make decisions and take responsibility. Through this involvement the employees become a part of the improvement process, thus reducing the reluctance and fears when wasteful existing routines need to be changed. The authors divide information into two types.

1. **Information of strategic type-**which is related to overall company performance objectives and intentions. This type of information is characterized by longer time perspectives and the distribution of information regarding functional areas that the employees are informed about, like marketing strategies, development plans and financial performances of products.
2. **Information of operational type-**contains key performance indicators of the employees and multifunctional teams in question. The performance is measured in terms of quality measures, productivity, upholding time schedules, and lead times *(Karlsson & Åhlström 1996, Åhlström 1997).*

Eliminating buffers constitutes the next principle. It targets all wasteful buffers especially time and inventory. These buffers are perceived as hiding problems instead of solving them such as process variation, instability, potential defects and reduced flexibility. They argue that buffers usually encourage more "push" thinking rather than "pull", thus severing the connection with the customers and the ability to immediately addressing their requirement.

The fourth principle, *Lack of indirect resources* implies that the multifunctional teams are trained in different areas, such as quality control and purchasing maintenance, thus beeing able to perform assignments and tasks that previously might have been performed by employees from other indirect functions in the company. Enabling the competence to be re-located to the source of the problem where the work is done.

The fifth and last fundamental principle of Karlsson and Åhlströms model is *the integration of network.* A network in this context indicates a number of different partners that are willing to participate in improvement efforts. First and foremost are the efforts to integrate supplier networks. This process is a rather complicated task and involves high-level managerial decisions in regards to external relations. However it does not only involve external relations but also matters such as internal integration which includes grouping shop floor operation into cell networks so that flow is achieved, and the relationships between different multifunctional teams.

3.3.4 Lean tools and methods

The different principles stated by literature attempting to define lean product development should not be viewed as mutually exclusive but rather mirroring each other and showcasing different understandings of lean application methods towards product development.

Any business and development system that is focused on employee development, organizational learning and continuous improvement, will essentially include characteristics similar to the principles stated by different authors and literature. As many manufacturing companies have seen improvements through the application of lean tools it is natural to assume that using lean tools geared towards product development should lead to similar improvements in value adding activities while eliminating waste and capturing knowledge, enabling the product development process to create usable knowledge, profitable value streams and developing products that the customers' put value upon and are willing to pay for *(ward 2007).*

Even though just applying tools and methods will not create a Lean product development process, there are a number of formal tools, techniques, methods and characteristics that are representative for LPD. This section will shortly summarize some of the key methods and tools that are associated with lean product development.

3.3.4.1 Set-based concurrent engineering (SBCE)

Conventional design approach is point-based and iterative. Designers explore a variety of possible solutions and subsequently one alternative is selected to be investigated further. The chosen design is then evaluated, modified and refined as required, then reviewed, revised and changed again, in an iterative process which continues until a satisfactory solution has been found. This process can at times be inefficient because of the continual re-evaluation of a selected solution. The inherent problem is the risk that the process never quite ends as deadlines approach, hence engineers and development teams simply stop without the process converging, resulting in a substandard design solution *(Sobek 1996).*

In set-based design, engineers establish sets of design variables, allowing the creation of an open design space from which the participating engineers can create their own sets of solutions independently. This process makes it possible to determine feasible overlap in solutions. The sets are gradually narrowed down as focus shifts towards the feasible overlapping areas as more trade-off information becomes available, until the solutions finally converge. Set based design rests on three principles:

1. **Map the design space-** defining a region of feasible solutions through investigation of different design alternatives. Trade-off between multiple solutions generates understanding of actual possibilities to solve the problem, as well as capturing the knowledge generation that accompanies during the research and testing process.
2. **Integrate by intersection-** when different functions achieve understanding of solutions possible from their own and other functional viewpoints, they are integrated, searching the overlapping feasible intersection space, where a solution that is acceptable for all involved is found.
3. **Establish feasibility before commitment-** working with multiple solutions in parallel and gradually eliminating the least feasible ones until converging on one final solution. This allows the assurances that the chosen solution is the most feasible before commitments are made, thus avoiding late changes, see Figure3.7 *(Sobek, Ward, & Liker 1999).*

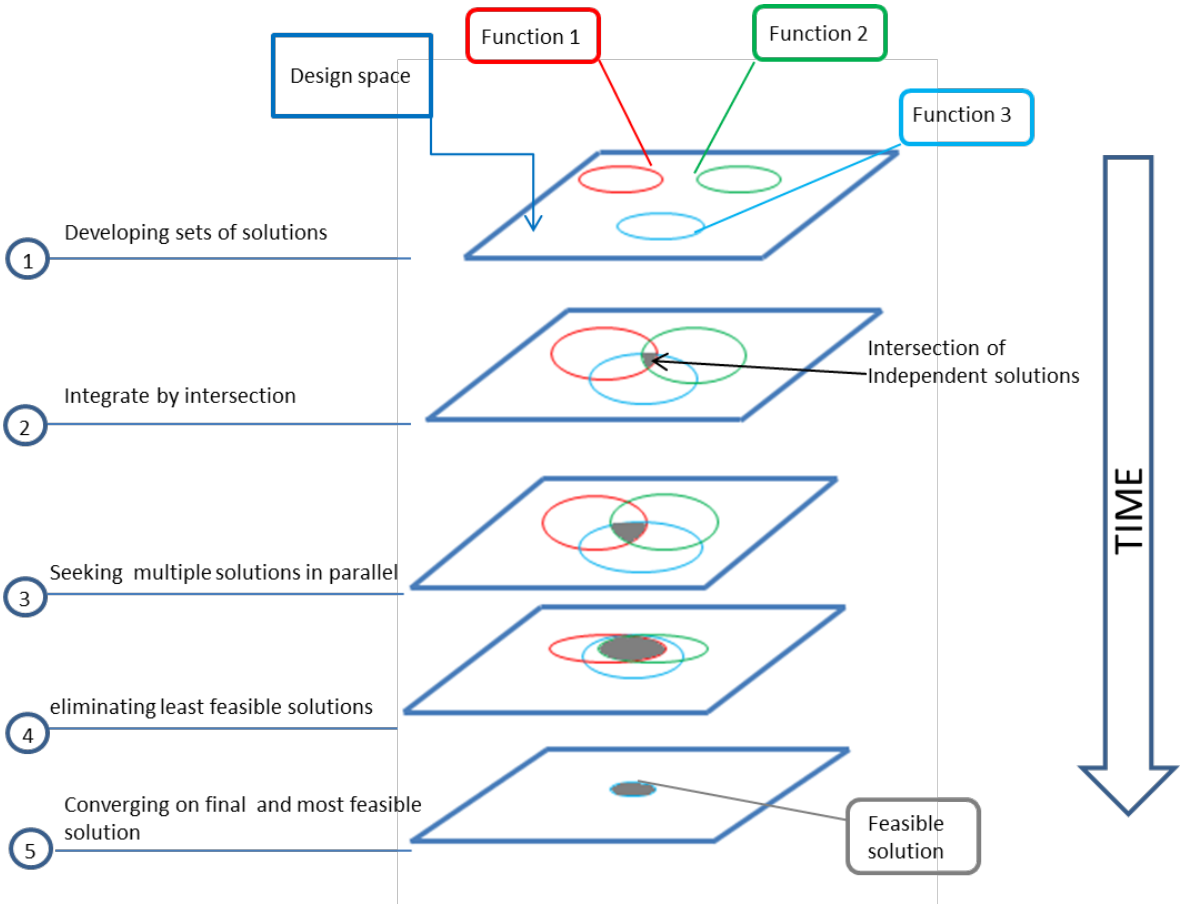


Figure 3.7-The process when working with set-based concurrent engineering (Bernstein 1998)

The benefits of applying set based design to development is that it allows designers to postpone the decision until optimal levels of information and knowledge is gained in contrast to freezing specifications too early on a solution that might prove to be sub-standard thus requiring costly rework. The SBCE approach also allows multiple design options simultaneously increasing the likelihood of finding the best possible solution. Exploring Different sets of solutions increases the flexibility and subsequently the response capability to changes and adjustments if necessary.

Communicating about Sets of solutions leads to enhanced communication, better information sharing, and ultimately the best possible final solution *(Sobek 1996, Sobek, Ward, & Liker 1999).*

3.3.4.2 The LAMDA Cycle

The **Look, Ask**, **Model**, **Discuss**, **Act** *(LAMDA)* is part of the LPD: s problem solving methodology. The model provides a framework for reusing knowledge that is gained and making it accessible for others. In problem solving, LAMDA is a framework that pursues to avert the waste of reinvention. The process incorporates *gathering of data*, *feedbacks* and *decision-making* procedures that address the problem solving procedures and implementing the solutions. The framework makes effective use of organizational knowledge and eliminates the waste of reinvention, *se Figure 3.8.*

Figure 3.8 - The LAMDA cycle- based on (Kennedy & Sobek 2006, LAMDA and TRIZ: Knowledge Sharing across the Enterprise 2009)

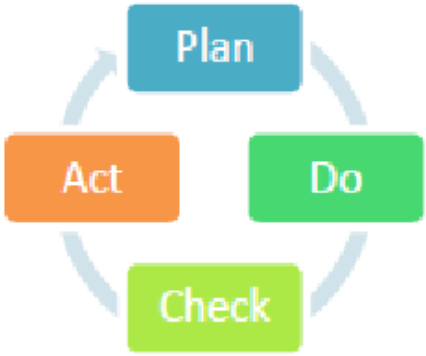


Figure 3.9 - PDCA Cycle- (Moen & Norman 2006)

The idea behind the framework rests on the development process of Toyota. The framework has some similarities with the Deming / Shewhart problem solving cycle: **plan**-**do**-**check**-**act** (or PDCA). PDCA emphasizes iteration in data collection, planning and testing before moving ahead to implementation. These iterations allow for overall system improvements. Iterating the cycle will increase the knowledge further of the system that is under study *(Deming 2000).*

Despite the obvious advantages of PDCA Allen Wards found that PDCA may not be sufficient enough when describing Toyotas successful methods of problem solving framework. Ward developed LAMDA in order to correct the re-occurring problem he observed in western organizations when they tried to implement PDCA. He saw that many organizations had the tendency to put insufficient amount of time on the planning phase and moving too quickly on to the action phase. LAMDA provides enhanced guidance about the **Plan** and **Check** stages of the cycle and defines the actions that should take place in these stages (*Ward 2002, Deming 2000).*

The LAMDA – **Look, Ask, Model, Discuss, and Act** – cycle is a tool that emphasizes knowledge creation during the problem solving process and thoroughly understanding the root cause of the problem before ”Acting” and implementing a solution. The PDCA cycle corresponds to two LAMDA cycles *(figure 3.10 below).*

Figure 3.10 - LAMDA and PDCA-LAMDA and TRIZ: Knowledge Sharing across the Enterprise (2009)

Look

The process begins by visiting the site of the problem (Gemba), to understand its full effect of the problem. The purpose of the Look step is to attain the best possible information to solve a problem. In order to fully comprehend the problem there is the need to acquire both *explicit knowledge*, which can be found in interviews reports etc., and the *tacit knowledge*, the knowledge gained from firsthand experience. Often only the *explicit knowledge* of a problem is known and very little or no time is to taken to a look at things directly and firsthand, thus missing the opportunity to gain valuable insights since all information and knowledge attained is secondhand (*LAMDA and PDCA-LAMDA and TRIZ: Knowledge Sharing across the Enterprise 2009)*.

Ask

The next step requires input by asking the questions ***“why*** ”and ***“who”.*** Why is this happening? The *“Why”* can be answered with root cause analysis tool such as; *fishbone diagrams* or *five whys* (5W). ”*The who”* must be resolved through research, who may know something useful, who has encountered the problem before and who has the proper expertise in solving such a problem? *(Radeka 2008), LAMDA and PDCA- LAMDA and TRIZ: Knowledge Sharing across the Enterprise 2009).*

Model

Modeling is a way to visualize Knowledge, test hypothesis and fill knowledge gaps. The knowledge acquired through the previous steps of Look and ask is made visible to others. Diagrams, charts, sketches, graphs and storyboards can all be used to visualize knowledge. These models support putting thoughts into words, allowing better communication and richer discussions, ensuring that everyone has the same image in mind when seeking to solve a problem.

Discussion

The Discussion phase examines all information gathered during the previous stages of Look, ask and model. The problem is discussed with diverse variety of people, mainly those impacted by the problem/solution the people involved can be experts who possess knowledge of the problem, and those who will ultimately make the final decision about the actions that should be taken. These discussion help to clarify ideas and recommend the response and actions to take en route to a solution and an implementation plan to achieve it *(LAMDA and PDCA- LAMDA and TRIZ: Knowledge Sharing across the Enterprise 2009).*

Act

In the final step, decisions made are followed through, and the implementation is put into place.

Look again

Reviewing the results and comparing them with the expectations. Does the result live up to them? Are there any issues that need to be addressed? Can further improvements be made? If so then a new LAMDA cycle may be necessary.

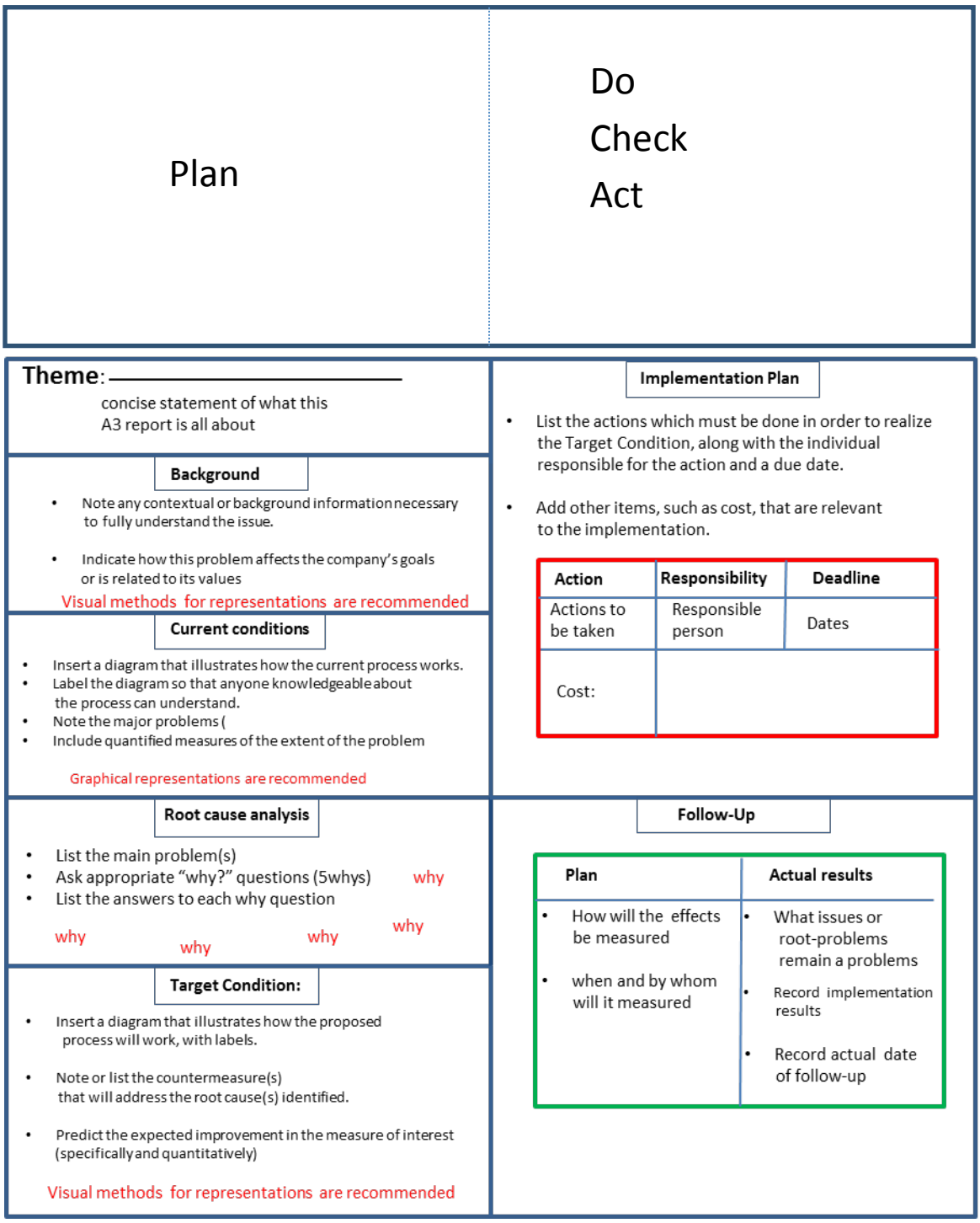
In practice this process is rarely sequential and linear. Several loops may be necessary in order to deepen the knowledge gained and clarify problems. Large problems may require several smaller LAMDA cycles to be resolved. These iterations will refine the models that are generated and improve models for potential solutions until enough information is attained in order to decide how to Act *(Radeka 2008).*

3.3.4.3 A3 – Communication tool

New product development is defined by *Goffin et al (2010) as* a learning process dependent on the generation and sharing of knowledge. *Mital and Desai (2008)* similarly state that new product development can be regarded as sequences of problem solving activities where the solution acquiring activities are the key to providing knowledge. Knowledge hence becomes the essential source of gaining competitive advantage in a market characterized by short product life cycles and ever increasing process complexity. The process complexity of new product development thus requires a simple approach in creating, capturing, visualizing and sharing knowledge.

The A3 report has its name derived from the A3 sized paper format in which the report is written on. The method is developed at Toyota and used as an effective approach towards problem solving and communication. It is used to support knowledge driven problem solving and combined with the proper learning cycle (i.e. PDCA/LAMDA) enabling a knowledge-oriented organization.

The A3 process can be divided into 10 steps, as described by Professor Durward Sobek. The result of the initial 6 steps is reported on an A3 paper. The A3 process is related to the LAMDA/ PDCA cycle. Steps 1-8 correspond to the Plan step. In Step 5 the Do step is planned and in step 6 the Check step is planned. Step 9 correlates to the Do step, and step 10 is the Check step. If during the evaluation, problems are identified the A3 process starts again corresponding to Act (Sobek 2006)



The steps of the A3 process are as follows:

Figure 3.11 – Main traits and look of an A3 report: Based on (Sobek 2006)

***Step 0*: Identify a problem or need**

Identify the problems which prevents achieving goals and meeting objectives

Step 1: Conduct research to understand the current situation

In order to address any problem it is vital to properly and thoroughly understand it.

This can be done by:

- Observing the processes first hand and documenting them
- Through diagrams and charts visualizing the work process.
- Quantifying the degree and significance of the problem (i.e. amount of customer deliveries that are late, quarterly number of errors reported *(Sobek 2006).*

***Step 2:* Conduct root cause analysis**

Once proper understanding of the problematic processes and how they work is achieved, the root causes of the errors have to be determined. "5Whys" (asking "why" five times), Pareto charts or cause and effect analysis can be aids in forming a factual and structured approach in order to identify the root cause of the problem *(Sobek 2006).*

***Step 3:* Devise countermeasures to address root causes**

Once the root cause has been determined and understanding of current process is acquired, countermeasure must be formulated. These are process adjustments that need to be made to make them more efficient. Thus creating specific outcomes, work activity tasks aswell as eliminating loops and delays *(Sobek 2006).*

Step 4: Develop a target state

Once the root causes of the problem are addressed by the countermeasures, the work process will be subject to changes. "Target state" Refers to this new way that tasks are done once the developed countermeasures applied. The target state should be visualized through a diagram, illustrating the new work process. Countermeasures developed related to the new work process and the improved outcome of the process that is expected should be recorded *(Sobek 2006).*

Step 5: Create an implementation plan

Implementation of corrective actions by highlighting countermeasures and tasks required in order to reach the targeted state. At this stage the resources needed, responsibilities, individual assignments and deadlines are appointed *(Sobek 2006).*

Step 6: Develop a follow-up plan with predicted outcomes

Measuring whether the implementation/improvements were successful what remains to be done and whether further process improvements are necessary. The follow-up plan also is a verification of whether the current condition was truly understood in order to realize improvements *(Sobek 2006).*

Step 7: Discuss plans with all affected parties

Communication with all those involved is essential. The results and target states should be compared with the viewpoint of all stakeholders. If the communication channels are open and can flow through across functions allows all parties involved to focus on the main problems targeted for solution and why. This allows for establishing a common language throughout the organization and enabling the development and alignment of work and strategy *(Sobek 2006*, *Sobek &Smalley 2008).*

Step 8: Obtain approval for implementation

If those conducting A3 process are not empowered to make the decision on wheter to carry out the proposed plan, it becomes vital to obtain approval and verification from such in order to confirm that enough knowledge has been gained and the problem has been thoroughly studied, making sure that all stakeholders agree on the course of action, and finally approving the proposed changes and allowing the implementation *(Sobek 2006).*

Step 9: Implement plans

Implementing the proposed changes and improvements.

Step 10: Evaluate the results

Implementation does not end the improvement process. The most important task is to figure out how to sustain the improvements. Hence a significant step is evaluation and measurements of results in order to confirm whether expected results were realized. Countermeasures might need to be taken if adjustments are required *(Sobek 2006, Sobek & Smalley 2008).*

(Sobek and Smalley 2008) put forth seven key elements to A3 thinking:

1. logical thinking process
2. objectivity
3. results and process
4. synthesis, distillation, and visualization;
5. alignment;
6. coherence within and consistency across organization
7. Systems viewpoint.

They emphasize that although these seven points might seem like common sense they should not be interpreted as isolated attributes required for an efficient product development process. Rather it is the interaction between them which is essential to the A3 thought process. It is the thinking behind the process, which is the key, allowing the problem solvers to improve upon their knowledge and their ability to tackle other problems *(Sobek & Smalley 2008).*

3.3.4.4 Visual planning

Visual planning is a method of coordinating work where ongoing activities and deliverables are defined and illustrated on a planning board and frequently reviewed at meetings. The aim is to visualize the efforts of the team in order to create a unified view and enhance communication through graphical representations posters, schematics symbols and color coding (*Lindlöf& Söderberg 2011).*

Whiteboards are the bases of visual planning. Project groups have meetings in front of the board to plan activities within the designated time frame. The layouts of the matrix created on the board can be adjusted according to organizational needs. The use of colors, graphics, and symbols generates clarification and easily understood information.

In the whiteboard matrix the vertical axes represents the resources and the horizontal axis represents time. In the cells of the matrix, notes with activities are placed *(Holmdahl 2010).*

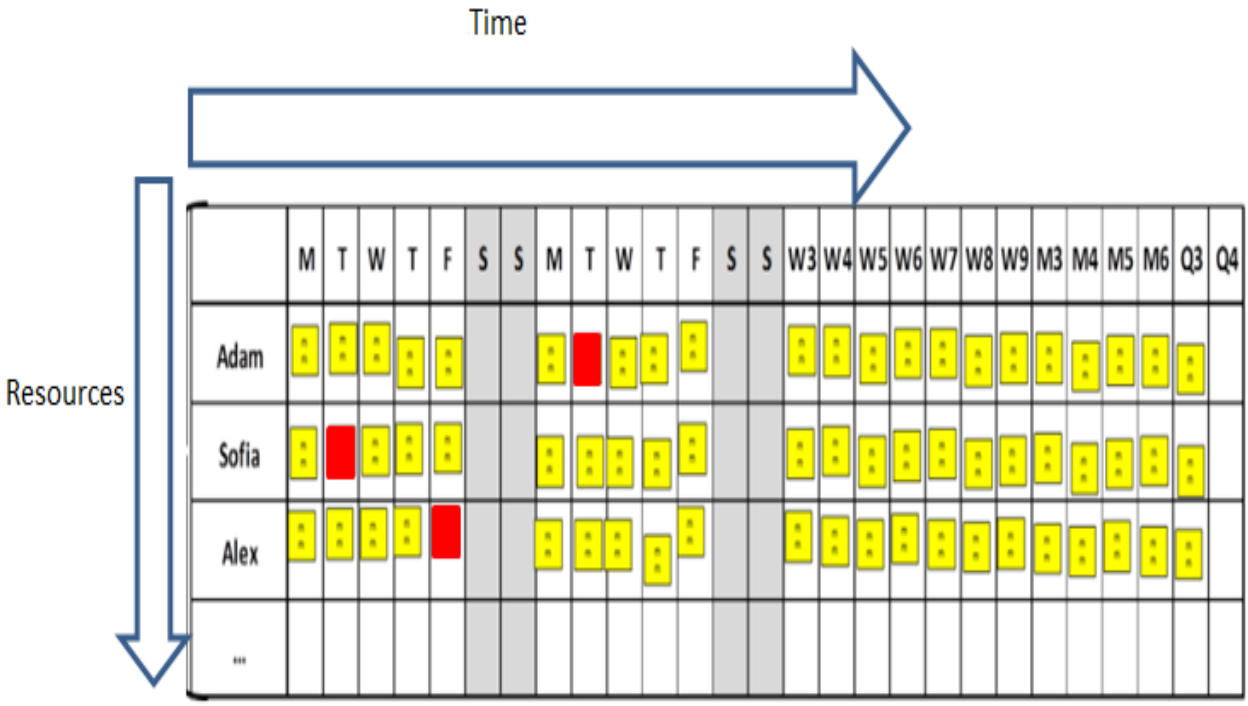


Figure 3.12 - visual planning board. (Holmdahl 2010)

During multi-project coordination, another layout can be used. At this board all the projects are on the vertical axes of the matrix and functions/departments on the horizontal.
The cells describe the project status and activities managed by the function/department of that column. These can also be color coded in order to convey project status.
Generally red is used to indicate problems, yellow is used for potential issues and green indicates that everything is OK *(Ström 2013).*

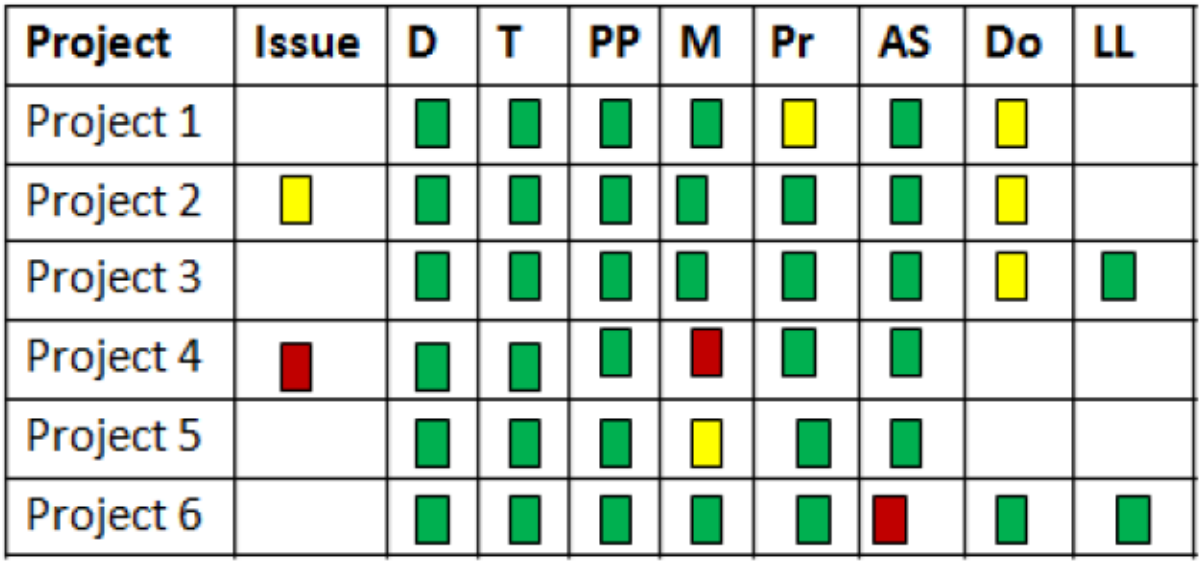


Figure 3.13 - Multi-project coordination with color coding *(Ström 2013).*

Visual methods form an important part of the communication improvement process, which is driven by lean initiatives. The complexity and uncertainty of product development processes advocate the need to create approaches which simplifies and clarifies the processes, enabling those involved to see and understand the different facets and activities of the process and its status at any time. Achieving transparency throughout the visualization facilitates immediate feedback of project status, making it easier to find deviations and indicate where adjustment may be necessary *(Womack &Jones 1996).*

3.3.4.5 Obeya

Obeya is Japanese term meaning “big room”. Obeya as a supporting tool for product development was introduced by Takeshi Uchiyamada the chief engineer of Hybrid car development at Toyota in the late 90’s *(Liker 2003).*

Obeya is a room for innovation with emphasis on visual control. Project activities and deliverables are outlined and visualized. Cross-functional teams are gathered from different divisions *(i.e. production, purchasing, and product development)* to review project processes, discuss major decisions, focus efforts and coordinate actions. This Allows for effective and rapid solutions by having the teams identify issues and problems early, and also leveraging the competence and expertise of employees from diverse disciplines and functions to minimize organizational barriers
(Liker 2003, Söderberg & Alfredson, 2009, Lindlöf & Söderberg 2011).

