CROSS-FUNCTIONAL
CO-OPERATION FOR IMPROVED
PRODUCT DEVELOPMENT

- A CASE STUDY AT SIEMENS INDUSTRIAL TURBOMACHINERY AB

Maria Alriksson
Lina Aronsson

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Maria Alriksson
Lina Aronsson

Supervisor at Linköping University: Anna Öhrwall Rönnbäck
Supervisor at Siemens Industrial Turbomachinery AB: Stefan Isberg

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Department of Management and Engineering
Industrial Economics
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Maria Alriksson & Lina Aronsson
ABSTRACT

The purpose of this thesis is to identify and analyze relevant dimensions of cooperation between design and production related to product development. The study also focuses on suggesting improvements of the co-operation dimensions between production departments and the product development departments in the Product Development Process (PDP) at Siemens Industrial Turbomachinery AB (SIT AB). SIT AB produces gas and steam turbines. Their increasing production pace and increasing number of product development projects have highlighted the importance of improved co-operations between departments within the company.

We have developed an analysis model including the dimensions of co-operation we found relevant for the study. These are Timing of Upstream – Downstream Activities; Richness & Quality of Information; Frequency of Information Transmission; Direction of Communication; Formalization of Communication; Organizational Support; Goal Optimization; Attitudes in Cross-functional Teams; and Understanding of Tasks.

For product development SIT AB follows an extensive process; the PDP. This is a sequential process where all activities are performed in sequence and therefore it obstructs the implementation of Concurrent Engineering. Concurrent Engineering aims to shorten development time and to consider the total job as a whole by performing independent activities in parallel. Hence, we argue that SIT AB should work toward a more integrated process with more parallel activities.

The performance in all the dimensions of co-operation differ between large and small projects since the co-operation in large projects work much better than in small projects due to better followed process description; more face-to-face discussions; a better balance between informal and formal communication; and more focus on project goals and team building.

The improvement proposals are presented in a separate chapter as actions classified according to the potential impact on the organization and the estimated difficulty to implement them. The proposals include for example: training more project managers; initiate work shop practice for design engineers; and give more and better explanations of decisions and actions.
SAMMANFATTNING

Syftet med det här examensarbetet är att identifiera och analysera relevanta dimensioner av samarbete mellan produktion och konstruktion i samband med produktutveckling. Syftet är också att föreslå förbättringar i samarbetet mellan produktions- och konstruktionsavdelningarna i produktutvecklingsprocessen (PDP) på Siemens Industrial Turbomachinery AB (SIT AB). SIT AB producerar ång- och gasturbiner. Betydelsen av ett gott samarbete mellan avdelningar i organisationen har belysts i samband med att produktionstaken de senaste åren har ökat och fler produktutvecklingsprojekt har initierat.

Vi har utvecklat en analysmodell som innehåller de dimensioner av samarbete som vi anser är relevanta för området. Dessa är: timing av uppströms – nedströms aktiviteter, rikhet & kvalitet på information, frekvens av informationsöverföring, riktning på kommunikation, formalisering av kommunikation, organisatoriskt support, måloptimering, attityder i tvärfunktionella team samt förståelse för uppgifter.

Vid produktutveckling följer SIT AB den omfattande processen PDP. PDP är en sekventiell process där alla aktiviteter utförs i en sekvens vilket motverkar implementeringen av Concurrent Engineering. Concurrent Engineering syftar till att korta utvecklingstiden för produkter och beakta arbetet ur ett helhetsperspektiv bland annat genom utförande av oberoende aktiviteter parallellt. Därför anser vi att SIT AB ska arbeta mot en mer integrerad process med fler parallella aktiviteter.

Det är stor skillnad på prestationen i samarbetsdimensionerna mellan stora och små projekt. Stora projekt fungerar mycket bättre än små vilket kan relateras till att stora projekt följer processbeskrivningarna bättre, har en bättre balans mellan informell och formell kommunikation, och fokuserar mer på projektmål och sammansvetsade projektgrupper.

Förbättringsföreslagen är presenterade som konkreta åtgärder i ett separat kapitel och är klassificerade med hänsyn till varje förslags potentiella effekt på organisationen och dess uppskattade svårighetsgrad att implementera. Föreslagen är bland annat att utbilda fler projektledare, inrätta verkstadspraktik för konstruktörer och ge fler och bättre förklaringar till beslut och handlingar.
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**GLOSSARY**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
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<tbody>
<tr>
<td>DB</td>
<td>Design Brief</td>
</tr>
<tr>
<td>GR</td>
<td>Product development department at SIT AB</td>
</tr>
<tr>
<td>GRP</td>
<td>Product management department at SIT AB</td>
</tr>
<tr>
<td>GT</td>
<td>Production department at SIT AB</td>
</tr>
<tr>
<td>NCR</td>
<td>Non Conformance Report</td>
</tr>
<tr>
<td>PIP</td>
<td>Product Integrity Process</td>
</tr>
<tr>
<td>PDP</td>
<td>Product Development Process</td>
</tr>
<tr>
<td>PRS</td>
<td>Product Requirement Specification</td>
</tr>
<tr>
<td>SIT AB</td>
<td>Siemens Industrial Turbomachinery AB</td>
</tr>
<tr>
<td>TTM</td>
<td>Time-to-market</td>
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</tbody>
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1

**INTRODUCTION**

In this opening chapter an introduction to the problem area and the subject studied is given. The purpose of the thesis is stated as well as the main research questions and the objectives for the investigation. This is followed by a presentation of the composed delimitations. Finally, a reading help in form of a disposition is presented.
1.1 BACKGROUND

The demands on the Swedish and global manufacturing industry has changed during the last decades. An increased demand for adoption to new and changing claims from clients and society require flexible and productive organizations. To stay competitive, many companies spend large amounts on research and product development. At the same time, they require reduced development time and reduced time-to-market (TTM) to meet the markets’ demands.1

As TTM becomes more important also Concurrent Engineering has a more significant meaning. It differs from the traditional product development in the way that tasks are done in parallel and all aspects of the product development is considered at early stage. Improvements in the early stages of the product development process are remunerative. Concurrent Engineering assumes co-operation between individuals, groups, departments, and separate organizations within the firm.2

One of the bases for co-operation is communication which requires information exchange and interpretations of messages3. Co-operation and process orientation is of vital importance to yield a good result and increase synergy effects between different competence areas.4 But to yield successful co-operation is difficult since it is influenced by the organization structure; the people’s behaviors; and their attitudes among others5.

Siemens Industrial Turbomachinery AB (SIT AB) is a part of the multinational corporation Siemens. SIT AB produces gas and steam turbines, employs around 2,000 people and is located in Finspång, Sweden6.

The company has experienced an increasing demand for their products and has, just in the last years, enhanced their production capacity from approximately 20 to 50 turbines per year. This has challenged the organization and highlights the importance of Concurrent Engineering and good communication and co-operation between product development and production. The organization has also experienced junctures when the co-operation could have been much better and when improved co-operation

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6 Siemens Industrial Turbomachinery AB’s Intratol (2007).
between product development and production in the product development process could have saved both money and time.\(^7\)

During the same time as the production pace increased also the number of product development projects increased. For product development a formal process has been developed to ensure efficient work methods and high quality in the procedure and the results. Processes are meant to be standard in the whole Siemens corporation, followed in all product development projects. SIT AB is unsure how their process is used and aware of their improvement potential in the co-operation field and hence took the chance to investigate it through this master thesis.

### 1.2 Purpose

The purpose of this thesis is to identify and analyze relevant dimensions of co-operation between design and production related to product development of single manufactured products. The aim is also to map out and suggest improvements in the co-operation between and within the production departments and the product development departments in the Product Development Process (PDP) at Siemens Industrial Turbomachinery AB.

### 1.2.1 Research Questions

The research questions that have been investigated in this thesis are:

- How is the formal product development process applied in practice?
- What dimensions of co-operation, between the production departments and the product development departments, exist during product development?
- Which co-operation dimensions need to be initiated, improved or impaired?
- How could the co-operation between the production departments and the product development departments be improved?

\(^7\) Isberg, Stefan (2007) *Interview 2007-01-31*. 

3
1.3 Objectives

SIT AB sees the possibility to cut both costs and TTM with a better co-operation between the product development and the production departments. If production aspects are included in the early product development stages it can eliminate time and cost consuming problems in the later stages of the development or in the day-to-day production. There is a great potential gain in the Concurrent Engineering strategy.

One objective with this thesis is to give the company knowledge about their strengths and weaknesses in the area by mapping the performance of co-operations between and within the production and the product development departments. One important objective is to highlight the knowledge about and current use of the formal processes. Another objective is to initiate and motivate action towards better co-operations, through development of tangible suggestions for improvements. If these suggestions result in some debates, activities or changes there is a great potential for cost and time savings.

1.4 Delimitation

SIT AB has the formal Product Development Process (PDP) and the formal Product Integrity Process which are used in different situations depending on the magnitude of development work. This thesis is delimited to examine the PDP since this is the most established and used process and since improvement potentials in this is considered more significant. Hopefully the results can also be used in the Product Integrity Process, after some adjustment.

SIT AB has in 2006 commenced a co-operation in product development with the sister site in Lincoln, England. This co-operation is experienced as difficult because of the culture differences, the language differentiations and the long physical distances. SIT AB has, as mentioned above, also experienced problems with the co-operation in the PDP within the site in Finspång. One member of the master students’ steering committee thought that the problems within the site need to come to a solution before the international aspects are investigated. Therefore we have chosen to focus on the co-operation at the Finspång site. Recommendations concerning the co-operation within the site in Finspång can, with adjustment, later be applied even in an international perspective.

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*Synthesis Coalition (1998).*
There are projects running parallel to this thesis at SIT AB. One project, Quality Culture, focuses on showing the fact that each co-worker at SIT AB is not alone, and by doing one’s task right, listen to, ask and meet with their customers and suppliers, the flow in the processes will be smoother. This project can be seen as a parallel project that rather can be utilized in this study than limiting it. There are two ongoing projects focusing on the compatibility between computer systems. One of them aims to integrate Pulse and R/3 and the other concern the conversion of 3-D models into CadCam where the NC-programming is done. Since these projects run in parallel and will solve problems related to incompatible computer systems we will not focus on investigating these areas and not give recommendation concerning the computer systems.

1.5 Disposition

The introduction chapter in this thesis aims to give the reader an understanding of the problem area in a broad perspective and also a background to this thesis origin. The purpose, research questions and delimitations are stated to make it easy for the reader to control the validity against the conclusions. For readers mainly interested in the results we recommend to read the introduction and then go on to the analysis, conclusions and recommendation chapters.

The introduction chapter is followed by a chapter about the methods of research where we state our research approaches. The chapter gives an account of the research procedure including a description about how the problem was framed and how the data were collected and analyzed. This chapter is of interest for anyone who is involved in any similar study or wants to take part of our methodological considerations.

The case company – Siemens Industrial Turbomachinery AB is presented in chapter three. Basic knowledge about the organization, their product development process and present work methods are presented. This gives a basic knowledge and understanding to the rest of the study since the investigation and results are close related to the case company.

The theories used to analyze the empirical data are presented in the theoretical frame of reference. These theories come from books and published articles in the areas of Integrated Product Development, co-operation and communication, processes and projects, group management among others. The theories are, together with the purpose, a frame for the analysis.
We have developed an analysis model which is presented in chapter five. This model highlights different dimensions of co-operation that we have identified and has been used to analyze and find answers to the research questions in a verifiable way.

The data collected through the empirical study is presented in chapter six. Knowledge, experience and statements from the interviewed employees at SIT AB were the fundamental elements in the development of the recommendations.

The empirical data is analyzed in chapter seven which is followed by conclusions in chapter eight. The conclusions answer the research questions and fulfill the objectives. Finally, the developed recommendations for improvements of the co-operation at SIT AB is presented chapter nine. This chapter is case specific and mainly useful for the case company. The recommendations are classified according to potential impact and estimated difficulty to implement. Our recommendations and implementation ideas can be used as a tool for the management at SIT AB if they develop any change strategies from to our ideas.
Methods of Research

This chapter describes the methods used in the study. The first part presents our choice of research approach which is followed by a description of the work procedure. Finally a discussion regarding criticism of the methods is brought up.
2.1 Research Approach

The research approach has many different dimensions. In this chapter different approach dimensions regarding the general research approach, the research purpose, the scientific approach and the type of data is presented. The choices we have made are also presented and motivated.

The research approach can, according to Lekvall & Wahlbin⁹, be classified as a cross-section approach; a time series approach; or a case study approach. When the cross-section approach is used, a number of cases are compared at a specific point in time. When the time series approach is used one case’s development over time is of interest. The case study approach aims to focus on one case in detail and is suitable for explorative research as well as descriptive and explanatory research. Case studies are often qualitative and enable detailed investigation and understanding of a problem through repeated contacts with the case and the involved people.

The purpose of this thesis outlines a specific interest in SIT AB’s product development process. Consequently this thesis is a case study that will focus on one case: SIT AB, and will investigate that one in detail. Also our study is of qualitative nature and we did repeated interviews with some persons as well as had close relationship with the case organization during the study period.

2.1.1 Research Purpose

The purpose, or emphasis, of a research can be classified as explorative, descriptive, explanatory or predictive. An explorative purpose aims to give knowledge and understanding of a research area and is often used for problem framing and defining. A descriptive purpose aims to describe what a situation looks like and is often used for mapping a situation or problem. A research with an explanatory purpose goes one step further and tries to explain the underlying cause of the problem. A predictive purpose aims to give a forecast or prediction about the future.¹⁰

These categories of purposes have an increasing information substance which means that it is necessary to have knowledge from underlying purpose categories to achieve satisfactory results in a problem of superior categories. For example: one has to

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¹⁰ Ibid. p. 185-187.
explore the problem to be able to describe it. In the same way, one has to be able to
describe a problem to explore the underlying causes to the problem.\textsuperscript{11}

It is common to have and combine more than one of these purposes\textsuperscript{12}. This thesis has
an explorative, a descriptive, an explanatory and a predicative purpose. We needed to
explore and describe the situation and problem area before we could develop any
explanations or recommendations. The explorative purpose was in focus when we
tried to understand and define the problem area and when we developed the purpose
for the thesis. One part of the purpose is to map the present performance of the co-
operation between the production and the product development departments which
gives the thesis a clear descriptive purpose. To develop and suggest improvements in
the co-operation, knowledge about the underlying causes of the problem is necessary
which means that the thesis also have an explanatory purpose. The improvement
proposals we gives can be classified as predictive; hence the thesis also has a predictive
purpose.

\textbf{2.1.2 Scientific Approach}

The scientific approach reflects our philosophical, ideological and knowledge
theoretical assumptions about the social reality. This is closely related to the data
gathering method but also to the interpretation about our own participation in and
influence of the research object.\textsuperscript{13}

\textit{Hermeneutic and Positivistic Approach}

There are two opposite positions in the scientific approach which are called positivistic
and hermeneutic\textsuperscript{14}. The positivistic approach originates from natural science and the
main idea is that one can observe an object without influencing it. Measurability is
important in positivism.\textsuperscript{15} Where the positivistic researchers are trying to explain
phenomena, the hermeneutic researchers are trying to understand phenomena. The
hermeneutic approach asserts that the involved people are affected by the researchers.
Therefore they think it is not possible to measure and objectively observe social
situations without being a part of them. The subjectivity in the research is accepted in

\textsuperscript{11} Ibid. p. 187.
\textsuperscript{12} Ibid. p. 186.
\textsuperscript{13} Bryman, Alan (1997) \textit{Kvantitet och kvalitet i samhällsvetenskaplig forskning} p.64.
\textsuperscript{14} Arbner & Bjerke (1994) \textit{Företagsekonomisk metodlärre} p.64.
the hermeneutic approach since the attempt to understand something always originates from the investigator and his or her experience and knowledge.\textsuperscript{16}

Positivistic and hermeneutic approaches are often called the opposite end of a chain with other, less radical scientific approaches in between. Anyway, we have a mix between the hermeneutic and the positivistic approach. In order to meet the objectives regarding mapping of the situation and to understand the problems a hermeneutic approach was applied. We agree that it was not possible to exclude the influences and interpretations from ourselves and our experiences in these stages. In order to give recommendations and guidelines our approach was more similar to a positivistic approach. In the analysis we tried to measure different dimensions of co-operation and explain the social context. We also give our recommendations for how to improve the situations which agree with the positivistic approach.

\textit{Participant and Analytical Approach}

The scientific approach can also be divided into the analytical approach; the system approach; and the participant approach. In the analytical approach the whole is equal to the sum of its components and each component is explained from verified judgments. The system approach asserts that the whole is not to equal the sum of its parts and the components are explained in terms of the whole’s characteristics. In the participant approach the whole only exists as structure for the components or participants and is only understood from the participants’ picture of the reality.\textsuperscript{17}

In the mapping of product development we had a participant approach which complemented the hermeneutic approach. We see the social situation as a structure of individuals and their actions and think that they are able to affect the situations. During the analysis and development of improvement suggestions a more analytical approach was used. We are aware of our own participation and possible influences on the social constellations.

\textit{Abduction}

Induction, deduction and abduction are three different approaches that can be used when analyzing. These three differ in how they use the general theories; the empirical data; and the results to make conclusions.\textsuperscript{18} With an inductive approach, the researchers use knowledge from the empirical data as results and conclude it into general theories. With a deductive approach, the researchers go from general theories

\textsuperscript{17} Ibid. p. 69-70.
\textsuperscript{18} Hörne, Sven-Ake (1999) \textit{Hur kan man frå struktur åt rapporter och uppsatser} p.8.
and apply them on the empirical data which gives the result.\textsuperscript{19} If the researchers use theory and empirical data alternated in order to obtain a result abduction is used.\textsuperscript{20} In this thesis abduction is used and we did the empirical study in parallel with the theoretical study which finally gave a result. This approach made it possible for us to give recommendations specific for the case company with support from both theories and the empirical results.

\textbf{2.1.3 Type of Data}

Another dimension of the research approach considers the type of data used. The data affect the research procedure; the result and its reliability, objectivity and validity.

\textit{Qualitative Data}

The data, as well as the whole investigation, is usually classified as either quantitative or qualitative. Quantitative data is coded into, and analyzed in, number format. Qualitative data is not presented or analyzed in number format since it should not be meaningful or add any value to the investigation to do so.\textsuperscript{21} In this thesis mainly qualitative data has been used. We interpret the problem as of qualitative nature, and since it is a case study with specific problems which just involve a small population, the qualitative approach seems to be most suitable.

\textit{Primary & Secondary Data}

Data used can be divided into secondary and primary referring to the sources of the data. McNeill & Chapman\textsuperscript{22} define primary data as data which is collected first hand by the researcher and define secondary data as evidence collected or produced by another organization or individual for a non-sociological reason. Primary data is mainly collected through surveys, interviews or observations. Secondary data is for example statistics or various documents.\textsuperscript{23} In this thesis both primary and secondary data have been used. The primary data have been collected through qualitative, semi-structured interviews (for more information see chapter 2.2.2 Data Collection). The interview data was collected as input to this thesis which resulted in well suited scope, concentration and adjustment to the purpose. The secondary data consists of internal documents from SIT AB which we collected from the Intranet and the common hard drive. They

\textsuperscript{23} Ibid p.131.
were created for another purpose but were anyway useful as a source for data and facts regarding the organization.

2.2 Research Procedure

When doing research one first has to consider how one’s research procedure should be designed. There is not one right way of doing research but it depends on the nature of each individual investigation. We have been working at SIT AB’s office in order to get a better perspective of the organization. Five persons from different departments at SIT AB formed a steering committee that aimed to support and supervise us in our problem solving and Anna Öhrwall Rönnbäck has been our supervisor at Linköping University. This part of the thesis describes our research procedure as well as our method of working.

2.2.1 Problem Framing

In the initial stage of this case study the problem was not specified to a precise question but consisted of a number of issues and thoughts. The first task was to define the problem and the purpose of the thesis. By doing about ten introductory interviews we created a picture of the organization and the problem area. Stefan Isberg, the supervisor at SIT AB, together with the rest of the steering committee at SIT AB gave recommendations concerning which interviewees they thought would give the best input at that stage. The interviewees work within different functions and have different experiences hence we received an as complete picture of the business and the problem area as possible. The interviews were complemented with studies done at SIT AB’s Intranet.

The introductory study gave an overall picture of the organization and an introduction to and insight into the problem area. A meeting regarding the purpose of the study, the definition of the problem and its issues and delimitations was held with the steering committee at SIT AB. The aim was to agree upon the purpose of the thesis as well as the research questions and delimitations.

To further concretize the research questions and find a way of tackling the problem we developed a problem framing model presented in figure 1. We generated the model from left to right by concretizing the purpose into research questions; by breaking down the research questions into areas used in the data gathering; and by developing

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topics and an analysis model to tackle the problem areas. During the analysis and conclusion stage, we worked back from right to left by using the analysis model to answer the research questions and fulfill the purpose.

Figure 1 The Problem Framing Model

2.2.2 Data Collection

In the initial phase both theoretical and empirical information were collected. The theoretical study comprised for example different dimensions of co-operation such as Integrated Product Development; organization theory; and communication; as well as implementation theory aiming to find an approach to fulfill the purpose. The empirical study was mainly focused on interviews but studies of the process descriptions published at SIT AB’s Intranet also were done. A significant part of the purpose is to find different persons’ views of the problem why we chose to use interviews as the main empirical study. The simplest way to get information and to find out one person’s opinion in a matter is to do interviews according to Lantz.\textsuperscript{25} We also think this

\textsuperscript{25} Lantz, Annika. (1993) p. 11.
approach gave the best understanding of the organization; the problem area; and the processes of concern.

A participating observation implies that the researchers devote themselves to the investigation objects during a long time with the aim to obtain an extensive and understanding view of the organization and the group of people studied26. The fact that we were working on site at SIT AB and therefore also received an understanding of the corporate culture indicates that this kind of approach partly is utilized. But the fact that the observed people were not followed during a longer period does not fully agree with the participating approach and limits the extent in which it was used in this thesis.

**Interviews**

As stated above this thesis is a qualitative study and the interviews were consequently of qualitative nature. A qualitative interview characterizes of simple, straight ahead questions with complex and comprehensive answers. The idea of this type of interview is to get an understanding of the respondents’ knowledge and experience and how they feel and think. The interviewer controls the conversation so that it is held within the topic and an analysis and interpretation of the data has to be made before the researchers can get use of them.27

An interview can be modeled in different ways depending on the purpose of the interview. Three different structures exist: open-ended, semi-structured, and fully-structured interviews28. An open-ended interview characterizes of open questions from which the respondent can express himself and his thoughts freely while the interviewer in a fully-structured interview ask questions formulated in advance29. Since the purpose of the study is clear, we had a general idea of the kinds of content we wished to explore but still we wanted to encourage the respondents to answer in their own words and therefore we think it was best to use semi-structured interviews30. This approach also enables a comparison between the respondents which is important in this study.