Since its introduction by *Takeshi Uchiyamada* Obeya has become an important lean P.D supporting tool and one of the first steps toward lean product development at various companies, *(Lindlöf & Söderberg 2011). Oppenheim (2004)* states: *“One of four success factors and metrics when defining the value stream is the availability of a large Obeya room”, see Figure 3.14.*

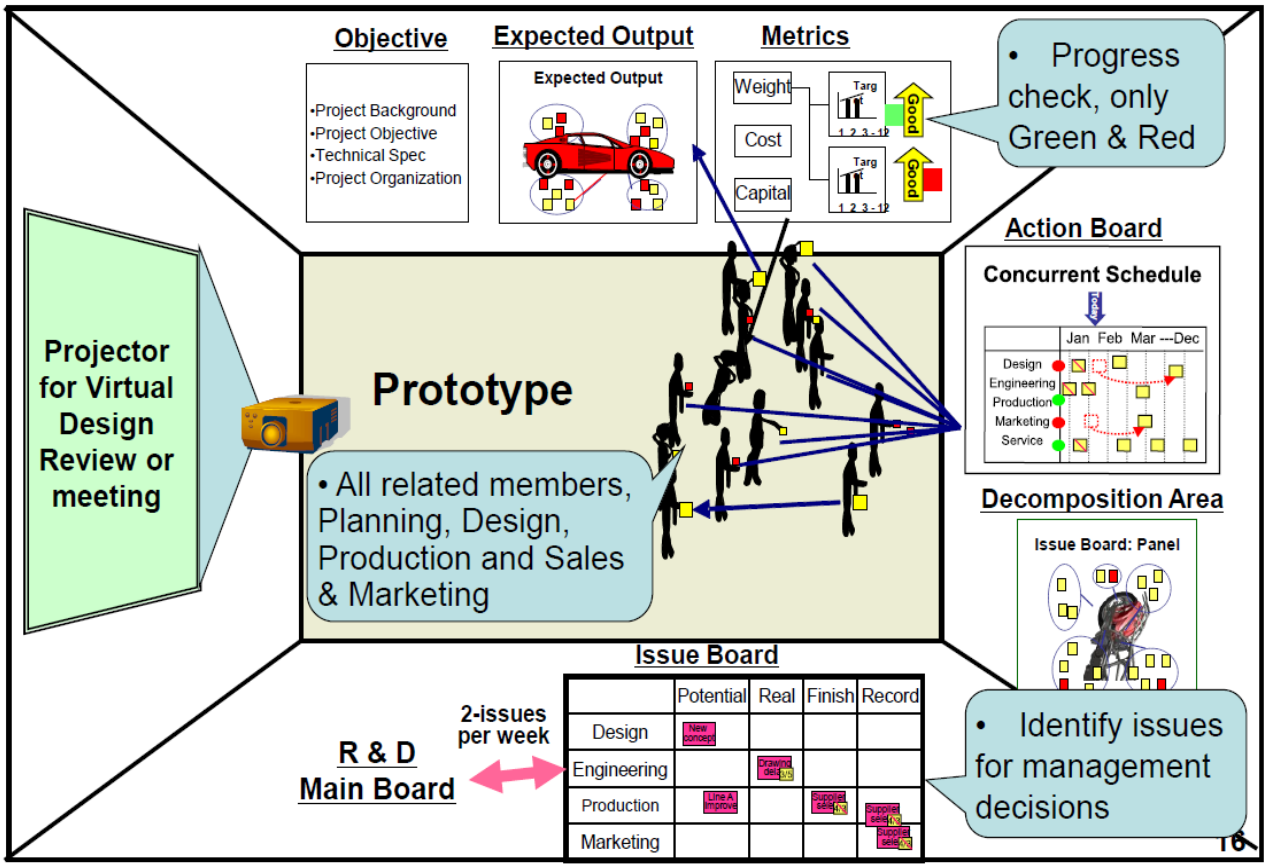


Figure 3.14 - layout of Obeya room (Horikiri, Kieffer & Tanaka 2008)

Prototype

At the center is a visual representation of the results that are expected by the cross functional team. The representation can take the form of a drawing, prototype model, or some other visualization. This visualization helps in discussions and in identification of issues (*Horikiri, Kieffer& Tanaka 2008).*

Project objectives

On the upper left of the primary wall *the project objectives* should appear. The objectives should be visualized graphically and the project scope should be related to the overall product plan. Targets that are set must be clear and concise *(Horikiri, Kieffer& Tanaka 2008).*

Metrics

The metrics board displays the status of the project. It contains the explicit and, quantified metrics that the project is measured towards. These metrics are usually based on **Quality**
Cost, and **Time**. Color coding the metrics visualizes wheter the project is ahead or behind set targets and goals *(Horikiri, Kieffer & Tanaka 2008).*

Concurrent Schedule Board

The concurrent schedule board is an activity board, displaying the activities and task of all participating project members and teams such as Marketing, Design, Engineering, Production, Logistics, Sales, and even suppliers if possible, see Figure 3.15 (*Horikiri, Kieffer & Tanaka 2008).*

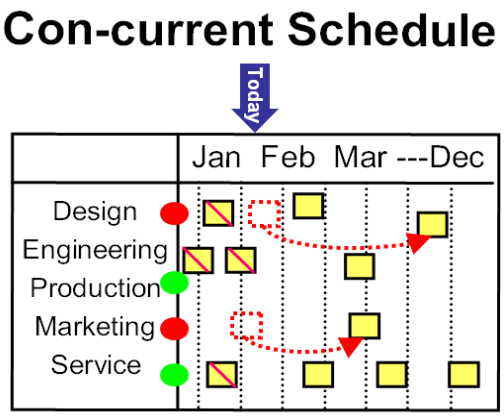


Figure 3.15-Concurrent schedule (*Horikiri, Kieffer & Tanaka 2008).*

On the board the color yellow represents critical activities vital in order to meet project objectives. Team member occupy and fill out their row on the board. By using the board team members communicate their activities and visualize their plans to the other team members. When an activity is completed, a diagonal red line is drawn over the yellow markers. If milestones are in risk of complications, red squares are posted on the board indicating the problematic situation and solutions are discussed in the meeting. Delays are shown by outlining the previous location of the yellow markers and moving the tag to the new date, permitting members of the team to recognize the significance of the delay and any further changes, making it possible to modify the plan if necessary*(Horikiri, Kieffer & Tanaka 2008).*

The decomposition board

The decomposition visualizes sub-projects or issues in need of attention. The board's composition will change during the course of the project. The issues in need of attention can be such matters as design, cost, quality or performance (*Horikiri, Kieffer& Tanaka 2008*).

The Issue Board

Here the critical problems are posted. Red color is used to mark potential issues. Each issue reviewed by the team. Team members usually use yellow post-it to reply or address the problem.

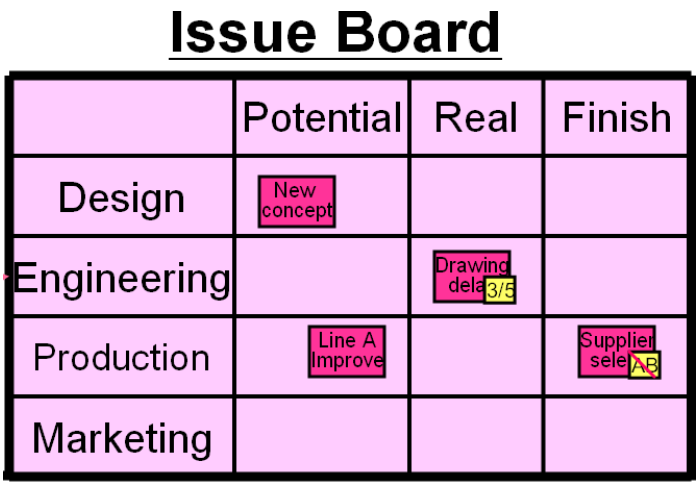


Figure 3.16 -example of an issue board (Horikiri, Kieffer & Tanaka 2008).

Thorough investigation of the problem might verify that a potential concern is in fact a real problem, which then will be moved from the *potential column* to the *real column*. When a solution is found the sticker will then be moved to the *finish column*. If the problem persists and cannot be resolved it would be moved to next managerial level in order to find a solution. It is critical that the communication between upper management is effective and straightforward, which is the primary purpose of the obeya *(Horikiri, Kieffer& Tanaka 2008).*

The obeya room meetings should be preferably under one hour. As the teams skills develops, the meetings become more efficient. The teams will within short timeframes be able display and relay important information. As the team participants become more used to the working procedure, problem identification and the ability to resolve them will improve more and more, giving more value and meaning to each meeting *(Horikiri, Kieffer& Tanaka 2008).*

3.3.4.6 Trade-off curves

Trade-off curves are an X-Y chart used to understand the relationship between different design parameters. It serves as a visual model for the relationship between of two or more key variables relating to design decisions. One variable is shown on the Y-axis and one on the X-axis a curve is then plotted visualizing their relative performance; see Figure 3.17 *(Morgan & Liker 2006).*

Trade-off curves serve as information input in the decision making process. The trade-off curve will help the decision maker in weighing different aspects against each other to gain a greater understanding of the performance between different options. The information obtained can be used in design reviews in order to choose the most feasible design *(Kennedy, Harmon & Minnock 2008).*

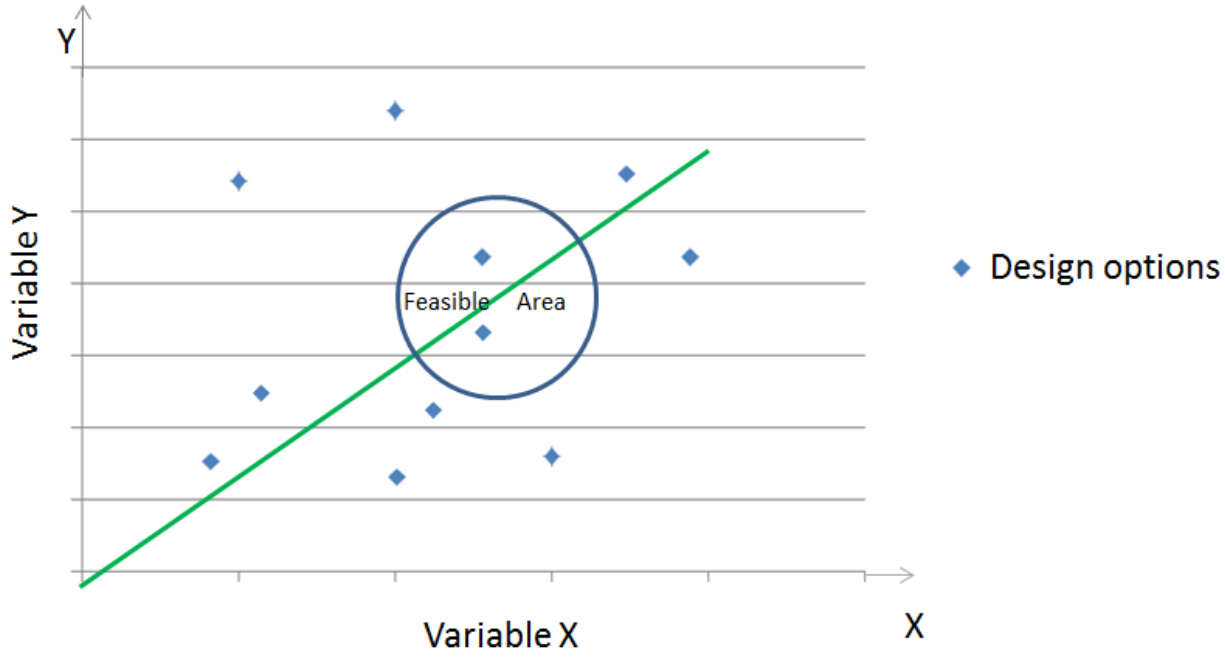


Figure 3.17 - Example of a tradeoff curve (Morgan and Liker 2006)

Trade-off curve analysis should include a picture or a sketch of the system that is to be modeled, a statement of desired outcome, root cause analysis and possible countermeasures. Conditions that lead to failure and the correlation between key parameters should be graphically illustrated. The resulting data from these studies should be gathered in check sheets for use in reviews.

In the trade-off curve the areas with successful solutions and the areas with unacceptable solutions should be identified. This makes the trade-off curve more valuable and beneficial by guiding the designers to know that choosing a design within the feasible area is more likely to be successful. Identification of feasible and unfeasible regions requires testing to failure so as to understand the limits and capability of the system *(Kennedy, Harmon & Minnock 2008).*

Efficient use of the trade-off curves helps in avoiding loopbacks and unanticipated problems in development .It also provides a way to organize data into reusable knowledge *(Radeka 2010).*

3.3.4.7 Value stream mapping

The value stream

A key activity towards becoming leaner is the understanding and management of both value adding and non-value adding flow of products, services and activities involved with developing a product. (*Rother &Shook 1998).Womack & Jones (2003)* define a value stream as all the activities required to bring a specific product through the three management tasks of any business

1. **the problem-solving task**, From concept development, detailed design and engineering to production launch
2. **the information management task**, going from order taking and detailed scheduling to delivery
3. **the physical transformation task**, going from raw materials to a finished product in the hands of the customer

Kennedy, Harmon & Minnock (2008) define two value streams within product development

1. The Product value stream and
2. The knowledge value stream

The product value stream includes the flow of activities, people, tools and equipment required for producing drawings, bill of materials and manufacturing systems. ***The knowledge value stream*** constitutes the capturing and reuse of the flow of knowledge about customers, markets and technologies. Throughout different development projects the knowledge obtained is a commodity, which can and should be reused in future projects, see Figure 3.18.

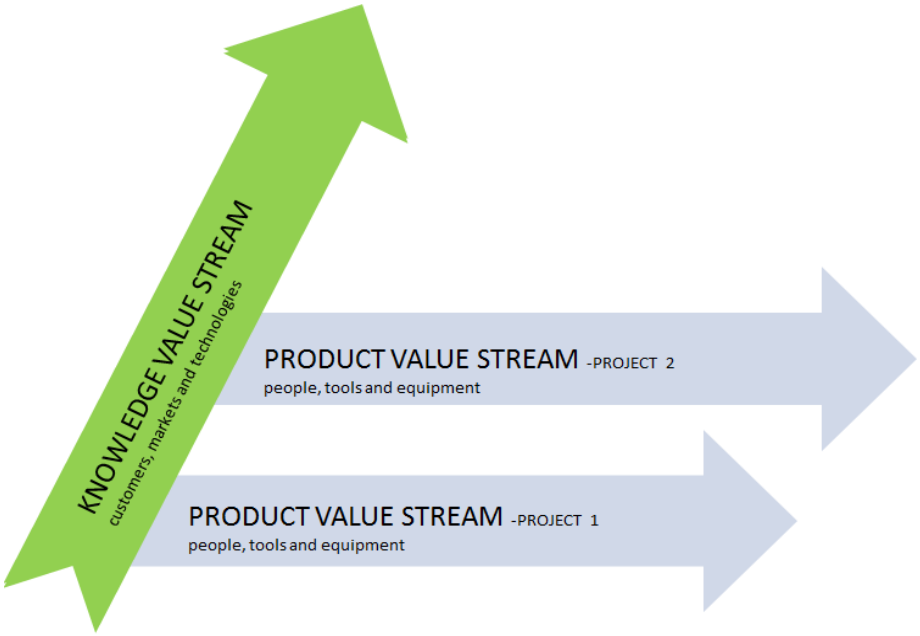


Figure 13.18 - The product development value streams (Kennedy, Harmon & Minnock 2008).

Value stream mapping (VSM)

Rother & Shook (1998) introduced the value stream mapping methods of Toyota in their book "*Learning to see"* which acts as a guidebook and manual in value stream mapping procedures in production. The method is used for process modeling and improvements by visually displaying the material and information that flows through a process from start to finish. The Visualization enables insight and provides the means for enhanced communication, understanding, thus advancing the process towards better efficiency (*Rother & Shook 1998).*

VSM charts the process flow through predefined standardized icons, symbols and diagramming principles displaying both value-added and non-value-added process characteristics. The emphasis in VSM is on improving the overall process and not the individual isolated operations *(Rother & Shook 1998).*

The mapping of product development processes is more complex and time consuming than in production. Longer cycle times makes gathering of metrics more uncertain and large scale cross-functional involvement is often required which puts larger demands on process visualization (*Locher 2008,Morgan 2002).*

According to *Morgan (2002),* VSM is more than just process mapping current state improvement. The benefits of organizational learning associated with the method alone would validate the time spent on learning and applying the method.

Value stream mapping adapted towards product development has been made by *Morgan (2002)* who to a large extent used the methods of Rother & shocks in "*learning to see"* as a basis for his model. Other adaptions can also be found from *Locher (2008), Mascitelli (2007) and Millard 2002)* these models are also largely influenced by Rother and shocks method.

Product development value stream mapping (PDVSM)

The steps of value stream mapping below are a summary of the value stream mapping method for product development prepared by *Dr. Hugh L. McManus* for *the Lean Aerospace Initiative (LAI) at* MIT *(2005).* The content is the research conducted by the LAI into value stream mapping and is based on works *by: Locher (2008), Mascitelli (2007), Millard (2002) and Morgan (2002).*

1. **Identifying Key Stakeholders**

   Identifying and creating an understanding of the meaning of value in the eyes of the stakeholders. Identifying the key stakeholders and their expectations of the final process and its improvements is crucial when putting the proper team together and defining what constitutes as value. Other stakeholders must also be identified these may include all those with interest in the process, the users of the output created by the process *(internal customers)* as well as the end user of the product *(McManus 2005).*

2. Defining the team

The complexity of product development activities requires diverse perspectives in order to make the value stream visible. The team must possess the expertise and knowledge required to see and understand the value stream. Management must support the effort and if possible should be a part of the team. If they are not a directly involved it must be clear to team that improvement efforts are supported by upper management. The process must be owned by the team, and they must be empowered to do the necessary changes .The balance of people and perspectives is crucial for success, the expertise and perspectives that should be included when mapping the value stream as suggested by LAI(2005) are listed below*(McManus 2005).*

- **Lean Experts and Facilitators:** Bringing necessary knowledge and experience in Lean methods and tools required for process improvements.

- ***System/Enterprise Thinkers:*** having a system view and taking into consideration the larger enterprise needs, as well as coordinating and conforming the upstream and downstream processes

- ***Process Owner(s):*** Having the knowledge and experience of the process which is to be improved, and the authority to implement required changes

- ***Process Participants:*** contributing knowledge on how the current process is carried out, what improvements measures should be taken and providing insight into process strengths and weaknesses.

- ***Customer(s) and Supplier(s):*** internal and external suppliers give valuable insight of process outputs and process input improvements, aswell as improvements in hand-offs and interfaces.

- ***Other Key Stakeholders:*** project managers, senior managers, representatives from finance and human resources are all essential elements for understanding the value stream and the existing constraints and expectations that need to be fulfilled in order to advance (*McManus 2005).*

3. Training the team

The team should be familiar with fundamental lean concepts, methods and tools. If they are not, training should be provided in lean and value stream mapping essentials. This training will prepare team members for more efficient communication by establishing common terminology and tools allows everyone involved contributing more constructively.

4. Bounding the Problem

The team needs to define several aspects of the value stream *(figure 3.19), (McManus 2005).*

- The Boundaries of the process encompassing the start and end point of the process.

- The organizational boundaries the work is done within.
- The product that the process should work towards must be specified.
- The process owner
- Responsibility for the stream (group or an individual)
- Initial inputs
- The expected output
- The required knowledge and information necessary for the process
- The constraints which the process will operate under

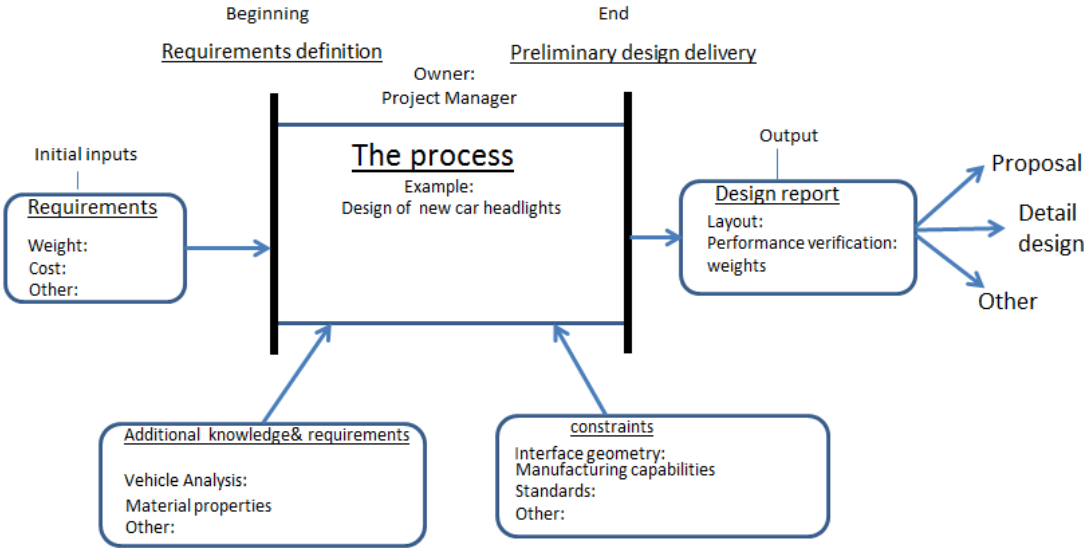


Figure 3.19 - illustrates the boundaries of the process to apply PDVSM, (*McManus 2005, release 1.0).*

5. Defining the Value

Defining the value of product development tasks is complex and probably never-ending. A definition is however required. Without a proper definition and understanding of the value created and how that value is created by the process mapped, improvement efforts cannot be properly guided (*McManus 2005).*

However, product development comprises of information and knowledge flow. The complexity existing between the final customer, market demand uncertainties, technical performance, cost and schedule makes defining value very challenging *(Chase 2001*).

McManus argues that value definition should be obtained in relation to two primary contexts:

1. The value of the process output in relations to the overall enterprise
2. Value creation when individual assignments are carried out

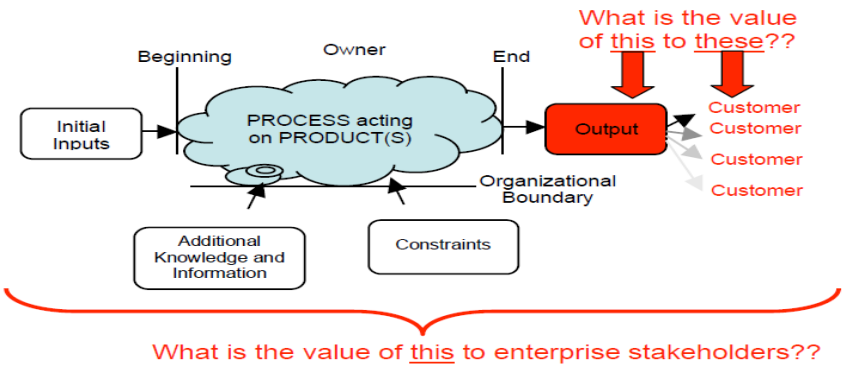


Figure 3.20 - Process value questions (McManus 2005)

Evaluating what aspects of the process is value producing is something that will become easier with experience training and availability of data output (*McManus 2005).*

6. Mapping the current-state

The first step when mapping the value stream is to collect information about the current state .The current state map is created continuously while the development project advances. *Rother & Shook (1998)* advice is to "*walk the flow*", this means walking the same path of motion as the product, gathering data and metrics on how the product travels through the factory. The mapping is done from material delivery to product transport. The starting point should be the customer i.e. starting from the end of the flow and moving upstream. The mapping should be drawn by hand with predefined symbols and special notations in order to avoid any delays and reduce waiting.

Due to the lack of a physical product in P.D, Womack*& Jones (2002)* suggest that it is the information, which should be followed from process input until process output. In contrast to *Rother and shook (1998), Millard (2001)* advises that the starting point should be at the input boundary while continually asking, *"what happens next?"* Reality however dictates that it might be necessary to trace the flow both ways, especially when tracing complex flows coupled with interdependencies and iterations *McManus (2005).* Similar to *Rother and shook (1998)* in "*learning to see", Symbols* and special notations are used in product development mapping as well *(See figure 3-21).*

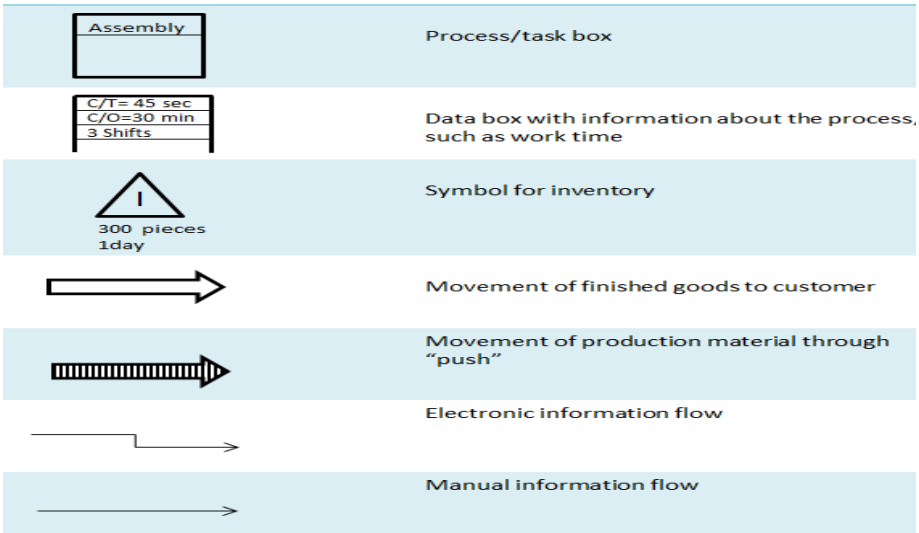


Figure 3-21 -Example of symbols and notations (*Rother & Shook 1998)*

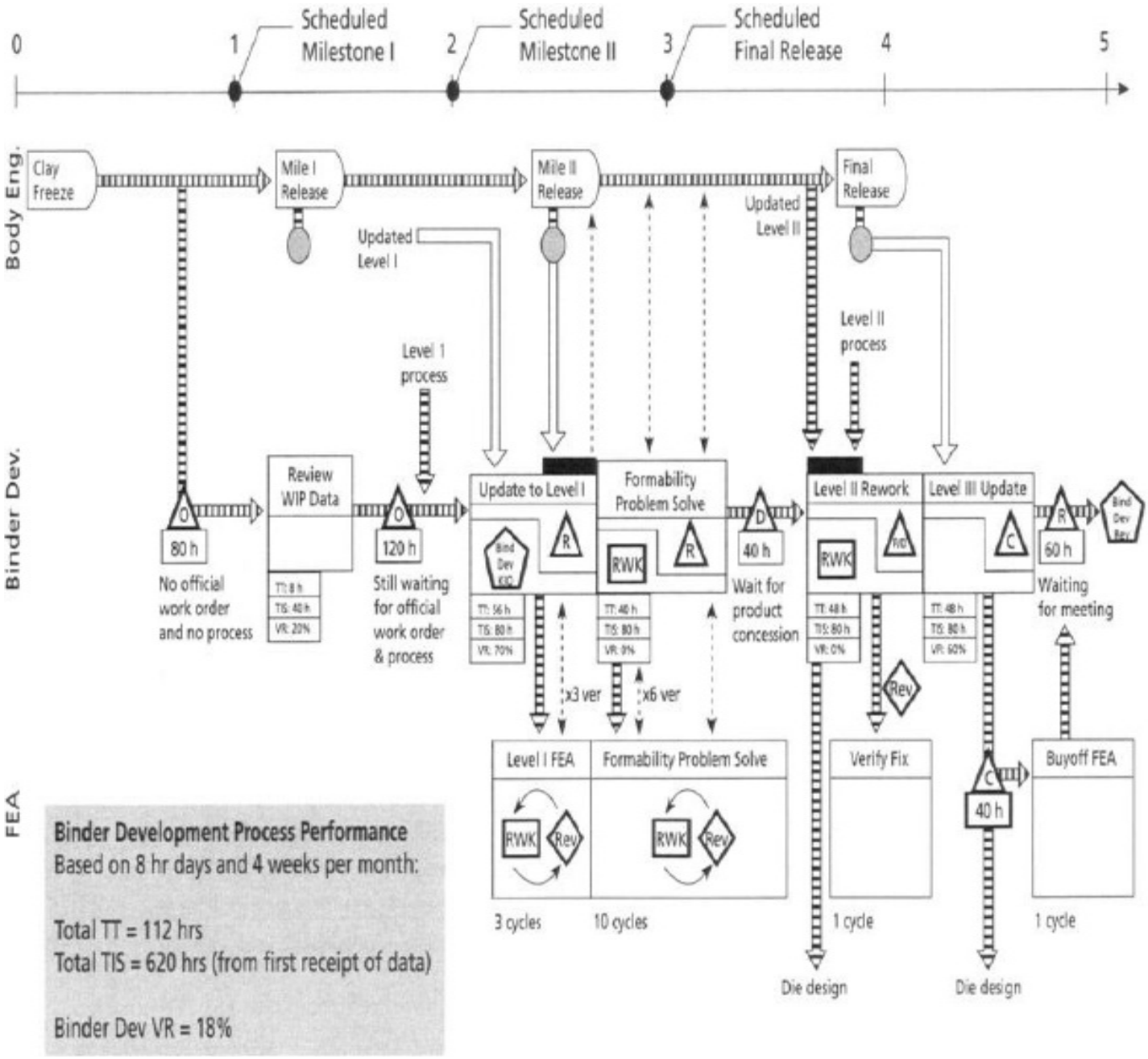


Figure 3.22 - **product development current state map (*Morgan & Liker 2006).***

Millard (2001) and *McManus (2005)* propose to start off with a draft to get an overview of the process. The process is then analyzed and evaluated until the map becomes more detailed and accurately describes the process. *Millard (2001)* and *McManus (2005*) suggest three high level mapping tools, which will provide an overall view, and each with different level of detail.

1. **A Gantt chart** or a **Ward/LEI map** facilitates process visualization, value stream definition and it allows the team to prepare for more detailed analysis. The benefit of these maps is that they visualize efforts required for task completion *(Millard 2001, McManus 2005).*

2. **Process flow map** for determining flow and value, for example Process flow map. The process flow map consists of standardized symbols and notations such as tasks, reviews and inventory. The symbols are connected to each other with different types of arrows illustrating the flow of products and information *(Millard 2001, McManus 2005).*

3. **Design structure matrix** (DSM) is used to analyze task dependencies (*Ulrich & Eppinger 2008)*. Product development value stream mapping has multitude of branches and iterative information flows, which might make the map to intricate and complex. If the complexity becomes too excessive the advantages of the tool for visualizing the process might get lost *(See figure 3.25), (McManus 2005).*

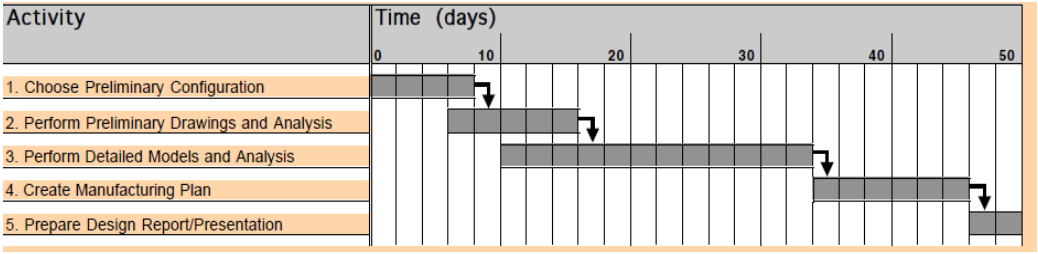


Figure 3.23: Gantt chart: tasks are listed in the left column; their duration is illustrated in the timeline to the right McManus 2005

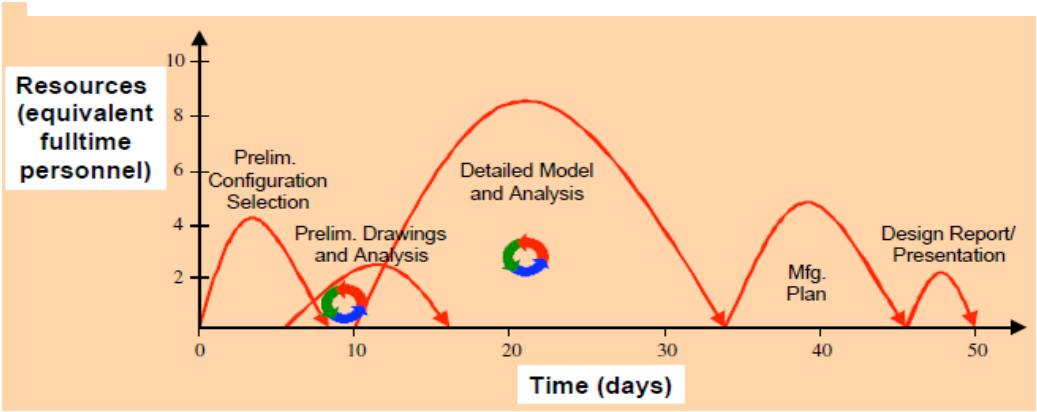


Figure 3.24 - Ward/LEI map illustrates time and resources required for different activities in a process. Each curve shows the duration of an activity and the distance from the horizontal axis represents the required resources. Tasks with a high degree of iteration are marked with a circle arrow (McManus 2005).

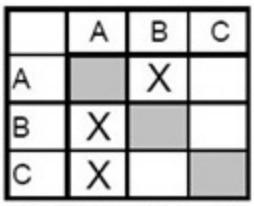


Figure 3.25 - A simple design structure matrix with three design parameters, A B and C. A depends on B, B depends on A, and C also depends on A (McManus 2005).

McManus (2005) emphasizes flexibility. The mapping, data collection and value assessments should be adapted to the researched problem. The author also points out the importance of letting the data and not the preconceptions guide the steps taken when mapping and improving the process.

7. The future state map

Once the view of the process is attained improvements can be implemented .The first task, should be the elimination of waste from the process and clearing bottlenecks that impedes the flow. The sources of waste in product development processes are many and varied. A future state map is drawn through analysis of the current state map with wastes eliminated. *Millard and McManus (2002),* suggest seven heuristics to apply to the P.D value streams to move towards an improved process state. These heuristics are:

1. Remove redundancy, simplify, and standardize
2. Create continuous flow of information
3. Minimize information handoffs
4. Balance reviews and responsibility
5. Improve communication systems
6. Implement integrated product and process development
7. Maximize concurrent processing

The value stream map should remain a "living document," in order to achieve future improvements. The drawing of an *Ideal state value stream map* will provide visions and objectives to work towards in terms of continuous improvement, but it also helps to eliminate stagnation in improvement endeavors *(McManus 2005).*

4. Empirical studies

The chapter describes the companies that were interviewed, and overview of some of the main topics discussed.

4.1 Ascom

Ascom specializes in wireless solutions for customer specific on-site communications. The company has its headquarters in Switzerland. Ascom was established in the 1950: s and has today subsidiaries in 20 countries and about 2300 employees worldwide. Ascom market segments include healthcare, hospitals, senior care and security. The company also holds market segments in, retail and the hotel sector (*Espling 2011).*

The development work at Ascom is conducted as projects. These are based on a Stage-Gate process, which at Ascom is called **Product creation process** (PCP). There is documentation and descriptions for passing each gate, but these are rather status descriptions, as Ascom does not employ hard gates. Before a project goes through PCP, it must be scrutinized in order to ensure that the project corresponds to the road map and release and whether the resources required are available. The subsequent PCP process consists of basic steps and gates; each phase ends with a gate where a committee makes the decision if a project is allowed to continue on to the next phase or not, *Espling, interview at Ascom 2013-08-23.*

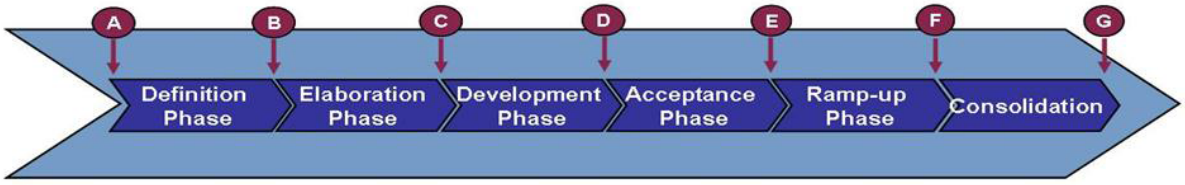


Figure 4.1 - Ascoms product development process, the product creation process PCP

4.1.1 Interview at Ascom

The interview at Ascom was conducted at Ascom Sweden AB: s headquarters in Gothenburg, Sweden with Mats Espling, the R&D Manager at Ascom. An overview of main topics discussed can be viewed below. *For in detail transcription of the interview view appendix 2.*

- **How is the Stage-Gate model at Ascom Used?**

Main Requirement specification (M.R.S) is the primary document that describes the goal and reasons for a project. There are other graphical descriptions for what is required at the gates! Everything from project planning to market functionality can be broken down into tasks such as; market demands, products and product functions. The processes are broken down into descriptive documents, the documents describe the responsibilities, and we call it *RACI–responsible, accountable, consolatory, informed*, this makes it clear who does what and who is responsible; under those documents there is the *standard operation procedure (S.O.P),* which describes the working

tasks more in detail. For example how the specification process works and so on, those working with any task can easily find exactly what they should do, much like a check list.

- **What Lean initiatives have you/your organization been working on /is working on**!

First initiative *- 5S in 1995*
First Visual Planning *- ~1996*
First tact one-piece flow production *- 2005*
Ascom Production System *– 2008*

We acquired the services of Swerea IVF and attended workshops. We asked ourselves the Questions *Where are we*? , *Who are we?* And *where do we want to be?* And worked towards answering them and improve.

- **What difficulties did you face?**

Some tools and methods might be implemented but they don't usually work because the proper understanding is missing. One should be careful in using the word "lean" it encompasses a lot of things and doesn't really say very much on how the work is done. It is better to assess what doesn't work properly or is less efficient, what can be improved upon, and start off little by little. There are plenty of things that can be improved, but I feel it is better to start off small. Find the most important parts and then start improving them.

And off course there are those who do not like change, who think it is tough, or annoying to change work practices.

But as I said better to start off small, like with visual boards and not being afraid of questioning what can be improved, start small, make sure it is implemented and that it's done properly and move on from there

- **Has any improvement in the P.D process effectiveness and efficiency been seen?**

It is easy to say you want metrics to assess improvements, but these things are difficult to measure. Especially the more upstream, the measurements become even more difficult. Just because you write something in a specification does not mean you fully understand it, or that others understand it, it can be several factors afflicting that. You might not have the proper expertise and knowledge, or the explanations and requirements are unclear. There are many reasons and because of that we have not put efforts into measurements and metrics.

- **How do you know if the new way working is better than the one before if there is no evaluation methods?**

We look at how the work progresses, does it work well, if the answer is no, then put efforts into making it better, and try to find the best way of conducting the work. If you focus on that I believe it might be enough!

A lot of things are difficult to measure, you can get a bunch of numbers but what do they really say, if it is a 4 instead if a 3, what should you do then. When measuring you need comprehensible knowledge of the flow, you can have these numbers and then what, how do you relate them back to the process and flow in the proper way? Working with knowledge loops like PDCA and LAMDA is better than measuring every little thing.

But off course we do have some measurements, we have something called *earned value*, its focused on time aspects, we look how the work is currently going in comparison against the plan, in terms of time, if work is done faster one might think, ”good we are doing things faster than planned”, but the question is, have you really done everything that should have been done to get there. Some requirements might have changed during that time, or maybe some new external laws are in place, or competitors have emerged with a new product which might change everything and all the numbers and metrics collected might become nullified and don't mean anything anymore. We need measurements over several projects so we take an average value of that. When we do that then we have something that actually is of value. For example taking 10 projects back and make an assessment of that, but you can not only take single projects and compare because the requisites for each project is different

- **One of the objectives of lean is to enhance learning and close knowledge gaps through continuous improvements. Have you noticed any changes in this area?**

It is very difficult to store knowledge. We have tried with knowledge portals, different sort of documentations, it works for a short time, but never in the long run. We try to build knowledge in groups instead, the group then possesses certain knowledge, but it is very difficult to document that knowledge. We mix senior engineers with new junior engineers, and have cross-functional groups and teams so that the knowledge can spread informally and within the groups, but documentation is difficult, the question is who will read it? Or even will they even read it??

- **What lean resources are primarily used in the organizations that you have had experience with?**

The human aspect and personnel is very important for us. Continuously try to learn and educate the personnel. Clarity from management on how the process should work and what is required. It shouldn't be to centrally governed, the closest managers should delegate learning and to be clear on how things are dependent on each other. Also not having too much things to focus on and overburdening. Cross-functionality and having people from different backgrounds giving diverse views on things

- **What are the primary product development wastes in your opinion**?

The knowledge waste is the biggest; the problem is when the same mistakes are repeated. Another important factor is not making to complex systems, if the system is to complex then the knowledge becomes very sensitive, if someone is absent then everything might come to a halt

- **What other management tools would you perceive as tools, which would be beneficial if integrated with lean principles?**

Portfolio management is very important in order to get the customer requirements. It is the primary reason for doing any work everything else comes later. Being clear with requirements and having the proper knowledge about the business case in order to continue forward. Knowledge and the product development funnel is a good way of thinking!

4.2 Telefonaktiebolaget LM Ericsson

Ericsson is headquartered in Stockholm and is one of Sweden's largest companies providing telecommunications and IP networking equipment such as mobile broadband, cable TV, IPTV and video systems. The company operates in more than 180 countries. Between 2001 Ericsson announced a joint endeavor in the mobile-phone sector together with Sony Corporation. The two companies merged into Sony Ericsson and the merger was in operation until February 2012, when Ericsson's shares in the venture was bought out by Sony, Ericsson opting to put focus on the market of wireless communications*, (Ericsson Sverige 2013).*

Ericsson has four main business units

- **Networks:** focuses on networks and Network infrastructure
- **Support Solutions** develops and delivers software solutions for operations and business support systems
- **Global Services** providing service related to telecom , systems integration, network rollout, network operation and customer support

Ericsson Gothenburg is located in Lindholmen Science Park in Gothenburg Sweden. There are almost 3000 employees. The organizational units from Ericsson Göteborg are: Global Services and Business Unit Network. Gothenburg is also the center for Ericssons Research & Development with main areas of research in:

- Product development for mobile technology,
- Radio Base stations,
- Power Solutions,
- Microwave Research,
- Alarm systems,
- Service delivery
- Antenna development.

Additionally Ericsson Academy is situated here, which provides training sessions for customers and internal employees. (*Ericsson Sverige 2013)*

Ericsson much like other developing companies run product development operations as projects. The project management process of Ericsson i.e. their model of Stage-Gate is called Project Management Process System (PROPS) and is used throughout Ericsson worldwide. PROPS was developed with aims

to serve as a common framework for project management at Ericsson and to facilitate a common terminology for all their units worldwide, allowing cross functional teams from different locations around the world to have a common perspective of the processes. At each gate business decisions are made by using checklist criteria to evaluate the results of the preceding activities, project status, technical solutions and business issues. The outcomes are either to Kill/go or continue with adjustments *(GreenlightPM 2007).*

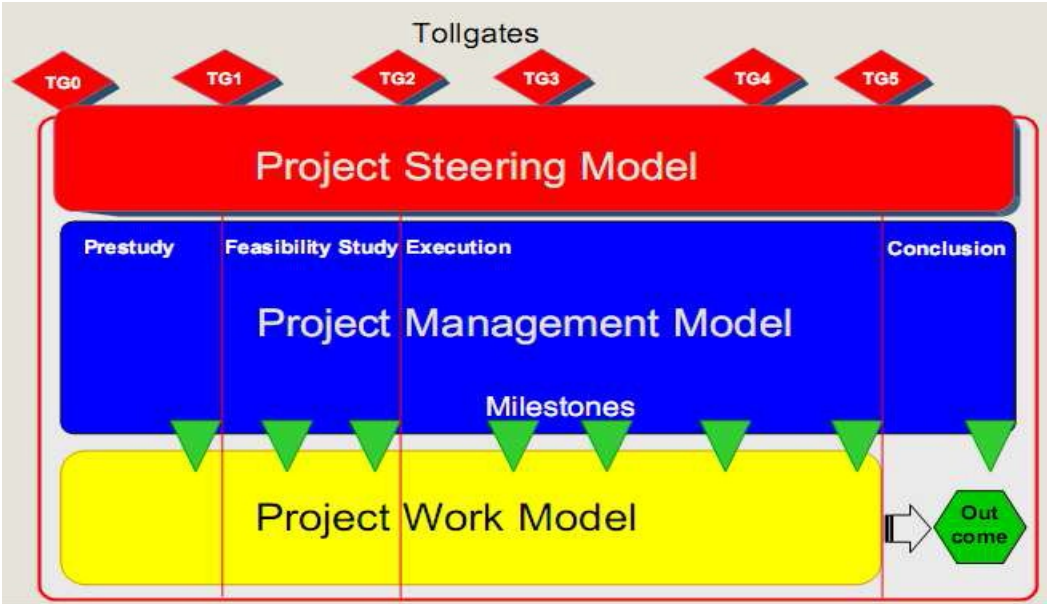


Figure 4.2 – Ericsson PROPS model *(GreenlightPM 2007)*

PROPS controls the process of product development from the initial prestudy to the conclusion phase the modell has phases which are:

Prestudy-The process begins with a pre-study. In the start of the pre-study phase customer needs, feasibility and technical requirements are is assessed

Feasibility-Involves time ,budget and resources planning, developing a business case, conducting risk analysis

Execution-This phase has two Gates. After TG2 the plans from the feasibility phase is initiated.At TG3 the project is reviewed and assessed in order to make necessary adjustments if required.At TG4 quality assesments are made and the product is reviewed. This is made in a test

Conclusion- The last stage of the PROPS process is the conclusion**.** where the project outcome are reviewed, the project is evaluated, and important experiences are documented, *(Yazidi & Leira 2008).*

Ericsson also uses a process managing tool (Stage-Gate model) for hardware development called HWDP The Hardware Development Process. it is a generic model built as a web-application. The purpose of HWDP is to provide a common process for all hardware design units at Ericsson. This Model is used in new P.D projects aswell as for maintenance and service projects *(Carlestål & Rashedi 2007).*

4.2.1 Interview at Ericsson

The interview at Ericsson was conducted at headquarters in Gothenburg, Sweden with Anna Sandberg the R&D Manager at Ericsson. An overview of main topics discussed can be viewed below. *For in detail transcription of the interview view appendix 3*

- **Can you tell us about the Stage-Gate system used at Ericsson and what flaws do you believe the model has?**

The PROPS model at Ericsson is based on tollgates as we call it. The project gets initiated at **TG0.**
TG 1 is when we have little more knowledge and thinks it is worth going on.
TG2 we go and take in the right people and employees for the work that needs to be done.
Later on **TG 3** we check that there is still a business case.
TG 4, we complete the development and start to test the pilot product.
TG 5 we finish the project.

That's at least how we used to work with the classic model; however the problem was that the scoops' became far too big and could take up to two years. Such large scoops were time consuming and would also change several times. During that timeframe scoops could in effect become invalid.

An example I can give, is if you imagine a big ball and in that big ball there are a lot of smaller tennis balls. Now days we work with the smaller tennis balls rather than the larger ball. We still need a model for making decisions, but if we make one tennis ball at the time, then we can get through the smaller scoops more quickly and are able to get the product out more rapidly and get compensated faster, that is the principle we are trying to work with now. So speed is an important factor for us.

We still need a lot of coordination, planning and order, and the Stage-Gate models are an aid to achieve that. We use the model and the tollgates to help in our decision-making process, but we make the decisions in a little different way than before. We take the decisions on the smaller scoops, the tennis balls I mentioned earlier, and we take them one by one, in order of our capacity. It doesn't always work the proper way, but now I am speaking more on how it should work in theory.