Another way of describing the interview form is by standardization which refers to in which extent the same questions are asked, in the same order and under the same circumstances to all interviewees31. A low level of standardization was used in this

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29 Ibid. p. 17.
study where the interviewees had an impact on the order of questions and resulting questions were formulated during the interviews. Questions and areas for discussion were formulated before the interview but they were not put in a specific order since the interview was of qualitative art and the interviewee should influence the conversation in as great extent as possible. We did careful consideration of which questions to ask and made sure that the questions were limited to the area of the study. The interview questions are presented in appendix 2.

One issue that needed careful consideration was to decide who to interview. In this work the knowledge achieved during the introductory interviews was utilized. Names of persons within the organization that could contribute with knowledge in the area of importance came up during these introductory interviews. This information together with guidance from the steering committee at SIT AB resulted in a list of people to interview. First out was the owners of the product development process, which aimed to give us an understanding of how the process is built up. We continued with the managers of product development projects and managers of departments. In the final stage were persons from production departments and product development departments alternated. We found this order and distribution good since it gave us the possibility to use the knowledge and understanding from previously interviews to ask the right questions and concentrate on the right details in the latter interviews. Appendix 1 presents an overview of the interviewee’s positions and characteristics. The distribution overview aims to secure the spread and differentiation of respondents.

If two persons understand each other well it can be an advantage to be two interviewers as they will probably do a better interview with greater amount of information and a better understanding. Since we find ourselves with a good ability to work together we think it was a great advantage that we did the interviews jointly.

As a complement to making regular notes we also recorded the interviews. The advantages of recording the interviews is that one can listen to the interview over and over again while the disadvantages is that it takes time to listen and to find the right details. The notes made it possible to note both what the interviewee said and also those interpretations and impressions we got. The disadvantage of notes is that they can be disturbing for the respondent who can get distracted when notes are taken.

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32 Ibid. p. 47.
33 Ibid. p. 44.
34 Ibid. p. 50.
35 Ibid. p. 52.
We sat down after each interview and summarized the important information and interpretations. This made it easier to remember the interview.

Data has also been collected during an internal seminar about Quality Culture held by SIT AB’s Business Excellent Centre for managers within the company. We had the opportunity to participate in the seminar where problems and topics related to quality were discussed. The seminar gave us an understanding of the Quality Culture project so it was possible to take in account during the analysis.

**2.2.3 Data Analysis**

The process of doing qualitative interviews can be divided into seven stages. In the first stage the purpose is formulated. The second stage is the design stage when the study is planned in detail and an interview guide is done. The next step is to carry out the interviews which are followed by a stage when the information received is saved in an accessible way. The fifth stage is the analyzing stage where the theoretical framework underlies the analysis of the empirical data. The analysis will end up in results which need to be examined in form of validity and reliability. The seventh and last stage is to report the results in an appropriate way.36

The first four stages are described in detail above. As we faced the fifth stage the aim was to analyze the observed data in line with the purpose. For this we developed a problem framing model which concretize the research questions into sub-questions. An analysis model was also developed because we wished to present different dimensions of co-operation in a clear and examinable way. This model and how it is used is presented in more detail in chapter 5 Analysis Model. Since a great effort was spent on finding good theoretical data as well as preparing for interviews the material was well organized for an analysis. From the analysis, results were found which are concluded in this thesis.

**2.2.4 Development of Recommendations**

As mentioned above, the analysis should end up in results which aim to answer the research questions and fulfill the purpose. The second and third research questions are very general but the first and the forth questions are more case specific. To answer the forth question “How could the co-operation between the production departments and the product development departments be improved?” we have developed

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36 Ibid. p. 29-31.
recommendations specific for the case company. These are mainly our opinions and we act as consultants rather than researchers in this chapter. Therefore we have not prioritized objectivity in this chapter instead we want to deliver as useful and specified recommendations to the case company as possible.

### 2.3 Method Criticism

All methods have positive and negative aspects and the choice of methods and procedures can always be discussed and questioned. In this chapter we reflect over the methods we have used in purpose to evaluate the validity, reliability and objectivity in the thesis.

#### 2.3.1 Reliability

According to McNeill & Chapman\(^{37}\) reliable methods means that if anybody else used the same methods they should come up with a similar result. Social science may have some problems to sustain reliable if the research is based on observations of a non-repeatable situation observed by one single person.\(^{38}\) We worked constantly in pair during interviews and interactions with the research objects and used a tape recorder during the interviews. These matters impaired the risk of unconsciously interpretations before the analysis which increased the reliability. We also worked in pair during the analyzing and conclusion stage and critically examined each other’s and our mutual interpretations of the data. Hence, the reliability was increased.

When the analysis model was developed we tried to keep the model simple and clear. The aim with the model is to describe the dimensions of co-operation and its extremes in a tangible way. But still the reader should remember that we have developed the model ourselves and our interpretations are reflected in the model and the analysis.

#### 2.3.2 Validity

Validity refers to the problem of whether what was intended to be measured has been measured and if the collected data actually give a true picture of the study object. The respondents of interviews and surveys are affected by their own values and interests which can threaten the validity of the research.\(^{39}\) One method to increase reliability and validity is triangulation which refers to the use of multiple methods or sources for


\(^{38}\) Ibid. p. 9.

\(^{39}\) Ibid. p. 9-10.
cross-checking the data. This can verify the reliability of a research tool and the validity of data collected.  

The purpose of this thesis was in our mind during the whole research process. The choice of interviewees and the development of interview questions were made out from the purpose and the goal was to find persons and questions which directed toward answers to the research questions and the purpose. The theories and critical interpretations were triangulated with respectively different books and different persons. We have been conscious about validity during the whole process and worked actively to be critical to our own work and to achieve high validity.

The analysis model that has been developed is a way to make the study more tangible and obtain verifiable results. The choice of dimensions in this model has been made from a literature study. It should be noticed that since we have developed the model ourselves there could be a risk for some missing dimensions or that the focus has been slightly misdirected. But we have put a great effort in choosing the dimensions and the model has been a good tool so we think it has been valid in this study.

### 2.3.3 Objectivity

Objectivity is a difficult matter and it has been debated whether or not it is a goal in itself to reach full objectivity in social science. The most important action to get closer objectivity in social research is to be aware about the researchers’ own normative conceptions: the influences from social, cultural, economical and political environment and influences from the researchers’ own personality and values.  

In this study our use of the hermeneutic approach and the fact that we were invited to the company and were working from the company’s office affected the objectivity of the investigation. But this chapter’s thorough expositions of methods, philosophical values and thoughts created consciousness about possible influences and subjectivity which, according to Arbnor & Bjerke, increases the thesis’ objectivity.

In the case specific chapter 9 Recommendations objectivity has not been prioritized in favor for as specific and useful proposals as possible.

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40 Ibid. p. 23.
42 Ibid. p.264-265.
In this chapter an introduction to the case company is given, starting with a brief opening with the history of the company. Next, is the organizational structure presented and finally is the product development with focus on the Product Development Process brought up.
3.1 Introduction

Siemens Industrial Turbomachinery AB (SIT AB) is located in Finspång, Sweden. SIT AB comprises development, manufacturing, and delivery of components and complete plants for power and heat production including an extensive service organization covering all delivered products and plants. One workshop being part of the organization in Finspång produces combustion chambers and is located in Trollhättan, Sweden.43

The site in Finspång has delivered equipment for power generation over the last one hundred years. It originates partly from the corporation AB de Lavals Steam Turbines in Nacka which was founded in 1893, and partly from the corporation STAL founded 1913 in Finspång by Birger and Fredrik Ljungström. The two corporations were during a period of time competitors but in the mid 1950’s they were merged into STAL-LAVAL and the site in Nacka was gradually moved to Finspång. During the 1980’s the corporation changed; first to ASEA STAL AB and later to ABB STAL AB before it in 2000 was bought by ALSTOM Power Sweden AB and in 2003 was bought by Siemens.44

43 Siemens Industrial Turbomachinery AB’s Intranet (2007).
44 Ibid.
3.2 Organization

The organization in Finspång belongs to the line of the business within Siemens called Power Generation (PG). PG is subdivided into five divisions where Finspång belongs to Power Generation Industrial Applications (PGI), which is divided further in five business units, PGI 1-4 and 6. Siemens calls these business units GZ and all of them except PGI 3 are represented in Finspång.45

We have limited the study to one of the units, PGI 4 (Gas Turbines), which organizational chart is presented below. The purpose of this study is to study the cooperation between the production departments and the product development departments why focus have been on examining the two departments; Product Development (GR) and Production (GT) also showed in the chart below.

![Organizational Chart for Division Gas Turbines (G)](image)

*Figure 2 Organizational Chart for Division Gas Turbines (G)*

*Source: Organization PD (2007)*

Siemens employs about 460,000 persons in 190 countries and the number of employees within PG reaches about 35,000. The site in Finspång has about 2,200 employees and the site in Trollhättan about 90 employees. 14 (Gas Turbine) represents the largest GZ unit in Finspång with over 1,000 employees.46

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45Ibid.
46Ibid.
3.2.1 Production Departments

As said above, GT is the notation for the production departments under I4. Their organizational chart is presented below.

Figure 3 Organizational Chart for Production Department (GT)
Source: GT Production / 1452 (2007)
3.2.2 Product Development Departments

The product development departments are summarized under GR and their organization is showed in the chart below.

*Figure 4 Organizational Chart for Product Development Department (GR)*

3.3 Product Development

I4’s product range comprises four different gas turbines; SGT500, SGT600, SGT700 and SGT800. The effect of the turbines is in the area of 15-50 MW. The production lead time for each turbine is approximately one year. Sales volumes have during the last five years increased from 20 to about 50 gas turbines a year.\(^47\) A development project varies to be between one month and up to five years depending on the scope of the development.

3.3.1 Product Development Process (PDP)

SIT AB follows a process called the Product Development Process (PDP) for new design and redesign of products\(^48\). The PDP is a quite simple gate model which is focused on milestones, reviews and gates and is supposed to guarantee a common language within Siemens which simplifies control and follows up on projects\(^49\). The process is owned by Chief Engineers Office. By owning a process means that they are responsible for the development and maintenance of the process and its descriptions.

Gates, Milestones and Reviews

The full version of the PDP can be seen in appendix 3 and a smaller version of the PDP is presented below where it is shown that it comprises a set of main phases. Each of these main phases finishes of in a milestone, denoted as M in the process map and defines the content of each phase. The milestones (M) are linked to a review (R). The reviews are there to evaluate the work and the results. The evaluation is supposed to be performed by a cross-functional group of experts who are not involved in the project work. The gates (G) control the main business decisions for the progress of the project. The decision group is usually formed by a fixed set of key-stakeholders of the project. At each milestone, gate and review the design tasks are evaluated in form of the performance of the product; the total product cost; the product delivery time; TTM; and the risk of the product and the project.\(^50\)

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\(^47\) Ibid.
\(^49\) Peter Ringsted (2007) PDP summary.
\(^50\) Ibid.
Each gate is described in the table below. Descriptions of the reviews are presented in appendix 4. The process is described more in detail in chapter 6.1 The PDP.

Table 1 Description of Gates in the PDP

<table>
<thead>
<tr>
<th>Gate</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>G0</td>
<td><strong>Project Assignment</strong></td>
</tr>
<tr>
<td>G1</td>
<td><strong>Project Initiation</strong></td>
</tr>
<tr>
<td>G2</td>
<td><strong>Design Gate</strong></td>
</tr>
<tr>
<td>G3</td>
<td><strong>Product Release</strong></td>
</tr>
<tr>
<td>G4</td>
<td><strong>Limited Sales Release</strong></td>
</tr>
<tr>
<td>G5</td>
<td><strong>Full Sales Release</strong></td>
</tr>
</tbody>
</table>

### 3.3.2 Other Improvement Methods

The PDP is used for new design and major product and method improvements. But there also exist other methods for improvements of products and product documentation, of strategies and of the use of produced material.

**Improvement Proposals Database**

Smaller improvement proposals from GT are registered in a database and GR gradually do the changes. Each proposal is evaluated with respect to the time it takes to perform, the cost and how important it is. It is possible for GR to regularly report the status of each proposal in the database.\(^1\)

**Product Integrity Process (PIP)**

The Product Integrity Process (PIP) is a process built up in a similar way to the PDP. The PIP is used for minor tasks and non conformance and focuses on the root causes of the problem while the PDP is used for development work. The PIP is an eight-step model and is showed in the figure below. The project is first defined in a Design Brief and then it follows the phases, gates and reviews specified in the PIP.\(^2\)

![Diagram of the Product Integrity Process (PIP)](image)

*Figure 6 Product Integrity Process (PIP)*

*Source: Project Management Process - General Description (2006)*

**Non Conformance Report (NCR)**

The Non Conformance Report (NRC) is a process owned by GT and handles non conformance according to drawings. This process is used when a part is produced and something goes wrong in the sense that the part is not in compliance with specification. GT then sends a NCR to GR where it is evaluated whether the produced part can be reused in some way.\(^3\)

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\(^2\) Uteförd PIP process (2006).

\(^3\) Räädekint, Ulf (2007).
THEORETICAL FRAME OF REFERENCE

This chapter presents theories we used for the analysis and the recommendation development in order to answer to the research questions. The theories comprise processes and projects; different dimensions of co-operation; and implementation theory.
4.1 Processes & Projects

A process is a description of the methodology to use in projects. Both projects and processes have a clear focus on which tangible results that should be delivered to the customer or the orderer. A result oriented business is much easier to follow up; since it is clearer when the result is obtained if one knows what should be measured from the beginning.54

4.1.1 Process Orientation

A process can be described as a system with one or more inputs and one or more outputs. The output of a process has controllable and uncontrollable variables. The purpose is to design the process to optimize the output by changing the controllable variables.55 A process also clarifies the organizational hierarchies and helps to increase visibility and understanding of the work to be done. The activities in a process are defined across functional boundaries.56

A process has to be communicated to the whole team. Mapping the process is of great help when creating a common project view for the entire team and when communicating the process to the project members. Milestones and gates facilitate the communication of the process which is of importance for the process approach to restrain.57

Process quality is associated with doing things right. A process is a way of describing how activities are performed in the best possible way. The process need to be improved continually which is achieved through experience and ideas.58

4.1.2 Projects

A project is a time-limited task with a once-for-all purpose. It has a fixed set of resources; demands resources from different areas of responsibility; and has a well defined objective with measurable results. A project is a way of working and gathering resources in a well defined temporary organization in order to create a tangible result.

57 Ibid. p. 121.
Project quality is associated with doing the right things. Clarity is a key requirement for a good result.\textsuperscript{59}

Well defined results and a co-ordination between the involved individuals are essential in a project. A project standard is important to create an understanding for the fundamental conditions of the project and to find concepts for co-ordination within the corporation. Descriptions form a good foundation for a project but it will not become better until the co-ordination between project members and decision makers works well.\textsuperscript{60}

Sverling\textsuperscript{61} has developed a model which describes how projects are related to organizations and processes. The model is shown in the figure below. A project is a dynamic system dependent on the action of individuals and can be described as a system of co-ordination. Input to the project is results earlier obtained; previous work; and new conditions. Also, external factors from the surroundings are given as input to the project. The ability to act in a certain situation is a result of the individuals’ capability; knowledge and experience but also dependent on the individuals’ personality. Many different individuals’ actions are co-ordinated so that the result hopefully becomes better than just the sum of the individuals’ action. The process gives a result which will constitute a new resource as an input to a subsequent project.\textsuperscript{62}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure7.png}
\caption{Model of a Project as Co-ordination of Individuals}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure7.png}
\caption{Model of a Project as Co-ordination of Individuals}
\end{figure}

Source: Sverling\textsuperscript{er}, Per-Olof M. (1996) p. 44.

\textsuperscript{59} Ibid p. 17 & 225.
\textsuperscript{60} Ibid. p. 10.
\textsuperscript{61} Sverling\textsuperscript{er}, Per-Olof M. (1996) Organisatorisk samordning vid projekttering – en studie ur ett konsultföretagsperspektiv. p. 44-45
\textsuperscript{62} Ibid. p. 44-45.
Gates are strategic checkpoints used for overall control of the project. At each gate the project orderer should say stop or go. The processes often control how and when these gates should be used. Gates can sometimes control the projects in a static and inhibiting way. To avoid this, it is important to remember that a model must be dynamic and support creativity. Gate decisions for parallel project parts must not be taken at the same time for all parts of the project.\footnote{Wenell, Torbjörn (2001) Wenell om projekt. p. 40-42.}

Milestones are well defined stage targets used by the project managers to run the project. Each milestone refers to a specific stage where a given result should be attained. Working towards deadlines gives a target orientated work and usually a shorter throughput time. Milestones should be bound to the project and not to the flow in the model. The project manager together with the closest co-workers defines the milestones. Important issues described by the milestones are the interfaces and integration between different parts of the project.\footnote{Ibid. p. 40 & 97.}

### 4.2 Dimensions of Co-operation

Co-operation is a complex but very important area for success in business. Different researchers define and classify co-operation differently and we have chosen to weight together different researchers’ approaches and present some dimensions of co-operation which act as the classification of co-operation in this thesis. The dimensions are: Timing of Activities; Richness and Quality of Information; Frequency of Information; Direction of Communication; Formalization of Communication; Organizational Support; Goal Optimization; Attitudes in Cross-functional Teams; and Understanding of Tasks. The researchers who have inspired the choice of dimensions are Clark & Fujimoto; Bakka et. al.; Wheelwright & Clark; and Andreasen & Hein\footnote{Clark & Fujimoto (1991) Product Development Performance – Strategy, Organization and Management in the World Auto Industry; Bakka et. al. (2001); Wheelwright & Clark (1992) Revolutionizing Product Development; Andreasen & Hein (1987) Integrated Product Development.}

#### 4.2.1 Co-operation

As stated above, different researchers have different definitions of co-operation. In Törnqvist\footnote{Törnqvist, Eva.K.(2000) Organisation, återande, kommunikation. p. 57.} De Micheli’s three definitions of co-operation is presented: co-ordination, collaboration and co decision. Co-ordination is referring to the process where group members organize and/or synchronize their actions around the task: what to do; who

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will do it; and to when will it be done. Collaboration refers to the actions different
people take together to solve a problem. Co decision is an extended form of
collaboration where the task is to make a decision. 67

Insufficient co-operation is often a primary source for delays or failures in projects 68.
Concurrent Engineering mirrors many of the important dimensions of co-operation in
product development. Eight fundamental principles form a base for Concurrent
Engineering. The first one is early problem solving and is important since problems
discovered early in the process are much easier to solve than those discovered later.
Also, early decision making is important since it is much easier to affect the design in an
early stage. The work and the work environment should be structured so that tasks can
be performed independently of each other. Another aspect is teamwork affinity, striving
towards creation of trust between groups. Another significant aspect is the utilization of
knowledge where decision support tools should be interlinked with a human knowledge-
base. Teams work better if they know and understand what other members are doing
therefore a common understanding is important. Also, teams work better if they are
empowered to make decisions and are given an ownership in what they do. Finally, the
whole corporation will do better if everyone works towards a common goal with a
consistent purpose and do not try to make themselves and their department look good in
proportion to the others. 69

4.2.2 Timing of Activities

The first dimension of co-operation presented is the Timing of Upstream -
Downstream Activities. We refer timing of upstream and downstream activities
especially to the timing of activities between the product development departments
(upstream) and the production departments (downstream). Intensive communication
and high degree of simultaneous activity are two crucial conditions for integrated
problem solving which may be used in successful product development 70. In a
sequentially organized development process, there is risk that a poor interplay between
marketing, design and production departments occurs. This results in poor awareness
of each employee’s role and tendency towards sub-optimization within each
department which have negative impact on the overall result. 71 Sub-optimization refers
to result maximization in one department at the expense of other departments’ and the

67 Ibid. p. 57.
whole’s result. Theories according to good timing include Concurrent Engineering and Integrated Product Development.

**Sequential Engineering**

Organizations have during a longer period focused on control of information flow and the functional organization with a hierarchical setup has had an important meaning. The product development was dominated by Sequential Engineering. This refers to a process divided into clearly separated phases with a consecutive order. The task of the upstream stage is completed before the downstream stages begin. In most sequential engineering processes a market research, determining the customer needs, is done and the technical requirements are developed. Then the product engineering group design and develop the product almost isolated from the manufacturing process. When finished, a prototype is handed over to manufacturing so they can prepare for large scale manufacturing. In most cases the product will not go into production in the first trial and several engineering changes are needed. The next step is for marketing and sales to introduce the product to the market. This sequential process is illustrated in the figure below.\(^2\)

![Sequential Engineering Diagram](image)

**Figure 8 Model for Sequential Engineering**


**Concurrent Engineering**

Manufacturing competitiveness means a sustained growth and earnings through customer loyalty by creating high value products in a very dynamic global market. This implies a great demand on today’s corporations. The complexity of product development has increased as a result of inherent product complexity; process complexity; team co-operation and communication complexity; computer and network complexity; and a maze of specializations including international regulations and safety.

Concurrent Engineering or simultaneous engineering is considered one of the key concepts enabling companies to reach manufacturing competitiveness.73

Concurrent Engineering is an approach to integrate concurrent design of products and their related processes including manufacture and support. It is a paralleled approach replacing the sequential engineering. The concept is supposed to consider the total job as a whole and to minimize the product development time.74

In concurrent processes, activities are performed simultaneously or overlapped. There is no need to delay the start of one activity if it is not dependent on the other ones. Concurrent resource scheduling involves scheduling the distributed activities so that they can be performed in parallel. This is especially difficult for activities with dependent characteristics. The critical task is to control the complex dependencies, and appropriate synchronization efforts must be made frequently. Concurrent Engineering also aims to minimize the interfaces including supplier, design development, design manufacturing, production and management. Transparent communication is another important element of Concurrent Engineering. Quick processing is also an essential part and refers to that individual activities should be performed as fast as possible using productivity tools or design aids.75

Some of the main benefits from Concurrent Engineering are that products get to market faster, at less cost and that quality is inherent in the product design rather than being thought of after the development. Many employees enjoy working in teams and appreciate when their voices are heard. Experience shows that Concurrent Engineering improves flexibility, efficiency and productivity. The number of engineering change orders are reduced and cross-functional teams can help to get up the speed and also reduce the learning curve.76

**Integrated Product Development**

Integrated Product Development originates from the fact that product development can not be carried out in the best possible way if it is disintegrated into different areas of specialization, activity and responsibility. Product development aims to create a good business which is a result of using the market, the product and the production in an advantageous way. One way is to integrate marketing, design and production. A corporation has three levels of activity: setting a strategy, leading product development

73 Ibid. p. 1, 44.
74 Ibid. p. 164.
75 Ibid. p. 182-183.
76 Ibid. p. 205-209.
projects; and performing the practical tasks, which all should agree and have a common objective. Different projects have different scope; significance; time frame; and profit. Interplay between different activities in the development should take place in such a way that they have a positive effect on one another. The answer is not to integrate departments, functions or management tasks but to introduce integrated procedures, aims, attitudes and methods into product development.\(^7\)

A product’s structure of components and the way in which they are put together is determined in the design stage. Hence the structure of the manufacturing system, such as the various operations, their sequence and dynamical characteristics, is also determined. That means that it already in this stage is important to incorporate knowledge and objectives related to production theory but unfortunately this is seldom utilized in industry. Results related to market, product and production must at all times keep pace with each other. \(^7\)

### 4.2.3 INFORMATION

Information is an important aspect of co-operation and is closely related, but not synonymous, with communication. Information can be described as the primary input to knowledge but information is not a synonym to knowledge either. To produce knowledge, which is important to do and keep in an organization, the information needs to be interpreted by a person. This interpretation is influenced by experiences, former knowledge and values which result in different interpretation from different individuals and therefore can different knowledge be produced from the same information.\(^7\) The dimensions of information used in this thesis are Richness and Quality of Information and Frequency of Information Transmission. We refer richness and quality to how much information that is transferred at each time, which is affected by how the information is transmitted, and to the quality of the information. In this thesis frequency refers to how often the information is transmitted, which is affected by how often people communicate and the easiness of information transmission.

**Richness and Quality of Information**

The richness of information that is transmitted is affected by how it is transmitted. Information transmitted by face-to-face communication gives high richness since the language used is richer when people talk compared to when they write. The body language and feedback from the receiver also make the information richer.

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\(^7\) Ibid. p. 15 & 37.
Information transmitted via computer documents has a much lower richness since there is no direct feedback channel, the language is formal and the text is often brief. Other important aspects of quality are that the information communicated should be clear and that the message should be received by the right persons at the right time. The quality of the information flow is of great significance though it facilitates understanding of the message and interpretations of the information.\(^{80}\)

There is a wide range of ways to transmit communication and by nature they allow different level of richness. Face-to-face meetings give the highest richness, as said above. Group meetings give lower level since everyone in a group can not catch every one else’s expressions, voice tones and body language. Nor does everyone give their opinion about every subject. Phone conversations loose richness since the body language is missing and it is difficult to catch voice tones and mimic. Written information transmission has even lower level of richness since body language, tone changes and insinuations are lost. The written language is often shorter and more concise which decrease the richness level. Chats and discussion forums on networks have a higher level of richness compared to e-mails since the chats are in real time and direct feedback is possible while e-mail conversations are more fragmented. But e-mails still often have higher richness than written formal documents such as protocols since the feedback is possible with e-mails and an informal language is used which can be adjusted to the receiver. Numeric represented information has the lowest level of richness.\(^{81}\)

There has to be balance between the richness of the information and the complexity of the situation where the information should be used and transformed to understandings. In simple situations very rich information can be overcomplicating and if there is a complex situation it is not possible to produce a good solution if the information is too simple.\(^{82}\)

Quality of information can be referred to as the timing and adjustment of content to the receivers. Interpersonal (face-to-face) communication and communication through social networks has a greater influence on a person than mass communication. Direct communication is stronger than computerized communication and messages related to individuals and local benefits are generally more efficient compared to messages referring to general or abstract benefits.\(^{83}\) Discussions about communication within

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\(^{82}\) Twent University (2004) *Media Richness Theory*.

organizations are often limited to information spreading. Corporations are often good in spreading its information for example through Intranets; regular newsletter; and smaller and larger meetings. There is no lack of information for the employees but the large amount of information makes it difficult to reach the right person with the right information at the right time. Too much information has an opposite effect on individuals who ignore much of the information if the amounts get to large. Quality of communication is about getting through with a message which can be large problem for corporations today.\textsuperscript{84}

\textit{Frequency of Information Transmission}

The frequency of information refers to how often information is transmitted. The contraries are piece-by-piece, which refers to frequent communication of small parts of information, and one-shot, which refers to transmission of all information at once when everything is collected.

The communication frequency is one way to measure the information transmission frequency. The distance between individuals affect both the frequency and the quality of communication since people who sit close to each other get to know each other better, have a better understanding of each other’s tasks and can therefore communicate more efficient\textsuperscript{85}. One study assert that the probability for face-to-face communication decrease with as much as 20\% with an increase in distance of just ten meters as shown in figure 9\textsuperscript{86}. The most critical distance is the first 50 meters around one person since it thereafter is just a modest drop in the probability, no matter if the distance is hundred meters or hundreds of kilometers\textsuperscript{87}. Except from the physical distance, the organizational distance does, in a similar way, affect the probability of communication. Organizational distance refers to a level of common knowledgebase between individuals and common department or project belongings. Hence, individuals with mutual interests communicate more frequently than individuals with large organizational distance between each other.\textsuperscript{88}

The findings presented above refer to face-to-face communication. But there is no large difference if communication via telephone or e-mail is considered. The probability of communication via other media than face-to-face is also declining with increasing distance between the individuals who communicate. This is because people

\textsuperscript{84} Ibid. p. 68-69.
\textsuperscript{86} Andreasen & Hein (1987) p.96.
\textsuperscript{88} Ibid. p. 155.
talk on phone regularly with the same persons as they communicate face-to-face with—persons who they have common tasks as, share knowledge with or have the common interests as.  

\[ \text{Figure 9 Frequency of Information Transmission} \\
\text{Source: Andreasen & Hein (1987) p. 96.} \]

### 4.2.4 Communication

Another dimension of co-operation is communication. To achieve strong co-operations intense communication, shared responsibility for performance and appreciation of the value added by each group is necessary. This section focuses on the communication by dividing it into the dimensions Direction of Communication and Formalization of Communication. Conditions for good and efficient communication are that every person knows who do what, which authorities each person has and that the group has mutual, good forms for co-operation. Communication between engineers in organizations can be referred as technical communication and classified into three types. Type one is communication to coordinate work; type two is communication to maintain staff knowledge; and type three is communication to promote creativity.

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89 Ibid. p. 155.  
Direction of Communication

Communication between individuals is crucial for all operations and teams. But it is a difficult and complex process which include both the distribution and exchange of information, individuals own interpretation processes, relations between individuals and disturbing factors in the communication. Communication in organizations is even more complex since factors such as corporate culture; organizational structure; economy; and environment also influence the communication.\(^{93}\)

With Direction of Communication, we refer to how communication is performed and directed between people and functions in the organization. Single-way communication from the top management down through the hierarchy is one example and dialogue within a cross-functional team is another example. Dialogues are important to maintain and strengthen relationships between people and are a product of communication and good relationships. The dialogue is not always the most efficient way to communicate since the dependences and power relationships are influencing. But the conditions for mutual understanding are better with a dialogue compared to one-way communication since the interpretations can be examined and influenced during the dialogue.\(^ {94}\)

A lack of communication often result in a mismatch between functions and their expectations, for example may the design engineer design products with requirements that the production functions can not perform\(^ {95}\).

Formalization of Communication

The formalization of communication refers in this thesis to how the communication is initiated and how it is performed. Communication can be initiated by a rule or process description which regulates the communication through a meeting, or it can be performed or initiated as an informal corridor chat when two employees meet in the coffee room. The formalization is also affected by the language used which differs between situations, between profession groups and between individuals. The formal communication paths in a project can for example consist of project meetings and balance meetings, while the informal communication include informal meetings and communication over phone, fax, email or mail. The informal communication tends to decrease dramatically when the geographical distance increase.\(^ {96}\)

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\(^{94}\) Ibid. p. 82-84.


According to Magrab, a combination of both informal and formal communication is preferable. The formal communication is under the management’s control and work well in predictable and routine situations. The informal communication is an important part of the organization’s processes since it develops the employees’ understanding of its own function and role as well as the organization’s structure and function. It also encourages the organizational learning when opportunities for the employees to meet and share experience in an informal way are presented. The informal communication is fast and more substantial compared to the formal communication. People need to have a relationship with each other to be able to communicate efficient, which arise when people meet. Hence, it is not possible to replace face-to-face communication with technological ways, but a combination of the two is, according to Falkheimer & Heide, the most efficient solution. In the traditional view of the organization communication is restricted to formal communication through formal paths such as PM, Intranet and meetings. In traditional organizations there is often a resistance to informal communication since it is outside the management’s control. The resistance affects the culture and employees talking with each other can be seen as unproductive even if the informal communication is important for the development of mutual understanding within the organization.

4.2.5 Organizational Support

The organization is often viewed as a system with exchanges with the environment. A system consists of different parts which are dependent on each other: for example individuals, groups, departments and divisions etcetera. In order for a corporation to succeed it has to be adoptive to the world and actively work towards its objectives. To accomplish this, the company not just has to develop products but it must also be innovative with respect to methods, aids, strategy and organizational structure.

The organizational structure may facilitate or oppose co-operation. The cause for disruptions or suspensions in processes can, according to Sverlinger, be divided into organization, aids, communication, process design and results. Disturbance because of aids can occur from lack of competence or routines or from use of wrong or non appropriate aids. The disturbance related to organization can be due to inadequate resource allocation and planning. Some researchers claim that the organization and its

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97 Ibid. p. 31-32.
99 Ibid. p. 89-91.
100 Andreasen & Hein (1985) p. 32.
structure have to be adapted to the production technology in the company since different technologies require different organizational support. One piece production requires small working groups with independent responsibility. On the other span, mass production companies require organizations with strong formalized production procedures detailed regulated with routines and administration.\textsuperscript{103}

In an organization many aids exist aiming to facilitate the execution of tasks; the information spreading; and co-operation. Examples of tools used for information spreading are personal papers, department meetings and the Intranet which became popular during the 1990s\textsuperscript{104}. Drawing programs and machines etcetera will simplify the execution of specific tasks. Tools facilitating co-operation include communication aids such as phone and e-mail programs; information sharing aids such as databases; and methods and processes advocating co-operation.\textsuperscript{105}

One path for integration and co-operation improvements is through project managers who may have great influence on the project work activities and performance\textsuperscript{106}. Another way to improve co-operation is team-building activities which aim to increase trust and understanding of each other and to create shared experiences. Individuals who are similar according to background, experiences etcetera or have worked a long time together do similar interpretations since the interpretation of information is influenced by the individuals' background, experience, education and organizational culture.\textsuperscript{107}

Some problem factors in product development are related to the culture of and the attitudes in the industry and the company. The organizational culture affects the decision making, the information transmission and the co-operation in a company but the culture is also affected by itself, the co-operation, the management etcetera. If the culture banishes individuals for mistakes; is hierarchical and power dominant; or is very competitive, the mentality in the company counteract co-operation and team orientation.\textsuperscript{108} The culture is not homogenous across the industry or across the company; instead there exist different organizational cultures and sub-cultures. During

\textsuperscript{103} Bakka et. al. (2001) p. 74-75.
\textsuperscript{105} Sverlinger, Per-Olof (1996) p. 70.
\textsuperscript{107} Falkheimer & Heide (2003) p. 93.
the mid-nineties many companies tried to change the culture toward a more co-operative, less confrontational culture.\textsuperscript{109}

One challenge related to different sub-cultures within an organization is to resolve problems and conflicts that stem from lack of understanding between people and functions. This can be avoided only with a good two-ways communication which may require changes in attitudes and culture from both sides.\textsuperscript{110} Clarks & Fujimoto\textsuperscript{111} describe these attitudes and cultures as:

“The stereotypical product engineer is a perfectionist in product function who changes designs for better performance as long as the schedule permits, but who hates late design rework imposed by manufacturing. The stereotypical process engineer emphasizes manufacturability of product designs and hate late design changes except as they relate to manufacturability”

(Clark & Fujimoto (1991) p. 124)

\textbf{4.2.6 Goal Optimization}

One dimension of co-operation in this thesis is connected to goals and objectives. Goal orientation can be referred to the different levels: organizational; project team/department; and the individual level which all are related to each other. Goal optimization and project objectives refer to if, and to which extent, there exist mutual understanding and use of common goals.

In organizational theory the importance of mutual organizational goals is highlighted\textsuperscript{112}. A successful project has clear objectives and there is a shared understanding of the project’s intent in the organization. Problematic projects often have multiple, vague or ambiguous objectives.\textsuperscript{113} But research and investigations show that organizations often find it difficult to unify to one common goal and instead receive different goals which can come in conflict with each other. The discussion about divergent organizational goals has provided the companies with consciousness about the difference in purposefulness of the individual employee as well as the organization as a whole. An organization with convergent and mutual goals is a utopia but it is still valuable to work

\textsuperscript{109} Cooper et al. (2005) p. 106-107.
\textsuperscript{110} Ibid. p. 124.
\textsuperscript{111} Clark & Fujimoto (1991) p. 124.
\textsuperscript{112} Bakka et al. (2001) p. 16-17.
toward that vision to receive and find goals for each individual to work toward and be motivated of which agree with and contribute to the business’ goals.\textsuperscript{114}

The project ideals and standards should be common as opposed to confusion and slovenliness. Decisions should be in line with the overall objectives and with a global optimum as target.\textsuperscript{115}

According to Herzberg’s two factors theory\textsuperscript{116}, there exist: hygiene factors that affect the level of unsatisfactory but do not release motivation; and motivation factors that affect the level of satisfaction and release motivation. Hygiene factors are company policies and administration, management, salary; interpersonal relationships, and working conditions. Motivation factors are performance, credit, the working tasks, responsibility and promotion.\textsuperscript{117} A person’s willingness to act is affected by expectations, motivation and commitment\textsuperscript{118}. Motivation in an organization affects employees’ work, effort and contribution where more motivated individuals contribute more. Team affiliation and position in a group motivate individuals as well as more varied tasks and possibilities for individuals to use their talents.\textsuperscript{119}

\section*{4.2.7 Attitudes in Cross-functional Teams}
Co-operation in a team is affected by the attitudes in the team or department and by each individual. Attitudes in and toward teams affect the result and is especially important to examine when cross-functional teams are referred to. We refer this dimension of co-operation both to how open-minded, inspirational and helpful one is in the teams and in broad terms how the attitudes are towards working in cross-functional teams. In an engineering group at least three sets of attitudes are relevant: the members’ attitudes about their own actions; their attitudes toward each other; and their attitudes about group goals\textsuperscript{120}.

In Integrated Product Development multidisciplinary, collaborative, flexible and responsive teams is a fundamental component for successful results. The team should include design, manufacturing and production engineers plus representatives from finance, sales and marketing, purchasing and service departments. According to

\begin{itemize}
\item \textsuperscript{114} Bakka et al. (2001) p. 16-17.
\item \textsuperscript{115} Cooper et al. (2005) p. 106-107.
\item \textsuperscript{116} Bakka et al (2001) p. 166.
\item \textsuperscript{117} Ibid. p. 166.
\item \textsuperscript{118} Sverflinger, Per-Olof M. (1996) p. 36.
\item \textsuperscript{119} Bakka et al. (2001) p. 160-162.
\item \textsuperscript{120} Clark & Fujimoto (1991) p. 243.
\end{itemize}
Magrab121 a team working with Integrated Product Development should work as a single unit; have a common goal; the combined efforts should result in better solutions; each member should have a specific assignment and its contribution should be crucial to the success; the team should have a leader; and the organization supplies guidance and resources. The teams do a better job if they meet criteria such as: 122

- The team has ten or fewer members.
- The team is involved from concept development to product delivery.
- The members volunteer to serve the team and do it full time.
- The design, engineering, manufacturing and marketing representatives are in the team.
- Members are located within conversational distance from each other.
- The team has a common vocabulary and the members are able to communicate information and collaborate to create shared understanding.
- The team agrees upon common purpose and priorities.

It is important to maintain balance between team work and individual work. Each individual has its expertise area and it is important to let them work in that area for maximum contribution.123 The effects of a good and bad co-operation differ much compared to the efforts of one single person where a good co-operation between people result in more than the sum of each persons’ individual efforts and where a bad co-operation results in less than the sum of each effort.124

In a project or team dependences between people and functions occur. These dependences can be divided into general, serial, sequential and mutual dependences. Dependence contributes to individual uncertainty which influence its risk perception and hence the willingness to act.125 One person’s amount of effort greatly affects the effect on the team. If a person puts little effort into the project it can have negative effect if the effort needed to pass on information and keep oneself informed is greater than the effort the person gives the project. Some information may be lost and the work can not proceed in an effective way if not everyone has sufficient information. But if each person passes the critical bound of effort the positive effect on the project

121 Magrah, Edward B. (1997) p. 44.
122 Ibid. p. 31-32.
123 Ibid. p. 44.
increase linearly with the increasing effort. Therefore it is important that all members of a team dedicate enough time and effort into the project for success.  

Project culture is the set of values, standards and attitudes possessed by the participants in the project. Efficiency, creativity, flexibility and dynamics are strongly affected by the project culture. The independence and responsibility of the project members is shown in a positive matter as energy and enthusiasm or in a negative matter typically through disloyalty and missing of deadlines. Respect and acceptance are other significant issues. A project is positively affected by solidarity but not by egoism and isolation. Also, openness, sensitivity and flexibility to changes and to the surroundings, and not to create a private universe and distrust from the surroundings, are crucial variables in a good project culture. An orientation towards results, diligence and quality instead of slackness, indifference and minimum performance are other significant aspects.  

Cross-functional teams can either act as real teams or as nominal teams. In real teams the members feel belonging to both the team and the occupational group but in nominal teams the members only identify themselves with their occupational team. This results in a “we-and-them” terminology.  

4.2.8 UNDERSTANDING OF TASKS

People try to understand what they are doing since they want to find their assessments meaningful; this holds both for their spare time and within the organization. Understanding of ones own task affect the co-operation since it affects the individual’s perception of the business and the organization as well as the motivation to co-operate. Generally, one wants to know what one is working with, how the organization works, and one’s role and how that is related to others. The answers are often communicated through information and explanations, such as processes, visions and values. But this information is often not adjusted for each target group and hence interpretation problems occur. People in the early phases of the project have to solve the quality problems in the later phases but it can be a problem since they usually do not have enough knowledge about those phases. Therefore it is important to encourage knowledge of the whole value chain.

4.3 Implementation Strategies

Changes can happen through strategies and planned activities but also due to internal and external powers in the organization. It is a challenge to put changes and new concepts into practice, especially if the organization has long, deep embedded traditions and work methods. Companies often try to implement changes either in an evolitional, step-by-step, soft way or in a revolutionary, fast, more direct way.

Different schools and thoughts about how organizations should be organized, developed and improved have existed but with the higher speed of changes, in the environment as well as around and within the companies, theorists as well as practices have developed more mutual ideas about organizations. The ideas can be summarized into a pressure towards more flexible organizations; reaction and adoption skills toward changes in the environment; and empowerment and improved employability. Continuous improvements and readiness for change have been key concepts in later years and therefore the evolitional, soft way to implement improvements has become more popular.

Without notice some change processes can go on in the organization during a time, but just up to a certain level. This kind of changes can be due to changes within or outside the organization; or due to internal or external powers. They are characterized by a lack of knowledge, planning and control from the management.

4.3.1 Strategic Changes

When strategies and changes are discussed they can be divided into the planning, the implementation, and the result phase. In the first the strategy or change is developed and can either be realized through the implementation phase or stay as a plan which is forgotten over time. In the implementation phase three scenarios are possible: the changes are realized as planned; new strategies are developed during the process because of changes in the context; or the actors that should realize the plan work against it and against the changes. Output from the implementation phase is the result which is a product of the performance in the earlier stages. So, the result is dependent

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134 Ibid. p.253.
on influences from different stages, context development and different actors’ interests.\textsuperscript{135}

When implementing strategic decisions and turning them into actions within the organization, the formulation of goals on different levels and the level of concretization of the goals are important. High up in the hierarchy the goals are general formulated missions which become more tangible down in the hierarchy. Goals can be used as a tool in the internal control of the business.\textsuperscript{136} The content and frequency of implementation activities should be adjusted to the depth of the changes\textsuperscript{137}.

### 4.3.2 Components of Change

One model that can be used as a planning tool for organizational changes is Leavitt’s system model which consists of: Tasks and Goals, Structure, Tools and Technology, Actors and Change Agents, as in figure 10. Tasks are often settled from the organization’s goals. The structure consists of the more stable elements, for example hierarchy, department and organization charts. The Tools and Technology refers to both hardware (machinery, premises and computer systems) and software (working processes, quality systems and administrative procedures.) The actors are the employees in the company and they are characterized and influenced by their knowledge, attitudes, values and motivation. The change agents are the initiators or drivers of the change. There are relations between all the components and changes in one of them often results in changes in one or more of the other ones. Each of the components can be used as a starting point for a change and the choice of which one/ones to start with depend on the goal and context of the change.\textsuperscript{138}

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{figure10.png}
\caption{Leavitt’s Planning Tool for Organizational Changes}
\end{figure}

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\textsuperscript{135} Ibid. p. 230-231.
\textsuperscript{136} Ibid. p. 240-241 & 244.
\textsuperscript{138} Bakka et al. (2001) p. 255-257.
4.3.3 Barriers for Change

There are different barriers for and resistance to changes. The resistance can appear in different intensities with a contingency from active oppositions, through passive opposition or indifferences, to acceptance. The resistance often differs over time and can be described as five phases: refusal; defense; leave the front of opposition; adoption and learning process; and understanding of the new. The organization goes through the phases from phase one to five over a period of time.\(^{139}\) Most changes require time and maturity in the organization.\(^{140}\)

The personnel barriers for change can be classified into company-wide barriers; management barriers; and employee barriers. The company-wide barriers relates to a strong corporate culture which is difficult to change. Management barriers include the lack of problem awareness and problem solutions. The employee barriers are on a psychological level and are caused by insecurity and fear of negative consequences.\(^{141}\) There are different causes of resistance to change, for example:\(^{142}\)

- Confusion (many and/or large changes at the same time)
- Too large uncertainty (lack of information)
- Surprise (lack of preparedness and background orientation)
- Lost of control and influence
- Uncertainty of own competence
- More work (changes require time, energy, meetings etc.)
- Consequences
- Real treats

Other barriers for change are lack of problem recognition, problem confession and problem description. Without the insight that a problem exist it is not possible to diagnose and react upon the problem in a structured and strategic way.\(^{143}\) There can also be problems due to lack of motivation and knowledge/understanding of the prerequisites for the strategic change.\(^{144}\)

\(^{139}\) Ibid. p. 265-266.
\(^{140}\) Ibid. p. 253.
\(^{142}\) Bakka et al. (2001) p. 266-267.
\(^{143}\) Ibid. p. 258-259.
\(^{144}\) Ibid. p. 238.
4.3.4 Implementation Process

There is no correct answer to how an implementation of a change should be performed in an organization since the goals; the culture and the traditions; the organizational context; the interests from different actors etcetera, have a great impact on how the implementation should be performed to end up in a successful outcome. Therefore no checklists for implementation can be developed but it is still possible to highlight important areas to analyze and consider before and during an implementation phase. One critical thing to consider succeeding with the implementation is the timing. It is difficult to find and choose the right time for action and activities. The right time is strongly dependent on both the organization and its context.

To overcome the barriers of acceptance to changes and to end up with a result which agrees with the management’s intentions the tangible process of implementation is important. Some areas to use to overcome the cause of resistance are:

- Involve the employees to encourage motivation and engagement. Involvedness can change the energy spent on resistance instead to be spent on support.
- Rebuild and strengthen the employees’ self-trust with understandable information about the background to the changes.
- Develop new competences; encourage testing the new; show understanding and empathy for the persons in the new situation.
- Give knowledge and insight into the new system and into the new roles.
- Take time to listen to the employees’ thoughts.