I very much doubt that you can have any form of agile or lean development without some sort Stage-Gate model, at least when it comes to large scale development efforts, to believe you could manage that without such a framework would be foolish.

- **What factors were decisive and what factors /reasons were there to start working with Lean at Ericsson?**

We started around 2001 it was roughly when the agile manifesto became known. And Ericsson was early in trying to implement changes around 2004/2005.There were some innovators within Ericsson that applied some of the methods on more autonomous products and started noticing how productivity increased with smaller cross-functional teams and these methods. Our projects are very large and we work on projects with 500 other people. These projects have to be in sync with 10 other

products and projects. So we started with the autonomous products, and noticed the benefits .A lot of times when changes are implemented at Ericsson it is due to the fact we ourselves realize that we need to change and improve, sometimes we see methods that might be good but also realize that it might be better suited for other companies and not us. With these methods the change came globally and almost simultaneously, and the request from changes comes from downstream in a different fashion!
The main problem that occurs when there is a desire to implement change, is how the change and implementation should be done? It needs to be put in context. We have a product that contains millions of lines of code, and changed platforms twice, imagine how complex the architecture for such a product is. Under these circumstances, a migration towards a new change must be done and new ways of working, merging of systems and departments. Then you also have those who oppose the changes. It's very difficult!
But several internal reports showed improvements which made the movement towards change grow stronger so that upper management also started talking about Lean agile and change. The request for implementation came from upstream aswell as downstream.

- **Now that you have started working with these methods do you do know if the new way working is better than the one before, are there any evaluation methods?**

Compared to many industries, we are bad at measuring. If i take the tennis balls analogy again, it's very difficult to measure and track the profitability of the tennis balls but we measure what we call *feature velocity*. We measure time per working hour or per engineer or per teams. One can ask whether it is beneficial or not to measure in this manner, but the alternatives is to measure the lines of code and code complexity and we know from experience that it would fail, so we've decided on feature velocity.
We always want to improve our ability to do more and do it faster. Sometimes faster is more important than doing more. We want the ability to make specific solutions to specific demands that are made from our key customers. However we measure some things l such as integration levels, error report levels and so on.
What we are going to work a little more with in the future is *team velocity*. Agile is based on the cross- functional teams, and we want the teams to be familiar with their own velocity i.e. know what they are capable of, and what they are not good at, thus beeing able find their own impediments *(mura)* and to improve. But it is important not use these metrics to compare teams or benchmark them against each other, it's important in such a large organization as Ericsson to identify your strengths and know which teams should be working on cross-functional teams, which teams are better at doing run-away projects, which teams should do the start-off and sign-off on the projects. it's a lot of these questions we work with when measuring.

- **One of the objectives of lean is to enhance learning and close knowledge gaps through continuous improvements. Have you noticed any changes in this area?**

Our major learning process is through or continuous retrospectives. Continuously be able detect and solve impediments and wastes ourselves, or in any other way for that matter.

It is ok to make mistakes and fail, but it is not ok to make the same mistake twice. Learning issues are major part of architectural and system issues. A lot collaboration work and communication is required.
Previously, coordinators and project managers solved much of these issues and perhaps it was enough to speak only with the closest team leader and tell him or her about the problems. Nowadays we want a person to communicate cross-functionally and between the teams, or call someone who is in another country late in the evenings. These things can be perceived as tough but if we are able to continue in this direction, about twenty years from now, we will have forgotten these difficulties and these new ways of communication will be standard.

- **With your knowledge and experience, what are the critical factors when an organization would want to create a successful lean and agile framework and the most difficult aspects that should be taken into consideration**?

First of all it's important to have a program or a framework such as the Stage-Gate model. It will not be possible to control and direct development efforts without such models.

Second is to always maintain a business perspective, and always ask yourself, is your efforts done towards the overall business efforts? You might have a product with a lot of features, but is important to know what the reasons are for it, why do we have the feature from a business point of view.

And the third is speed! *Speed trumps any other improvement*. Getting the product out faster is the best way to make the processes more effective. Quality takes time and is slow, but that does not mean that speed gives worse results. If you do something fast, you get faster feedbacks from the customer, then your understanding and knowledge increases faster, and you can improve on issues faster, instead of trying to understand everything on your own and try to present the customer with something you regard as good! Speed gives quality. Before we have had to prioritize between time quality and scoop, now we understand that they all merge.

4.3 Volvo Penta

Penta was acquired by Volvo in 1935 and has been part of the Volvo Group since. Volvo Penta is a supplier of internal combustion engines and complete power systems for marine and boating industry. Volvo Penta is divided into three main divisions, the marine leisure engines, marine commercial engines and industrial engines. The marine segment of Volvo Penta focuses on engines made for boats and the industrial segment focuses on industrial machines such as electrical generators. Volvo Penta has three main production facilities, which are located in Vara in Sweden, Lexington Tennessee in the USA, and Wuxi in China (*volvopenta 2013*

Volvo GTT and Volvo Penta use the same overall framework for development. They use several different control systems, which aggregate to something called Global Product Development (GPD). It is used during execution of product development activities, and acts as a foundation and framework model consisting of best practice and years of practical experience. It is used as a workflow document that is based on the Stage-Gate model, *See figure 4.3.*

Depending on the complexity, the projects are divided in different classes. Classes 1 and 2 are the projects that are considered least complicated. Class 1 and 2 usually comprise small changes. Class 3 projects are the most complicated and are usually new product development efforts. As it can be seen in figure 4.3 projects with low class numbers have shorter way to go and fewer gates to pass.

A gate is a GDP checkpoint that is supervised by a committee that bases its kill/goes decision in reference to profitability. The GDP consist of six steps where each step starts and ends with a gate.

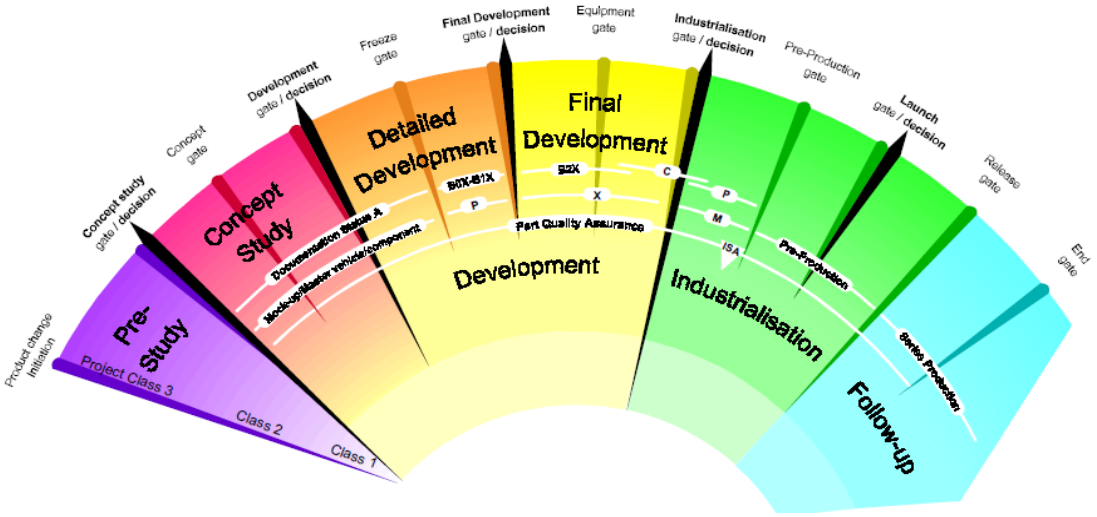


Figure 4.3- Global development process (GDP), (reports volvogroup.2013)

The phases of GDP consist of:

Pre- study- Technical feasibility and market studies are conducted. Project scope and targets are defined.

Concept study- Establishing requirements, concept evaluation and selection

Detailed Development- Detailed development of solutions and documentation

Final Development- building, testing, refining and verification to enable production

Industrialization and Commercialization- preparation of product launch. The installment and verification of industrial systems in order to enable production

Follow up- project follow-up, validation of aftermarket products. (*Volvo 2013)*

4.3.1 Interview at Volvo Penta

The interview at Volvo Penta was conducted at Volvo Penta headquarters in Gothenburg, Sweden with Azadeh Fazl Mashhad, the R&D Manager at Volvo Penta. This interview was not recorded with audio, only notes were taken.

- **What Lean initiatives has Volvo Penta been working on /is working on and why?**

Reason for trying to implement lean is mainly due the amount of re-work and loops that has shown to occur in the end-phases of development. The GDP has become more knowledge oriented and main targets are freezed until the concept milestone.

The lean product development efforts started with

VRES 2004-2009
VPS PDP-2009-2010
RnD30 started in 2010 and is what we are working on now.

RnD30 was an initiative that not only involved top management but also middle management that were very strongly involved to get the RnD30 frame work started, these middle management were working the RnD30 project without a budget and were a driving force throughout the implementation.

We are selecting different areas to start with lean in the first step and start working with set-based engineering. The early gates are steered towards being more flexible and finding the right knowledge before pursuing development. Concept milestones have been introduced to the GDP in order to attain proper knowledge rather than just fulfilling gate criteria. We must be sure to have enough knowledge to continue to development stage. After the development events are done, P.D continues as usual, however with some modification on gate passing criteria. Critical gate deliveries must be passed, which is an indicator of knowledge levels attained and how front-loaded the project is. Often

the project can be halted if the requirements are not met; this might slow down the time schedule slightly but enhances the quality aspects of the project. These first events involve a lot of feasibility tests.

- **Has any improvement in the P.D process effectiveness and efficiency been seen, and are there any evaluation methods?**

Major differences to the better have been noted since the implementation and a change in working culture aswell.

Alternative concepts are pursued and are graded through a numerical grade system called TRL (technology readiness level. The scale is between 1-9 and gives an indication of technical maturity. The concept is copied from NASA. In order to pass through the milestone a score of minimum 6 is required.

- **One of the objectives of lean is to enhance learning and close knowledge gaps through continuous improvements Have you noticed any changes in this area?**

A procedure called Integrating events has been implemented where stakeholders are gathered and all available information is presented. These presentation ranges from technical to marketing and economical aspects are presented for all concepts that are pursued. This procedure is done until the development events are due in order to identify gaps in knowledge.

Educating the personal continually is very important, especially in the beginning when the concepts are new; there are a lot of misunderstandings. To avoid the rigidity of the gate criteria from the earlier GDP model, SPRINTS have been implemented. Sprints (agile) are events every 4-5 weeks where deliverables must be presented. At each sprint the deliverables for the next 4-5 weeks must also be decided. This is incremental improvement and knowledge oriented development
But different functions still have adapted the RnD30 and the working procedures of GDP to their own functions

- **What are the primary product development wastes in your opinion**?

The most important one is a knowledge waste; using documentation is maybe the only way to avoid doing the same mistake on projects in the future. The effects of knowledge waste in the project can be delays and any defects or reworks.

- **What other management tools would you perceive as tools, which would be beneficial if integrated with lean principles?**

Improving the portfolio management, to find out which resources do we have and which project is more important and have enough knowledge to continue to the next level.

Knowledge management is also very important, making the decision based on knowledge; for achieving the best results managers must ask themselves probing questions in order to gather the

knowledge of everyone in the project. The tools and method are important in lean but most important thing is that the decision making process is based on knowledge.

4.4 Volvo Trucks Technology

Volvo Trucks Technology is a part of the Volvo Group. A global companies with products multiple areas such as, trucks, construction equipment, marine power, industrial engines & systems. Volvo GTT also has business units within finance, IT, and logistics.

The organization of Volvo is built in a cross-functional manner, with projects and processes involving various functions dispersed geographically over the world. Operating in several countries with different cultures and working practices directs the company to continuously engage in implementing improved working methods throughout the organization.

Volvo Trucks underwent a re-organization in 2012 and the different units, Volvo Powertrain, Volvo 3P, Volvo Parts, and Volvo Technology were brought together as one corporation. This was done in order to enhance the utilization and the global potential of the different brands and products within the truck operations.

4.4.1 Interview at Volvo Trucks Technology

The interview at Volvo trucks was conducted at Volvo trucks headquarters in Gothenburg, Sweden with Thorsten Martinsson and David Haglund at Volvo trucks. An overview of some topics discussed can be viewed below. *For in detail transcription of the interview view appendix 4*

- **How is the Stage-Gate model at Volvo trucks Used?**

The basic principle of GDP is the same both at Penta as well as GTT. We used the rnd30 in order to make proper changes in or decision-making process and our Stage-Gate model. We're trying more to make the right decision at the right time. Before decisions were made with *time* as the decisive factor, (time based decision), this has changed somewhat in our Stage-Gate model now, and we're trying rather make the decision *at the right time* instead.

- **What difficulties have you faced when trying to implement Lean P.D practices (RnD30)?**

It is always difficult when implementing changes on a large scale. It requires a clear and explicit leadership, and if you do not have that, it will be more difficult and time consuming. If lean principles are to be implemented, the support of upper management must be there. One could bring forth the perfect processes but without proper management support who understands what lean is and what we are trying to do, these perfect processes will never be used.

Another thing is that Lean is often associated with production, and more often than not, those concepts are copied directly into the product development, and it fails, because they are two entirely different environments.

You can always have these theories on how for example Stage-Gate and lean and lean practices should work together, but in the end it's the journey undertaken to reach those goals that is the decisive factor in whether the efforts will be successful or not. Then you also have the risk that comes with changes, mainly due to knowledge gaps that exists about the processes and procedures.

Set-based design for example has been very difficult to work with because the principles of the method are not understood properly. Despite working with iterations, cross-functional groups and development loops, there is the lack of understanding of the design space, and the trade-off that must be made. It's the lack of proper maturity and understanding of what set-based really means. To a certain degree it might be that people haven't really cared about creating knowledge about it on a deeper level, it's easy to jump on the wagon of new and popular methods without really taking the time to create deep knowledge of what the method and procedure really entails. Those who have understood that changes is really necessary, also understand the challenges that come with them, we haven't traditionally had that culture of knowledge history, with trade-off curves and so on, that's what we need to put efforts on, to create knowledge value streams, its hard work to do.

- **What are the primary product development wastes in your opinion**?

Re-use of knowledge is not really that good, we capture facts and information, but not re-usable knowledge that can be used in new projects. It is a difficult task, we have the so called white books, but they are rarely used, and difficult to accesses when needed. Often they are linked to certain projects, and it's those who work with the projects that have access to them. Hence it becomes difficult to re-use them. It is a root cause problem that needs to be fixed.

- **What other management tools would you perceive as tools, which would be beneficial if integrated with lean principles?**

We do a lot of visualization, and use scrum in our software development. But a lot is dependent on the leadership. It requires certain maturity level to understand what the customer really wants and desires, instead of just having a long list of features. A true product owner knows what the customer really values. Other important things that you should be aware of in terms of your thesis, is to close knowledge gaps and to adapt the working procedures and methods to the company culture. Cut down on the number of projects in the project portfolio and have a level of projects where you can deliver what is promised.

4.5 Swerea IVF

Swerea IVF is a Swedish research institute offering consulting services, on innovation, Product production development. The institute works with industrial and public institutions in developing improved processes. They are a part of research institutes of Sweden (RISE) who in addition to consulting publishes about 70 scientific articles annually on and organizes conferences in various subjects.

Swerea IVF has worked with lean implementation issues since the mid-1990s in close collaboration with the Swedish industry. The company also provides courses for managers and company specific lean training courses in collaboration with Chalmers University of technology (*Swerea 2013)*

4.5.1 Interview at Swerea IVF

The interview was conducted at Swerea IVF: s facilities in Mölndal Sweden with Magnus Thordmark, concept development manager at Swerea IVF. *Interview transcript can be viewed in appendix 6*

- **What weaknesses do you see in Stage-Gate?**

When I worked myself into the industry as a project manager, we had something called Project council, which was in essence gate-meetings, but it was the gates, which would be timed with the meetings and not the other way around. It was time- based decisions rather than knowledge. I think that's a kind of weakness.

From experience i can say that resource allocation is also a weakness. If you have different types of projects, there is usually a single resource to use, the same designers, project managers will then be used to do both the pre-development work, have new projects, take care of existing products, serve production and serve the market with complaints and such, so one needs to be able to divide the resources in a rational manner.

Better portfolio management is important as well, although it depends on the size of the company, too many firms have to too many projects or starting too many projects instead of trying to find the pace of implementation and do it right. It is better to have fewer projects and putting focus on them and finishing them in the best way possible.

- **Which lean principles tends to be the most utilized when beginning to work with the lean framework, and which one is most difficult to implement?**

It usually starts with some kind of daily management of projects such as standup meetings, allowing project managers to report status and set some goals and coordinate resources. Maybe start some kind of project rooms (Obeya), not necessarily co-location in that sense, but having some common space, where information is gathered, and group meetings are held.

- **What are usually the main problems encountered the implementation efforts?**

A lot of engineers think in terms of "solutions". It's difficult for them to visualize their trail of thought to others. There are efforts to work cross-functionally and towards set-based engineering, but the methods are not used so much. In large companies there are too many people working different on

things so coordination becomes a problem. In smaller companies people are used to working alone and on many projects simultaneously so there is no time for proper collaboration. Also it may be difficult for individuals to begin to visualize and talk about what they do, you usually find arguments such as: *These are my responsibilities, "why should I tell this to anyone who is not familiar with this"*

- **What effect does culture / company culture have in implementation efforts?**

We are generally very informal in Sweden, we do not have the "hierarchy mindset", and we have "collaboration" way of thinking, both between departments and in the corporate hierarchy, which in my opinion is an advantage for Swedish organizations and the engineering culture. We work a lot with the facts, and if your arguments are backed by facts, change and reducing conflicts might not be that difficult.

In terms of lean, It is difficult in the early stages with a principle that requires holding /waiting on making decisions as long as possible and working with different concepts. When there usually has been a corporate culture that is accustomed to working fast and want to see quick results, it can be perceived as nothing happens.

It's also necessary to take advantage of the knowledge that might not lead to a product in the projects that knowledge is also important; it gives information on what can and can't be re-used and useful for future projects. What company or culture it is does not matter in this instance; it is the approach that must be changed to support lean principles.

All changes require explanation *''why are we doing this? ",* some things may require that you should gain knowledge and learn new things; but the right conditions to do that must be available as well. For example if you want to work with building knowledge, then you have to have a way to take advantage of the knowledge created in the project, it is very much about creating the right conditions so that people do not become frustrated.

- **Which lean principles do you think are the most critical? Most implemented, easiest to start with?**

Visualization is good, knowledge preservation is also very important, for it will lead to decision-making based on facts. Also be able to work a little more with front-loading and several concepts at the same time.

These things are still an engineering approach that should appeal to the engineers and their mindset. Perhaps the challenge is to get management to create the conditions for it and understand the benefit of it. And of course customer focus, because that is what drives and pulls everything else. Sometimes you might not have a specification, and then it is the vision that will lead forward.

Value stream mapping is not so common, you may find companies that make some type process mapping, or some type of project plan / master plan which they constantly will recycle to the next project. Most companies are not good at gazing back and look into how the different stages of the project really progressed and turned out, and what lessons could be learned. VSM may not be so widespread but can be a useful tool to understand the problems and challenges in a project, getting a consensus on things, and getting an overall picture.

- **What do you think is the biggest waste in product development and what is your recommendation?**

Customer insight can often be poor; companies are a bit poor at finding out what the customer wants. It requires having an ongoing dialogue, it's good to have some type of chief engineer who is on the whole development journey, because sometimes a lot of firms lose track of what the customer really wants. A lot of investigation may have been done with the customer during the market investigation, but then during the other phases of work, that knowledge is forgotten. It is a big waste if we forget that and develop the wrong product.

It's also important to find good ways of preserving the knowledge created, and perhaps generalize the knowledge about a specific solution, how to document it and spread it. I have seen this in one company where they have some form of "knowledge owners".

Also A3 documentation is important, trying to document in some way. Maybe someone outside the project, in conjunction with someone working on the actual project should be tasked with formulating an A3 document so that knowledge that can be transferred to others. On this point there is much work to be done. I believe most of the knowledge created knowledge is within the minds of individuals, workers and engineers, rather than in the organization. It's important to remember that that it's not only a product that's delivered but also knowledge.

5. Results

The chapter presents the findings obtained from the literature review and the interviews

5.1 Literature review discussion

The literature review has revealed that studies conducted in development environments have acknowledged the need to adopt more flexibility in development. To some extent, this has raised skepticism towards the Stage-Gate model, as a framework for development activities. The model has been criticized for being too bureaucratic, rigid, killing innovation and inflexible (*Cooper 2008), (Becker 2006*).

Cooper &Edgett (2008) address these critics of traditional Stage-Gate processes by incorporating lean principles through value stream mapping in an effort to remove inefficiencies making the framework more adaptable and flexible. *Becker (2006)* argues that it is not the model that is the problem, but whether the implementation is done correctly or not. Becker asserts*" there is no one size fits all".* If gates are treated as business checkpoints coupled with proper arrangement of activities, the right management and leadership will allow the process to be more flexible and context sensitive.

Alternative development frameworks have been suggested with the claim of being more flexible and being able to handle development activities better. The spiral model was proposed by *Boehm (1988)*, which asserts that the model can better cope with iterative development activities and the building of knowledge and improvements efforts.

A comparison was made of the spiral model and the Stage-Gate model in regards to product development in ten different industrial companies by *Unger and Eppinger (2009*). The conclusions drawn by the authors were that that, depending on company culture and context, they tended to prefer one of them over the other. Manufacturing companies preferred the Stage-Gate model, while software companies favored the spiral model.

As a framework lean has changed substantially and extended beyond its origins of beeing a concept of manufacturing practices and production improvement. The frame work as evolved and continues constantly to develop with new research and books emerging from prominent experts such as Durward K Sobek II, Ronald Macitelli, and Michael Kennedy. Nevertheless much of the ever evolving principles has maintained the connection to *Womack and Jones (1996)* basic five principles but has researched Lean adaptability and implementation on other company operations.

The lean movement has been spreading across different industries. The academic communities studies of the applications of lean in various settings has revealed some key principles that seem most frequently proposed by authors when efforts are made to translate product development into becoming a lean environment.

With regards to the aim of the study a summary of lean principles and key concepts drawn from the literature study (see table 5.1) is used as a basis when analyzing the interviews and drawing conclusions.

Karlsson and Åhlström (1996)	Ward (2007)	Morgan and Liker (2006)	Womack and jones (1996)
Information flow	Value and value stream focus	Customer defined value	Customer defined Value
Strategic management/Visions and guidelines instead of detailed specifications	Front loading	Front loading	Value stream focus
Strong project manager/heavyweight project manager	Strong project manager/Entrepreneur System designers	Strong project manager/Chief engineer	flow
Cross functional teams	Cross functional teams	Cross functional teams	Pull
Leveled workflow	Leveled work flow/chunks of work	Leveled work/process flow	Continuous learning/ improvements /perfection
Top management commitment	Visual communication / planning/control	Visual communication	
Lean culture/coherent whole	Establish lean culture	Standardization	
Pull	Continuous /learning/knowledge preservation	Establish lean culture	
Simultaneous/concurrent engineering	Pull	Continuous /learning/improvements	
Supplier involvement	Set-based concurrent engineering	Pull	
		Simultaneous/concurrent engineering	
		Integrate suppliers	

Table 5.1 - A summary of the Lean product development Principles and concepts.

5.2 Interview analysis

Lean has emerged as promising concepts for business development and process improvement. The strong focus on waste reduction, efficiency, learning and continuous improvement of organizational processes are of immense value when technology and market conditions change so rapidly.

An efficient product development process requires effective and high degree of cooperation between different functional departments, such as marketing sales, purchasing and production. Providing methods and means for visualization, cross-functionality, knowledge capture and future improvements lean Product Development (LPD) has been established as a framework to address these issues.

However, Lean Product Development principles are not easy to implement, as it is often implied in literature and interviews conducted, it rather demands profound organizational changes in viewpoints, learning, development and communication. Results will not be seen from working with a few concepts or tools, but from applying a new way of thinking for the company. Thus a rational and systematic implementation strategy is a pre-requisite for making the most of the possibilities of Lean product development

Ascom began to work with Lean Product Development in 1995 with the 5s, and intensified the implementation efforts during the years that followed. Mats Espling discussed that some difficulties were faced because the proper understanding of tools and methods at the time was missing. He also mentioned that is better to start of small find the most important parts and then start improving step by step. Mats Espling further stated that difficulties were due to the many functional interfaces of product development and it is the quality between them that is important, it doesn't help to improve and optimize the processes if the interface between functions does not work properly.

Ascom has addressed these difficulties through visual planning cross-functional teams, and continuous learning, improvements and education of employees in a manner that corresponds to company culture. They have defined lean principles in accordance with the changes made and these values were conveyed throughout the company. These principles are listed below.

- Respect
- Cross functional collaboration
- Individual and team collaboration
- I can, I want to, I dare
- Policies and values guide us
- Involvement

Analysis of the data collected during the interview at Ascom in relation to lean principles can be seen in (table 3)

Attributes of ASCOM	Lean principle
Cross functional teams	Flow/ pull
Graphic planning system for assignment formulation	Flow/value stream
RACI/Task description documents/ Procedures	Waste elimination/flow/work leveling
Visualization for projects and line organization	Value stream/waste elimination
Pulse meetings	Value/Flow /waste elimination/work leveling
***process Creation process* ;Stage-Gate model for cross-functional communication /status descriptions/no hard-gates**	Flow and pull
PDCA/LAMDA loops	Value stream/flow/learning organization
Continuous improvement teams/groups	Value stream/ value creation /work leveling/lean culture
Value stream mapping	Value creation/Value stream/flow
Management support	Value creation/flow
"Bottom up" approach	pull
Issue backlogs	Organizational learning /flow/value
Group learning/ integrative supervision	Flow and pull

Table 5.2 - Analysis of the data collected during the interview Ascom

Ericssons Lean and Agile-based methodology started with small cross-functional teams working with products that were more autonomous and had few dependencies. Internal aswell as external reports and evaluations revealed that the lean and agile methods proved to be successful, thus convincing upper management to support a change towards becoming more agile and lean.

Adopting Lean and Agile philosophy in a company of Ericsson's size has proven a very difficult endeavor. *"The large-scale migration of Lean and Agile is very hard and difficult for us"* says Anna Sandberg. Ericsson has huge systems with millions of lines of code; size of these development projects makes it difficult in migrating towards large scale Lean and Agile transformation.

Today Ericssons works a lot with architecture to minimize the dependencies, which in practice always exist between the teams' tasks. These tasks are sliced into smaller tasks called scoops that are each verifiable and can be tested on their own at the system level. The work is done in parallel by cross-functional teams and the scoops are developed and integrated continuously during the development process. The learning and improvements efforts are through continuous retrospectives and cross functional collaboration. Important principles derived from the interview at Ericssons in regards to agile and lean are:

- **Maintaining business perspective:** Always keep in mind the customer is and why things are done
- **Having speed**: Getting the product out faster, means faster feedback from the customer, thus allowing improvements to be made faster
- **Guidelines:** instead of checklists Ericsson uses guidelines for the team and how they should work in order to achieve set goals
- **Synergy between Stage-Gate, lean and agile:** For a large company like Ericssons these frameworks allow cross functional communication, stability, managing these processes without a Stage-Gate-model would be immensely difficult

An overview of Ericsson's attributes and the corresponding lean principles gathered from the interviews can be seen table 5.3.

Attributes of Ericsson	Lean principle
Smaller scoops Fast/delivery frequency	Flow/value stream/waste elimination
Agile lean As one framework	Value stream/Flow/waste elimination
Learning from Continuous retrospectives	Value stream/value creation/learning organization
Always maintain business Perspective	Flow
Guidelines for work instead of checklists	Value stream/waste elimination/learning organization/ strategic management
Cross functional teams	Flow/pull
Specialist to support the teams instead of approving tasks	Work leveling/waste reduction/
Information Frontloading with why and what, instead of how	Value stream/flow/waste elimination
Stage-Gate review process for cross-functional communication and supervision	Flow and pull
Integration of activities	Value stream identification/ waste elimination
Strong manager with knowledge of business, systems and management	Flow/waste elimination Strong project manager
Backlogs	Value /waste elimination
Other management method	Agile/change management
Visualization/white boards and Electronic media	Value stream/waste elimination
Value stream mapping	Value creation/Value stream/flow

Table 5.3–Overview of Ericsson s interview

Both *Volvo Penta* and *Volvo Trucks* are working with a programme they call RnD30 with the aim of reducing rework and loops that has shown to occur in the end stages of development. The RnD30 initiative seeks to make the GDP more knowledge oriented and to reduce lead times in product development .The goal of both Volvo Trucks and Volvo Penta is to become more efficient and leaner in their operations.

RnD30 was an initiative that not only involved top management but also middle management was very strongly involved to get the RnD30 framework started. Major differences to the better have been noted both in results and working culture in Volvo Penta since the implementation.

Set based engineering has been implemented but at Volvo Trucks it has encountered some problems due to lack understanding for the method.

The early gates of GDP are steered towards being more flexible and finding the right knowledge before pursuing development. Concept milestones have been introduced to the GDP, and alternative concepts are pursued to attain proper knowledge rather than just fulfilling gate criteria.

The different departments have adapted the RnD30 and the working procedures of GDP to their own functions. There is no universal Volvo standard for it yet. Further research into this is required for getting a full picture of the implementation and its potential benefits for Volvo.

At Volvo Trucks it was emphasized by the interviewees that a cultural change is the most important factor when implementing change. The underlying reason for implementing each lean method and principle must first be properly understood before change is pursued; else the efforts will end in failure.

Attributes of both Volvo companies in regards to lean principles can be seen in table 5.4 on the next page.

Attributes of Volvo Penta	Attributes Volvo Trucks	Lean principle
Early phase activities/ Frontloading	Stage-Gate model Knowledge driven Frontloading	Value stream/ flow/waste elimination
Supplier involvement	Supplier involvement	Waste elimination/flow/pull
Concept milestones rather than gate criteria	Not implemented at Volvo Trucks	Waste elimination/flow/work leveling
Technology readiness level(scoring system)to pass milestones	technology readiness level(scoring system)to pass milestones	waste elimination value stream
Integrating events With stakeholders	Not implemented at Volvo Trucks	Value /waste elimination
Halting projects if criteria not met	Not implemented at Volvo Trucks	Waste elimination/value stream
Visual management	Visual management	Value stream /flow/learning organization
Scrum/agile/portfolio management	Change Management/portfolio management /Scrum	Value/value stream
PDCA loops	PDCA loops	Value creation/Value stream/organizational learning
Lean context and culture	Lean context and culture	
standardize	Standardize	Waste elimination
Cross functional project management	Cross functional Project management	Flow/pull

Table 5.4- attributes of Volvo Penta and Volvo Trucks

6 Analysis and discussion

The chapter presents the findings obtained from the literature review and the interviews

There are both similarities and differences in the approach towards lean in all the companies. The similarities are the implementation of visual planning. Visual planning is a method that cultivates commitment, which makes it a favorable method to start with, (*Lindlöf and Söderberg 2011*).

Set-based engineering is something that Volvo has started working with but it seems the method is difficult to understand and implement, even though this method is strongly underlined in literature, and many renowned authors it have among their Lean product development principles. The method requires resources and an additional task in the startup of a development project, and the methods seems difficult to synchronize in a proper manner with the Stage-Gate models that the companies use.

The importance of adapting the principles to company culture was emphasized several times. None of the companies has adopted the principles directly from literature. Instead the principles have been adapted to fit company specific circumstances. Ascom and Ericsson pointed out that it was necessary to do it in such a fashion in order to achieve employee acknowledgement for the methods in a successful way. This holds up well with the Lean philosophy as many authors and researchers have stated that just copying the methods and tools will not lead to any benefits

All the companies with exception of Ericsson seem work towards more front-loaded development to gain the proper expertise before development starts as a way to increase the effectiveness in the development process. Knowledge waste was deemed the biggest waste by several participants and they all expressed a desire to enhance knowledge capturing procedures.

There are no chief engineers at any of the companies, but interviews at Volvo GTT did reveal it might be necessary to have someone with such an authority earlier in the development process. The respondents revealed that such an authority figure only comes in when the project has encountered serious problems .The interviewees also mentioned that at Volvo buses they have a group that takes on the role and responsibilities of an chief engineer and Volvo cars has two people for the role, one that takes responsibility for marketing issues and one that takes responsibility for technical aspects.

At Ericssons it was mentioned that new roles have been assigned, people with extensive knowledge and expertise in the technical system aspects, business, and project management, this has been interpreted by the authors as a strong project manager.

Except some minor metrics no companywide measurements or metrics for comparison between pre-lean implementation and post-lean implementation had been taken by the companies. Volvo Penta had noticed major benefits, but the others were satisfied with the implemented methods and felt that work progressed well.

Other project management methods in order to add value to developments process and making them more efficient was suggested by the participants. All companies used scrum and agile methods

together with lean. They also expressed the need to have synergy with portfolio management and change management in order to make the processes more efficient.

6.1 Suggestions

Much of the research on lean Product development has rested on the pioneering work of the authors mentioned in the literature review of this thesis. This section has aimed to summarize the principles most frequent and commonly agreed upon in the literature review and the information obtained through the interviews some of the principles have been interpreted due to differences in phrasing. Nonetheless the review and the interviews have identified some characteristics considered relevant in regards to the aim and research scope of this thesis and have been summarized in table 6.1.

	Key principles identified
1	Customer defined value
2	Front loading
3	Cross functional teams
4	Value stream focus
5	Strong project manager
6	Visual management
7	Leveled workflow
8	Set based /simultaneous/ concurrent engineering (*requires lean maturity for implementation)*
9	Continuous improvement/learning
10	Standardization
11	Reduce waste

Table 6.1–Key Principles derived from interviews and the literature review

1. Customer value

The starting point in the Lean PD process is the customer. Customer value must be understood early in the process, making it easier to separate value-adding activities from waste in regards to customer perspective and focusing efforts into delivering that value (*Morgan &Liker 2006).*

2. Front loading

Approximately 75 % of a product's total life cycle costs are determined in the early phases of a development project, despite the fact that the knowledge is low and uncertainty is high at this point. Front-loading aims at decreasing knowledge gaps and uncertainty by increasing the resources early in the process and delaying decisions until enough information and knowledge is acquired, thus avoiding complications later in the later stages (*Sehested & Sonnenberg, 2011).*

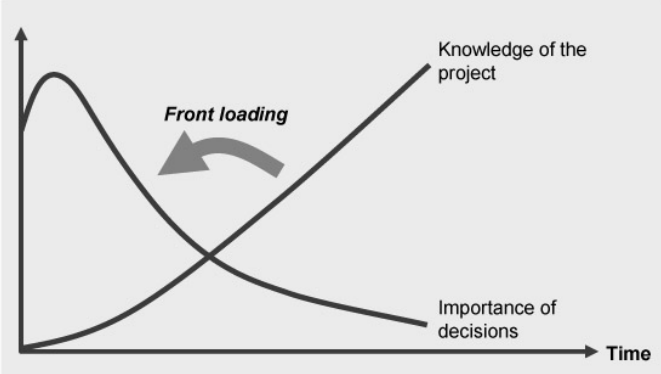


Figure 6.1 - Front loading (Sehested & Sonnenberg 2011)

3. Cross functional teams

An important factor in terms of front-loading is that different solutions are discussed early by cross-functional teams. By gathering members and experts from relevant functions at a very early stage to evaluate the project aids in detecting and solving potential problems. Cross-functional work leads to better coordination , communication increases, and helps in keeping what the customer values in focus *(Hoppmann et al.2011), (Morgan & Liker 2006).*

4. Value stream focus

Macitelli (2007) defines the value stream as "*the sequence of events or actions that enable value to be delivered to customers"*. He also argues that defining the beginning and endpoints of a process under scrutiny is one of the most critical factors for process improvements and success. Understanding the value stream helps to find bottlenecks and waste making it possible to systematically improve the process while capturing and reusing knowledge gained (*Macitelli 2007), (Kennedy, Harmon & Minnock 2008).*

5. Strong project manager

Toyotas chief engineer is an individual with deep technical expertise and authority who is responsible for the project from start to finish. In contrast to the western role of project manager who usually manage people and time, the chief engineer has the role of technical systems integrator and architect, is the voice of the customer, sets performance targets and manages the project. Literature suggests that such strong leadership is a key factor for product development success (*Morgan & Liker 2006*,*Ward 2007).*

6. Visual management

Visual Management is the process of creating a work environment that makes information visible visual management could be divided into three parts.

6.1. Obeya - project room

Obeya is a project room where project activities and deliverables are outlined and visualized, (Cross functional teams are gathered from different divisions to review the project .The walls of the room has project processes visualized with information that can support decision-making *(Lindlöf &Söderberg 2011).*

6.2. Visual planning

Visual planning is a method of coordinating work where ongoing activities and deliverables are defined and illustrated on a planning board and frequently reviewed at meetings. The boards should be kept simple and only value-adding information to the process should be put on display *(Morgan & Liker 2006).*

6.3. A-3-communication

The A3s contain information and specifications of a product/project in one single A3 sheet. The information on the paper could concern, problems and action plans .It is used to support knowledge driven problem solving and combined with the proper learning cycle (i.e. PDCA/LAMDA) enabling a knowledge oriented organization *(Morgan & Liker, 2006).*

7. Leveled workflow

Reducing waste from the very beginning, balanced Portfolio management, and shared resource scheduling at the front end of a process are pre-requisites to leveling work is essential to create a product development that is lean .By establishing specific set of tools and methods it is possible to create a leveled flow in product development. Strong focus on learning, continuous improvements and standardization, generates a workflow that can be predicted and anticipated, thus leveling the processes.

8. Set based /simultaneous/ concurrent engineering

In set based concurrent engineering, sets of possible solutions are considered, the set of possibilities are gradually narrowed until they converge on a final solution. By putting more time early and defining the best solution, will make moving towards production more rapidly once the solutions is converged compared to traditional point based engineering *(Sobek et al. 1996).*

9. Continuous learning and improvements

Continuous learning and improvements should become an integrated part of developing companies' values. Through dialogue, concurrent engineering, re-use of knowledge, and mentoring, the learning and improvement process can be kept alive and problems can be solved more rapidly The occurrence of mistakes should also viewed as potential opportunities to learn and become better *(Morgan & Liker 2006, Sehested & Sonnenberg, 2011).*

10. Standardization

Standardizing lower level tasks in order to achieve stable and predictable outcomes can be derived in the unpredictable environment of product development. Creating flexible standardized design practices through checklists and guidelines saves time and reduces errors (*Morgan & Liker 2006*, *Mascitelli 2007).*

11. Reduce waste

The core principal of Lean is to streamline the processes to reduce non-value added. Examining the development process from a Lean perspective, standardizing, and creating continuously improved value streams generates the opportunity to identify and eliminate waste, creating a resource efficient and value oriented product development process.

How can product developing companies use lean ideas to improve their product development?

All companies today face dozens of issues and problems during their product development cycles. Failure to rapidly solve these problems will eventually result in project failure excessive development costs and unplanned loopbacks.

While Stage-Gate as frameworks has provided much needed structure it must be enhanced with the ability to provide diverse perspectives and solving problems more rapidly, cost effectively, and with less waste in order to result in accelerated innovation outcomes and improved business performance. The product development process has lots of places where errors happen and in the later phases of development the opportunities for improvement are fewer and less likely to have an impact.

That is why lean principles and practices should be implemented and operated in the early stages of product development, speeding time to market by finding issues faster and eliminating the root causes of time consuming and expensive late design changes.

Examples of problems that are costly and difficult to remedy can be seen below: figure 7.1

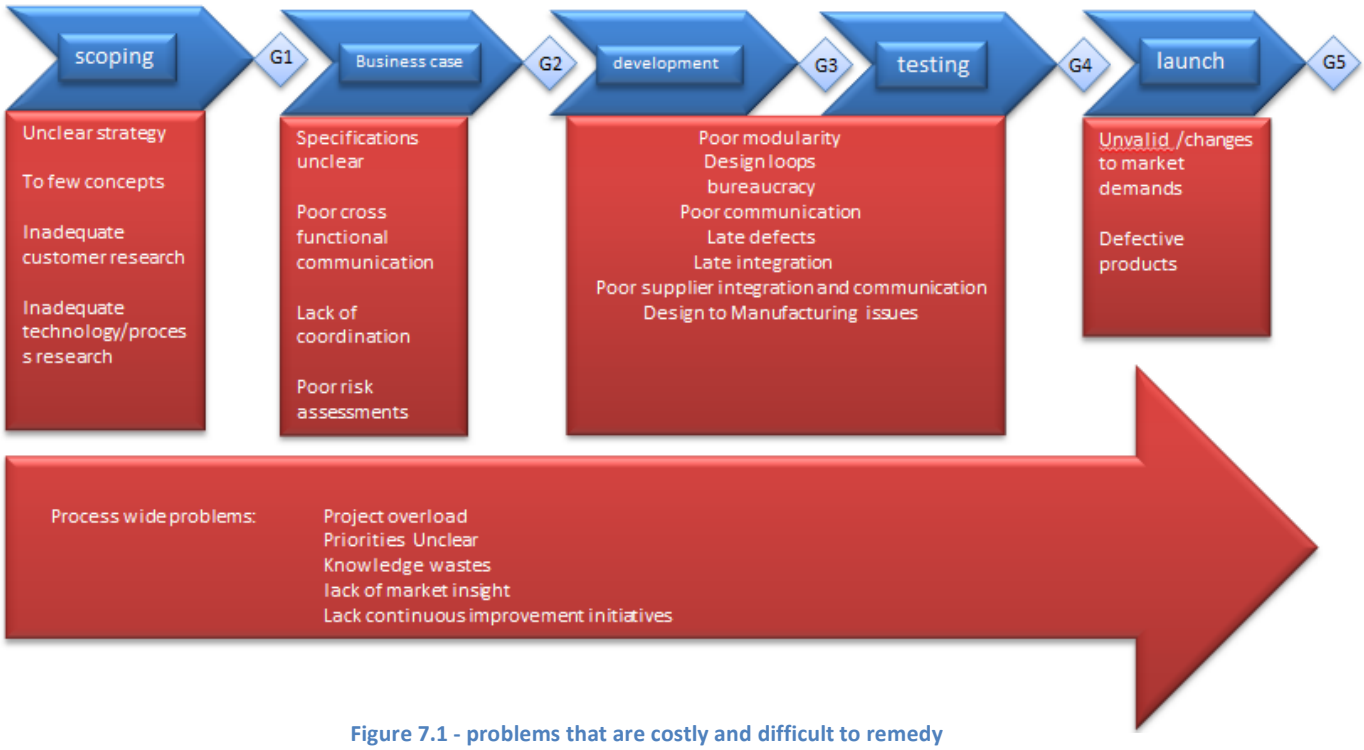


Figure 7.1 - problems that are costly and difficult to remedy

Through lean practices the root causes of these problems can be identified and addressed faster. Although applying these principles may not entirely eliminate all issues, it may reduce re-work and wasteful activities in great amounts and stimulate the learning process, allowing for future improvements.

This thesis suggests that:

- Developers frontload their activities and allocate resources to the activities of early development.
- Use value stream mapping to truly understand the value stream, finding bottlenecks and systematically improving the development process
- Delay detailed design decisions about specifications until the learning process in the early stages are completed. This allows insight on what really can be delivered rather than wasting time on unclear goals with little knowledge and information.
- Use visual management tools to focus team efforts on problem-solving and clear cross-functional communication.
- Pursue multiple alternatives with set-based concurrent engineering. Although many interviews suggested that understanding is lacking for the method and it is difficult to comprehend. Efforts should be put on educating the method and its application in order to converge upon a single best solution.
- Have a strong project manager with authority to lead the project from start to finish.
- Product Portfolio Management to reduce work overloads reducing unclear priorities and selecting the projects with most value.
- Continuous learning and, re-use of knowledge. Avoiding stagnation and keeping the improvement process alive.
- Standardizing lower level tasks in order to achieve stable and predictable outcomes
- Knowledge based decisions in favor if time based decisions

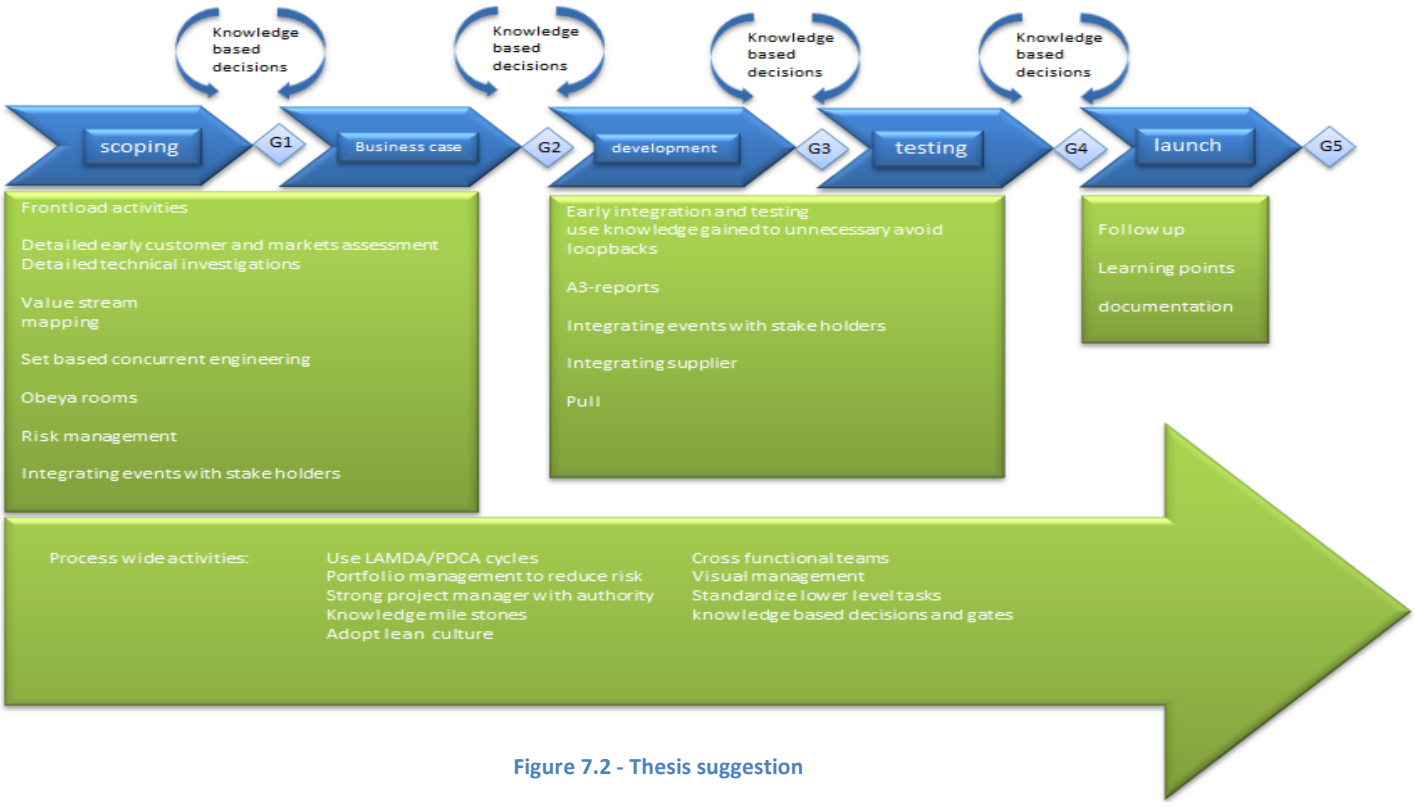


Figure 7.2 - Thesis suggestion

7. Conclusion

From the analysis and discussions, conclusions of the most important areas are drawn and presented below

Implementation of Lean product development requires time and dedication. The companies participating in the interviews have all put years of efforts into implementation. Still, they point out that there is lots of work to be done. It is clear that close examination of current industry practices is required in order to fully adopt lean principles. There is no one "right way". Different organizations must establish their own models that's adapted to their business culture and accommodates their business's needs. The field is constantly developing with new research emerging from experts such as Durward Sobek, Ronald Macitelli, and Michael Kennedy.

It must also be recognized that the development of lean as a framework in recent years has led to difficulties in assessing what lean encompasses. Researchers and practitioners have suggested a number of models of lean applications in product development. The Literature review has revealed that lean consists of numerous concepts and principles. Although all principles researched are relevant for improvement efforts, it would be a fallacy to consider that the sum of all these principles would constitute Lean.

Lean depends upon the understanding of fundamental characteristics of business, development processes, people, and other dependencies. Certain company specific adaptations are required depending not only on the specific tools and methods but also how learning and improvement should be carried out. Successful transformation will ultimately depend on overall organizational culture, values and commitment to change.

The results from this study indicate the following:

- Visual management seems to be the preferred start when working towards lean. It is also the easiest to understand and implement. It enhances communication and the results of implementation are seen comparatively faster than other methods. The method does not require large investments and is fairly easy to test in smaller groups before implementation. On a larger scale.
- Lean principles should adjust to the culture and circumstances of each organization.
- Set-based design, trade-off and limit-curves require a high level of understanding and education in order for organizations to be able to understand and implement.
- Portfolio management is an important framework that needs to be considered when implementing lean. Portfolio management helps in reducing work overload and confusion in regards to prioritization when working on multiple projects.
- Agile is a frame work that if implemented correctly for hardware development will be an excellent framework to integrate with lean in order to make developing processes even more effective.

8. Further research

This thesis did not have the proper time and means to do a more comprehensible research on the subject. The authors of this thesis suggest that for further research a larger sample of companies and their lean transformation efforts be studied in order to allow a greater generalization of the findings.

A deeper research into the underlying reasons as to why some methods such as Set-based design, trade-off and limit-curves are so difficult to implement, and what grade of lean maturity is required in order to implement these methods properly.

How to integrate existing project management methods, such as scrum, portfolio management and change management together with lean principles would greatly benefit development activities. Many of these frameworks are already in use in the industry, and if it is possible to reconcile them with lean principles great advantages from a business perspective are to be gained

The question of capturing knowledge properly seems to be a critical issue. The companies interviewed all seemed to regard knowledge waste as one of the primary wastes of their organization. Research on how to preserve, generalize and re-use knowledge gained through different projects is a subject that might require large resources to investigate, but the authors believe that a possible outcome of such research would greatly benefit developing companies more than any other method or principle.

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Appendix 1-interview questions

Semi-structured questionnaire used during interviews

1. **Tell us about yourself/What is your primary job description?(experience/interviewee info)**
    - Name
    - Occupation:
    - Work description:

    - **Your experience with Stage-Gate, what flaws weaknesses it have in your opinion?(stage-Gate info)**
    - Stage-Gate models (flaws &strengths)
    - How is it used

    - Literature often suggests that that **the front end tasks** arevery much **underutilized** when implementing Stage-Gate models! What is your perspective of this in regards to P.D and stage in companies you have worked with!