Even if activities to overcome resistance and find acceptance cost time and money they are necessary to perform since it otherwise will be impossible to succeed with the implementation.

An improved process can be one way to change work methods and co-operation. An example of process improvement is seven principles developed by Aronsson et al. These are elimination of non-value creating activities; simplify necessary activities;

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145 Ibid. p. 263.
148 Ibid. p. 267.
integrate activities; parallelize independent activities; minimize wait time between activities by synchronization; time material supply; and communicate information in the process. Additional principles include elimination of bureaucracy; elimination of duplication work; standardization of activity performance procedure, and discovering of errors.\textsuperscript{151}

There can either be a focus only on the result of a changing process or both on the result and the process in itself. When there is a focus also on the process there is an interest in conditions such as: communication; roles and functions in groups; co-operation and competition in groups; problem solving and decision processes; management and authority; and culture and traditions. These conditions can be studied and improved at individual, group or organizational level. At the individual level the components can be improved through coaching, role analysis, creativity encouragement and competence development. At the group level role analysis, process analysis, co-operation training and team building, feedback and quality groups can be useful tools for change. At organizational level tools such as management development, survey feedback, organization development, strategic development seminars and confrontation meetings are useful.\textsuperscript{152} Further education of the employees in in-house training of complete groups is more productive than individual courses held by external training organizations.\textsuperscript{153}

As mentioned above integration and involvement is one way to overcome resistance. Integration can be performed at different levels: value-based, group-based, individual-based, result-based, structuralized and professionalized integration. It is important for the management to identify the different target groups and to identify open and hidden opponents and advocates. Krüger\textsuperscript{154} has developed a toolbox for implementation according to Issue Management, Power and Political Management and Management of Perception and Beliefs which are presented in figure 11. Management of perceptions and beliefs aims to receive attitude acceptance which aims to change existing negative attitudes of opponents into positive attitudes and more advocates. It mainly uses value-based integration to receive wanted acceptance. Power and political management aims to receive behavior acceptance both from individuals and groups. It aims to affect open opponents and potential promoters to overcome their negative or indifferent

\textsuperscript{152} Bakka et al. (2001) p. 261-262.
\textsuperscript{153} Andreasen & Hein (1987) p.96.
\textsuperscript{154} Ibid. p. 211 & 216.
behavior. Issue management focuses on actual barriers to change such as cost, time and quality. \textsuperscript{155}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{Fig11.png}
\caption{Krüger's Implementation Toolbox}
\end{figure}


\textsuperscript{155} Ibid, p. 212-213.
Analysis Model

This chapter describes the analysis model we have developed and used in the thesis. This is a model used to examine and classify different dimensions of co-operation which we found significant in this study in order to answer the research questions.
5.1 Development & Use of Model

We analyzed the empirical data by means of an analysis model, which states the dimensions of co-operation that we found most significant for this study. It was developed with inspiration from Clark & Fujimoto’s\textsuperscript{156} model about Dimensions of Integrated Problem Solving but improved and adjusted for this investigation. Bakka et al.’s book about organization theory\textsuperscript{157}; Andreasen & Hein’s “Integrated Product Development”\textsuperscript{158}, and Wheelwright & Clark’s “Revolutionizing Product Development”\textsuperscript{159} are other books that have inspired us when we identified more dimensions aiming to cover as many important aspects of co-operation as possible.

Important to notice is that the dimensions are adjusted for co-operation specifically in product development and especially for this case study. We have discussed and weighted different approaches to finally come up with this model. If the model is used in other contexts, careful consideration of whether the dimensions are justifiable and whether new dimensions should be added is recommended.

As shown in the problem framing model the analysis model is mainly aimed to be used when examining the second and the third research questions. The second research question in this thesis refers to what dimensions of co-operation between the production departments and the product development departments that exist. We have used the analysis model to answer this question by examining each of these dimensions to clarify how the co-operation at SIT AB agrees in each and one of them. This analysis aims to lead us to focus on the aspects most worthwhile to consider for improvements. Hence, the model is a tool for answering the third research question regarding which co-operations need to be initiated, improved or impaired.

5.2 Dimensions of Model

The model is presented below and the dimensions examined are: Timing of Upstream-Downstream Activities; Richness and Quality of Information; Frequency of Information Transmission; Direction of Communication; Formalization of Communication; Organizational Support; Goal Optimization; Attitudes in Cross-functional Teams; and Understanding of Tasks.

\textsuperscript{156} Clark & Fujimoto (1991) p. 211.
\textsuperscript{157} Bakka et al. (2001)
\textsuperscript{158} Andreasen & Hein (1987)
\textsuperscript{159} Wheelwright & Clark (1992)
Figure 12 The Analysis Model
With inspiration from Clark & Fujimoto (1991) p. 211.
The Timing of Upstream-Downstream Activities refer to when different departments carry out their activities and if they do it sequential or parallel to other departments’ activities. Richness and Quality of Information refers to how; how much; and with what quality information is transferred between the departments and people in the product development departments and production departments. The Frequency of Information Transmission refers to how often information is transmitted between the departments. Direction of Communication examines if feedback is received and to which extent the communication is of two-way direction. Formalization of Communication refers to how much communication that is formal and regulated; how much that is informal and on the employees’ own initiative, and the balance there between. Organizational Support means how well the aids, the processes, the company culture and the management support co-operation and communication between and within product development departments and production departments. Goal Optimization eludes to which extent the goals are convergent and toward what kind of goals each person work. Attitudes in Cross-functional Teams include attitudes to teams and co-operation between and within departments. Understanding of Tasks refers to each person’s understanding of their own tasks; their colleagues’ tasks, priorities and situation; as well as the understanding of their own contribution to a whole business’ success.
EMPIRICAL STUDY

This chapter comprises the empirical study performed at SIT AB. Interviews; the Intranet; and internal documents form a basis for the study. First the PDP is described in detailed and then each of the four interview groups’ results are presented.
6.1 The PDP

As mentioned in chapter 3 Siemens Industrial Turbomachinery AB, the company means to follow a process called the Product Development Process (PDP) for new design or redesign of products. Here follows a description and explanation of the process, when and how it is aimed to be used and why SIT AB chose to use the process. Information about the process is accessible on SIT AB’s Intranet and as internal documents. The Chief Engineers Office owns the process and is responsible for it and its development and implementation. We met with two of the process owners for interviews in the beginning of the empirical study. This part of the empirical study is based partly on information from the Intranet, partly on internal documents and partly on these interviews.

6.1.1 Why a Process?

Both positive and negative aspects follow a process. Some people might argue that a process is boring, bureaucratic and restrains creativity but it also clarifies roles and responsibilities. According to SIT AB the process can be seen as a complement for creative competent engineers to ensure quality. Using the process in all cases a comparison of risk, cost, time as well as quality between different projects is made possible.

SIT AB means that the PDP results in shorter development time since unnecessary rework can be prevented. Clarified roles and a common language should mean fewer misunderstandings and better motivation and hence the communication should be simplified. The PDP also describes, not just for the person working with the assignment but also for others, what is and will be done and hence a cross-functional understanding should be worn out. Processes forces priorities between different projects and strengthens the understanding of the scope of a project. Gates and reviews handle risk and quality assurance and should prevent non conformance costs.

A process owner explained that one of the motives for the PDP is to solve problems early in a project. This should be guaranteed through gates and reviews.

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161 Ibid.
162 Ibid.

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One of the interviewees pinpointed that SIT AB today has several more ongoing product development projects compared to previously when not more than one or two projects were run in parallel. Today’s more complicated organization shows the importance of planning resources. According to the interviewee, by using the PDP a better control over the quality of the solutions is obtained. Also a process is good in order to structure the resources when several persons work together.

### 6.1.2 Design of the Process

According to one of the interviewees, product development at SIT AB has followed the PDP since the corporation became SIT AB four years ago. Previously, another process existed but it was not used in the same extent as the PDP is. Hence, the process is still young and under development and no project has gone through the entire process yet.

When a project is started it follows the PDP as a minor, a medium or a major project. The scope of the project is decided from a matrix; classifying both the difficulty and the consequences of the project. This matrix is presented below. Difficulty refers to complexity, experience, innovation, design margin, resources and co-ordination while consequence refers to technological performance, financial exposure, units affected and schedule.

**Figure 13 The Matrix Classifying Projects**
Source: Review & Gate structure applied for 14 (2006)

\[ \begin{array}{cccc}
\text{DIFFICULTY} & \text{A. Low} & \text{B. Controlled} & \text{C. Large} & \text{D. Business Wide} \\
\hline
\text{1. Repetitive} & \text{Not Required} & \text{Minor} & \text{Medium} & \text{Medium} \\
\text{2. Routine} & \text{Minor} & \text{Minor} & \text{Medium} & \text{Medium} \\
\text{3. Significant} & & \text{Medium} & \text{Major} & \text{Major} \\
\text{4. Complex} & & & \text{Major} & \text{Major} \\
\end{array} \]
Projects are run across the line organization and should, according to one of the process owners, be performed by a cross-functional team. Production is supposed to be involved through the entire product development project. This is according to the process owner of great importance since it assures that production related issues are brought up early in the process. One of the process owners sometimes gets the apprehension that it in product development is difficult to involve production in an early stage since they sometimes question why they are there. A co-operation is important and necessary since many different areas of experts are needed in a project. One process owner often hears that production wants to be involved earlier in the process but he means that this is not possible in practice since it means that one has to spend a lot of time in meetings where one could not contribute.

One process owner explained that people from GT are involved in a project when there is a need. In larger projects there should always be a need. In a process it is difficult to control the co-operation between departments why, he meant that, commitment from each individual is needed and the co-operation is mostly based on own initiatives. Design engineers are involved in the process through the whole project, but in different parts of the process they co-operate with other functions. Figure 14 on next page shows each discipline’s main links to each step in the PDP. This is an attempt to clarify when and to what extent co-operation with other functions (one of them production) takes place.164

Spreading of information is, according to one process owner, not regulated by the PDP, but he meant that a contact list with area of competence to facilitate communication and information spreading exists. The process owner pinpointed that this regularly needs to be updated in order to serve as it is supposed to. Product development has divided its resources into three groups according to three parts of the machine: combustor, compressor and rotor; and turbine. Production has divided the machine into main groups of components with one responsible for each group. One of the process owners thought that it is diffuse who in the product development group that corresponds to which main group in production and said that the structure of the circle of contacts could be further developed.
**Phases**

The Strategic Product Planning is a pre-phase to the PDP. The PDP can be seen in its full version in appendix 3. Each year a strategic product planning meeting is held where product development projects are decided and the budget is set, resulting in Product Requirement Specifications (PRS:es) for each development program. Proposals come from sales, representing customer requirements, but also from technology programs. Technology programs go in parallel with the product development projects and focus on research and development of technology.\(^{165}\)

Each project is assigned with a project manager who based on the PRS perform a Feasibility Study and a project plan. This results in a Design Brief (DB), clearly defining the design task and the strategy to accomplish the objectives. The DB should be reviewed and aim to create a common and clear view of why, how, when and where the team should go in their design efforts. At this stage resources needed in the project should be determined; and a schedule and a communication plan for the project should be set up.\(^{166}\)

First in the Design Phase the Conceptual Design takes place. In this phase cross-functional teams should work out various design concepts and potential concepts should be thoroughly examined. Different activities should be performed at this stage of which one is an examination of manufacturing requirements and preconditions. In the Basic Design; calculations and drawings should be made as well as a specification of tools for manufacturing and assembly.\(^{167}\)

Next, when the design phase is finished, the project continues into the Sales Preparation phase where the approach for market entry should be defined.\(^ {168}\)

\(^{165}\) Ibid.

\(^{166}\) Ibid.

\(^{167}\) Ibid.

\(^{168}\) Ibid.
The Design Implementation phase starts with a Final Design and Procurement Preparation. A Failure Modes and Effect Analysis (FMEA) should be performed in order to identify and prioritize engineering, manufacturing, inspection and testing requirements and to evaluate related risks. At this stage manufacturing drawings and CAD data sets should be established. Next follows a Manufacturing and Assembly phase. In this phase; work instructions regarding orders of materials, parts and tools; manufacture of parts and components; quality control and assurance of parts and documents; assembly of parts, components and tools; test of assembled products according to quality specifications; compiling of documentation; and feedback on product cost data and cost update if deviations are found. In the Commissioning phase the product should be erected, installed, commissioned and put into trial operation. Deviations in measurements found in the trial operation must be evaluated and solved or accepted.  

The final phase in the PDP is the Validation Phase. This phase starts with a Product Monitoring where data concerning operating characteristics, performance, reliability, availability, serviceability and reparability are gathered and evaluated against the product requirements and predicted values. In the Full Release Gate (G5) validation plans are confirmed and the responsibility is transferred to the line organization and by that the development project is formally closed. Next is the Product Validation phase, which aims to confirm that the validation is successfully completed and the product and technology has reached the status of “operational proven design”.  

Gate Committees

At each gate a decision either to continue the program, to cancel it or to rework unsatisfactory areas of the project are made. The gate committee is responsible for the gates and evaluates strategic, technical and commercial risks.

One interviewee explained that projects are classified in four grades (A-D) depending on the scope of the project. The grades determine who should be responsible for the gates. At the lowest level the product manager is responsible, at the next grade the

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169 Ibid.
170 Ibid.
171 Ibid.
manager of product management is responsible, then the manager of product
development is responsible and finally at the highest grade the manager of gas turbines
is responsible for the gates.

Project Groups

Each project group comprises a project manager and project members. In the large
projects the project manager is determined by the executives. One interviewee
explained that the organization does not have more than five to ten project managers
with the competence to run these large projects and they are employed at the product
management department (GRP).

One of the interviewees explained how the project group is appointed. The project
manager should in an early stage perform a feasibility study and a resource plan.
According to this study resources needed in the project should be determined and the
line organization should appoint persons with the needed competences in the right
places. The manager of each department should be asked to find co-workers for the
projects. Both full-time and part-time resources are available and if needed tasks can be
performed by other corporations or consultants. According to one process owner the
project group follows the project from the start to the end of the project but the
members’ workload changes through the project.

The project manager is responsible for the realization of the project including
responsibility for reaching the goals concerning deliverables, time, costs and quality;
initiate reviews; define tasks and the time schedule; keep the project members up to
date; and to report to the steering committee.172

The project members are collectively responsible for the result of the project and
responsible for their tasks which have been delegated by the project manager. They are
also expected to give suggestions for possible improvements in the working process
and for the variables of the project and also to identify potential risks in the
realization.173

Large projects have except from the project manager team leaders, with a co-
ordination responsibility for each function. One of these functions is production. The
team leaders have, as one of the process owners said, a responsibility to contact the
project with the right person if one can not solve the problem or answer oneself. Team
leaders for production are chosen for large projects and projects with a heavy

172 Ibid.
production work. The choice is partly regulated according to the classification of major, medium and minor project but, according to one process owner, no direct decision rules exist. It is decided by the project manager and to some extent by the gate committee.

Reviews

The project manager orders a review at the Chief Engineers Office. One of the chairmen at the Chief Engineers Office, together with the project manager, designs the review and composes the review group with different experiences and competence areas depending on the needs in the project and the project phase, a process owner explained. The members of this group are not in the project but rather represent a specific knowledge. If production is not represented in the project they should, according to a process owner, be represented in the review groups but there are no exact rules showing upon this. Resources to the reviews are chosen from a competence based list. One week before the review a notice to attend to the review should be sent out together with the material composed for the attendants. Instructions of how the material should be read and how the roles are assigned are also available. The attendants can give comments both before, after and during the review. As one process owner explained, reviews are consultative and not decision-making and the persons forming the group should be independent of the project. A review is most often structured as a meeting and can be everything between twenty minutes and three days long and comprise five to twelve persons.

The content and meaning of each review is presented in detail in appendix 4. Reviews with significant importance for production are, according to one of the process owners: R2; R3; R5; R6; R7; and R8. R6 arose especially to handle purchase and production related questions.

6.1.3 Implementation of the Process

According to one of the process owners, all involved in product development are expected to know the process and to structure their work according to it.

The process owners explained who should be trained in the process and said that all project managers have a compulsory training in the process. For other employees in the product development department training in the process is voluntary but they are expected to follow the process in their work routines. No special training is given for new employees and neither for production personnel. According to one process owner, the project manager has the responsibility to make sure everyone in a project is
aware of the process and understand it so that they can structure their work according to it. One of the process owners meant that it is good if everybody is aware of the process and understands the outlines of it. Although, all participants will not need the same deep understanding of the process as the project manager needs. To get this understanding it must not take more than thirty minutes to go through the process.

6.2 Findings from Interviews

This case study is based on interviews in order to collect information; find different person’s opinions; and develop understanding of the organization and its employees. The results from the interviews are presented in this chapter which has been structured after personnel groups: project managers; managers; design co-workers; and production co-workers. The interviewees are presented in appendix 1 and the interview questions can be found in appendix 2.

6.2.1 Project Managers

In this category both project managers and team leaders are represented. The project managers co-ordinate whole projects, while the team leaders co-ordinate activities in a smaller project team within the project. There is one department, product management (GRP), which employs the professional project managers for large projects. The project managers have the responsibility to prioritize, plan, schedule and execute development projects. They also recruit team leaders from different departments in the organization with respect to the project’s desired needs.

In the following text almost no differentiation between the project managers and the team leaders is made since they have similar experiences from projects and co-operation between functions.

Product Development in Operation

All the respondents said they know the PDP. Some team leaders, especially from GT, said that they only have a superficial knowledge of the process and not a deep understanding about the different phases and the activities within them. They were informed about the process in the initial phases of projects but they did not have any training in it. They thought it would be useful to have a deeper understanding so they know expectations and coming activities.
Most project managers thought that they have to know and understand the PDP better than the project members since they are responsible to plan, co-ordinate, follow up, and control activities and the progress of the project while the project members are more focused on specific tasks. Some project managers thought it would be good if the project members had a better understanding of the process but they also said that they work toward a better understanding now.

Most of the project managers thought that at least the large projects follow the PDP. The process was introduced approximately three years ago and several project managers thought that the process now is well implemented and firmly established, at least in the GR organization. There is no, or maybe a few, projects that have passed through all the gates in the PDP so the organization is still in the learning process.

Some of the project managers said that they read the milestone descriptions when they start a new phase to plan the activities and in the end of the phase to secure that all necessary activities are executed and goals are fulfilled.

“I read in the PDP when I plan activities as well as when we get close to a review to check that all necessary activities are performed”

(Project Manager GR)

The PDP is described in general terms and it is possible to do interpretations differently from one project to another. The project managers thought it is both positive and negative that the process is described in general terms. It is positive that the description is applicable on both small and large projects but some project managers asserted that the description is unclear and difficult to understand. The descriptions of the milestones require most interpretation. To make good interpretation some of the project managers said that they ask colleagues or Chief Engineers Office. Some project managers wanted more specified process descriptions and checklists since they thought the process would be more useful and less interpretation would be needed why the process should be more standardized. Others thought the PDP is good as it is.

Information about results and progress is shared at the reviews where the project receives feedback from others in the organization. The project managers thought this works well and that the feedback is appreciated. The project chooses which feedback to consider and if some feedback can be overseen. But generally the feedback is considered since it often is good viewpoints.
Role Responsibility

The project manager thought they have the main responsibility to ensure that the project follows the process description and that all activities are performed and they also have to answer for the gate committee.

“GT is working with product development on commission of GR”

(Project Manager GT)

Some of the project managers thought that GR have a larger responsibility to initiate contact with GT in development questions since GR employees have more information and are upstream in the development chain.

Team leaders at GT experienced that they work with development projects on commission of GR.

Information Flow

The respondent explained how often meetings concerning a project are held. The project managers decides how often meetings should be held and it depends on the project’s size, current phase and character. In the large development projects regular meetings between the project managers and the team leaders are held (once a week). Each team has a team meeting once a week or every second week. The steering committee for the project has meetings every fourth to sixth week with representatives from both Finspång and Lincoln. At every meeting a protocol is written and distributed to the people who the chairman thinks are concerned.

“It is important that there is a balance in the information flow. People always ask for more information but timing in both time and content of the information must be if it should be relevant for a person”

(Project Manager GR)

The information flow is different in different parts of the organization and in different projects. Within a project, much of the information is exchanged during informal chats.

Information flows to and from the project manager through the team leaders who have the main contact with the project members within each team, the respondents
explained. Project members within a team talk directly to each other, but also to project members in other teams about specific subjects. In the large projects there is one team leader from GT who is responsible for a GT team. To increase the flow of information between GR and GT teams, the GT team in one project tries to invite team leaders from GR groups to inform about their work and progress.

All information about a project is collected either at the common hard drive with restricted or non-restricted access or in a special information database with restricted access. The purpose is that the right team members should have access to the right information.

Two purposes with the continuous information is to easy the production planning and to give feedback to GR in early stages. Another way to increase GT’s involvement early in the development process is to work more with 3D models at GT so no extra work to create temporary drawings just for discussion meetings with GT has to be done, some project managers thought.

**Inter-departmental Contacts**

Some respondents thought that GT is contacted at right time and in right questions while others thought GT could come in earlier in the process and that design engineers sometimes miss how small changes on a product could have large affect on the manufacturability and therefore do not discuss the smaller changes with GT.

The project managers said that contact seems to be taken when the design engineers need production viewpoints or have questions regarding affect on manufacturability etcetera.

Some project managers, especially from GT, thought that GT comes into the development process too late when most large decisions already are made. They thought it partly could depend on lack of information about the projects and their respectively stage and progress. One way to remedy the lack of information could be to invite GR team leaders to the GT team meetings so the GR team leaders can inform GT about the progress in each area regularly. This method has just been initiated.

The project managers thought that no communication or contacts are regulated in processes or work descriptions. Some thought that is good since it otherwise could restrain the adjustability to individual preferences while others thought it would be good with some suggestions for communication timing and paths since that would ensure quality.
In the large projects, in which GT has a team leader, the contact between departments naturally goes through them and it secures that GT is involved in the product development process from the first day. The project managers agreed that it is important to have this kind of co-ordinator. They also said that there is no co-ordinator or team leader employed from GT in the small projects and some thought it would be good if that existed in all projects. Some project managers thought most of the information and contacts should go through the team leaders and that it would be difficult to co-ordinate the work if all team members from GR have to take direct contact with respectively co-worker at GT. Others thought that direct contact is a necessary and the most important way to make progress and that the contact through team leaders could give distortions, and hence misunderstandings on the way. Further some thought it was a good balance between direct contact between team members of different teams and contact taken through the team leaders.

**Inter-departmental Communication**

Most project managers thought that the communication between individuals from different departments generally works well but that it, of course, depends on the individuals. When a contact has been initiated it is a two-way communication. Both parts are equally responsible that it works well. The contact between co-workers at GT and GR is, according to some project managers, very focused on problem solving.