2. **What Lean initiatives have you/your organization been working on /is working on**! **(Lean projects current &past)**
    -
    - What difficulties did you face?
    - Has any improvement in the P.D process effectiveness and efficiency been seen?
    - One of the objectives lean is to enhance learning through continuous improvements Have you noticed any changes in this area?
    - Has the organizational learning improved since implementation of lean
    - Has the implementation given any noticeable benefits as of now*? (better lead times/cost effectiveness, better in meeting customer requirements)*
3. **What lean resources are primarily used in the organizations you have had experience with?(Lean tools and methods at Ericsson)**
    - Tools?
    - Way of implementation/effectiveness
    - Integration with other processes/ management methods *(i.e. SCRUM, Agile DMAIC/PDCA, standardized working operations, VSM, downstream pull etc.)*
    - Have you any thoughts on how lean tools and practices should be fused in the Stage-Gate model in order to become more efficient?
    - Which parts are crucial to look at?
    - What do you perceive as the lean principles that are not well understood by most companies/employees, and hardest to implement?
4. **What are the primary product developments wastes as you them**? (waste reduction)

- Muda-non value added?
- Muri, in terms of overburdening of employees, stress as gates are approached, Have there been any changes?
- Mura - unevenness or fluctuation in work, fluctuating production plans
  How should work be done to reduce these?

5. **Have you any experience with other companies which have tried to implement lean into their version of Stage-Gate**?**(knowledge on other implementation methods)**
   - What was their approach?
   - Do know if it was successful
   - If yes/no-why?
6. **What other management tools would you perceive as tools which would be beneficial if integrated with lean principles**
   - Scrum /agile
   - Portfolio management
   - other

Appendix 2-transcript of interview at Ascom 2013-08-23

Intervju på Ascom 2013-08-23 Göteborg

Mats Espling: chef projekt kontor och hantering av processer

Change Agent Berätta om dig själv, dina arbetsbeskrivningar och erfarenheter!

Mats Espling heter jag, jobbat på Ascom länge! Som konstruktör som, projektledare, varit sektions chef samt chef för Rnd resurser. Just nu chef för projektkontor, där man hanterar processer och gemensamma saker, Vi har omorganiserat och fokuserat så att produkt chefer sitter nära varandra. I en organisation blir det lätt att alla jobbar endast på sina processer, men kvalitén mellan processerna är det viktiga, folk glömmer detta, hjälper inte och optimera sin process om interfacet till andra inte funkar, och det är detta man vill ha med lean och visuella hjälpmedelen, det jobbar jag med mest!

Har ni någon typ av gate modell?

Egen snickrat Stage-Gate modell! PCP-*Product Creation process* används som Stage-Gate modell Vid mindre projekt så används en förenklad variant! Agile metoder hanterar mycket av det i mitten, men inte de tidiga eller sena faserna! Processen består av ett antal ”swim-lanes” för olika delområden, t.ex. ”Marketing”. Det finns en beskrivning för vad som behövs för att komma igenom gate A respektive gate B. Dessa är status beskrivningar, och Ascom har inga hard-gates!

De olika delarna av processen består av**, definitions fas** (vad), **elaborerings fas**(hur), **utvecklingsfas** (utveckling**), acceptans fas**(godkännande) och ramp-**up fas,**

Vad som måste göras vid toll-gates finns att läsa. Det finns beskrivningar! Beskrivningarna är på ett grafiskt sätt, allt som rör projekt planering, system produkt, marknad funktionalitet. Huvudflödet är grafiskt och det kan brytas ner. Allt ifrån från att titta på marknad kraven till och visa användar system, produkter och funktioner etc.

MRS-**Main Requirement Specifikation**- huvuddokumentet, beskriver grunden, när detta är läst och gjort så vet man vad det är man vill utveckla!

Elaboreringsfasen – är förståelse. Bryta ner krav hantering på produkt nivå, funktionalitets nivå, både mjukvaran och hårdvaran. Bryter man ned alla dessa saker då hamnar alla dessa aktiviteter in i banorna på swim-lanes, och dessa är interaktiva klickar man på något kommer man till ett dokument, som beskriver vad som skall göras och vad det behövs för output.Processerna har brutits ner i beskrivande dokument. Vi kallar dom för **tasks**, här finns tydliggjort vilka som är ansvariga, s.k **RACI**-*Responsible, Accountable, Consultant ,Informed* så man vet vem som ska göra vad, och vem som är ansvarig! Under detta finns ytterligare dokument vi kallar **standard operation procedure (SOP),** som är mer ingående i hur man gör på detaljnivå och hur kravhanterings processen fungerar. De som ska jobba med något kan då hitta exakt vad de ska göra! Som en checklista

Utvecklingsfasen – Är ett slags integrationsplan, hur ska produkten utvecklas? vilka steg vi har? sedan loopar man. Detta är ingen scrum, utan helt enkelt Ascoms process och det styr man med integrationsplanen. Måste kunna blanda olika sätt och arbeta (scrum, lean etc.) och det måste processerna kunna stödja. Det man glömmer ofta och fokuserar på en metodik och glömmer andra.

Vi försöker får saker så enkelt som möjligt. Finns fortfarande dokument som är för tunga. När dessa är för tunga så läser ingen dessa! Vi har fått feedback på det grafiska, att det uppfattas snabbare, man ser flödet på engång. Skulle det beskrivas i text hade det inte synts. Så vi har jobbat mkt med det grafiska!

När började lean initiativen införas, anledning till att det påbörjades?

Finns en presentation angående detta som jag kan skicka till er! Generellt började det i produktion runt 2007!

Hade ni någon prioritets lista när ni började med lean?

Vi hyrde in Swerea IVF, gjorde en workshop. Frågan som ställdes var: *Var är vi?* och *var vill vi vara*? Därefter togs de tre viktigaste punkterna och dessa jobbades det med! det var så Ascom kom igång. Vi hyrde någon utifrån som kunde titta på företaget, och därefter gjordes en prioriterings lista.

Vilka problem fanns för att komma igång?

En del metoder och verktyg implementeras men funkar inte för att förståelse saknas! Det måste finnas några eldsjälar som vill införa det! Finns alltid de som inte vill ha förändringar! Man tycker det är jobbigt, Man bör också tänka på att begreppet ”lean” ska man akta sig för. Det innefattar så mycket. Att säga att man jobbar med ”lean” säger inte så mycket. Det är bättre och tänka på vad som fungerar dåligt och vad som man kan förbättra, samt börja med små delar. Det finns så många saker man skulle kunna göra, men det är bättre att börja med smådelar, hitta den viktigaste förbättringspunkten och sedan göra det och inte göra massa annat! Exempelvis visuella tavlor som är relativt enkelt och börja med .Det viktigt att inte vara rädd för att ifrågasätta vad som kan göras bättre, börja smått se till att det blir färdigt och att det blir bra.

Har ni något sätt att mäta resultat av implementering?

Nej finns inte! Enkelt att säga att man vill mäta, men det är svårt att mäta! Ju längre up-stream man kommer desto svårare är det med mätvärden. I produktion är det enkelt, man ska göra en detalj under en viss tid så är det färdigt. Men i utveckling är det svårt. Man vet att man har en specifikation och när det ska vara färdigt. Problemet är, bara för att du skriver en rad i specifikationen, så är det inte 100 % tydligt att alla vet vad du menar. Ofta finns det oklarheter, därför blir mätning mycket svårare. Man kan få en instruktion men ofta förstår man instruktionen heller. Det kan bero på att man inte har relevant kunskap eller att förklaringen är dåligt. Det finns massa orsaker, men just av den anledningen blir det svårt och mäta..

Arbetsmetodiken är bra och fungerar, det är en stor fråga, om svaret är nej, så försöker vi förbättra det, strävar efter att jobba på bästa sätt och att arbetsmetodiken är så bra som möjligt. Om man fokuserar på det så kanske det räcker. Många saker är mycket svåra och mäta, man kan få fram siffror, men vad betyder dessa siffror egentligen, om det är 3 istället för 4 vad ska man då göra?

Om man mäter så måste man också ha väldigt ingående och omfattande kunskaper om flödet och förstå det fullt ut! Man kan presentera siffror till chefer och ledning, men vad gör man med dem sen

hur dessa siffror matas tillbaka! Det är bättre och jobba med förändrings loopar så som PDCA och LAMDA är mycket bättre än mäta.

Hur vet man att detta nya sätt är än bättre arbetsmetodik i jämförelse med förut om inga mätvärden finns?

Vi mäter en del saker trots allt**.** T.ex. fel i produkten efter att leveranserna startats. Vi ser att totalt sett har antalet fel minskat sedan vi införde mer genomarbetade processer på specifikation och test.

Man skulle kunna tänka sig och mäta hur arbetsmetodikerna står mot varandra och mäta, men detta har vi inte gjort! Dock finns det några mått! Finns något som heter *earned value,* det är fokuserad på tid och följer upp hur arbetet går mot planen. Man kan se framåt i planen. Det finns graf med planerade tasks. Om man ligger under den kanske man tänker; *”bra man lägger ner mindre tid för att komma lika långt”!* Men frågan är egentligen; *”har du verkligen gjort det som skulle göras, eller har du gjort mindre”*.

Detta ger möjligheten att ställa frågor. Om det finns stora förändringar i projektet, då kostar det tid och pengar vilket blir synliga. Inte riktigt som earned value där man också tittar på innehållet, medan här kollar man endast på tid. Detta är en förenklad variant av earned value. Det är ett exempel på en av de mätningar som görs!

Sen finns det andra mätningar som görs också. Mätningar där man tittar övergripande på projekten. Om man har sina faser, och som produkt chef säger man att en viss produkt kostar 4 miljoner kr och den har en viss funktionalitet i den tidiga fasen när utvecklingen kommer igång! Men man vet ju inte riktigt förens i slutet på riktigt vad som ska utvecklas. När man står och säger att det finns en viss kostnad eller tid, då har vi jobbat genom detta, längre fram i planeringen måste frågan ställas igen ” *är det fortfarande 4 miljoner som gäller här? ”Är det fortfarande samma punkter som är viktiga*? Det brukar nästan aldrig vara det! När arbetet påbörjas så får produktchefen massa frågor, t.ex färg, form etc. och dessa saker ändras hela tiden, därmed blir ju kraven också annorlunda. Den initiala budgeten på 4 miljoner ändras till 5 miljoner.

Dessa mått på kostnad och tid finns! Måttet är att det ska vara 1.0 nu blev det 1.2. Alltså 20 % dyrare. D.v.s. vi var 20 % för dåliga i vår uppskattning. de måtten används, på hela processen.

Man kan jämföra medelvärden, man tar 10 gamla projekt och jämför med 10 nya projekt då kan man ta ett medelvärde. Men man kan inte jämföra ett projekt med ett annat, för förutsättningarna är väldigt annorlunda projekt till projekt. Det finns produktchefer som gör jättebra jobb, allt är perfekt beskrivet, så finns det de inte gör så jättebra jobb, eller det kanske kommer in en konkurrent med en ny produkt, då måste man göra ändringar för att möta konkurrensen. Om dessa nya krav tillkommer, då ryker ju alla siffror. Då kan man fråga sig, gjorde vi tillräckligt bra marknads undersökning, eller blev det bara så. Mäter man dock över många projekt så kan man få hyfsade värden, vi rullar tillbaka 10 projekt bakåt i tiden hela tiden.

Agile,scrum,PDCA och LAMDA.Hur arbetar ni med att integrera dessa processer? Hur kan få dessa management processer att fungera tillsammans?

Scrum är ju en arbetsmetodik.

A B C D E

Vid A Här jobbar man med scrum. Scrum fungerar inte så bra på den övergripande inledningen (A till B) eller att samla ihop för utleveranser av färdiga produkter (D-E). Man får fundera på vad det är för viktiga gemensamma punkter man har. Det är där man får börja. Sedan bryr man sig inte om du kör scrum eller ej, du ska vara klar vid deadline, sedan kan du jobba som du vill!

Har *organizational learning* förbättrats ?

Väldigt svårt och spara kunskap, det har försökts mycket. Vi har försökt med portaler och länka in olika dokument. Fungerar ett litet tag, men inte i längden. Vi försöker bygga kunskap i grupper istället. Sedan har gruppen en viss kunskap. Men det är väldigt svårt att dokumentera det. Våra kunder betalar inte för den tiden. Vi försöker numera blanda erfarna med mindre erfarna. Lite som Team module enginners (Toyota) . Gruppen har lite kunskap om något område, men väldigt djupa kunskaper om något annat område! Blanda olika typer av personal för att sprida kunskapen, men dokumenteringen är tung, frågan blir hur många läser den sen, eller om någon läser den överhuvudtaget!

Vad anser du är det största slöseriet (wasten)?

Kunskap Waste! Problem kan vara att man gör om samma misstag. Man får se till och inte göra för komplicerade system då blir kunskapen väldigt känsligt, är en person borta, så kanske allt stannar upp.

Hur hade tyckt att dessa projekt styrningsmodellerna och principerna bör samverka, vad bör man tänka på vilka punkter är kritiska för lyckad implementering?

Personalen är en viktig del. Sätter vi utbildar vi vår personal, och att man gör det hela tiden. Toyota har bra tänk, utbilningen är det viktiga. Vara klar med hur man tänker sig att processen ska fungera, och inte vara för central. Närmaste chefen bör kunna delegera ut utbildningen och grupperna måste själva står för utbildningen. För sedan kanske saker och ting måste göras om, och det är de måste ändra saker och ting, därmed borde det ske på lokal nivå! Sedan att man kan vara tydlig med hur saker hänger ihop (grafiskt och tydligt). Fokuserar på så få (viktiga) saker som möjligt, inte på för mycket saker på engång. Och att man är tvärfunktionellet, att alla är med, så att man får med folk som har olika vyer och tankar ,så man får med alla olika synpunkter.

Vad tycker du har varit svårast med implementering, vad har folk haft svårast att ta till sig?

Det är svårt att göra saker enkelt! mycket av svårigheten beror på att vi är ingenjörer inte pedagoger, det är svårt och utbilda. Vi skulle kunna bli bättre på att utbilda vår personal. Och sedan att man gör det enkelt.

Måste tänka igenom; ”*hur jag ska kunna förklara för andra?”*. Jag måste förstå det bättre själv för att kunna förmedla den kunskapen vidare. Finns en positivitet i det att man utbildar, för samtidigt lär man sig själv också!

Portfolio för customer requirements. Den handlar om kundkrav det jobbar man mot först sedan kommer det andra. För att kunna starta vid punkt A måste man redan ha beskrivit en del requirements. Man får tänka på att ha en business case . ”*vad kostar det?”* och *hur mycket pengar får vi in här* etc. Kunskap vs produkt, och *the development funnel!* Är bra sätt att tänka på!

Är det något du tycker vi bör tänka, kanske kolla djupare på!

Er osäkerhet och vad ni får av intervjuerna gör det svårt. Men implementation, hur det blev och hur *bra* det blev kan vara viktiga punkter och tänka på!

Appendix 3-transcript of interview at Ericsson 2013-06-11

Intervju Ericsson lindholmen 2013-06-11 Göteborg
Anna Sandberg: Change Agent

Berätta om dig själv, dina arbetsbeskrivningar och erfarenheter

Arbetar som Change agent. Jobbar med att implementera förändring i mjukvaror och produkt utvecklingen. Just nu är det stort fokus på agile och lean. För tillfället jobbar jag som change agent och driver ett program för en Produkt på tre olika sajter med 500 personer involverad. Vi går arbetar med att gå ifrån från klassiskt utveckling till agile och lean. Det vill säga man går över till en mer optimerad utveckling. Skillnaden är att man går över till att jobba med *backlogg managment*, man jobbar mer med backloggar. Man har nya roller och jobbar med krossfunktionella team som driver utvecklingen.Man har en *latest system version branch* som man försöker kontinuerligt ”deploy”.

Dina erfarenheter med Stage-Gate, vilka svagheter har den enligt din åsikt?

PROPS-modellen på Ericsson som bygger på våra toll-gates som vi kallar det för. TG 0- 5 har vi haft. Där TG0 har varit att initiera,

TG 1 är då vi kan lite mer och tycker att det är värt att gå vidare,

TG2 då kör vi och tar in den stora mängden,

sen på TG 3 kollar vi så att det fortfarande finns en business Case.

TG 4 är vi klara med utvecklingen och vi börjar testa pilot produkten.

TG 5 avslutar vi projektet.

Så gjorde vi under det klassiska arbetssättet och den stora skillnaden var väl att vi gjorde enormt stora scoop i de här projekten. Vi kommer ihåg scoop som var miljontals timmar över två år. Om man tänker sig den stora fotballen och i den stora fotballen får man plats med massa tennis bollar. Nu gör vi tennis bollar istället. Men vi måste fortafarande ha en modell för hur vi taktar de här besluten. Om vi gör en tennis boll i taget så kan vi ju dels, med dessa mindre scoop snabbare få igenom de, och vi kan bli kompenserade fortare. Det är principen. Så speed är oerhört viktigt för oss.

Det vi trodde att när vi inte har speed det kan ta två år och hinner bli inaktuellt. Då ändrar sig scoopet så många gånger, det som vi kallar för CR hantering – change request hantering, försvinner nästan när man lägger alla tennis bollarna på raken och tar dem en efter en efter en, istället för att bunta ihop dem och behöva ta beslut och förstå alla från början.

Och då kan man säga så här ni skriver att: *literature often suggests that front-end tasks are under utilized*. *Vad menar ni med det?* Front end tasks?

Att man arbetar väldigt mycket mer med informationssökning i de första, initiala stagen för så de senare stagen med utveckling och business Case ska gå mycket smidigare så att man avstannar med själva gaten ganska länge i början så att man samlar på mer information, lägger mer resurser på att få en mycket klarare bild av projektet, projektets gång.

I de klassiska modellerna var det så. De spenderade för mycket tid på att förstå detaljer och man tog alldeles för stora scoop. Nu försöker vi ju då att inte lösa alla detaljer, men där emot måste vi fortfarande förstå *vad* och *varför* men inte *hur*.

Ofta kommer vi in på skillnader, vad sipprar ner i systemet? Vad är det som ska göras, business folk funderar på ***why*** och på någon nivå ***how*** också, detta skrivs i något dokument som ofta blir svårtillgängligt. Sedan ska nästa grupp av människor leta efter detta dokument, och försöka förstå vad andra hade tänkt sig, alltså ”*vad ska göras”*, ”*vad vill vi med informationen vi leta efter*?” När man initialt gick mot lean och agile hade vi för lite sådant.

Om alla bara ser solen så kommer det bli så bra och om alla bara får jobba på så kommer det att bli så bra. Tyvärr är det så att mycket av utvecklingen är väldigt komplext. Dessutom nu distribueras det globalt och det går liksom inte att ha miljontals rader kod och tro att detta ska *rippla* som jag kallar det. Utan vi har ganska mycket koordinering, planering och ordning och reda. Dessa Stage-Gate modeller hjälper oss med ordning och reda. Då har vi en sådan modell där vi tar besluten motsvarande vår gamla TG modell fast vi tar dem på ett annat sätt. Vi tar besluten på Tennis bollarna. Vi tar dem med mycket mindre scoop och vi tar dem allt eftersom vi har kapacitet. Det är inte alltid r att det fungerar på rätt sätt, men nu pratar vi hur det ska fungera i teorin. Jag skulle vilja säga, att tro att man kan ha agile och lean utveckling utan någon Stage-Gate modell åtminstone när det gäller *large scale agile development* som det kallas för, Det är bara dumt.

Det finns åsikter om att Stage-Gate bör avskaffas helt och hållet. Dom anser att den är för rigid och att det hämmar kreativitet att bara klara själva gaten kriterierna utan att egentligen arbeta proaktivt

Empowerment och accountable begreppet, Det jobbar vi jätte mycket med, att få det här krossfunktionella teamet att känna sig empowered och accountable och ta ansvar för något. Att ta vara på deras fulla kapacitet. Exempelvis designa och testa den här tennisbollen och ta den hela vägen till från en vis fas till nästa fas. Till skillnad från tidigare när man bara gjorde en liten del i mitten så ska hela teamet göra den här resan tillsammans. Men vi är väldigt tydliga på vad den resan är. Vad är början och vad är slutet. Men det finns de som är extrema i syn på empowerment.

Vad menar du med extrema?

Man tror på den här kraften i empowerment.Tror att bara vi alla är hundra procent motiverade och tycker att det vi gör är fantastiskt, så kommer det att gå bra. Så ser det tyvärr inte ut i verkligheten. Om vi tar en feature så finns det finns minst tio olika sätt att göra den på. Göra olika versioner av produkten alltid. Det är inte så att våra ingenjörer har bara en syn på hur detta ska göras. Det kan vara så här att den person som är bäst eller det teamet som är snabbast på att göra en feature är redan belagda med andra saker. Vi får då ta det tredje bästa teamet på det. Vilket leder till att det tar dubbelt så långt tid att göra. Dessutom kanske de inte tycker att detta var det roligaste att göra. De

kanske hellre hållit på med att göra annat som de upplever som roligare att arbeta med. Och det här med *"att om varje människa bara får bestämma vad de ska göra"* så *ripplar* inte utvecklingen.

Vi behöver sådan gate modeller för att fatta affärsbeslut hela tiden. Hela tiden har vi koll på *"kan vi tjäna pengar på det*?" Och sen så får vi se när i tiden behöver vi få ut det, och vem har kapabiliteten och göra det. Vi behöver planerings team till våra stora produkter som hjälper till att planera den agregerade biten. Om olika produktägare inte vill göra vissa arbetsmoment så kanske den här planeringensteamet går vidare och ställer frågan till någon annan grupp; *"kan ni göra det"*? Och om de också säger *"Nej!* det *vill inte vi heller"*! De kanske har andra grejer som driver dom, och då inser man det istället blir lite *cherry picking* mellan arbetsuppgifterna och det kommer inte fungera i längden.

Där kommer Stage-Gate modellen in som någonting jätte viktigt för oss. Det hjälper oss med ordningen och reda. Framför allt då att kunna kommunicera utåt. Att kunna kommunicera med *"marketing","sales and pricing"* och *"packaging and supply"*och alla andra som jobbar för att vi sen i slutändan ska kunna känna pengar.

Det är nödvändigt för oss och kunna få reda på hur långt är vi är utvecklingen. När kommer utbildnings materialet ut så att vi kan utbilda våra anställda, som i sin tur ska utbilda våra operatörer på dessa featuren. Då måste vi veta; till en viss tid och plats i den här fasen så måste vissa saker vara redo och skickas någonstans, så att nästa fas ska kunna starta ett antal saker måste vara klara v för då måste nästa grupp börja arbeta på sin pris strategi för att vi ska kunna sälja och så vidare. Vi har ett enormt maskineri och värdeström att mappa upp och det inte skulle gå att göra utan en Stage-Gate modell. Det är bara naivt att tro.

De som tror på den här typen av extrem empowermet är ofta personer som har ganska smal bild av hur produkt utveckling går till i sin helhet. Man vill alltid hitta olika sätt på hur gruppen ska göra sina arbetsuppgifter roligare och bättre. Men det är inte alltid det blir bättre för helheten eller produkten och vissa tråkiga arbetsuppgifter måste göras också för att produkten ska bli klar. Jag är en av de som tror på empowerment rörelsen men inom rimlighetens gränser.

Vi hörde nyligen att ni har ändrat själva PROPS-modellen till något som kallas HWDP? Kan du berätta mer om det?

Så är det inte. Utan PROPS är modellen som vi har haft för att ta våra Toll-gate beslut på all typer av projekt.

HWDP är en SUB- process som används för en viss del av vår hårdvaruutveckling. Den har också följt standard toll-gates men har varit mer anpassad för hårdvaran och följt andra checklistor.

Vad vi däremot gör nu, är att vi gör en jätterörelse/förändring i princip där alla går mot agile och lean. Vi tittar på hur de stora ramverken behöver förändras. Detta är jobbigt för oss, för att vi förändrar allt. Vad som sker nu är det blir lite som agile och lean är ute i världen. En bottom-up rörelse. Om vi nu antar att *bottom-up* är en produkt, så har vi kanske 100 produkter så gör man produkterna lite olika och så blir det informellt olika *best practices* och det bildas olika besluts modeller. Vi har väl idag lite olika beslutsmodeller som får anpassa sig till varandra. Det är väldigt svårt förändra och göra om besluts modeller och besluts process.

Vi förändrar väldigt mycket i själva grunden just nu. En jätte duktig ingenjör eller designer får kanske nya arbetsuppgifter som en utvecklare istället med helt nya arbetsuppgifter. Det innebär att man förändrar grundvärderingarna i vad de tycker är viktigt, så det är väldigt svårt.

Var det något specifikt som fick er att börja med agile och lean? Var det något som bara kom upp eller hade ni några påtagliga faktorer som indikerade att detta kan verkligen vara bra och arbeta med?

Det är lite när agile manifestet kom ut. När forskningsvärlden föreslår och tänker ut metoder oftast är då några, främst mindre företag som påbörjade med detta. När vi då började med detta det var väl 2001 det började med agile manifestet och sen var Ericsson ett av de företagen som var tidigt ute 2004/2005. Då var det verkligen innovatörer inom Eriksson som började röra sig åt det hållet. De började snabbt se hur produktiviteten ökade med mindre krossfunktionella team och man gjorde det inom produkter som var mer autonoma.

Vi säljer ju främst nätverk, jag kanske berättade att jag jobbar på ett projekt som har 500 man, det är klart att då måste detta synkas med tio andra produkter och projekt som också körssamtidigt. Så det började med de autonoma produkterna och man såg att det var bra!

Det roliga med dessa rörelser tycker jag, är att många gånger inom Ericsson då vi har genomgått en förändring, beror det på att vi ser någonstans själva att det behövs och många gånger tänker man också att; ”Det *passar dem men inte oss”*. Men här har hela världen ändrat sig samtidigt, folk läser om det, det kommer ut böcker. Rörelsen kommer underifrån på ett annat sätt idag.

Problematiken som tillkommer är; hur bör själva förändringen ske? Alla som läser om detta ,tar också åt sig saker som passar dem. Sen ska man sätta det i kontext. Vad har vi för produkt? Vi har en produkt som innehåller flera millioner rader kod och bytt plattform två gånger. Ni kan tänka er hur den arkitekturen är och hur den produkten ser ut. Under dessa förutsättningar ska då en migration ske mot en förändring, nya arbetssätt, och sammanslagning olika system och avdelningar.

Sen finns det folk som positionerar sig fast i sina discipliner. Då ska man plötsligt slå samman dem och bilda ett team. Det finns många frågor som kommer upp till, så som; prestige mässiga saker, position mässiga saker, lön, Kunskap och liknande.

Men det blev så naturligt i detta fall. Det kom rapport efter rapport, internt och externt som visade att det blev bättre. Detta gjorde att rörelsen växte sig så stark att även högre chefer började allt oftare prata agile och lean. Det måste sägas att det fanns chefer som var väldigt för detta och kämpade för detta uppifrån också. Så man kan säga att trycket för förändring kom även uppifrån såväl som nerifrån. Data finns där för förändring, nu är det endast svårigheten i att göra det, att migrera.

En av de allra svåraste delarna är att vi använder agility för att bli mer responsiva, och lean för att arbeta mer effektiv genom att hela tiden jobba med impediments (waste). Så r vi ser detta som ETT KONCEPT, vi jobbar inte med agile eller lean utan vi jobbar med att vara mer agile och lean. Det är dit vi rör oss mot. att bli mer agile och att vara en lärande organisation (kontinuerligt förbättrande organisation) med hjälp av lean.

Det svåra med detta är att vi har folk som exempelvis pratar med kunderna och kollar marknaden. Och sen jobbar de med business planer och produktplaner för att sedan ställa upp kravspecifikationer för produkten. Nu vill man att dessa krav är mer förtydligade mot business perspektiven, Och då tillsätter vi roller som produktägare som ska kunna gå emellan de här funktionella leden. För att ens kunna bara rekrytera dessa roller, så måste vi ha personer som är kunnig inom business, system och projekt Ledning. Det är människor som kommer från helt olika discipliner och olika organisations funktioner. Det är otroligt svårt att få tag i kompetenserna. Vi har i åratal odlat kompetenserna på ett visst sätt. Nu ska vi hitta personer i ett smalare område och de ska dessutom agera över de här organisationsgränserna och det är extremt svårt att omorganisera detta. Det är inte lätt att pilla med lyckade organisationer som redan är väldigt vinstgivande för företaget, i hopp om att vara ännu mer lönsamma. Det vill säga man kan inte bara komma in och göra anspråk på duktiga människor och kräva att de ska göra nya saker bara så där.

Nu när ni har satt igång detta har ni haft några projekt som ni har kört med den här nya processen? Hur har ni mätt dessa förbättringar, förutom lönsamhet som mått, mäter ni resultat i tid eller annat?

Jämfört med många industrier så är vi dåliga på att mäta. Då pratar jag inte bara om den stora vyn Om jag tar tennisbollarna som analogi så är de väldigt svåra mäta och spåra lönsamhet till tennis bollarna. Vi mäter vad vi kallar för *feature velocity*. Vi mäter det per arbetstimme eller per ingenjör eller arbetsteam och detta ligger vi hela tiden och mäter. Men man kan fråga sig om det är bra eller inte, men alternativen till det är att mäta kodrader och kodkompexitet och där vet man att det fallera, så vi har bestämt oss för feature velocity.

Vi vill hela tiden öka vår förmåga att göra mer och snabbare. Ibland kan snabbare vara viktigare en mer. Man vill kunna göra mer specifika lösningar till specifika krav från specifika kunder. Dessa kunder kallas för key customers. Utöver det mäter vi lite andra saker också, vi mäter en del felrapports nivåer och integrations nivåer. Det vi kommer att jobba lite mer med framöver *är team velocity*. Det går ut på att teamet ska känna till sin egen velocity d.v.s. veta vad de är kapabla till och utifrån det, kunna ta bort sina impediments/ (mura, waste). Och på så sätt bli bättre.

Och det är svårt .För att väldigt svårt om du får jobba med en komplex produkt, En gammal kod eller någon ny utvecklad del, storleken på det ,eller hur välbeskriven den är arkitekturmässigt. Så det blir väldigt viktigt att inte använda detta som måttstock för att mäta teamen mot varandra (benchmarka teamen mot varandra). Detta kan bli så väldigt personliga då. Men vi behöver förstå om ett team som är så är ett visst antal människor, vad är de kapabla att prestera? Vi behöver förstå att i en organisation som är på 500 personer hur många av de ska vara i ett *tvärfunktionellt team* och hur många av dom behöver vara i s.k. *run-way teams* d.v.s. teams som ska se till att ett projekt startar och landar. Så det är många sådana frågor.

Har ni förutom nu agile och lean att speciellt typ av metod som kan vara en viktig när man rör sig mot agile och lean.

Man behöver ett verktyg för att hantera Backloggen bättre. Men på senaste två till fyra år har marknaden för dessa typer av verktyg fullkomligt exploderat.Det finns inget som är outstanding bäst. Vi har i olika delar av Ericsson valt att gå mot *Hansoft backlog management*. Som är ett som verktyg

som man kan jobba med när det gäller *backlogg managment*, *Collaboration management* och *task handling*. Vi har inte bestämt ännu vad vi ha verktyg till. Vilken information behöver finnas tillgänglig, om det ska vara något elektronisk. Det beror på lite hur distribuerade vi är. Teamen ska ju företrädevis vara på samma site. Och då kan man säga att informationen som är ämnat internt för teamet ska vara på whiteborden. Där det är visuellt och folk kan samlas kring det.

Sen finns de whiteboards i de här verktygen när man behöver dela med sig och, där håller vi fortfarande på att fundera vilken information som bör finnas. Vill man göra det lite enklare så bör man hålla sig till scrum metoden när det gäller att implementera vissa roller kring teamen, ifråga om teamen själv, scrum masters och project owners ,sen behöver vi skala upp allt vi gör, vilket gör det hela väldigt mycket svårare

Om du själv var i vår situation med den kunskap och erfarenhet du har, hur tycker du är det bästa sätt att kombinera de viktiga faktorerna som är för att skapa en framgångsrik lean och agile modell. De faktorer som har påverkat mest? Samt de som har varit svårast att ta itu med som har visat sig vara kritiska för att en projektstyrningsmodell ska fungera.

För det första måste du ha ett program ,en Stage-Gate modell/ projekt styrningsmodell. Man ska inte tro att man kan styra utvecklings verksamhet utan sådana här modeller. Det går inte med att bara tänka *"om alla bara gör så gott de kan så blir det nog bra".*

Det andra är att man att hela tiden kolla på *business* perspektivet och fråga sig hela tiden; *"är det business att göra detta?"*. Kanske var man mer RnD orienterad förut, man höll på och jobbade med scoopet väldigt länge och sen tog man ett jättestort beslut. I den här branschen kunde man kunna sitta och jobba med teknologi excellensen lite väl länge. Nu görs små scoop med *"business tänk"* hela tiden. ? En feature fylls med informationen, *"vilken kund", "varför" "när"* och*" hur".* Ofta kommer folk fram till mig med en apparat som har olika förkortningar och då frågar jag vad gör den här? Då svarar de att; *"den får en viss signal att hamna här eller där"*. Då ställer jag frågan;" *om jag var en operatör varför skulle jag ha den"? "Till vilken nytt är den?"* . Det handlar inte att det är dumma människor utan det är för att vi har tidigare jobbat så. Så man kan säga att nummer två är *business perspektivet.*

Det tredje som är väldigt viktigt för oss är speed. "*Speed trumps any other improvement"*. Om du kan tänka dig att du jobbar på att effektivisera tio procent kontra att köra tio procent snabbare där du kan få ut en produkt och bli kompenserad. Med lite räkneexempel ser man snabbt att få ut saker lite snabbare är den absolut bästa effektiviseringen vi kan göra. Det innebär det att man måste ha detta som en tankesätt sätt hela tiden. Medan kvalité tar tid och är långsamt så innebär det inte att speed ger sämre resultat i slut ändan. Gör man något snabbt och får snabb feedback från kunden som gör att man förstår saker och får kunskap snabbare därmed kan man återgärda dem snabbare så att det blir rätt. Detta är bättre än att på egen hand försöka lista ut alla detaljer som ska bli rätt och försöka presentera en så bra produkt till kunden första gången. Problemet där är att ofta tar det långt tid och det blir svår att spåra *vem* har gjort *vad* vid eventuella fel. Speed ger kvalité tänket. Tidigare har vi alltid prioriterat mellan tid, scoop och kvalité och nu ser vi att de går samman. För den lilla tennisbollen du gör så är tid alltid väldigt viktigt och då får du samtidigt kvalité.

Andra företagen betygsätter efter varje steg gör ni det? Exempelvis på Volvo görs en Review, de har satsat på en mer framtung version av sin GDP där dom tog bort stagen och satte in milestones.. Review fungerade som en slag bas på hur man ska förbättra sitt arbete med avseende på olika aspekter så som tekniska aspekter och business aspekter.

Det finns i grunden i vårt system. Varje team jobbar i sprintar. En sprint varar i två till fyra veckor och avslutas med en retrospektiv. Där man går igenom vad som var bra och vad som var dåligt. Där fångar man bl.a. impediments/wastes. Impediments som de kan lösa själva eller sådana som de behöver andras hjälp för att lösa?

En annan sak är att vi jobbar med stage modellen istället för milestones. Stage-Gate är lite mer formell och större en milestones. Skillnaden är väl den att Stage-Gate blickar framåt medan milestones blickar bakåt. I vår modell försöker vi jobba med guidelines för hur man ska jobba istället för att göra som gjorde förr. Då hade vi checklistor. Istället för att ha någon som ska gå och kolla att 248 punkter på en check lista är uppfyllda så har man guidelines för hur våra team ska jobba för att åstadkomma sina mål. Vi ser på detta som ett organisatoriskt minne där en del saker för all del blir obligatoriska. Sen finns det andra saker som inte är valfria och rekommenderade är inte heller rätt ord, men det vi säger är *"det här är något ni själva ska brinna för och känna för och lära er"* och det ska med tiden sitta i ryggmärgen.

Det är inte som det var förut där man sa att man passerade en milestone genom att ha gjort en check lista. Man tog då egentligen inget ansvar. Nu vill vi ge teamen förutsättningar för alla saker som borde göras, men det är upp till dem. Då slipper man säga *" nu vi har fyllt i check listan och vi är klara".* Utan antingen funkar det eller inte. Antingen blir det bra eller inte, antingen blir det klart eller inte. På den nivån är det. Men jag tror att alla som jobbar med agile och lean jobbar med de här sakerna. Det just det svåra här, innan har vi haft massa roller i form av specialister som ska godkänna massa saker för teamen. Nu är det inte så, utan teamen måste lista ut detta själva. Om de behöver hjälp så är hjälpen där, man får råd och rekommendationer. Detta gör att man bygger upp empowerment samt att accountability ökar också.

Har du erfarenheter från andra företag med lean agile process ändringar?

Jag har bara jobbat på Eriksson med dem här frågorna. Jag har forskat tidigare och är docent. Så jag har tittat mycket på det och läst om det.

Har du stött på dessa frågor Under forskningens gång??

Jag har jobbat med två Volvo bolag och Saab. När jag pratar med andra kollegor så har de exakt samma typer av problem. Så på ett sätt har vi varit väldigt lika i våra klassiska modeller. Då det rör sig om agile och lean har vi haft samma svårigheter när det kommer till migrationen. Men då kommer vi mer in på Change managment aspekten. Och där tror jag att i jämförelse med många andra företag att Eriksson är bra.

En sista fråga, du har berättat lite om det här men, kontinuerlig inlärning. För folk som har jobbat i projekt och projektet är klart hur man tar vara på den kunskapen

Vår stora läroprocess är via vår kontinuerliga retrospektivs. Att hela tiden få igång den här processen där man själv löser impediments/waste, eller hittar andra sätt att lösa det på . Det är helt ok att göra fel och misslyckas, men det är inte ok att göra samma misstag två gånger. Det gäller att lära sig och vara mer systematisk. Man ska komma ihåg att det som triggar en ingenjör eller utvecklare är att lösa problem. Hitta problem och lösa det! Men här ska du helt plötsligt göra saker så att det inte ska bli några problem och du ska lära dig av det som har gått bra. Det är lite process och arkitektur frågor och det är väldigt mycket kollaborationer. Frågor om hur man jobbar tillsammans, Hur du kommunicerar etc. Vi kan inte hitta alla beroenden (dependencies) inom up-front planering.

Vi stöter på beroenden(dependencies) i vår process som vi aldrig känt till! Då måste man kommunicera med varandra. Det kan vara väldigt jobbigt för detta har koordinatorer och projektledare löst innan. Det kanske räckte att endast tala med sitt eget team ledare och berättat om problemen. Nu vill vi folk ska kommunicera tvärfunktionellt och mellan teamen i de andra avdelningarna, eller ringer till någon som är i ett annat land på kvällen. Dessa saker kan uppfattas som jobbiga men om vi fortsätter i den här riktningen, om tjugo så kommer vi ha glömt de här svårigheterna.

Appendix 4-transcript of interview at Volvo Trucks 2013-09-05

Thorsten Martinsson

- system konstruktion på Ericsson,
- Marknadsanalytiker på Ericsson
- Pris chef på Ericsson
- Volvo 10 Change agent

David Haglund:

- Produktion operation manager
- Senior Project Manager
- Arbetat 2.5 år med Lean.pd på Volvo i olika applikationer
- Change management på Volvo sedan 2006

Kan ni berätta lite om ert arbete med lean och RnD 30 på Volvo Trucks?

Thorsten Martinsson: Grundprincipen samma på Volvo Trucks och Volvo Penta (R n D 30). De flesta Volvo bolagen har tittat på detta ur en övergripande princip nivå Volvo Trucks (f.d. 3p) tittade på detta både från rot-orsak samt processer. Man styrde mera på tiden som mått/variabel på effektivisering i projekten, man tittade mycket på att ändra besluts logik i Stage-Gate modellen. Att fatta besluten vid rätt tidpunkt.

***David Haglund**: Sobek pratar mkt om detta, skillnaden mellan tidsbaserad planering kontra beslutsplanerad planering och hur det påverkar*.

Thorsten Martinsson: Det man har gjort nu på lastbilssidan, är att titta på; *"vad ä den logiska ordningen i arbetsätt när det gäller att tillverka och få ut en lastbil som uppfyller marknadskrav?"* Och använda det som underlag för kritiska beslutspunkter i den ordningen sakers görs. På det sättet identifiera adaptiva och iterativa arbetssätt för att hitta gradvis mognadstillväxt. Detta görs i både produktion och produktsystemet parallellt. Historisk sett har man jobbat mycket med att mognads tillväxt är sekventiell .Först produkten sedan produktionssystemet, sedan får man ofta iterera om produkten för att det ska passa.

***David Haglund:** Sedan får man säga att logiken har anpassats utifrån den Stage-Gate modellen som fanns med vissa uppdateringar, vi har inte gått hela vägen till och köra **integration events**, även om vi gör utvecklings loopar mellan gates.*

Thorsten Martinsson: Vi löst detta teoretisk, men måste jobba mer med processer för att sedan få till en praktisk lösning, det kommer ta en bra tid till. Framförallt jobba med kulturer och beteenden och ta ansvar för att få till en förändring och implementering.(RnD30) Det är svårt med storskalig förändring. Förutsättningen för förändringar är ett tydligt ledarskap och har man inte det kommer det ta tid och bli svårare.

David Haglund: *Om man ska föra in en lean system, måste ledningen ge sin support, man skulle kunna ta fram de perfekta processe beskrivningarna, men utan ledningens/chefernas stöd som förstår vad lean är och agerar efter det kommer de nya lösningarna inte användas*.

Thorsten Martinsson: Lean förknippas oftast med produktion, och oftast kopieras produktionskoncepten direkt till utveckling vilket inte fungerar pga. av det är olika miljöer. Det innebär att man inte kan styra på samma sätt. Om inte ledningen som driver detta inte förstår dessa skillnader, kommer det leda till problem i praktiken.*(*

David Haglund: *Man kan sätta upp en bra/fin teori för hur man bör implementera Stage-Gate med lean koncepten, men det är inte en förutsättning om man lyckas eller inte.Det är förändringsresan dit som avgör om implementeringen blir framgångsrik eller ej.*

Thorsten Martinsson: Styrning kommer också vara viktigt, hur man styr. kopplad till gaten i Stage-Gate modellen finns s.k. **KPI**: er, har man stark KPI men kommer väldigt sent in i projektet då innebär det att man styr väldigt hårt på tid och datum för gate-passagen*, (G-POT) gates passed on time, (handlar om projekt kvalité, kostnad för produkt och projekt leverans datum, etc.)*.

Viktigt för ert arbete är att förstå hur gate beslut går till. Hur det går till om man har projekt specifika styrgrupper som har anpassar sig efter projektet, eller om de har rigida möten som innebär att alla möten ska gå upp en vissa datum, och man bockar av en massa saker och alla projekten på engång.

Såsom jag ser det inom lean P. D Idealt, så behöver man inte ha sådana möten, man har en ledning som har möjligheten och gå omkring i olika Obeya rum och får en bra uppfattning av nuläget. Det blir möjligt att agera med engång och det behövs inga formella presentationer. Man har en bra koll på vad som hände och kan då också ta bort massa dokumentation från projekten. Samt interaktionen medarbetare emellan hjälper detta att fortskrida.

I projekt teorin har du 3 dimensioner.

1. **medarbetaren**
2. **projektledaren**
3. **styrgruppen(beslutar och frigör pengar)**

i Volvo är styrgruppen delat i två delar. Det som är styrgruppen är inte en riktig styrgrupp. De rekommenderar en beslutskommitté att frigöra pengar. Och de som har pengarna har inte någon djup förståelse för projekten utan agerar på rekommendationer av det som på Volvo kallas styrgruppen. Volvos system stämmer inte helt överens med projektteorin.

David Haglund: *Det kan också gå åt andra hållet. Det pengabeslutande organet kan säga till styrgruppen att;" nu vill vi köra det här projektet, det är ett viktigt projekt!". Oavsett vad styrgruppen kan tycka, så kanske projektet inte blir klart, då måste man öppna en gate trots att det inte finns pre-requisites eller beskrivningar av vad som ska göras eller resurser heller .Detta samspel mellan dessa 2 grupper kan ju leda till en del konsekvenser för Volvo om man drar igång projekt som inte är klara och det inte finns klara beskrivningar av vad som skall göras.*

Thorsten Martinsson: Det viktiga och veta om Stage-Gate är att när du passerar en viss gate så gör man vissa grund antagande om projektets skick. På Volvo är det ok och göra vissa formella releaser av dokumentation för att kunna begära offerter av leverantörer. Vid andra tillfällen har man möjligheter och beställa produktions verktyg för miljarder kronor. Möter man inte intentionerna i modellen, får man väldigt dyra loopbacks.

Om du mäter *G-POT* kommer styrgruppen att se till att gaten öppnas enligt tidsplanen, trots att projektet inte är mogen nog för det. Därmed är man tillbaka på tidsbaserade beslut framför kunskap/aktivitets baserade beslut.

Om man vill göra en förändring som VD måste man vara mycket tydligare med tänket bakom. Att verkligen förstå vad det innebär, det gör man oftast inte. Om jag ska göra driva ett projekt, som lean P. D så är det risk baserad, det är riskplanen som styr hur du tar dig framåt. Risk hänger ju initialt ihop med kunskapsgap, och senare med andra saker.

Set-based har varit svårt att jobba med, för man förstår inte principerna fullt ut. Vi sätter utvecklings loop, vi sätter takt i projektet, och tydliga mognadsmål i slutet av varje tvärfunktionell iteration. Men om du jobbar set-based tittar du mer på design rummet, och trade-offs. Man är inte mogen för detta för man har inte förstått vad det innebär. Det kan dessutom vara så att man inte har tyckt att det är värt och skapa djupförståelse. Det är lätt när man vill ha förändringar att hoppa på koncept som är modemässiga och som är populära utan att ägna sig åt djupare förståelse.

David Haglund: *De som har förstått, inser vilken utmaning det är, för vi har inte den kunskapshistorian, vi har inte trade-off kurvor etc. Och så måste vi samla kunskap och bygga på kunskapsvärde strömmen, samtidigt som vi ska ta till oss nya arbetssätt för att kunna applicera en metod. Det måste finnas balans mellan ledningens önskemål om snabba fix och resultat, kontra den praktiska verkligheten att det finns ingenting som är snabbt, billigt och enkelt, det är hårt arbete!*

Hur Jämförs Volvo trucks med Penta, där man lagt mycket tid på front-end tasks?

Thorsten Martinsson: Om man tittar på projektutvecklings teori, en viktig del i början är hur man bryter ned en produkt. Om man har krav, som man bryter ned i hanterbara enheter så att man kan jobba på ett vettigt sätt i projekten, om man denna fas har för mycket folk så havererar det.

Varför blir det så?

Thorsten Martinsson: Man börjar front-load, men när man sätter själva arkitekturen i själva projekten så bör seniorer ta de beslut som krävs innan man drar in folk som gör detaljjobbet. Det kan vara en svaghet i lean P. D den tänker inte i projekt utan i nyckelmetoder men inte så mycket på produkt arkitektur frågorna.

David Haglund: *Det bör tilläggas att vår tolkning av front-loading har mognat och gått ifrån att man ska lägga mycket resurser tidigt, till att snarare stänga kunskapsgapen tidig. Sen kan det innebära att det behövs mer resurser för det men det måste vara en följd av att kunskapsgapen ska stängas tidigt det är syftet med att front-loading*

Thorsten Martinsson: Du vill stänga kunskapsgapen innan du fattar några konceptbeslut som styr produkten och detaljutveckling. Om du har kunskapsgap vid den tidpunkten är risken stor att du får göra om ett grundkoncept för produkten. Då tillkommer massa följdändringar. Kunskapsgapen måste då vara stängda. Begreppsförståelse är också viktig. Få djupförståelse vissa begrepp innebär för min vardag. De kan täcka vida saker. Vissa saker kan vara enkla medan andra delar är teknisk jobbiga. Så det är möjligt att man kan jobba på olika detalj nivå med samma begrepp.

David Haglund: *Något som många talar om är kopplingen mellan kunskapsvärde strömmen kontra produktvärde strömmen, där vi traditionellt har satsat väldigt mycket på produktvärdeströmmen. Där finns mycket styrmodeller och GDP. Men hur kan vi styra om ifrån detta tidsbaserade tänket till att även inkludera kunskap som en leverans? Kunskap är det värdeskapande i en P. D process, det är en resa och en mental ändring som behövs, och även ledningen måste fråga efter det.*

Angående Kunskapsbevarande-Återanvänds kunskap? Hur görs det med dokumentering och sådant för att ta tillvara på kunskapen som genereras?

Thorsten Martinsson: Kunskapsåteranvändning är dålig. Vi fångar fakta eller information, men inte kunskap. Vi generaliserar inte informationen så att det blir applicerbar på nya fall. Det är ganska svårt. Man bygger in det ofta i projekten och i gate-modellerna, man har så kallade white-books anteckningar, men de används väldigt sällan och svåra att komma åt. Oftast läggs de till vissa projekt och det är de som jobbar på projekten som har tillgång till dem. Det blir väldigt svårt att återanvända dem. Dessutom är det gjort i ett format som gör det svårt för att återanvända dem. Så det är en rot-orsaks problem.

David Haglund*: Detta är då kopplat till värdering att kunskap inte viktig. Det är 2 aspekter, det är inte värdeskapande arbete, för jobbet är ju att skapa en produkt. Samt när det blir problem så löser man problemet för att fixa till projektet. Man gör en 1:a ordningens problemlösning, och ingen 2:a ordningens problemlösning som innebär att hitta och lösa rot-orsaker, det hinner man inte. Det är oftast när man har kvalitets problem som det görs. Inte ens då görs det fullt ut. Man följer inte upp effekterna av det, och allt som oftast görs inte det ner till process nivå. Exempelvis: hur kunde vi missa det, vad var det i processen som gjorde att vi förbisåg problemet eller missade att det blev något fel. etc.)*

Thorsten Martinsson: Problemet är också, för att försvara det litegrann. Om man jämför med problem lösning inom produktions miljö som är en mer väldefinierat miljö, och man har snabb en snabb återkoppling på problem, exempelvis; redan vid nästa station märker du att något är fel. Jämför man då med produkt problem, så är det en kombination av artiklar som inte fungerar ihop. Sen att hitta ett mönster i detta är inte så lätt. Återkopplingscykeln är mycket längre också i produkt utveckling än i produktion vilket gör det svårt att förebygga. I produktion jobbar man oftast i ett flöde, i P. D så i jobbar man i många projekt samtidigt. Det är många parallella flöden och de är inte linjära flöden heller utan de är iterativa och cirkulära. Ofta försöker man dela utvecklingen mellan de olika projekten och det gör det ännu svårare, speciellt under olika utvecklingsskeden.

Är det svårt att döda projekten?

Thorsten Martinsson: Volvo dödar väldigt sällan projekt. Bara vid ett tillfälle görs det, när det är lågkonjunktur budgeten måste reduceras. De läggs då på is ,och så kommer de upp igen! En viktig sak är också, man kan ha en perfekt modell för lean P. D men matar man in för många projekt i systemet så kommer systemet haverera ändå(portfolio management – tippning Point)**.** Sen är det också skillnad mellan arbetstimmar man lägger ner och projekt tid. Man måste vänta på saker. Såsom att andra gör klart saker för man ska kunna gå vidare. Många glömmer dessa faktorer när man lägger räknar timmarna.

Man inför olika kontroll system som tidsrapportering, bokar personen för x antal timmar, så tror man att man har kontroll. Sen är det oftast inte själva systemet eller Stage-Gaten som är dålig. Snarare applikationen av modellen. Om gaten hade av default varit stängd tills man kan bevisa att man är mogen för nästa steg och man styrt mer på output, vad som faktiskt levereras istället för timmar.