*"The optimum is if the project is closely located but that is difficult to attain when not everyone are working full time on the project"*

*(Project Manager GR)*

Much of the communication happens through small-talk, for example in the corridor and that is necessary for efficient work and progress. Some project managers highlighted that the products are too complex to work with alone. The physical distance has great impact on this kind of communication, even the small distance between the building where GT is located and the building where GR is located affect the frequency of communication. One project manager thought that the distance between the buildings at the Finspång site have almost as great impact on the communication as the distance between Finspång and the co-workers in Moscow. Everyone agreed that it is important to regularly meet the one you work and cooperate with.

Most of the project managers thought the distance between people affect the communication. The distance could be identified as a physical or an organizational
distance. The project managers employed at GR agreed that a mutual project space and a project group sitting close together are desirable. Then all extra information would reach more individuals and the level of co-operation between different functions would be higher. If this should work well for everyone it assumes that the project members are employed one hundred percent on one single project. Team leaders from GT had a more diverse opinion; they thought that it is good to be close to the project group but it is also very important to be close to the usual business and the experts at GT. Especially if the person is employed part time at the project and involved in more than one project. One team leader had tried to have two work places, one at the ordinary department and one in the project team and found it working pretty well.

“The GT organization and the GR organization live their own lives under the same umbrella.”

(Project Manager GR)

Also an organizational distance between GT and GR exist which affect the frequency of communication and the understanding of different department’s working conditions. The organizational distance refers to how the company is organized and which parts/functions/managers that works close together due to the same function area or the same manager etcetera. Some project managers thought the organizational distance decrease in the project organization. According to the project managers there is no organizational distance due to culture differences. Cultural differences between design engineers and production co-workers existed ten years ago but no relics exist today.

**Level of Formalization**

Both formal and informal communication takes place within the company and within projects. As mentioned above regular meetings are held in the projects but a lot of the communication happens through small-talks. The protocols from the meetings are one formalized way to communicate with decision makers, resource suppliers and other interest groups.

Everyone agreed that face-to-face communication is the preferable communication path but that communication also goes through phone, e-mail and data base systems etcetera. The face-to-face communication has low formalization which makes it easier to focus on problem solving and increase the richness of the information transferred. One interviewee pin-pointed the advantage of communication through pictures and models that is possible in a technology company such as SIT AB.
Goals

The mission of the company and the general goals are, according to the interviewees, broadly described so everyone strive toward them. Some project managers thought that different departments have different goals due to lack of insight into each others business. Most interviewees thought that these goals do not counteract too much with each other but instead point forward in slightly different directions. It was a general opinion that it is important to strive toward common goals and that this could be improved on a more detailed level.

Some project managers saw a difference in prioritizations where GR focus on performance and GT focus on costs, lead time and quality. Each employee’s goal orientation depends partly on the projects one work on and the employee’s department affiliation. Some persons thought that one feel most solidarity to the person one work closest together with which usually is the department colleagues.

The team leaders from GT did not find it difficult to be the link between the departments but they thought it was hard work to cope with different prioritizations from the project and different departments.

Understanding of Context

The project managers thought it is important to have an understanding of the goals and directions of a project; an understanding of other projects’ and functions’ situations and problems; an understanding of the whole business and the own person’s contribution to the value chain.

Lack of understanding could lead to wrong prioritizations, wrong neglects and other mistakes. To motivate and make it easier to understand others you have to meet each other, the project managers highlighted.

“People who do not talk to or co-operate with each other do not develop any understanding of each other either”

(Project Manager GR)

Many of the project managers thought the level of understanding of the business outside its own tasks depend on each individual, its motivation and curiosity. To encourage curiosity and solidarity to different people in the organization and not just the own department socialization is important. Some project managers experienced a
lack of social activities or experience sharing activities between GT and GR as well as with everyone involved in a project.

“Personal contacts motivate people to care about more than its own task and to co-operate with others”

(Project Manager)

The project managers thought that many of the employees have developed their understanding of their tasks and the business processes from long experience of similar questions and problems. Some employees are focused on solving their own problems and do not find time and energy to focus on other things outside that – it depends on the person. The understanding of the contribution to the value chain is important to be able to do the right prioritizations and to help other functions.

6.2.2 Managers

The group representing managers in this chapter consist of managers from both GT and GR on a “three-letters”-level which also means that they are three steps down in the hierarchy at the Finspång site. These managers have both “four-letters”-level managers and co-workers they are responsible for. In their role as managers they are also resource suppliers to development projects and do not work in the projects themselves.

Product Development in Operation

All managers recognize the PDP but have different opinions about have well they know and understand the process. One GT manager stated a narrow understanding and knowledge about the PDP and thought it would be good to have a better understanding. The interviewee referred the lack of knowledge about the process to a lack of marketing of and communication about the PDP to the GT organization. Lack of time is another reason, the manager said.

“The gates and reviews are there to ensure quality in the product development process”

(Manager)

The managers highlighted the importance of following the PDP since it is developed to ensure quality in the product development. They said that processes for product development have existed previously too but since they became a member of Siemens
it has become more important to follow the process. This also because there are many more projects going on at SIT AB now compared with previously. The more complicated product development portfolio is another reason why the processes have become more important, one manager said. According to one interviewee the process is sequential and first when the drawing is finished at GR, GT says what they think and start preparing for production, developing tools and so forth. He meant that in order to handle a more parallel process computer systems and processes supporting this are needed.

Most of the managers thought the PDP, and processes in general, work better in large projects compared to smaller ones. One reason described is that people involved in smaller projects often work on more than one project simultaneously hence not able or allowed to concentrate totally on one project. A process for testing has been developed in order to actively support these parts during the entire project and is running in parallel to the PDP. One manager thought it would be good to have checklists in the PDP but the process still has to be general and not too controlling.

**Role Responsibility**

According to the managers their largest responsibilities in product development are to secure the supply of resources and to secure that the resources have the right competence.

> “Project managers are responsible for the timing of the projects and to highlight their demand for resources from the departments. The department managers are responsible for supply of right resources at the right time.”

(Manager)

The project managers have a crucial role in the product development and some managers thought it is risky to have so few trained project managers as they do today and that project managers for the small projects have less training in project management. The project managers are responsible for the team; the goal orientation; and the goal fulfillment in the project. They also have the responsibility for GT contacts to be initiated. The tool Primavera is a help both for project managers and department managers when resources and projects are planned.

One interviewee said that it is the design engineers’ responsibility to contact GT in smaller projects since they usually do not even know there is a project going on.
**Information Flow**

According to some of the managers the information flows with different intensity within different levels of the organization. As department managers they have little contact with departments in the other organization (GT or GR). They said people at higher level, for example the managers for the whole GT/GR organization have more contact with each other, and people at lower levels, for example project or department members have more contact with each other compared to managers interviewed.

One manager thought that the information flow is very good in projects, especially between project members in new product development projects. But another manager thought that most information flows upwards in one of the organizations (GR/GT), then is transferred on a “two-letters” management level to finally flow downwards in the other organization to reach other department’s co-workers. Continuous meetings and informal chats are the main source of information transfer between managers and co-workers. One manager thought that most of the information between GR and GT is transferred via email since there is a lack of face-to-face meetings and visits in other departments. According to some managers not much information about ongoing and coming activities and projects is spread, neither about prioritizations or explanations of decisions.

Drawings are another source of information which flow between the departments and are discussed and reviewed by both sides. When changes and improvement proposals are registered in databases the database also transfer information about the handling process between departments. One interviewee thought there is a problem regarding that GT can not discuss 3D-models but only drawings and GT has to learn how to do this in order to simplify the work. First GR creates a not geometrically correct 3D-model, then GT does the drawing; first a 2D-drawing and then a geometrically correct 3D-model. In the steam turbine system this is automatic.

Reviews are an organized way of spreading information. Also the project managers and the team leaders in development projects spread information to other parts of their organization. Daily Monitoring is, according to one manager, a good way to spread information in the GT organization. The GR organization has got something similar but there is no link between the two, which might never happen, the interviewee thought.
Inter-departmental Contacts

Some departments at GR naturally have more contact with GT than others because of their different responsibility areas, which also are reflected in the information flow between the departments. GR departments with a natural close relation to GT have, according to one manager, a good contact and co-workers from both GT and GR ask questions to each other, especially in new product development projects. The interviewee experienced that GR deliver things to GT who ask the most questions back to GR. Other departments at GR have much less contact with GT and according to one manager the relationship between those departments and GT has been tense. The tenses were due to the upstream - downstream relationship between the departments and experiences of blaming each other for issues they were not in charge of. Therefore they now communicate less with each other and just meet in small, balanced teams.

One manager from GT said they hope they are a part of GR’s development even in an early phase but sometimes they experience being involved too late. The person said they want to be a part of the project already in the concept phase where seventy percent of costs are set. A team leader from production has facilitated this matter considerably. The respondent also thought that GT has to stand up for their knowledge and communicate costs and lead-time in an early phase.

The managers at a "three-letters"-level have, according to themselves, limited contact with people in the other organization (GR/GT) due to lack of time and lack of need. But at the same time they thought it would be good if they had more contact with others. One interviewee thought it might be because GT and GR are not reflected in each other, which makes them not comparable. Some managers thought their employees have contact with many co-workers in the other organization (GR/GT) while other managers thought their employees have limited contact. GT managers thought especially the specialists have much contact with other departments due to their competence as well as the fact that they are well known in the organization.

"The contact between departments is better and more frequent in the large projects compared to the small projects"

(Manager)

Everyone agreed that the inter-departmental contacts are better in the large projects compared to the small ones. Some highlighted the importance of contact with GT early in the project which can enable cost and lead time savings later. The managers
thought most of the contacts are taken by individual co-workers when they experience a lack of knowledge within an area or when they need to discuss other aspects of a problem. Some experienced that the contact is taken too late when a problem or emergency situation already has arisen instead of earlier in a preventive matter. One interviewee thought that if they follow the PDP the timing will be right as well.

**Inter-departmental Communication**

Most of the managers had little to say about how the inter-departmental communication works. Some thought it works well and did not know if it needs improvement and in that case how. Others thought more face-to-face communication is needed. One highlighted the fact that different computer systems obstruct the communication.

Some managers reflected over how the physical and organizational distance between the departments impact the frequency of contact. They thought the distance decreased the level of contact and a closer placing would be good, but difficult to implement.

In order to be closer to reality some respondents thought design engineers should be closer located to production and one referred to Toyota as an example. According to that person it is a huge difference in how well it works in the steam turbine organization compared to the gas turbine organization. The steam turbine organization has a better culture and understanding of one another, thinking more of production related questions and better responding production employees, the organization is flatter and the customer is in focus, while in the gas turbine organization much is slow and sluggish.

One respondent said that GT and GR employees come from two different worlds, and that this still is reflected in the organization. How well people in the two organizations understand each other depends on each person and is based on cultural differences; approaches to others’ background; and competence and also their knowledge of others’ job. The interviewee experienced that the further away from production one is located the more high-class. Another interviewee said that it is good with job rotation and someone who previously has worked in the GR organization can easier find contacts there and also help others at GT to find an entrance in that organization. One interviewee also highlighted the fact that the size of the organization makes communication more difficult.

One of the managers in the GT organization said they do not think they gain a hearing for their improvement proposals. It is frustrating not to get response and it results in
less understanding of the whole business. No matter how the budget is set, there should be no errors.

**Level of Formalization**

Most managers thought that most of the communication goes through informal networks and is not regulated through processes or directions. They asked for some more structure and recommendations regarding the communication but wanted to keep the balance between individual and mutual working styles so the structure will not restrain the creativity. The fact that the gas turbine organization is quite large also affects the level of formalization and the need for some more structure according to one manager.

The importance of clear contact paths were highlighted by most of the managers. They thought it is difficult to know who to contact in different situations and that contact lists or similar would be helpful. Some contact lists exist and some are under development but still they felt a lack of clearance and consistence in this matter. One manager said problems arise when the wrong person is contacted who try to help but lack some important knowledge. But some of the managers also highlighted that informal chats in the corridor and during coffee breaks are valuable. Another respondent thought there has to be a need for a forum to take place, otherwise it dies straight away.

One interviewee thought that the informal contacts should not take over and processes have to be followed. Even if one know someone who can answer your question you should not pass one step in the chain since the person being passed might feel left out and will never learn one’s job. The interviewee thought sometimes in the organization instructions are handled as norms or recommendations which makes it even more difficult for a new person to be familiar with the organization. According to the respondent, this is a management question.

**Goals**

Most of the managers thought the organization have mutual, overall goals. It is to produce competitive gas turbines and earn money. When the goals are realized in the different departments they may focus on different things, for example lead time and performance, but everyone think about costs, some managers explained. One manager said sometimes development projects are seen as interruptions in the production. This must be eliminated. One interviewee thought that GR and GT sometimes have different goals because they do not work together with concretizations of the overall
visions. One highlighted that there could be a need to be more clear about the mutual goals and to work more with the communication of them. According to one manager the ratios to strive for are set too though and not realistic enough to be goals, goals should be challenging but achievable.

“Goals should be challenging but achievable”

(Manager)

Some interviewees highlighted that the prioritizations in the departments sometimes differ due to goals and adjustments to goals and that sometimes the person who do the prioritization do not have all necessary facts to do the right prioritizations. Problems also occur when people have to prioritize between different projects or between projects and daily work at their department. Then the projects often are prioritized over the daily work. This is mainly a problem when people do not work full time on one project. One said that communication about prioritizations is very important and at GR they try to improve this through weekly meetings with “four-letters”-level managers and then “three-letters”-level managers about resource staffing and prioritizations. This has worked very well. Another problem is when extra tasks are required but no extra resources are employed. This may result in that some tasks are dropped.

Understanding of Context

The managers had very different points of view regarding whether the co-workers at different departments understand others’ situations and tasks. Some thought that the understanding is good between people who work together. Others thought that many have a lack of insight into others’ tasks and problems, especially if they do not have direct contact with others. Some thought workshop practice is a good idea and one compared to Toyota, where it is well established. One interviewee said that the prioritizes regarding cost and lead-time in the GT organization and the “cool solutions” in the GR organization has to be overcome and an understanding and interest of each others’ everyday life must be created in order to better understand each other. Everyone agreed that it is important to understand the issues others are dealing with if one’s tasks have any impact on theirs.

Most of the interviewed managers also thought it is important that everyone know their contribution to the value chain and understand the overall organization. But they had different opinion whether this understanding exists or not. Some thought their co-workers have good understanding both of the whole and of their customers,
customers’ customers, suppliers and suppliers’ supplier. Others thought their coworkers have good understanding of their own tasks and the situations at their own department but limited understanding of the rest of the business. The managers said this depends on each person as well as the nature of their tasks. To increase the awareness of each person’s contribution and impact on others’ tasks more information, communication and discussion is required as well as working more actively with discussions about common goals, one manager said. Quality Culture is one way to focus even more on this. One manager thought that it is GR’s responsibility to acquaint GT with GR’s work and vice versa.

### 6.2.3 Design Co-workers

The next group of interviewees presented is the design co-workers who all belong to the GR organization. For more information about their organizational structure see chapter 3 Siemens Industrial Turbomachinery. The respondents in this chapter work with product development every day but with different tasks and responsibilities. They represent product managers, design engineers, and managers of “four- and five-letters”-level departments.

#### Product Development in Operation

All of the interviewees in this group recognized the PDP and many of them structure their work according to the process. Most of the employees said they overall know the process and it is a natural part of their work but that they do not have a detailed knowledge about it. One person said the process now is deeply rooted especially in the GR organization, and thought it is very good, a big step forward in quality. The respondent thought the process might be a bit woolly in other parts of the organization. The person also said that project managers need a detailed knowledge about the process while managers and project members need an overall knowledge about the process. Some of the interviewees also thought that almost all product development processes look the same and this is one of many others.

“The process is deeply rooted in the GR organization”

*(Design Co-worker)*

Most of the respondents thought the process is understandable in an overall matter but not that easy to understand in detail. Some thought the text and especially the abridgements are difficult to understand and that the descriptions of milestones could be improved. Some of the interviewees said that they think it would be good if the

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milestone description was broken down into checklists or if examples were given and if the process was more clarified. One person underlined, that it would be especially helpful for new employees. Some of the interviewees said they have gotten training in the process but most of them said they still have a lot to learn. One person thought the process works better and better once more people understand it and the meaning of each step and concept. But according to one interviewee some are opposed to the process and do not understand why they have to change their work routines and can not work as they have always done.

Another thing that came up a couple of times is whether one process can cover all different types of projects. Some said that they choose from project to project which parts of the process which are relevant. Some interviewees said that the process is not as well implemented in the small projects as it is in the large. According to one of the respondents there is too much administration around the process in the small projects. One person said the level of details is good since it has to be general in order to be applicable on all different types of projects and still keep the innovativeness in the projects.

“We still have a lot to learn about the process”

(Design Co-worker)

The overall apprehension was that reviews are good and that they work well. One respondent said they are good since they set a target to work towards but the reviews are often performed too early and thought the time schedule in the process should be reflected on. One person said that the quality of the reviews depends much on the chairman and how one structures and documents the review. In most cases the right material is sent out on time but some interviewees thought that many invited are not well prepared for the reviews but still they can give input because of their experience and competence.

“It is not always the right people that are called together for the reviews”

(Design Co-worker)

A few persons thought that it is not always the right persons that are called together for reviews. One person said there are few persons from GT and that there is a risk for Chief Engineers Office to miss good competence. One person said that Chief Engineers Office invites the same persons over and over again to the reviews and
meant that the reason for that is probably that they recognize some persons but that does not, according to the interviewee, mean that they have the wanted competence. The interviewee proposed not to invite specific persons but departments and then the manager who knows the employees competences can distribute the job.

One of the respondents said that production usually gets involved too little and the problem is that they do not take their time. According to one of the respondents proposals in the production review are appreciated and meant that sometime drawings passes and later improvement proposals which could have been pinpointed already in the review continues to be sent. Some of the interviewees underlined that GR need to be clearer from the beginning but also GT need to be clearer and make sure the drawings are good when they reach production.

**Role Responsibility**

One person thought that the priority and support the project has depends much on the project manager. The project manager interprets the DB, which clarifies what can be done in the project.

**Information Flow**

Processes, drawings and reports are available as information some respondents said. Some of the interviewees thought that the information spreading can be improved and it is good to know persons in order to get the right information.

One interviewee thought most people in the organization have a sense of responsibility for the products and a responsibility to inform concerned about problems. Another person emphasized that it is important to have a balance in the flow of information; some people always seem to want more information but timing in both time and content is significant in order for the information to be relevant and in order to understand and remember the information.

Each department group has a group meeting each or every second week. According to one person this is an opportunity to spread information one person got from somebody in the GT organization or from somewhere else in the organization.

Each project has project meetings where information concerning the project is spread. According to one person the representatives at these meetings are supposed to filter and distribute information to their co-workers. In large projects one person is delegated to control information spreading. In the small projects this differs. Some of the interviewees said that information spreading within the project works well,
information about progresses is regularly sent out to project members. Information concerning NCRs is available in a database and also continuous improvements have a database, which GR is responsible for.

“In project meetings we are supposed to filter and distribute information to our co-workers”

(Design Co-worker)

Inter-departmental Contacts

Most of the interviewees agreed in some way with what is mapped out in the process about when production should be involved in the projects. Some said that it is important since the parameters for cost are set early but it is also more difficult in an early stage since ideas, drawings and models are not there to be discussed. One person said that in some way production will always be involved due to the production review but it is good to establish contacts before that and it is the design engineers’ responsibility.

The interviewees gave varying answers on the question of how often they meet with GT employees. One person said it never happens except on reviews and the reason is that in the interviewee’s job there is no need. Some others said that since the project they are working on is in an early phase they do not have high frequency on their contacts with GT employees, but also highlighted that they have had a more frequent contact, especially with the montage and that their relation is great. During these times they have been in contact about once a month and on a daily basis during hectic periods. Another person said they are in contact on a regular basis and meant that curiosity and learning makes one go down to the workshop and check how test are going.

Most of the respondents agreed on that GT are contacted in the right aspects. Some thought the timing is good as well. One person said that GT comes into the project in an earlier phase now then they did before. Another person thought that some people are competent and have an overall view so that they can discuss the right things at the right time but this differs a lot from person to person. But some interviewees also thought that GT is contacted too little. One meant that everything is not evident in CAD and a design engineer can find use of seeing the reality and talking to production employees.
Most of the interviewees thought there is a big difference in how well the small and the large projects work. The large projects are better structured and also have a team leader for production related questions. In the small projects, one person said, there is less resources both as people and money and this affects the projects.

“Some people are competent and have an overall view and can discuss the right things but it differs from person to person”

(Design Co-worker)

In the large projects there is a team leader with the responsibility for production related questions. In the small projects this is not as clear and it is up to the project manager to make sure there is a dialog. One person said this is a problem in these projects.

Most of the interviewees thought they work in cross-functional teams. One person said that even the small project teams are supposed to be cross-functional concerning those areas of interest.

**Inter-departmental Communication**

The overall attitude was that the communication works well. Most interviewees thought the organizational attitude is positive and that managers encourage co-operation. One person thought that a reason for the communication to work as well as it does is the fact that the attitude in the organization makes the people not afraid to ask.

Most of the interviewees highlighted that communication depends on the persons communicating. Everybody talks different with different persons and in different situations. How the conversation goes depends for example on how well the persons know each other, how formalized the conversation is and what the other persons attitude to the conversation is.

“The organizational attitude is positive and the managers encourage co-operation”

(Design Co-worker)

Most of the respondents agreed on that the physical distance affect the frequency of communication. People sitting close to each other and having coffee breaks together communicate much more frequently. Some of the interviewees said they go down to the workshop when there is a problem. They said it is much easier to solve the
problem there. One person said that of course the distance affect the communication but he is still glad that the workshop is located in the same city which simplifies the communication and co-operation a lot.

According to most of the respondents it is good if the whole project sit together, including the GT team leader. But some of them highlighted that it is impossible to sit together in the small projects. One person said that one should sit close to the people one work together with; in the large projects the project team and in the small projects the line organization department.

The line organization gives a good long-term personal development and a long-term competence development. One person said that Lincoln has tried the project organization and it did not work that well since everybody had to change managers frequently. Another person emphasized that the project rooms in the GR organization has facilitated the communication within the GR organization.

Most of the interviewees agreed on that there is no need for a design engineer to be located in the workshop. Some of them thought that it is important for them to be close to their competence, which would not be satisfied in that way.

“There is no need for a design engineer to be located in the workshop”

(Design Co-worker)

Most of the respondents thought the “we-and-them” culture is less significant today then it has been but it still exists in some way. One interviewee said that a feeling of belonging to one owns department exists. The person meant that it is not a resistance to other parts of the organization but less commitment when the organizational distance increases. One person said that a way to overcome this culture is by explaining arguments and background better. The person also said that some people are good at this while others are not. Another person explained that employees at different departments think different and have different wills which make the “we-and-them”.

Level of Formalization

Most of the interviewees thought face-to-face communication is best since you get feedback and can check the understanding right away. Everybody agreed on that most of the co-operation is on one’s own initiative. There are some systems that regulate the co-operation, for example the NCR system and the production reviews. These systems
demand co-operation between GT and GR. The PDP controls only which disciplines that should take part in each of the phases and not when and how to co-operate. One of the interviewees meant that which competences needed in the project and at what time is known from experience. Another person thought that the understanding of when to co-operate and with who is built up during the first years of work and the cooperation do not need to be controlled by a process. Such a process would be impossible to handle according to one of the interviewees. Most of the respondents thought that the balance between formal and informal contacts is good.

“It would be impossible to handle a process controlling the co-operation and the communication”

(Design Co-worker)

Some of the respondents underlined that it is very important to know who does what but that it sometimes is diffuse who does what and who the best to contact in a special matter is. GT has a list of responsible persons for each main group. This list is according to one of the interviewees appreciated, but one respondent had never seen it. One interviewee thought that it is best to have contact with one person from production and let that person pass on the information and have also heard that they feel the same on production. One person said that GR can become better in specifying what they do and who does what. Some parts of the organization have lists of all employees and their area of responsibility but they are not sent out. The respondent thought this list should be better distributed and demands a corresponding list from other departments, meaning it would save time not frequently having to answer questions about who to contact.

“For me it is not always clear who does what, even though I have been in the organization for a longer time”

(Design Co-worker)

One person said that when there is a need to contact somebody one talks to someone one knows in the GT organization and that person helps to find the right person to talk to. The interviewee meant that there would be no difference if this was formalized since however one finds the right person. Another person said that once there is a problem in the workshop they give a call to someone of concern or tell us when we are down in the workshop.
Most interviewees thought that new employees’ situation is more difficult. They are supported by a mentor who is supposed to facilitate creating a circle of contacts. Also, people sitting close to them give support and answer questions. New employees usually ask their way to the right person while employees with long experience in the organization go direct to the person concerned.

**Goals**

Most of the interviewees agreed on that everybody in the corporation work toward common goals. The overall goal is to make money and they thought all employees are aware of that. In a more detailed level different opinions arose. Some thought that different prioritizations are made in different parts and levels of the organization. While others thought that even in a more detailed level the goals are mutual. But everybody agreed that common goals are important.

Some also highlighted the fact that it would not hurt to clearer communicate and to better emphasize the goals. They would appreciate if the goals were broken down on each department and also on each group. If the managers were better on communicating the goals and where they are going the efficiency and job satisfaction would increase.

Sometimes different prioritizations in different departments are made. One of the interviewees thought that it is often diffuse, especially that some parts of the organization is focused on delivery while others are focused on development and experienced that it is not always clear how the prioritizations should go hand in hand. Some desired clearer directives from the management regarding this question. Most of the interviewees thought that the goals in the line organization and in the projects sometimes can differ. Most of these differences concern prioritizations.

One respondent said that sometimes centralized initiatives which do not fully go in line with what the organization is up to at the moment are taken. This makes the organization less stable.

**Understanding of Context**

Some of the respondents thought that an understanding of others’ job do not exist in as great extent as one would hope. One person highlighted that if one not communicates with each other, neither one will understand each other. Most of the interviewees agreed that the understanding of others is good in general. One person also said that the understanding of one another is much better now then is has been before.
One person said that a detailed understanding of what everybody does do not exist but do not have to either. The important thing is to understand the persons working close to one and the interviewee thought this could be improved. Another person said that when people get stressed they do not understand other people’s stress. They do not take time to try to understand others’ situations. The interviewee thought that Quality Culture is a great step in the right direction and it is enough to understand one’s customers and suppliers. One does not have to understand the customers’ customers and so forth. The respondent thought that curiosity and openness is important in order to create an understanding of others but there is not enough time to be visionary and think in long terms.

One person highlighted the fact that you can not know everything even though you might want to and thought that job rotation is a good way to improve the understanding of others’ tasks. Another person explained how they used to spend more time in the work-shop and thought that was better since they got better contacts and understanding of the whole. That person thought that practice in the workshop is good for all design engineers.

According to one interviewee, the new component organization in GR means clarified roles and owner responsibilities, which mean better insight. Another person thought that it is not always good that everybody, including the managers, in the GR organization is so focused on technology and felt that sometimes the managers lack organizational understanding.

“GR employees are familiar with and have a good understanding of the whole business and their contribution to the value chain”

(Design Co-worker)

Most of the respondents thought they and the GR organization have a good understanding of the whole business and their part in the value chain. One person thought that how well people understand the whole differs and different persons at the same level in the hierarchy sometimes have different levels of understanding. The person thought that the Change Control Database helps to create an understanding of how changes in one place affect other parts of the value chain. They also agreed on that it is important to have an understanding of the whole business in order to get a good product. One person thought that many people are too lazy and only see their own part instead of realizing that even though something is difficult to do it can make a great difference somewhere else in the value chain.
6.2.4 Production Co-workers

The production co-workers interviewed have different responsibilities and naturally different levels of co-operation with GR. They all work in the GT organization which are responsible for manufacturing but also for quality and logistic planning. For more information about the GT organization, see chapter 3 Siemens Industrial Turbomachinery AB.

Product Development in Operation

Most of the production co-workers had never seen, or have just had a glance of the PDP before. They thought it would be good to have a better knowledge and understanding of the process for those times they are involve in product development projects. The person familiar with the PDP highlighted that it is quite new in the organization and has not been promoted to everyone. The person thought the PDP has to be spread to everyone in the organization and that a process for development has to exist in such a large company as Siemens - and it has to be used to secure the quality in the projects. Therefore it is important that everyone knows about it.

“The procedure is very different if we talk about new product development or improvements of existing products”

(Production Co-worker)

Some production co-workers highlighted that the procedures are very different for new product development projects and smaller changes on existing products. They thought the new product development projects follow something similar to the PDP and knew that reviews and gates exist in those projects since some of them have participated in review groups.

Role Responsibility

Since most GT co-workers felt a lack of information about ongoing projects and improvement activities they thought GR have a larger responsibility to contact GT than the other way around. They felt a responsibility to highlight problems but some thought there is a lack of response in some questions.

Production co-workers have the opinion that GT work with product development on commission of GR, for example with specific questions GR bring up. But they also said that GT sometimes miss to initiate a contact when they have the opportunity.
**Information Flow**

Most of the information between individuals goes, according to the production co-workers, through phone, but also through meetings, e-mails, drawings and the Intranet. Some highlighted the importance of discussions and feedback which is easiest when sitting together in meetings and therefore that is preferable. Information flow between larger groups goes through department meetings and their protocols as well as through the Intranet where I4 information to everyone is published. How often each department has meetings differ from once a week to once a month. Some production co-workers declared that except from the information distributed at meetings you have to search for information yourself in order to get any. Some highlighted that the hierarchy is very flat and no barriers according to hierarchy exist for communication between different levels.

The organization supports communication through Microsoft Office Outlook with e-mail and meeting booking system and the telephone directory Netwise. Some communication is performed via e-mail but most production co-workers thought it is better with phone when one receive feedback directly and best when people meet and have a dialog about the problem. One person thought that they need more efficient meetings and more efficient use of e-mail. The person highlighted that communication is not to take “Reply all” on all e-mails.

*“It is best to meet each other and sit down and discuss the problem”*  
*(Production Co-worker)*

The information flow in projects differs from one project to another. One example was given when information is distributed at least once a week via e-mail and project meetings are held regularly. Another example given was when project meetings are held with the GT team once a week and at these meetings a team leader from GR are there to present their status in the project (also mentioned above). The production co-workers involved in this project appreciate this information from GR and other GT areas since many of them have a broad base and enough experience to both understand and give input into other areas if they are given the chance to do so.

Some interviewees said that regular meetings with GR just in order to have meetings together is not a good idea since it takes too much time. Instead they thought GR should contact them with each discussion point. One department had previously regular meetings with GR but has quitted due to lack of interest from GR, one person said. Now the only forum for discussions with GR this department has is the Change
Control Board. That is a good forum with decision rights, but it is not enough since discussions, communication and information flow with GR is crucial for their work.

**Inter-departmental Contacts**

The frequency of contacts between the departments differs between the large projects and the rest of the business. In these projects, frequent contacts exist with other departments through project meetings with each team and between individuals from different teams.

In the usual business there is, according to most of the production co-workers, a lack of contacts. They also thought that they give feedback on GR’s questions while GR is not that good on giving feedback on GT’s issues. GT has initiated co-operation as soon as they have known the project exist and then they have been involved, said one production co-worker about an example of both lack of information and co-operation. Some thought that they seldom get involved in smaller improvement projects.

Most of the production co-workers agreed that the contacts between GT and GR are about the right aspects but questions when contact is taken. Some highlighted that the GT co-workers receive information too late. They experience a lack of understanding of why GR sometimes contacts them and sometimes not. The timing of the contacts is often too late, many thought.

“This is the right thing, but the timing could be better”

*(Production Co-worker)*

The persons who are (or have been) involved in new product development projects felt participation and insight. The concept with a team leader or a co-ordinator from GT who participates in the project team is very good according to the production co-workers. They thought this gives GT good insight and that GT comes early into the project, which is of great importance for them.

In the small development projects, such as changes of existing products, many production co-workers thought shortcomings exist both in strategies, processes and routines as well as in co-operation and sensitivity between GT and GR. Many thought that GT becomes involved too late in this kind of projects and that it sometimes is too late to make larger changes at that time. They also thought it is boring to come into a project and the first thing to do is to criticize work done and take the project a few steps back by demanding large changes in the conditions. To overcome this kind of situations, the production co-workers required a tighter co-operation between GT and
GR. Already in the time planning stage a co-operation around lead time estimations is desirable. Some highlighted that they would prefer if the design engineers came and discussed solutions with them before a problem arise instead of too late when a large problem has arose and has to be solved immediately. Others described the product development work as discussions and problem solving in cross-functional teams initiated by GR. The timing of when these teams get involved vary, it is sometimes in an early stages and sometimes too late to enable real impact on the result.

One production co-worker thought that the company does not work successfully with maintenance and in small projects. The person thought GR and GT only focus on “hardware” when they co-operate, for example performance and geometry, and too little on soft, surrounding things such us requirements and requirement specifications. Today it is not clear who are responsible to set requirements and fulfill them and also why some requirements actually exist. These are also important aspects to become successful through the whole value chain.

**Inter-departmental Communication**

When a contact has been initiated the communication works well according to most of the production co-workers. Most of them agreed that new product development projects work quite well in the perspective of co-operation between GT and GR. But they also highlighted that the communication is highly dependent on each individual and that the quality of the information vary according to those involved. A few thought that sometimes the communication do not work that well. They have experienced when everyone at a meeting agree but then execute the opposite afterward. They saw a lack of explanations for the choice of actions and instructions which create irritation and misunderstanding. Others experienced that design engineers, especially the young ones, are impressive to and interested in manufacturing aspects and that they listen carefully to the production co-workers’ opinions.

The physical distance between the product development department building and the workshop affect the communication according to most of the production co-workers. Some production co-workers thought some design engineers come and visit the workshop often enough while others come too seldom, hence the understanding of the production system also vary.

Some persons thought that the lack of contact between GT and GR can be remedied if some design co-workers with responsibility for manufacturing preparation sat in the workshop. These design co-workers should be a vital link between GT and GR. According to these people this has been successful in other companies. These persons
should work with broad production related questions that come up frequently. But they did not think production co-workers should win that much on a location in the product development department building since they need to be close to the workshop and the business there. Some projects have been located so production co-workers have been sitting together with the project team and not in the workshop. But according to the production co-workers this did not work well because they lost the tight connection to the expertise at their own department and because they were not engaged in the project full time, hence the co-ordination with the ordinary work struggled.

“Very seldom, someone explains why the specific decisions are taken”

(Production Co-worker)

The GT and the GR organizations look different and can not be mirrored which makes natural connections between departments not possible. Therefore it is difficult to know who to contact, one production co-worker said.

The past culture differences between manufacturing and product development is now almost erased according to most of the production co-workers. A few still experienced a "we-and-them" culture with a strong spirit within GT which is not extended to GR. Some highlighted that the hierarchy is flat and the attitude is open-minded.

A few persons said that there have been discussions about the co-operation between GT and GR before due to a management initiative. Ideas and actions from that meeting have resulted in both permanent improvements and temporary changes that now are back in old tracks. The person required a follow up meeting and similar activities to continuously improve the communication.

**Level of formalization**

According to the interviewees both formal and informal communication paths exist. Some highlighted that co-operation should not be too formalized since each person has an individual preferred working style. But some guiding principles could make the co-operation more frequent and efficient, they thought.

In the projects contact lists with responsibility areas as well as contact information exist. Some production co-workers have these formal communication paths in the usual business too but it varies according to which departments that are involved.
Otherwise the right contact person is found by informal networks which seniors have developed during their long time in the company. New employees have to develop their own network but should be supported by a mentor and the colleagues. According to the interviewees there is a helpful attitude in the company so if one calls the wrong person in a question one is passed on to someone more suitable.

According to many of the production co-workers the co-operation between departments mainly is on individual’s own initiatives. The management often talks about the importance of co-operation but they meant that the actions come from employees in a working level.

“Many contacts are made out from informal networks”

(Production Co-worker)

In the company the employees account for their work to different accounts. Some production co-workers have experienced that this has created barriers for co-operation when the issue cannot be related to an account at GR and therefore the design engineers can not take time to deal with the issue. But they highlighted that attitude and flexibility to this accounting vary between individuals and departments.

**Goals**

The production co-workers have varying opinions whether the company and the departments have mutual goals. Some thought that most of the goals are mutual and that everyone work toward lower costs. They thought the product development departments focus more on performance while production departments focus on lead time but that they all strive toward earning money and produce good products. They also thought the goals and the goal orientation is better and clearer today than previously. Others experienced distinguished strategies between GT and GR and that each department works toward their own goals. Hence some departments push their problems downwards in the value chain to other departments. One person highlighted a lack of follow-up on the goals and deviation between goal and result.

Some thought the prioritization different departments do is very strange and they have never received any explanation of other’s prioritizations which result in irritation and confusion. Some highlighted that the focus in the company is to solve emerging problems instead of working toward removing causes; constant high quality; and long term goals.
**Understanding of Context**

Some interviewees experienced that some design engineers lack understanding of manufacturing processes and a practice in the workshop would be helpful for many design engineers. Everyone agreed it is important to have an understanding of the products and manufacturing process when designing. Some design engineers visit the workshop often, hence they receive good understanding.

Some problems with understanding of each other can be referred to the large gas turbine organization (compared to the steam turbine organization) one thought. While some thought they have good or at least enough understanding of the design engineer’s situation, others required more explanations of their choices to acquire understanding.

Some interviewees thought they have a good understanding of the whole and the different influences on the value chain. They referred this to better information now than previously. Others thought they have quite good knowledge about what they contribute with but not a full understanding of the rest of the chain. Further some thought employees have a very limited insight into the whole value chain and that they prefer to focus on their own task and the closest colleagues.

The introduction of new employees is one important phase where more focus could lie on understanding of products, manufacturing and the value chain, according to one co-worker. The person said it would be preferable to have design engineers with manufacturing experience. A practice in the workshop for new employees would be very good for them, otherwise it takes long time to receive an understanding the interviewee thought.
The chapter includes the analysis of the product development procedure and the design of the PDP. Each dimension of co-operation is analyzed and the status is mapped through ratings for large and small projects.
7.1 The Product Development Procedure

A process is according to Ortnan\textsuperscript{174} a good way to describe how to work in projects. SIT AB argues that a process should clarify roles and responsibilities, and ensure quality and a comparison of cost, time and risk. SIT AB’s arguments for a process are in line with the researchers\textsuperscript{175} arguments. We find it good that SIT AB aims to structure their work according to a process and work continuously to improve the process, hence achieve a quality assurance in their work.

Sverlinger’s model\textsuperscript{176} shows how individuals are co-ordinated in projects and that their work is structured according to a process. A project group, with needed competences, is at SIT AB composed from the line organization. They mean that project members should have different knowledge and experience; hence they mean that a cross-functional team is needed. SIT AB’s aim is in line with Ortnan’s\textsuperscript{177} arguments that a project demands resources from different areas of responsibility. The empirical study indicates that the large projects at SIT AB are set up as cross-functional teams but in the small projects other functions are not involved until in a late stage of the projects and hence lack in the cross-functional setup.

Researchers\textsuperscript{178} mean that a process aims to be a methodology to work according to, and that a process forms a good foundation for projects if it describes how activities should be performed in the best possible way. From the study it can be concluded that SIT AB at least aims to structure their practical work like this. The interviewees explained their experience of projects just as Sverlinger\textsuperscript{179} describes his view; all individuals contribute with their knowledge, experience and personality to the projects. Results from the empirical study indicate that a great deal of what is done and how it is performed in projects depend on the individuals, why everything can not be controlled by a process and the project quality, defined as doing things right\textsuperscript{180}, is important as well. Ortnan\textsuperscript{181} also means that co-ordination between project members and decision makers is essential for a project to perform well and that clarity is a key requirement for a good result. This is further discussed in chapter 7.2 Dimensions of Co-operation.

\textsuperscript{175} Ibid. p.9.
\textsuperscript{176} Sverlinger Per-Olof M. (1996) p. 44-45.
\textsuperscript{177} Ortnan, Leif (1999) p.225.
\textsuperscript{178} Ibid. p.10.
\textsuperscript{181} Ibid. p.10.
7.1.1 Knowledge of the PDP

Researchers argue that in order for a process to be a good tool it has to be practiced in the whole organization and for that to be possible it needs to be well known and understood. The study shows that the process is well known in the GR organization, but not that well known in the GT organization, where some have heard about it, some recognize it and its outlines and some have never heard about it at all. The project managers declared that they have a good understanding and knowledge of the process, including a rather good detailed knowledge. Project members from the GR organization understand the process outlines but most of them declared that they do not have a deeper knowledge and understanding of the process. Team leaders and also some managers, especially in the GT organization, said they have too little knowledge of the process. From the study can be concluded that the knowledge and understanding of the process is not sufficient.

As mentioned by Cooper et al. it is good to map the process in order to create a common project view and to communicate the process. We think that the PDP is mapped out in a good way, which makes it easy to follow the outlines. But, we argue that in order to improve the work routines a better knowledge and a deeper understanding of the process is desirable. Researchers argue that it is important to communicate a process to the whole team and not just to the managers. We argue that the project members should have a deeper understanding than they have today, including understanding and knowledge of milestones and gates. Still we mean that the project managers need a deeper understanding than others in the organization, but also their understanding can be improved. This would help the organization to use the process to its full extent and to utilize its capacity. According to Ortman a process needs to be continuously updated through ideas and experiences in order to maintain its quality. We argue that if employees of concern do not have enough knowledge and understanding they are not able to contribute to improvements of the process and hence there is a risk that the PDP is not developed in the best way and finally becomes as out of date that nobody follows it at all.

We think that the process could be better spread through both training in the process and marketing of the process in order to, as Cooper et al. argues, be communicated and be an aid for everybody. We experienced problems when trying to find the PDP.
on the Intranet, where it was said it should be published. It turned out that the version on the Intranet is not the same version as on the common hard drive, which is the version the project managers work according to. Also, when asking people in the organization not many could answer to where the process can be found straight away. We think the poor knowledge of where to find the process and the difficulty to find the process is a huge problem which is an explanation to the poor knowledge and understanding of the process. Hence, we argue that the process should be available on both the Intranet and the common hard drive in the same version and also it should be marketed both that the process exists and where it is available.

As concluded above the knowledge of the process is not sufficient. We propose that training for project managers; project members; managers; concerned GT employees; as well as other concerned should take place in order to increase the knowledge of the process. The groups do not need the same training but the training should be adjusted for each group. This would mean that the project managers would have less responsibility for training in the PDP and the projects would work better from the beginning. Also a better understanding of why things are done, and by who, could be worn out. The empirical study indicates that even though most employees find the process good some employees are negative and want to follow other work routines, and this negativism need to be remedied. We argue that better knowledge and deeper understanding could also make employees more positive to the process, which also is supported by Falkheimer & Heide\textsuperscript{187}.

\subsection{The PDP in Product Development Projects}

The PDP, in the form it has today, is rather new in the organization. SIT AB assert that they should follow the PDP for both new design and redesign of products, but most interviewees argue that the process is still under development and is well implemented in the large projects but not as well in the small projects.

Three versions of the PDP exist and the projects are classified according to their scope. The large projects follow the major version of the process, while the small projects should follow the medium or the minor versions. We get the apprehension that not many in the organization know of and understand the differences between the versions or are able to implement them.

Empirical evidence show that the PDP works rather well in large projects. From the study can be concluded that one explanation is that the gate committee and the steering committee are tougher in large projects compared to in the small ones; hence it is better secured that the process is followed in the large projects. The empirical study also shows that the process is not as well implemented in the small projects. The project managers interpret the process description according to the projects’ size, scope and purpose and find interpretations necessary since they think not everything in the PDP is of importance in a small project and it is not clear what should be included in each case. The small projects should, according to the process description, follow the less extensive versions of the process but still the project managers thought interpretations are required. According to Wenell\textsuperscript{188} gates can sometimes control the projects in an inhibiting way and it is important to remember that a model must be dynamic. The empirical study indicates that the process do not fulfil these criteria for small projects and that the process is rather bureaucratic than helpful. We conclude that this is a weak side of the process and we think the minor process should be designed to better meet the demands of small projects without need for interpretations and without uncleanness for example with checklists.

From the study it is concluded that in the large projects the project managers are well trained and have a good knowledge of the process. These project managers, employed at GRP, are five to ten to the number, enough only to cover the large projects. We argue that with their knowledge they are a great and important resource in the organization. The empirical study shows that project managers for the small projects are taken from the line organization.

The empirical study shows that the project managers translate the PRS into a DB, where the tasks, the goals and the strategy are defined. Orman\textsuperscript{189} argue that well defined results and a good co-ordination of individuals are essential for a good result in a project. Since the project managers are responsible for these essential parts their knowledge is crucial. We think that it is a risk to have that few well trained project managers. We conclude from the empirical study that one of the reasons for the small projects not to work as well as the large ones is that the project managers do not have as good knowledge about the process and are not as well trained project managers as the project managers running the large projects. We think one way to overcome this is to train more project managers. One advantage would be that the small projects could be run by well trained project managers as well; hence the process would be better

\textsuperscript{188} Wenell, Torbjörn (2001) p. 42.
\textsuperscript{189} Orman, Leif (1999) p. 10.
practiced. Another advantage is that the organization would not depend as much on a few persons and hence be less vulnerable.

### 7.1.3 The Design of the PDP

Ortman\(^{190}\) argues that process quality is to describe how activities should be performed in the best possible way. One of the aims with the PDP is, according to SIT AB, to shorten the development time. However, the process is structured as a sequential process. Researchers\(^{191}\) argue that in order to further shorten the development time Concurrent Engineering should be practiced. Since Concurrent Engineering was not considered in the design of the PDP it does not satisfy the demand of describing how activities are performed in the best possible way. Apart from that, we think the process is adjusted for the organization’s activities. It is worth mentioning that the PDP still is young and under development. We think SIT AB is on the right track to describe activities but if they consider working more with the Concurrent Engineering approach, we argue that the process need to be restructured. A deeper discussion regarding Concurrent Engineering is brought up in chapter 7.2.1 Timing of Activities.