Balanserar man portföljen utifrån den faktiska realistiska tiden aktiviteterna tar. Man kan tänka sig att det är **lösningen** som ska igenom gaten, istället för **antalet beställda timmarna** som ska gå igenom. Man köper 10,000 timmar, för det är vad budget system säger att man ska göra snarare än en lösning.

Köper man timmar till projekten, då har man egentligen inget incitamenten till att bygga kunskap. För det är antal timmar som säljs ut inte någon lösning. Köper man lösningen istället då finns det ett egenvärde i det för att processen blir smartare och har mer kunskap så att nästa gång kan du sälja den lösningen billigare.

Vad tycker ni värdesätts mest, human, process eller tools and technology?

Thorsten Martinsson: Mäniskan är underordnad teknologi i detta fall. Även om tid är en mått på effektivitet, är det inget ändamål eller allmänt vedertaget av ledningen. Det är mer att inte ta risker, eller bli uthängda. Man kan köra projektet som går mycket snabbare än vad som egentligen är möjligt, man försöker klämma igenom projekten igenom systemet, man respekterar inte system konsekvenser av besluten. Projekten körs inte i en takt man klarar av. Detta beror på att man inte har rätt system förståelse. Då pratar vi om antal projekt inte komplexitet i projekten.

Ett annat område som är viktigt att titta på är hur produkt-ledning fungerar. Produktledning är en funktion som har en viss livscykel ansvar för produkten. Att se till att man får maximal avkastning på de pengar man lagt in i produkten, både på befintliga, nyutvecklade och att underhålla gamla. Det fungerar olika bra på olika företag. Generellt så fungerar detta bra i Telecom företag. På Volvo skiljer det sig åt mellan bolagen hur bra det fungerar. Finns ingen som har ansvar för helheten, Finns ingen bra motsvarighet till *chief Engineer*.

Tycker ni det är svårt att implementera den typen av ledning som Toyota har med en stark chief Engineer?

David Haglund: *Det är byråkratin som står oftast vägen. Det behöver oftast inte vara en person heller, Volvo bussar har lyckats bra med det. De har en gruppering som tar den rollen, samt Volvo personvagnar har två personer som tar den rollen, en som tar hand om det kommersiella och en som tar hand om det tekniska de går i par. Mycket handlar om vad produkt ledning är och organisations*

struktur som tillåter att någon går utanför ramarna. Vi är oftast i vår silos och tänker komponent organisation istället för processerna som helhet.

Thorsten Martinsson: Finns folk som kan ta den rollen här på Volvo trucks, men de kommer endast in när ett projekt har havererat och som är extremt affärskritiska.

fanns ett projekt som hade havererat, som drevs i mål av en stark person som egentligen inte hade formell behörighet/befogenhet. Men personen hade en så pass stark position i företaget att han fungerade nästan som en Chief Engineer. Detta skedde sent i slutet som en ”firefighting” åtgärd istället för att ha det i tidigare skede.

Ofta när man kör ”firefighting”, så växer förtroendet för det. Tankesättet blir; ”*om det skiter sig så fixar vi det”*, *vi har gjort det förut ”*. Så tänker många, därför är man är inte så noga i ett tidigt skede. Sen utvecklar man metoderna för att släcka bränder, och de som stiger fram blir hjältar och blir befordrade. Han som sedan blir chef befordrar sina likar som också är duktiga ”firefighters” på detta vis blir det blir en självförstärkande beteende, och man bygger in det i system, det blir en ond cirkel.

Vilka andra management metoder ni jobbar med ,som kan vara av värde från ett lean perspektiv?

Thorsten Martinsson: Vi jobbar mycket visuellt, Scrum hos mjukvara tillverkarna, det är bra arbetssätt. Men det bygger mycket på produktledningens kompetens. Det kräver en viss mognad och vara aktiv. Man behöver veta ingående vad kunden värderar istället för en lång feature lista, en riktig produkt ledare vet vad kunden värderar. Om man inte förstår det utan och bara skickar långa listor med specifikationer så är det ingenting annat än bara önskelistor, man vet inte vad målet egentligen är. Det gäller och våga prioritera. Har man en miljö där man inte är van vid att prioritera och *allting är hela tiden* viktigt, då är egentligen *ingenting viktigt*. När vi har återkommande budget möten, försöker vi ta fram strikta prioritering listor. Det kräver en mognad som behövs, och som är svår att få till.

Vad baseras prioriteringslistan på?

Thorsten Martinsson: Kundens önskemål, man måste förstå varför man gör dessa projekt egentligen!

Har ni sett lean och Stage-Gate implementerat på andra företag, hur det har gått till, om det funkat bra eller dåligt?

David Haglund: *Överlag så lean P. D så är det mycket olika skolor. De som fokuserar på kunskapsuppbyggande och har förstått det, och de som focuserar på metoder och applicerar bara verktyg, och kanske får man lite bättre och tydligare flöde men de bygger ingen kunskap.*

Thorsten Martinsson: Dels är det olika filosofier för vad man implementerar, och dels olika perspektiv på hur man implementerar det. Om man gör det som en ”snabb fix”, och kör breda program där man tror sig kunna massutbilda eller massförändra på kort tid, då kommer det haverera

Saab Defense systems har gjort detta bra. De hade en smart modell för att få ut förändringar eftersom de insåg att ledningen kanske inte var helt ombord. Man byggde in valfrihet och lade mycket tid på att förklara tänket bakom. Reflektionsdagböcker, grupps diskussioner och olika events.

Man tvingade inte ut implementeringen. Scania gjorde också något liknande, man körde studiecirklar som passar den svenska kulturen.

David Haglund: *Detta leder tillbaka till syftet med implementering, och programmet. Är syftet "kostnadseffektivisering" så tvingar man och trycker ut det, för då har man lovat aktiehållarna eller chefer att göra det. Volvo har ju gjort det, 2009 lovade man att man skulle effektivisera si och så mycket, och förra året stängde man formellt programmet för att man nått målen.*

Hur ska man kombinera lean och Stage-Gate?

Thorsten Martinsson: Min bild är att; om dessa ska komineras, måste Stage-Gate modellens syfte uppfyllas. Man måste sätta kriterierna i samband med gaten och se till att man är framåtriktat och inte bakåtriktat. Man måste titta **affärsvärdet** också **istället för** bara **aktivitete**r, samt **resultat** istället för **checklista mentalitet**. Sen finns det massa nyckel komponenter runt detta, såsom *produkt ledning*, *projekt kompetens* och *projekt portfölj hantering* som möjliggör detta.

Teori vs praktik vad är den stora skillnaden?

Thorsten Martinsson: Teorin är för enkel ibland. Teorin glömmer av 2 saker,

1. teorin inte kopplad till projektmiljö tillräckligt mycket
2. Kopplingen till organisations förändring har inte studerats tillräckligt väl.

Man missar frågan; "*varför gör vi detta?* "Om folk inte vet "*varför*" man gör saker så blir de oroliga, blir man orolig då vill man inte förändras. Förändring är per default farligt.

David Haglund: *Man kan slänga upp en knowledge value stream. Hur ska man i praktiken få till det beteende som krävs? Man måste ha en värdering i att människor kan bidra, människor och den kunskap som de besitter är din tillgång,, då kan inte sparka ut dom.*

Att ta Set-based engineering som ett exempel. Det finns inga konkreta exempel på det hur det fungerar. Det finns inga beskrivningar på detalj nivå, det finns ett gap i litteraturen. Ett annat gap som finns är att det inte finns en tillräckligt bra förklaring på vad skillnaden mellan trade-off och limit-curves är. Literaturen är ibland för abstrakt.

Bästa sättet att inkorporera lean principer i Stage-Gate? Vad bör man focusera på i första hand?

Thorsten Martinsson: Det är en lednings fråga att driva det och de måste förstå att det tar tid. Ha en stor grupp av personer som driver detta. Anpassa kulturen till företaget. Som Scania kvälls kurser och studie cirklar det blir ett sätt att föra ut denna kunskap och vara uthålliga och skapa intresse för det istället för att bara trycka ut det.

I vilken en ordning/rent praktiskt, så skulle jag: börja skära i *produkt portföljen*, och skära ner på projekten. Få ett mått på *affärsvärden*, vilka projekt är mest värdefulla och ta bort de som är mindre/lägst Värda tills man når en nivå så att man kan leverera det man föresatt sig.

Den tid som då frigörs bör läggas på att systematisk förbättra systemet. Då ska man rikta in sig på viss kontroll punkter. **I projektdimension**, så ska vi trycka på kvalitets *gater/milstenar*. Och då pratar vi om *konceptvalen*. För att komma förbi den måste vi ha *stängd kunskapsgapen*. **I kunskapsdimension** så måste man se till att *strategin hänger ihop,* och sedan jobba med *kunskaps kultur.*

Appendix 5-transcript of interview at Volvo Penta 2013-04-29

This interview was not recorded and was only recorded through writing

- **Azadeh Fazl Mashadi**- Industrial Ph.D
- Lean program manager Volvo Penta
- Lean management coach

Reason for trying to implement lean is mainly due the amount of re-work and loops that has shown to occur in the end-phases of development. The GDP has become more knowledge oriented and main targets are freezed until the concept milestone.

The pursuit for leaner P: D started with

VRES 2004-2009

VPS PDP-2009-2010

RnD 30 2010-ongoing

RnD 30 was an initiative that not only involved top management but also middle management that were very strongly involved to get the RnD30 frame work started, these middle management were working the project without a budget and were a driving force throughout the implementation.

A major difference to the better has been noted since the implementation and a change in working culture aswell. Different areas of work are usually selected and require set based engineering. These are the areas with lesser knowledge at hand. The early gates are steered towards beeing more flexible and finding the right knowledge before pursuing development. Concept milestones have been introduced to the GDP in order to attain proper knowledge rather than just fulfilling gate criteria.

Alternative concepts are pursued and are graded through a numerical grade system called TRL (technology readiness level. The scale is 1-9 and gives an indication of technical maturity. This concept is copied from **NASA**. In order to pass through the milestone a score of minimum 6 is required. A trade off must be off course made between knowledge gathering and time, not only incorporating technical requirements but also market etc.

A procedure called **Integrating events** has been implemented where stakeholders are gathered and all available information is presented. At these events everything from technical, marketing to economic aspects are presented for all the concepts that are pursued. This procedure is done until the development events start. The underlying reasons for these events are to identify gaps in knowledge.

After the development events are finished, P.D continues as usual, however with some modification on gate passing criteria. *Critical gate deliveries* must be passed, which is an indicator of knowledge levels attained and how front-loaded the project is. Often the project can be halted if the

requirements are not met. This might slow down the time slightly but enhances the quality aspects of the project. These first vents involve a lot of feasibility tests.

TRL is one of the most important aspects here and involves a lot of visual management of the project portfolios and lots of scrum planning in the pre-study phase.

To avoid the gate criteria rigidity prevalent in earlier GDP models, **Sprints** have been implemented. **Sprints** are events every 4-5 weeks where deliverables must be presented. At each sprint the deliverables for the next 4-5 weeks must also be decided, upon(i.e. this is incremental improvements and knowledge oriented development)

Different departments and Volvo companies have adapted the RnD 30 and the working procedures of the new GDP to their own functions; there is no universal Volvo standard for it yet.

Appendix 6-transcript of interview Swerea IVF 2013-12-16

Magnus Thordmark

- Technical project manager
- Concep tdevelopment manager

Berätta lite om dig själv och vad du gör/har gjort?

Magnus Thordmark heter jag och arbetar på Swerea IVF som är en industriforsknings institut. vi ingår i en koncern som heter Swerea som består av ca 500 personer i fem olika bolag. IVF jobbar med 3 -4 olika områden, såsom applikationer av olika material kombinationer och i de processer som dessa används.

Själv arbetar jag med metodutveckling. Vi har en avdelning som arbetar med produkt framtagning. Det handlar mycket om arbetssätt och metoder för produktframtagning. Det kan vara i tidig innovations faser, produktutveckling, produktions utveckling, arbetsmiljö, och ergonomi. Mycket av detta sker utifrån lean tankesättet. Vi bedriver forsknings och utvecklings projekt och arbetar då oftast ihop med både industrier och universitet.

Jag har varit här på swerea IVF 1,5 år, men har arbetat större delen av mitt yrkesliv ute i industrin. Jag började som konstruktör i början, sedan teknisk projektledare för nyutvecklingsprojekt, där efter som konsult för att hjälpa företag konstruera och utveckla produkter. Arbetade 10 år på TA Hydronics som projektledare, konceptutvecklare, samt varit utvecklings chef där.

När ni arbetar med olika företag med lean ramverket, hur mäter ni förbättringar som gjorts, finns något bra sätt att veta att implementeringen är lyckad?

Finns sätt i teorin, men inget som jag sett i praktiken. Det jag vet är att man vill lägga in mer resurser tidigt och *front-load*, för att få igen det sen. För att jobba med front-loading, måste man fråga sig ”vad vill vi uppnå”?

Vilka svagheter ser du i stage-Gate?

När jag arbetade själv i industrin som projekt ledare så hade vi något som kallades ”*Project council”*, då var det var gaterna som skulles tajmas med mötena och inte tvärtom, och det blev mycket tidsbaserade beslut istället för kunskapsbaserade det är då en svaghet. Jag också upplevt det här med hur man allokerar resurser, om man har olika typer av projekt så är det oftast en och samma resurs man använder, samma konstruktörer och projektledare till olika projekt. Dessa personer ska då kunna göra både förutveckling, ta hand om nya projekt, befintliga produkter, serva marknaden med reklamationer och sådant. Man måste kunna dela upp resurserna på något vettigt sätt, annars blir pivoteringarna sådana det dagliga får högt prioritering, på det sättet blir projekten sena och

förutvecklingen som är en förutsättning för införande av nya projekten lidande. Bättre portfolio management, sen beror det på storleken på företaget naturligtvis. Men det är ett stort fel, man har för många projekt. Man startar för många projekt istället för att försöka hitta takten i genomförandet, det är bättre och ha färre projekt och göra dem på bästa sätt istället.

Vilka lean principer brukar vara de som används mest vid uppstart, och vilka är svårast och implementera?

Man börjar oftast med någon form av en daglig styrning av sina projekt, *(stand-up möten),* man låter projektledare redovisa status och fastställa vissa mål, att man samordnar sina resurser. Kanske starta någon typ av projekt rum*(obeya)* kanske inte samlokalisera helt och hållet*,* men ha något gemensam utrymme där man samlar informationen och har gruppmöten och ett dedikerat projekt grupp.

Många konstruktörer tänker i lösningar men har lite svårare för att visualisera dem för andra. Man arbetar väldigt mycket individuellt och mentalt, det finns metoder som man jobbar mot, såsom set-based, men jag tror inte de används så stor utsträckning.

Vad är det som gör det svårt med att använda set-based concurrent engineering?

I ett stort företag är det många ingenjörer som jobbar med väldigt avgränsande bitar, då är samordningen en svårighet, och i mindre företag är det snarare tvärtom, många jobbar ensamma, de jobbar inte med många andra, man kanske är 7-8 st personer och jobbar på 14 olika projekt, då blir det ingen tid över för att arbeta tillsammans.

Vad brukar vara anledningen till att påbörja med lean?

Man har oftast en strategi, Företaget vill vara ledande. Man vill kunna växa och komma ut med nya produkter kontinuerligt. Dessa saker har de som en del av sin tillväxt strategi och det är dessa faktorer som driver förändring mot lean. Man vill få större out-put på sin produktutveckling

Vad brukar de största problemen man stöter på oftast under övergången till en ny arbetsmetod som lean?

När man börjar visualisera så blir oftast synligt var man har sina resurskonflikter, och prioriterings konflikter och dessa kommer upp till ytan, prioriteringarna kanske varit annorlunda innan, men det men har skett på ett sådant sätt som man inte varit medveten om. Börjar man lista projekten och resurserna, då ser man att vissa saker blir liggande, man kan då börja ta aktiva beslut istället.

Sen kan det också vara svårt för individer att börja visualisera och prata om det man gör, man tycker oftast att:

”dessa är mina arbetsuppgifter”, varför skulle jag berätta detta för någon annan som inte är insatt i detta”

”vad är vinner jag av det, blir mitt jobb snabbare, enklare, roligare om jag dessutom ska berätta vad jag gör”

Man måste vara tydlig med vad syftet är med det när man ska implementera

Vilka andra produkter utvecklings/projekt lednings ramverk anser du funkar bra med lean?

Jag tror att i dem tidiga faserna handlar det om att experimentera och lära sig. Då tror jag att det passar sig med scrum tänket, att man gör ett experiment och lär sig av det, och man jobbar under lite kortare perioder.

Har haft ett projekt där man tittade på det här med att jobba i sådana projekt rum(obeya). Det första man göra är att titta på sin omvärld och sina kunder och försöka förstå, vilka är de viktigaste egenskaperna som den här produkten ska innehålla för att lösa de uppgifterna man letar efter.Sen, utifrån det identifiera de kunskapsluckor som man har. ”*vad är det vi ska lära oss för att kunna realisera det här?”.* Vissa saker kan man fråga sina kunder, andra saker kanske man måste utföra någon form av experiment för och när det är gjort, börja med att definiera arbetsuppgifter och med fördel använda visuell planering. När dessa frågor sedan är lösta kan man gå tillbaka och titta på det igen. Det blir då en loop, så de tidiga faserna kan man köra scrum för att stänga kunskapsluckorna, och det är många som har börjat titta på detta och jobba med scrum, även i hårdvara utvecklingen.

Vilken påverkan har kulturen/ företag/ för implementering av vissa dessa metoder!

I Sverige är vi ju generellt väldigt informella. Vi har inte så mycket hierarkiskt tänk. Det främjar nog sammarbetstänket både mellan avdelningar och i företags hierarki. Det är en förde för svenska organisationer. Inom ingenjörers kultur arbetar vi ju mycket med fakta. Lägger man fakta bakom varför man gör förändringar så ska det nog inte heller vara så svårt och genomföra, och även minska konflikter.

Det som är svårt i de tidiga faserna, är en principen med att vänta med besluten så länge som möjligt och arbeta med olika koncept. Har man en företagskultur som är van vid att arbeta fort och vill se snabba resultat kan det uppfattas som att det händer ingenting. ”*Varför håller vi på med 5 olika förslag, det är ju bara en produkt vi vill ha fram etc.”* det blir en omställning. Man kunna ta tillvara på den kunskapen, det kanske inte leder till någon produkt i just det här projektet, men då har vi lärt oss någonting som kan återanvändas och vara till nytta nästa gång och för senare projekt. Konceptet vi har fått fram är nu mycket mer robust och mer verifierat, då kan tid och pengar sparas in. det finns nog en delkulturskillnad, men det spelar inte någon roll om det är ett svenskt företag eller ett annat företag, utan det är synsättet som måste ändras för att supporta lean principerna. Alla förändringar kräver att man förklarar *”varför vi detta”.* Vissa saker kräver att man ska lära om och lära sig nytt, då måste även rätt förutsättningar för att göra det finnas. Till exempel om man ska arbeta med kunskapsuppbyggnad, då måste man ha ett sätt att ta tillvara på den kunskapen som skapas i projekten. Det handlar mycket om att skapa rätt förutsättningar så att människor inte blir frustrerade.

Hur ser en optimal Stage-Gate ramverk sett ut för att inkorporera lean principerna enligt din åsikt?

Det måste finnas ett bra flöde. De som ska fatta beslut måste komma till projekten istället för att projekten ska komma till de *(Genchi Genbutsu).* Sedan har ju gaten olika syften det finns ju gate där man ska ha investeringar, för rätt verktyg, projektets ekonomi etc., i början av kan man givetvis inte veta allt, men det borde inte bli några i stop senare skeden. Man bör ha ganska bra vy av projekten. Man måste också noga se över hela sin portfölj, och granska den ordentligt. Beslut över ett projekt kan ju påverka andra projekt också, när det gäller resurser och prioriteringar. Om kontinuerlig granskning portföljen hade skett, då hade man nog hade vågat avbryta fler projekt.

En bra sak bra med gaten, är att det finns checklistor. Man kan komma på saker att göra och inte glömma andra saker. Dessa saker på checklistan kan man ha med sig vid en tidigare gate nästa i projekt. Det blir användbar som kunskapsåterföring, och möjligheten finns att fylla på sin checklista och det blir mer användbart.

Sen pratar man mycket om *integration events*, och det har jag inte sett fungera riktigt. Man brukar vanligen ha konstruktions genomgångar. Där sker någon granskning sker med produktion och beredning. En *integration event* är ännu mer genomgående och hela projektet med alla delar ska finnas, teknik, produktion och marknad. Man stämmer av att man är på rätt väg och att man kommer och kunna klara av sina åtaganden.

Har du stött på något företag du arbetat med, att det funnits en chief enginner(s)? och hur det fungerade?

Har inte sett någon som använt rollen som chief enginner, har varit med om tungvikts projekt ledare, eller programledare

Hur ska man kunna få fram en sådan person, finns det något sätt odla den typen av yrkesroll och kunskap i organisationer idag?

Det kommer nog vara skillnad mellan om man jobbar i ett stort företag eller ett företag som är mindre. Yrkesrollen som projektledare är ju mer etablerad. Med min erfarenhet från medelstora industrier så kommer det oftast någon från teknik sidan, någon som arbetat som konstruktör som blivit projekt ledare. Sen kanske man blir teknisk projektledare och har ansvar för samordning, men de kommersiella aspekterna fattas. Det gäller och se till att det finns personer som jobbar med marknadssidan också. Att det finns förståelse för kunden och kunna ha dialog med alla stakeholders. Det kräver någon som är mer av en generalist och kan dessutom vara trovärdig i den rollen. Man får ta en person som kan vara på de olika delarna i en organisation och lära sig.

Hade det varit enklare och dela upp det och ha fler personer i rollen, någon som har teknisk expertis och en som har marknadsexpertis?

Det hade då krävts att de passar bra ihop. Dessutom måste det finnas någon som kan fylla ut den rollen om en av de förvinner. Det är nog enklare i mindre företag och ha det på det viset och arbeta med en helhet, men det skulle vara svårt med ett stort företag med många hundratals personer och anställda och mycket detaljer.

Vad anser du är det största wasten inom produkt utveckling?

Kundinsikten kan ofta vara dålig. Man är lite för dålig på att ta reda på vad kunden verkligen vill ha! Där krävs det en kontinuerlig dialog. Det talar väl för en yrkesroll som chief engineer som är med på hela resan. Ibland har företag någon typ av överlämnande som kan göra att man tappar bort vad kundens önskan är. Det behövs kontinuitet, man kan ha haft omfattande dialog talat med kunden under marknadsundersökningen. Men när man byter fas i arbetet så glöms det bort, vad kunden verkligen ville ha! Många beslut som skulle vara bra att stämma av med användare innan. Så det är ett stor slöseri, om man utvecklar fel produkt.

Sen det här med kunskapsbevarande. Att hitta bra sätt att ta hand om kunskapen som skapas och kanske generalisera den kunskapen. Om kunskapen består av en specifik lösning finns det möjlighet att göra den mer generell, hur man dokumenterar och sprider den. Har väl sett detta i något företag där det finns någon from av ”kunskapsägare”.

A3 dokumentering kommer in också som en viktig punkt då man ska försöka dokumentera på något sätt. Kanske någon utanför projektet och att någon i linjen bör få i uppdrag tillsammans med någon/några i projektet att formulera en lämplig A3 dokument som består av kunskap som kan föras över till andra. På den punkten tror jag det finns mycket att göra för mycket av kunskapen ligger mer på individnivå än på organisations nivå

Kanske någon typ av ”lessons learned” som vissa företag försöker ha i slutet av projektet. Har du haft ett långt projekt så är det möjligt mycket kunskap redan gått förlorad, vissa har slutat i projektet och gått vidare till nästa projekt, så det som man lärde sig i tidigare faser har glömt bort i de senare faserna. Bör finnas något system så att man kontinuerligt fångar upp den kunskapen under projektets gång istället för att vänta till slutet. Det kräver att man ändrat sin syn på det. Vi levererar inte bara en produkt, men kunskap också.

Hade varit bättre då att ha kontinuerliga retrospektiven som i agile, med kortare antal veckors jobb och sedan reflektera på det man gjort och lärt sig, för att sedan fortsätta igen?

Ja det hade kanske kunnat fungera. Ju mer man gör saker desto mer blir det ett arbetssätt. Det är först när man har tillräckligt mycket av den kunskapen som man inser nyttan av det. Tycker det är bra att jobba i mindre projekt att lägger focus och tid på, hellre än att sprida ut sig för tunn. Man får fokusera mer på det viktiga, får snabbare takt och kommer snabbare ut på marknaden.

Vilka lean principer anser du är de mest kritiska? Mest implementerade, enklast att börja med?

Visualisering är bra! Kunskapsbevarande är också väldigt viktigt, för det kommer leda till att fatta beslut grundade på fakta. Att jobba lite mer med *front loading*, och flera olika koncept samtidigt, dessa saker är ändå ingenjörsmässiga arbetssätt som borde vara tilltalande för de flesta ingenjörer. Kanske utmaningen är att få management att skapa förutsättningarna och förstå vinsten med det. Att inte glömma bort kundfocusen. Det är det som driver och drar allt annat framåt. Ibland har man inte har någon specifikation, då är det visionen som ska leda en framåt.

Value stream mapping är inte så vanligt, finns företag som gör någon typ process kartläggning, men det är någon typ av projektplan/master plan som återanvänds hela tiden i nästa projekt. Man är inte

så bra på att gå tillbaka och titta på hur arbetet *egentligen* gick och vilka lärdomar man kan ta få med sig av det. Det är inte så spritt men kan vara ett användbart verktyg för att förstå problem och utmaningar i ett projekt, och att man gör det i ett team och får en samsyn på saker och ting. Kan vara bra om fler är med på mappningen och får den övergripande bilden.