The PDP has, as Wenell\(^{192}\) states it should, gates and milestones. This is a good start in order to develop a good process and we think the aim of these components of the process is good. Gates are strategic checkpoints and are used as stop or go points in projects, just as Wenell\(^{193}\) argues. The empirical study shows no specific problems regarding gates. We think it is good that the gate committees comprise the same persons through the whole project and that they are chosen differently depending on the scope of the project.

The milestones should, according to Wenell\(^{194}\), be well defined stage targets, especially aimed to project managers. Empirical evidence shows that most of the well trained project managers read the milestone description both in the beginning and in the end of a phase, which they think is good in order to make sure the process is followed. Some employees stated, just as Wenell\(^{195}\) argues, that it is good with milestones since they give clear objectives and deadlines. The empirical study indicates that most employees find it difficult to understand the milestone descriptions. They think it comprises too many abridgements and that the language is too complicated and we

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\(^{190}\) Ibid. p. 226.


\(^{192}\) Wenell, Torbjörn (2001) p. 40 & 42.

\(^{193}\) Ibid. p. 40.

\(^{194}\) Ibid. p. 40.

\(^{195}\) Ibid. p. 40.
think this criticism is fair. We argue that it would be good if the process was designed in order for as many people as possible to be able to understand it, why abridgements should be avoided unless they are very clear and make sense. Another thing we want to point out is that the milestone descriptions are not clear but give room for interpretations which is not in accordance with how Wenell\textsuperscript{106} describes milestones. One example is that it is written in the description that specific aspects should be considered but no guidance for how to consider these aspects and what is meant by considering an aspect are given. We desire checklists and examples of how things can be performed in the milestone descriptions and mean that this would decrease the need for interpretations and hence less misunderstandings and less uncertainty regarding the process would take place. We think that the negative aspects of checklists are that the process would not be as general and that it might restrain creativity but we find the significance of having a clear process more important. Further we argue the largest differences between projects are according to the size of the projects which should be taken care of by the minor, medium and major classification of the project and hence each of the classifications can be general for each type of project.

We argue that it would be good to find a way to gather best practice within the organization, for example in a database, on the Intranet or at the common hard drive. Then project managers or other employees could see how something previously has been interpreted in the organization. According to Sverlinger’s\textsuperscript{107} model this means that results obtained could be a resource and an input to future projects.

The reviews in the PDP are connected to each of the milestones. These are, unlike gates, not decision-making but only consultative. The project managers pinpointed this fact and that the project group can choose which feedback to consider. We think that this is good as long as feedback of importance is considered. The empirical study indicates no direct problems in this question. The study indicates that much is up to Chief Engineers Office concerning who attends the reviews since they are responsible for the performance and for calling to the reviews. They have a list of possible attendants and their areas of responsibility and knowledge. We mean that valuable resources can be missed in the reviews since the empirical study shows that too often the same persons are called and it is not guaranteed that the attendants are spread over the right competences. The study shows that people who are well known in the organization are called more frequently and their voices are better heard. We argue that one way to overcome this dilemma is to call a competence instead of a person. Then

\textsuperscript{106} Ibid. p. 40.
\textsuperscript{107} Sverlinger, Per-Olof (1996) p. 44-45.
the manager or the employees together can decide who best attains the review. Another way is, according to us, to follow the same routine as today but to frequently update the list of attendants and fill out gaps, changes, new competences and new employees.

Another dilemma regarding reviews is whether all concerned functions are called or not. Most interviewees argued that they are, but some said that production representatives sometimes are missed. We assert that it is even more important to guarantee this knowledge in the small projects where production is not as well represented during the projects as in the large ones. As described in the empirical study one of the motives for SIT AB to follow a process is to solve problems early in the projects and that should be secured through gates and reviews. In order for this to be secured, we think gates and reviews need to be well performed and all competence areas need to be represented.

7.2 Dimensions of Co-operations

In this chapter each of the dimensions in the analysis model is examined. The aim is to analyze what dimensions of co-operation that exist and which dimensions that need to be improved. We found a great difference between the small and the large projects in the empirical data why we choose to map out where on the scale both the small and the large projects are. Large circles represent large projects and small circles represent small projects. In each of the figures an arrow is drawn aiming to show to which extent we think the dimensions need to change.

7.2.1 Timing of Activities

We refer the dimension Timing of Activities to the timing of activities between the GR organization and the GT organization. The optimum is when activities are performed simultaneously and Concurrent Engineering and Integrated Product Development is practiced, while the worst scenario is when activities are performed sequentially and no stages are overlapped.

A sequential process is, according to Prasad198, divided into clearly separated phases with a consecutive order and upstream activities are performed before downstream activities begin. From empirical evidence we conclude that this agrees with the PDP and hence it is a sequential process. The risk with sequential engineering is, according

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to Andreasen & Hein\textsuperscript{199}, a poor interplay between design, production and marketing. Results from the empirical study indicate that the interplay between design and production is both too late and too poor. From the study can be concluded that in many parts of the organization one is aware of the importance of stage overlapping and talks about Concurrent Engineering but does not reflect on the possibility to change the process.

The study shows that some attempts for a better timing of activities have been introduced in the organization. One attempt is the way they have mapped out functions and their involvement in different stages in the process outlines. This goes in line with how Prasad\textsuperscript{200} describes Concurrent Engineering; an approach to integrate concurrent design and their related functions. We argue this is a good start toward Concurrent Engineering since it gives a clear picture of when other functions should interplay with product development. Empirical evidence indicates that most employees find the mapping in accordance with reality. In the map the interplay with production is focused during the Design Implementation, but introduced with small interactions prior to that phase. We assert that it would be good with more interplay between functions and particularly in the early phases in order to better fulfill the criteria of Concurrent Engineering.

The empirical study shows that another attempt to increase the interplay between the departments is through the introduction of GT team leaders. They aim to co-ordinate the production co-workers in the development project. Although, these team leaders are yet only introduced in the large projects. Andreasen and Hein\textsuperscript{201} argue that product development can not be carried out in the best possible way if it is disintegrated into different areas of specialization, activity and responsibility and refer to Integrated Product Development. We argue that the GT team leaders are a good initiative to integrate different areas and hence are one way to introduce Integrated Product Development. From the empirical study we conclude that the GT team leaders are appreciated and most employees thought they have improved the co-operation between the departments. We think that the introduction of GT team leaders is a great improvement towards more integration between departments and better timing of upstream and downstream activities.

Empirical evidence indicates that the milestone descriptions agree with what is declared in figure 14 presented in chapter 6 The Empirical Study where different

\textsuperscript{200} Prasad, Biren (1996) p. 164.
\textsuperscript{201} Andreasen & Hein (1985) p. 2-3.
functions’ interplay in the projects is mapped out. Results from the empirical study indicate that SIT AB thought it is difficult to control the co-operation between departments in a process and that it is not possible to declare exact co-operation points in a general process. We agree on this fact, but argue that the process could be simplified by examples and checklists as mentioned in chapter 7.1.3 The Design of the PDP. We also think that if the process was stage overlapping instead of sequential as today it would be clearer and more natural when co-operation in an early phase should take place and the timing of activities would be improved.

The empirical study shows that production related questions in large projects are considered in an early phase but the process that is followed is still sequential and hence gives not enough support for a concurrent, stage-overlapping approach why the score in the dimension is rather sequential than stage overlapping but not totally sequential as shown in figure 15. We argue that SIT AB should consider an integrated process. Prasad argue that activities that are not dependent on each other can easily be performed simultaneously but the scheduling is difficult for activities with dependent characteristic. Hence going from a sequential process to an integrated process is difficult and the PDP needs to be restructured in order to meet these demands. Taking the long term view, we think that the process should be upgraded to include Concurrent Engineering and Integrated Product Development and hence we argue that SIT AB should strive towards a high score in this dimension.

![Timing of Upstream – Downstream Activities: Large Projects](image)

**Figure 15** Timing of Upstream – Downstream Activities in Large Projects

From the empirical study we conclude that in the small projects production aspects are too often missed in an early phase. Partly because these projects had no GT team leader and partly because design engineers sometimes do not understand how a small change on the product can have a large impact on the manufacturability. Hence, the score for the small projects is lower than for the large projects in this dimension as shown in figure 16. But we also think it is not as essential to perform ultimate in this

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dimension in small projects because these projects are shorter and less complex hence the arrow does not reach as far to the right in the figure as for large projects.

**Timing of Upstream – Downstream Activities: Small Projects**

> Figure 16 Timing of Upstream – Downstream Activities in Small Projects

Concurrent Engineering is, according to Prasad\(^{203}\), a key concept enabling companies to reach manufacturing competitiveness. SIT AB aims to be competitive in terms of manufacturability and we think a better timing of activities would benefit SIT AB regarding both product development time; quality and cost; and future production of the products. This study indicates a problem regarding small changes on products and how these are handled. Prasad\(^{204}\) argues that the number of engineering change orders is reduced when implementing Concurrent Engineering and hence we mean that by improving the product development projects SIT AB can prevent later problems regarding changes.

One of the owners of the PDP mentioned that production is supposed to be involved through the entire product development project and that it is of great importance. The empirical study shows that most employees are aware of the fact, which Andreasen & Hein\(^{205}\) highlight, that most costs are set already in an early phase of the product development and hence it is important for production to be involved in an early phase. Different opinions regarding when and in what way production should be involved arose during the interviews. Some employees, especially from GT thought they become involved too late. Of course, the best would be if production was involved in “the exact right time”; not spending too much time and effort but enough to give good input. The empirical study indicates that production is involved when there is a need, but we question how it is guaranteed that this is enough. We argue that it would be impracticable and not reasonable to include all production related functions at all meetings during the entire project but it would be possible to, in all projects, have a GT team leader or a representative from production with full control over what is

\(^{203}\) Ibid. p. 91-93.
\(^{204}\) Ibid. p. 205-209.
proceeding in the project. We also think that they should be responsible for reporting back to other concerned people in the GT organization. If GT has all information we think it is their responsibility to act when there is a problem and make sure they are as involved as needed in all aspects. We argue this is one possible way to make sure GT becomes involved and informed during the entire project.

The empirical study shows that design co-workers sometimes experienced that production not always take time to, in an early phase, examine the projects. We argue that this is of great importance just as it is that GR makes it possible for GT to become involved in an early phase. We want to emphasize that both GR and GT need to make an effort in order for the timing of activities to be improved.

### 7.2.2 Information

The dimensions we have analyzed are Richness and Quality of Information and Frequency of Information Transmission. Information is the primary input to knowledge; is used during communication; and is required for co-operation declare Falkheimer & Heide\(^{266}\). They also explain that information is interpreted and then used by each individual. We argue that each of the dimensions affect the interpretation of information and is therefore important to analyze.

**Richness and Quality of Information**

Richness of information is in this thesis referred to how the information is transferred. Respondents from all the interview groups declared that in large projects face-to-face meetings within the teams are held regularly and the meetings are followed up by written protocols distributed to concerned partners. Allen’s\(^{267}\) definition of richness define that high richness is received when people meet face-to-face and low richness is received when information is transferred via short written messages or formal protocols so we conclude that both high and low richness of information exist in large projects. We also argue that in large projects the problems to solve are complex and a high richness of the information is therefore required which agree with the recommendation from Twente University\(^{268}\) that complex situations require rich information. According to the project managers, face-to-face information transfer and problem solving is facilitated by short physical distances. In large projects there have been attempts when all project members have been located in the same project space. Interviewees who were involved in these projects thought the near localization


\(^{268}\) Twente University (2004)
encourage face-to-face dialogue; hence a general high level of richness of the information arose in the projects. These empirical data indicates high levels of richness of the information in large projects which results in a high score in the dimension (figure 17).

![Richness & Quality of Information: Large Projects](image)

**Figure 17** Richness & Quality of Information in Large Projects

The quality of information refers in this thesis to the timing of information transmission; the adjustments of content to the receiver; and the accuracy in the choice of receivers²⁰⁹. Allen²¹⁰ highlights that a high quality of information always is preferable since it facilitates the understanding of a message. Some interviewees experienced inefficient meetings and too many meetings. We think this can be explained by a low quality of the information. Even if some project managers highlighted the existence of communication and information plans in large projects, we argue these should be more influential and prioritized, both in small and large projects. Hence, we think improvement potentials exist both concerning the existence of communication plans and in the methods of their development. We think company best practice forums could be facilitating which also Krüger²¹¹ suggest as one tool for improvements.

We think that small projects are less complex since the problems often are narrower and it is fewer people involved. Researchers at Twente University²¹² argue that the richness has to be balanced against time and effort required to transmit the rich information and simple situations are rather opposed than helped by very rich information and therefore the richness should be adjusted to the situation. Therefore, we argue that small projects do not require as high richness of the information as large projects. Examples of information transmission media in small projects given during the interviews are: through notifications in data bases (such as the improvement proposal database); via e-mail; via phone; at arranged meetings; visitations in the

²¹² Twente University (2004)
workshop; or small talk when dumping into concerned persons. The richness vary in these different paths but the we conclude that, in general terms, the level of richness in small projects is often right according to the complexity of the situation.

Richness & Quality of Information: Small Projects

![Richness & Quality of Information in Small Projects](image)

According to the quality of information different aspects exist. The subjects GR and GT co-workers discuss are, according to most of the interviewees, mostly the right ones which indicate high quality of information. But some interviewees highlighted a lack of feedback from receiver of improvement proposals and drawing change requirements as well as examples when actions do not agree with decisions. Feedback is a form of communication affecting the level of experienced involvement which, according to Bakka et al., is very important for motivation, co-operation and future complaisant attitudes. Therefore we think it is important that also this information have high quality. The empirical evidence shows upon improvement potentials in the quality of the information in small projects.

**Frequency of Information Transmission**

In this thesis, the Frequency of Information Transmission refers to how often information is transferred. According to Prasad, this can be crucial for the receiver’s choice, and possibility to choose, working methods. Researchers mean that the frequency of information transmission is highly dependent on the distance between the individuals involved and that the frequency decrease rapidly when the distance increase from a few meter up to twenty meters and then just slightly decline when the distance increases more. We argue that these theories agree with the results from the empirical study. Most interviewees agreed that the distance between different departments decrease the frequency of information transmission and frequency of meetings; hence decrease the frequency of co-operation.

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The empirical study indicates that apart from the physical distance the frequency of information transmission depends on in which phase the project is. Information is transferred frequently to production in a later phase of the project than in an early phase.

In large projects when the project group sit close together and everyone are fully employed on the project the physical distance is short and the involved experienced a high information transmission frequency due to the short distances. In large projects when the members do not sit together, the interviewees said that frequent meetings which enable piece-by-piece information transmission exist. Therefore we ranked Frequency of Information Transmission in large projects high.

![Frequency of Information Transmission: Large Projects](image)

**Figure 19** Frequency of Information Transmission in Large Project

The empirical study shows that in the small projects seldom all involved are located near each other. Therefore the interviewees experienced that frequency of information transmission highly depends on the involved individuals and especially the persons holding important information others are dependent of, for example design engineers and project managers. During the interviews both examples of quite high frequency and inadequate frequency were highlighted with a dominance of negative examples.

Prasad argues that piece-by-piece information transmission makes an earlier start of activities possible; facilitates activity planning in downstream functions; and increase the possibility of Concurrent Engineering. We conclude that one-shot information transmission can result in increased lead time between activities; inadequate understanding of decisions made in previous stages; and loss of feedback opportunities at stages when many costs are set. We also argue that continuous information transmission can facilitate production planning and feedback on the product design from downstream functions but that information can not be transferred constantly since it takes time from both sender and receiver and some interviewees experienced they already receive too much unnecessary information. We want to highlight that we

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think it has to be a balance of the amount of information so it still has good quality even if it comes more often. In small projects employees in downstream functions experienced lack of information in early stages which indicates one-shot information transmission. Therefore we gave small projects a varying ranking with dominance toward a low frequency. Since it in small projects are few involved, we think it do not have to be complicated or very time consuming to increase the frequency of information transmission between the involved persons or functions. By increasing the understanding of the importance of piece-by-piece information transmission; increasing the understanding of the reliability of early information; and decreasing the physical distances between co-operating people, the information transmission frequency can be improved in small projects.

![Frequency of Information Transmission: Small Projects](image)

**Figure 20** Frequency of Information Transmission in Small Projects

We think project rooms and project areas facilitate more frequent information transmission since the barriers to meet each other and the power unbalance should decrease at the neutral area. We argue that the frequency, as well as the timing and quality of information affect the usefulness of the information transmitted. According to Clark & Fujimoto\(^\text{217}\), one success factor in Japanese manufacturing companies is their frequent, intense and informal communication between production and product development employees. The managers at SIT AB also talked about the Japanese car manufacturer Toyota as a good example. This indicates a need for SIT AB to always strive for further improvements and good strategies in dimensions of co-operation.

Since it is not possible to locate all employees close to each other we think it is most important that individuals who often co-operate or often need to co-operate are closely located. This is supported by the empirical study where GT employees highlighted the importance for them to sit close to others in their line organization. We think improvement potentials exist: the location of people can be planned according to both necessary co-operations and information transmission required for performing the

tasks and not just according to department belonging. Co-operation required can include experts from near fields in the same department as well as functions and expertise from other departments. Therefore we argue that in large projects it is preferable if the members are allocated to one or just a few projects during the same time which also is supported by Magrab\textsuperscript{218}.

One improvement proposal from some of the interviewees employed at GT is to locate some design engineers in the workshop. We agree that this can highly increase the frequency of information transmission; as well as the richness of the information; the timing; the formalization of communication; and understanding of other’s tasks and the whole. Therefore it is a good idea which also is supported by researchers\textsuperscript{219}. Since some employees from GR showed resistance to this suggestions, we think the idea also has to be evaluated with respect to the structure of the design engineers’ tasks; their need of design expertise; their attitude toward a changing placement; and the support required to keep good and frequent co-operation with the rest of the GR organization because these components affect the individual design engineers’ motivation and input effort according to researchers\textsuperscript{220}. We suggest that design engineers are placed in the workshop on a rotating schedule. This makes it possible for more design engineers to get the experience and assures that information and knowledge continuously flows in the organization.

7.2.3 COMMUNICATION

Technical communication can be divided into three groups according to its objectives: to co-ordinate work; to maintain staff knowledge; and to promote creativity\textsuperscript{221}. The dimension Direction of Communication affects mainly the first two objectives and the dimension Formalization of Communication strongly affects all three of them.

Direction of Communication

The organizational structure and the corporate culture affect the direction of communication; the direction of communication in its turn affects the co-operation since it influences the possibilities to co-ordinate work; the information transmission; the decision paths; the mutual understanding; and goal focus according to Falkheimer & Heide\textsuperscript{222}. The empirical study indicates that SIT AB has changed the direction of

\textsuperscript{218} Magrab, Edward B. (1997) p. 31-32.
\textsuperscript{221} Allen, Thomas J. (2000) p. 158.
\textsuperscript{222} Falkheimer & Heide (2003) p. 15-16.
communication from a top-down information spreading to a dialogue dominated organization with low hierarchy and a culture with high ceiling. We think this is a strength in the organization. The interviewees experienced mainly two-way communication within and between departments. But GT co-workers also explained that think they work on command from GR and that they sometimes experience a lack of feedback on their suggestions from GR. Some interviewees, both from GR and GT, explained the direction as “GR delivers and GT asks questions”. Many interviewees thought GR need to take most responsibility for the initiation of the communications since they hold the most information.

Figure 21 Direction of Communication in the Organization

Figure 21 presents our map over the directions of communication in the organization. The empirical study shows a low frequency of communication between managers at a “three-letters”-level. We think an increase in the communication between these managers can increase the understanding of and insight into others’ problems and situation, as well as improve the attitudes to other departments and the co-operation with them. With increased communication misunderstandings and wrong prioritizations can also be avoided, which otherwise is of great risk according to Wheelwright & Clark233. The interviews show that the managers at higher level than “three-letters”-level communicate more frequently in both horizontal and vertical direction through the executive group and direct with their underlying managers. The empirical study indicates that at co-worker level the horizontal communication mainly

takes place with others in the same department, but they also communicate some with other co-workers in the same division and a little with co-workers in the other division.

The co-workers’ horizontal communication with co-workers in other departments is mainly when they co-operate in projects, the managers and co-workers said. We have mapped the directions of communication in large projects as the empirical data indicates it is worn out (shows in the figure below). There exists horizontal communication within each team and the team leaders have good communication both vertical and horizontal. The project managers belong to the same department (GRP) and have meetings about strategies, resource allocation etcetera; hence they have both vertical and horizontal communication directions. Some interviewees talked about a new initiative when GR team leaders visit the GT team meetings to inform them directly about what happens in their teams. According to the involved persons this is good and therefore we think this could be extended to other teams and projects.

![Diagram of Communication Directions](image)

Figure 22: Direction of Communication in and between Projects

According to the direction map and the unreserved culture highlighted by the interviewees, large projects receive a good ranking by us in this dimension. Some interviewees thought all communication should go via the team leaders to keep it formalized while others thought that would be a disturbance in the work flow. We argue that a communication strategy should exist in each project since it is important to highlight the preferred communication paths and directions. We suggest that information spreading should go through the team leaders but focused questions should be solved between project members with dialogue and close feedback. This suggestion is supported by Magrah\textsuperscript{224} who highlights importance of a balance to reach efficient problem solving.

\textsuperscript{224} Magrah, Edward B. (1997) p. 44.
We think the directions of communication in the organization have a great influence on the direction of communication in small projects, but it is also very dependent on the persons involved and their relation to each other. The empirical study pinpoints that communication strategies do not exist in small projects which obstructs a good communication as well as increase the difficulty to know exact who are involved or should be involved in the different stages of the small projects. We think the communication in small projects sometimes is dominated by one-way communication which we think could be due to the one-shot information transmission that the empirical study shows upon. Examples with a good dialogue results in that simple solutions also exist. We argue that either the vertical direction (task ordered by and reported back to manager) or the horizontal direction (dialogue with concerned co-workers in other departments) of communication dominates each project. We think the communication in all directions should be stimulated to increase the balance and common understanding in small projects which is crucial for Integrated Product Development according to Magrab.\(^{225}\) We also argue that Integrated Product Development should be better applied in small projects.

Feedback facilitates mutual understanding and prevents misunderstandings, according to Wheelwright & Clark\(^{226}\). Hence, we think that two-way communication feedback

\(^{225}\) Ibid p. 31-32.
systems are important to maintain and improve: both for new ideas and opinions but also for feedback on these ideas.

**Formalization of Communication**

In this thesis the Formalization of Communication includes the form of initiation and the performance of communication. According to researchers\(^{227}\) it is important to have a balance between formal and informal initiation and performance of the communication since the formal paths enable managers to secure the existence of communication while the informal paths enable individuals to adjust the communication to themselves, other partners and the context. According to the interviewees, as well as researchers\(^{228}\), informal communication is efficient, flexible and important in order to stay competitive. We agree that the existence of both informal and formal communication paths are important but think that in general they rely too much on the informal initiation and execution of the communication in both small and large projects. We think that too much reliance on individuals own initiatives may result in fail to communicate because the individuals’ lack of time; energy; knowledge of the importance; or persons to contact. This is supported by Ortman and Bakka et al.\(^{229}\). From the empirical study we got the apprehension that individuals keep calling the same persons in the organization even after these persons have changed tasks and function and is no longer responsible for the question. But we also want to highlight that the empirical data shows that it for some persons work very well with only informal communication paths. Still the whole organization has to have a high quality of communication; therefore we think that managerial control to a certain extent is necessary. The communication strategy in large projects increases the ranking compared to small projects as shown in the figures below.

![Formalization of Communication: Large Projects](image)

**Figure 25** Formalization of Communication in Large Projects


Examples of existent formal communication paths are department meetings, general meetings, project meetings, the improvement proposal data base, reviews and gates. The interviews indicate that contact lists with individuals in other departments exists in some parts of the organization but are not fully distributed since some interviewees never heard of them. The empirical study also indicates that people often have difficulties to know who to contact and then they try to contact the one they think can answer their question but becomes put on a few times before they find the right person. Some thought this was a problem while others do not experience that as a problem since they thought they always come right in the end anyway. We think contact lists are a good way to clear the contact paths and formalize the communication to a balanced extent. Another way is to improve the telephone directory Netwise so it is possible to, in a standardized way, search for people according to their responsibilities and functions. In order for Netwise to be a good tool it has to be continuously updated, which someone have to be responsible for.

Informal communication paths in the empirical data are small talk: in the corridor, coffee room; and in the open space office; as well as due to established contacts and personal relationships. We think there is a lack of informal communication paths between different departments like small talk and spontaneous visits of design engineers in the work shop. We also think it is important for the company to have a good strategy to introduce new employees into the organization’s informal communication paths since it otherwise can be difficult for the new employees to communicate efficiently in the organization. We argue that each new employee should have a mentor that can support them and that the mentor program should be developed in order to satisfy these demands.
7.2.4 Organizational Support

The organization; its structure; the aids used; the culture; and the management can act as a support or obstruction for co-operation, according to Bakka et al.\textsuperscript{230}. Therefore we think it is important to analyze this dimension. Adjusted aids and organizational structure together with an open-hearted and helpful culture with mutual goals will support the co-operation and are crucial components for a long-term succeeding co-operation between individuals\textsuperscript{231}. We think the organizational support is good at SIT AB within both large and small projects. Both managers and co-workers highlighted supporting aids such as Outlook for e-mail and conference booking; the phones; the phone book Netwise; the common hard drive; the improvement proposal database and project databases. We think some of these can be improved; such as the phone book and the use of the improvement proposal database which we have discussed in previous chapters. But according to the empirical study there are also aids that oppose co-operation, for example the incompatibility between the design engineers’ drawing programs and the CadCam program used in the workshop. We argue that such technical problems may create double work and frustration as well as difficulties to discuss details and make improvements in others’ drawings and models. Double work should be avoided both according to Aronson et al.\textsuperscript{232} and our opinion. This problem is handled in a separate project which hopefully will turn this opposing aid into a supporting one.

One component of the organizational support is adjusted processes\textsuperscript{233}. The interviews indicate that the employees have been informed that the work should be process orientated and many agreed that so it is in large projects where the PDP is quite well implemented. But the empirical study indicates a lack of use of the PDP in small projects, and the lack of information about the adjusted versions of the PDP decreases the ranking in the dimension for small projects. According to Bakka et al.\textsuperscript{234} one-piece-production, such as SIT AB’s business, require small working groups with independent responsibilities but when the number of produced products increase the importance of routines also increase. Therefore we think the process orientation is important to implement in all projects and in the whole business so the business adapts to the higher production pace that it is experiencing.

\textsuperscript{230} Bakka et al. (2001) p. 74-75.
\textsuperscript{231} Andreasen & Hein (1985) p. 32.
\textsuperscript{232} Aronson et al. (2003) p. 210-211.
\textsuperscript{233} Bakka et al. (2001) p. 74-75.
\textsuperscript{234} Ibid p 74-75.
According to both managers and co-workers the management is focused on the cooperation in large projects where the importance of cooperation is discussed and brought forth. For small projects no recommendations or guidelines for how and when to cooperate with others exist and we experienced a lack of interest from some interviewees to improve this since it requires time, energy and changes in work methods. Hence we think improvements are possible and therefore small projects receive a lower ranking. Improvements can be in form of gathering best practice in the organization to find good, effective and simple forms of cooperation in small projects which others can be inspired of.

**Figure 27** Organizational Support in Large Projects

**Figure 28** Organizational Support in Small Projects

Decision making paths is another component of the dimension in this thesis and is influenced by the culture and the management in the organization. We think that it is the management’s responsibility that the decision making paths are clear, consistent followed and adjusted to the context. Some interviewees experienced a diffuse decision making process, mainly in small projects, which we think can be clarified if the adjusted PDP is marketed and used as intended.

The organizational structures in the GT and the GR organizations are different and do not mirror each other which increases the organizational distance between departments. Therefore there are no direct correspondences in one organization to functions in the other organization which can make it difficult to know who works

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with what in another organization. We think the differences in the organizational structure can explain both the unclear decision making paths and the unclear contact paths experienced by interviewees from both GT and GR. Some interviewees thought the organizational structure is more supportive in the smaller steam turbine organization hence, we can conclude that the large gas turbine organization is difficult to adjust because of its size. Despite that, we do not recommend SIT AB to change their organizational structure because the structure is deeply rooted; the empirical study indicates that the structure with projects and line functions works well; and a project organization has been tried at the sister site in Lincoln but with insufficient result.

The culture is, according to the employees, characterized by a high ceiling and strong feelings of belonging to the nearest department. The employees experienced some feeling of a “we-and-them” culture which we think mainly is due to function belongings and localizations rather than hierarchical levels and status. We think the strong department spirit is good since it maybe can be extended to the whole company. Otherwise a new spirit for the whole company needs to be created which can be very difficult. In large projects the project members experienced feelings of project belonging which confirm that team-building and social activities such as kick-offs increase the mutual understanding, which also Falkheimer & Heide\(^\text{236}\) point out. To increase the mutual understanding and extend the spirit to a company-wide one, we think practice in the workshop for design engineers is an activity useful in long term which also is supported by Krüger’s implementation toolbox\(^\text{237}\).

Clark & Fujimoto\(^\text{238}\) describe stereotypical design engineers as perfectionists who focus on performance improvements and hate late design rework due to manufacturing; and production engineers who hate late changes except if they are to improve the manufacturability. We think this description is partly applicable on the employees at SIT AB; hence their different prioritizations create a psychological distance between the functions. We think everyone needs more understanding of others and their task to overcome this psychological distance.


7.2.5 Project Goal Optimization

According to Bakka et al.239, it is of great importance to have mutual objectives and strive toward common goals but it has to be acceptable that goals on an individual level diverge within the company. The persons interviewed had very different opinions whether the different parts of the company have mutual goals or if sub-optimization exists. In the ranking of this dimension, we could not separate large and small projects since the whole organization and all projects are included in the ranking. Even if some interviewed persons thought the goals are mutual the fact that others did not think so indicates an area of improvement in the organization. The managers agreed that they have the responsibility to inform and work toward common goals and that this could have more focus in many of the departments. The conclusion, from a previous chapter, that the “three-letters”-level managers have an insufficient communication can partly be a cause of the problem. Another possible reason is a lack of adjustment of the information about the goals to the different departments which is of importance for the understanding of the information according to Allen240.

![Goal Optimization Diagram](image)

**Figure 29** Goal Optimization in Small and Large Projects

The empirical study indicates that a mutual vision to produce turbines and to earn money exists and is known by many. But we think the different prioritizations and the different use of business ratios in the departments, that the empirical study indicates, create feelings of having divergent goals. Some interviewees experienced that some of the business ratios are not comparable with other ones in a fair way. We argue that this is of great importance since we think comparable business ratios support decision-making such as prioritization between improvement ideas. We think such prioritization rules can give understanding and explanation of decisions made in all parts of the organization if the rules are used consequent and if they have been well marketed in the organization, which is the managements’ responsibility.

239 Bakka et al. (2001) p. 16-17.
The empirical study shows that each individual has to make his own prioritizations every day if he is not allocated full time to one project and at least some team leaders said these prioritizations are difficult to make. We think that the responsibility for prioritizations of resources to different projects should mostly lie on the managers since these kinds of prioritizations can weigh heavy on the individual and the requirements of time may be unfair to coop with. Magrab\textsuperscript{241} supports this by highlighting the importance of specific assignments for the individuals to enable good contribution. At GR they try to have weekly meetings with project manager and “four-letters”-level managers to solve all resource conflicts and to enable for the individuals to focus their engagement on the right things. This works well according to the involved and we suggest that the example is used as best practice within the company if other departments experience similar situations.

To fully develop and use each employee’s capacity and to motivate them to put much effort into the work it is important to encourage each person’s motivation factors defined by Bakka et al.\textsuperscript{242}. Therefore researchers\textsuperscript{243} argue that the tasks and the work structure should be adjustable to people since some work very well in groups and others prefer individual tasks; some prefer to follow regulated procedures and others prefer own initiatives etcetera. We think it has to be a balance between regulation and flexibility and that the management has to be able to ensure quality in work to stay competitive in the long term.

\textbf{7.2.6 Attitudes to Cross-functional Teams}

The attitudes within cross-functional teams include the attitudes toward ones’ own actions and toward each other\textsuperscript{244}. According to researchers\textsuperscript{245} the attitudes are highly personal but are also affected by the common culture; the motivation level; and the balance of individuals, clear tasks and team work. Bakka et al.\textsuperscript{246} declare that to be able to perform Integrated Product Development cross-functional teams are necessary. We think integration between functions is very important for a good co-operation and efficient product development, therefore this dimension is analyzed.

In large projects at SIT AB the project managers create teams where everyone have a purpose for being there and have collaborative skills which is an expected want. The

\textsuperscript{241} Magrab, Edward B. (1997) p. 44.
\textsuperscript{242} Bakka et al. (2001) p. 166.
\textsuperscript{244} Clark & Fujimoto (1991) p. 243.
\textsuperscript{245} Andreasen & Hein (1985) p.93-94; Magrab, Edward B. (1997) p. 44.
\textsuperscript{246} Magrab, Edward B. (1997) p. 31-32.
members of large projects are not involved in many projects at the same time and the resources for each project are allocated from the line function which enables a balance between individual focus on few projects and rotating resource transfer within the organization. Each person’s motivation and contributing effort is dependent on their attitudes toward and within the teams.\textsuperscript{247} The empirical study pinpoints that the process orientation in large projects ensure the initiation of cross-functional teams if the project manager takes his responsibility to invite different functions to the project team. We think this works well in large projects at SIT AB.

The attitudes to and within teams in large projects are overall good, according both the interviewees’ answers and our experience, hence a high ranking of the dimension is achieved.

![Figure 30: Attitudes in Cross-functional Teams within Large Projects](image)

The attitudes towards working in cross-functional teams in small projects are strongly influenced by the company’s culture\textsuperscript{248}. At SIT AB some “we-and-them” spirit exists according to the empirical study. This can oppose the initiation of cross-functional teams according Törnqvist\textsuperscript{249}. The interviews indicate that in small projects little regulation and focus lie on initiation of co-operation with other departments; instead time pressure creates focus on quick problem solving. We think the responsibility to initiate co-operation is not clear since it is not regulated in a process and is dependent on the persons involved in the project. Some of the interviewees experienced how upstream departments have more information, hence a dependency arise which affect both initiation of, and working methods during co-operation, according to Andreasen & Hein and Törnqvist\textsuperscript{250}. We ranked this dimension in the middle for small projects since we think improvements of individual attitudes are needed.

\textsuperscript{248} Andreasen & Hein (1985) p 93-94.
As mentioned above, the project managers have a crucial role and great responsibility to encourage positive attitudes to and within cross-functional teams. The fact that SIT AB has just a few well trained project managers create a risk of varying quality and attitudes that we think depend on which project manager a project has or an employee has been working for. Therefore we strongly recommend training more project managers to ensure positive attitudes in both small and large projects and in both short and long term.

### 7.2.7 Understanding of Tasks

People’s motivation is affected by their understanding of their contribution and of the whole and the motivation is in its turn affecting the performance, attitudes and power of initiative. Therefore we think it is important with a deep understanding of ones’ own task, the whole business and the connection there between. A mutual understanding of the whole also facilitates goal optimization and opposes sub-optimization in early stages of the product development chain according to Andreasen & Hein.

At SIT AB we experience a varying understanding of each person’s importance and contribution to the whole. The interviewees did also have varying opinions whether they understand the whole and if they think others do so. Some argued that they have the understanding they think is necessary for them but they also thought others need more understanding than they have. We think it is necessary to be curious about others and their tasks to achieve a higher level of understanding, hence we think the organization needs to encourage this curiosity. Senior co-workers argued that it takes time to achieve a good understanding but we think it is so important with understanding for each other’s tasks that it must be more facilitated by the organization to achieve understanding quick. All interviewees thought that it is important to have a common understanding of the whole; hence we think the understanding has to be

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improved in both small and large projects as well as in other functions. The empirical study indicates that in large projects one focus more on goals. Hence, we think a slightly better understanding exists in large projects.

![Understanding of Tasks: Large Projects](image1)

**Figure 32** Understanding of Tasks in Large Projects

![Understanding of Tasks: Small Projects](image2)

**Figure 33** Understanding of Tasks in Small Projects

A project is by definition delimited\(^{233}\) why we argue it should be easier to receive an understanding of the whole in projects compared to in the usual business. We think that the suggested practice in the workshop is one way to improve the understanding of other parts of the business and hence receive the deep knowledge about the products which some interviewees highlighted as very important. Some interviewees mentioned that in history design engineers spent more time in the workshop and therefore had better understanding of the product than they thought design engineers have today. The project Quality Culture is another way to improve the understanding of each function’s part in the value chain and what requirements one have on others and they have on oneself. We think Quality Culture is a good initiative in order to improve the understanding but we also think it should be extended to discussions about the customers’ customers, the supplier’s supplier as well as the end user. The product development departments’ choice to adjust or not adjust drawings to the Finspång site’s workshop is an empirical example of when strategies were not clear and frustration occurred. We argue that clearer management strategies and decision rules could also improve the understanding and oppose misunderstandings in the organization. These arguments are supported by Clark & Fujimoto\(^{234}\).

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\(^{233}\) Sverlinger, Per-Olof M. (1996) p.70.

Conclusions

In this chapter the conclusions of this investigation is presented. The conclusions answer the research questions and hence fulfill the purpose of the thesis. A reflection over the use of the analysis model is also presented as well as suggestions for further studies.
8.1 The use of the PDP

In this study it is concluded that a process is a helpful tool to achieve a structured work method in projects if the used process has high quality. But for product development to work well in practice a good co-operation between the individuals involved in the projects is also required.

From the study it can be concluded that the PDP is much better implemented and work much better in the large projects than in the small projects. In small projects the process is perceived as bureaucratic and a hindrance rather than an aid.

The PDP aims to be used for new design and redesign of products. The empirical study shows that the PDP is used mainly by the project managers, who interpret the PRS into a DB with goals and objectives and make sure the process is followed. They read the PDP in their daily work with aim to fulfill the criteria in each milestone description and to work towards gates and reviews. Empirical results show that the project managers for the large projects are better trained in the PDP compared to project managers for small projects, which we argue is one of the reasons why the application of the process is not as good in the small projects. The design engineers have an overall understanding of the process, which help them to follow the projects but we argue it is not sufficient. Results from the study show that most employees in the GT organization do not use the PDP since either they do not know it exists or they do not have enough understanding of it. Also the GT team leaders have too little understanding of the PDP in order to contribute to the projects as they aim to. We argue that in order for a process to work well in practice it has to be well known and understood in the organization.

8.2 The existing Co-operations

We have investigated which dimensions of co-operation that are important in product development. In this study it is concluded that nine dimensions are significant: Timing of Upstream – Downstream Activities; Richness & Quality of Information; Frequency of Information Transmission; Direction of Communication; Formalization of Communication; Organizational Support; Goal Optimization; Attitudes in Cross-functional Teams; and Understanding of Tasks.

From the empirical study it can be concluded that the large projects perform better than the small projects in all of these dimensions. As mentioned in the section above
the PDP is not as well implemented in the small projects and we argue that the structure and organization in the small projects is overall worse.

The study shows that the PDP is a sequential process, which gives a rather low score in the Timing of Upstream – Downstream Activities. Empirical evidence indicate that in small projects production aspects are often missed in an early stage but in the large projects it works much better. The GT team leaders constitute a link between production and product design which increases the score for the large projects.

Results from the study show that in the large projects face-to-face meetings are held regularly and the project information is well shared; hence a high score in Richness & Quality of Information is achieved. In the small projects much less face-to-face contacts are held and the quality of the information is sometimes insufficient; hence the score is much lower.

Members of the large projects are often located within a small distance from each other and hence talk frequently which result in a good score in Frequency of Information Transmission. In the small projects members do not sit together, and how often information is transferred depends to a high degree on the individuals; hence the score in this dimension in general is rather low but spread.

Empirical evidence shows that in the large projects both the horizontal and the vertical communication paths are well developed why a high score in Direction of Communication is achieved. Due to the one-shot information transmission that often occurs in the small projects the communication is often one-way, but it varies between individuals and projects why the score in this dimension is spread.

We argue that the organization relies too much on informal communication paths, but that it in general works well hence the score in Formalization of Communication is over average. The small projects do not have a communication plan and hence receive a lower score than the large projects.

Results from the empirical study indicate that the ceiling in the organization is high and that the organizational support, in general, is good. The fact that the structures in the GT and the GR organizations are different results in unclear decision paths and contact paths. Together this results in a rather high score in Organizational Support but since the management focuses much more on the large projects a slightly higher score for these projects is achieved compared to the small projects.
Empirical evidence indicates that the overall vision is mutual but that the prioritizations sometimes diverge since different departments focus on different things hence both the small and the large projects receive a score slightly under average in Goal Optimization.

The study indicates that in the large projects it is fully understood that cross-functional teams are needed and the attitude to involve and listen to other functions is good; hence the score in Attitudes in Cross-functional Teams is high. In the small projects the empirical data indicates a low focus on initiating contacts with other functions and hence the score is lower.

We argue that the understanding of others and their tasks vary in the organization and the score in Understanding of Tasks is therefore just below average. For large projects the score is slightly higher than for small projects since there are closer co-operations, mutual goals and social activities that encourage the understanding of others in the large projects.

**8.3 Needs for Improvements**

The empirical study shows that all dimensions of co-operation are represented at SIT AB and hence no co-operation dimensions need to be initiated. Instead we argue that all dimensions need to be improved, some more than others, and hence no co-operation dimensions need to be impaired.

We argue that the Timing of Upstream – Downstream Activities need radical improvements both in the large and the small projects by working towards Concurrent Engineering.

We also argue that since problems are more complex in the large projects compared to in the small projects these projects need higher Richness & Quality of Information. To fulfill these criteria the large projects need only a slight improvement while the small projects need more improvements. Concerning the small projects one needs to introduce more face-to-face contacts and improve the information about the project. Moreover, we argue that the Frequency of Information Transmission in the small projects require improvements in form of more piece-by-piece information while the large projects only need to be slightly improved in this dimension. The physical distances are one of the main problems influencing the Frequency of Information and we argue that the location of employees can be improved.
Concerning Direction of Communication the large projects need only a slight improvement while the small projects need more improvements. The small projects need to introduce more face-to-face contacts and a two-way communication. In Direction of Communication the vertical communication between “three-letters”-level managers need to be improved. The Formalization of Communication needs some improvements both in the large and the small projects in order to obtain a good balance between informal and formal communication. We argue that more formalized contact paths are needed in order to simplify who to contact.

The Organizational Support is already very good and only small improvements are needed. We argue that mainly already existing tools and processes need improvement in order to be a better support. In Goal Optimization it is mainly the prioritizations and the use of business ratios that need to be clearer, more convergent and better communicated within the organization. We argue the Attitudes in Cross-functional Teams can be improved in the small projects by working towards mutual help and to guarantee a cross-functional setup trough the entire projects. The Understanding of Tasks which includes understanding of others and of the whole can be improved through better knowledge of the products, the processes and the organization in its whole.

**8.4 Ways of Improvements**

We conclude that all the dimensions of co-operation have improvement potential. How improvements best are performed depends on the organization. We have developed organizational specific actions for this case study. Organizational changes can be performed evolutionary or revolutionary, and the focus can be either on the result of the changing process or both on the result and the process itself. All components in an organization are related to each other and changes in one of them often affect other ones. Therefore we argue that when one improvement is implemented it usually affects more than one of the dimensions of co-operation. To succeed with the implementation it is important to involve the employees in the planning and realization of the changes. The improvement proposals for SIT AB are presented in chapter 9 Recommendations and compromises 20 things we think SIT AB can do to improve the co-operation between product development departments and production department.
8.5 Reflections on Using the Analysis Model

We think the analysis model was a helpful tool to structure the study. The dimensions of co-operation are not scientifically measurable and interpretations are needed in order to find a score hence we think the ranking of the status in each dimension becomes subjective. Further we argue that the analysis model covers all relevant aspects of co-operation for this study. We rather think that some of the dimensions of the model are difficult to separate and the model is maybe not totally exclusive. None of the dimensions are specific for SIT AB but we argue that in order to prove that the model is general further research focused on its general validity is needed.

8.6 Recommendations for Further Studies

One of the recommendations that is given is to develop an integrated and concurrent product development process and to leave the sequential method of working. How to perform this and how the process should be designed need to be further investigated, both in general terms and specifically in the case of SIT AB.

We think the analysis model covers all important aspects of co-operation for this study. But in order to use the model in other studies we recommend it should be investigated if more dimensions could be developed and added to the model. Also, the extremes of each dimension could be further investigated aiming to better specify these and to ensure exclusiveness of the dimensions.

This study shows that the placement of employees is difficult and that not all employees that need to co-operate can sit close together. We think that further research is needed in this area aiming to find what generally is best.

We think as mentioned in the recommendations that the milestone descriptions need to be improved. In order to develop a better and clearer process description a new investigation is needed.
RECOMMENDATIONS

In this chapter we present the recommendations of actions to improve the co-operation between the product development and the production departments at SIT AB. These are created from the findings in the empirical study and from conclusions in the analysis and are adjusted to the company and its present situation.
9.1 Recommendations to SIT AB

As mentioned in the background to this thesis, the demands on companies have changed and the customers require more from the companies today. Researchers agree more and more upon that the organizations have to be more flexible and able to react toward changes. We argue that also SIT AB have to meet these fast changing demands and therefore they have to improve their organization; their work methods; and their internal co-operation to stay competitive all the time. The recommendations presented in this chapter aim to be one part of these constant improvements.

The recommendations are focused on strategic changes since these are planned activities possible to control by the management, compared to changes due to internal or external powers. Strategic changes can be divided into planning, implementation and results. To increase the chance to end up with a good result, barriers for changes identified by Bakka et al. (see chapter 4.3.3 Barriers for Change) have to be overcome which is possible if concerned parties are involved in all the different phases. During the planning it is important to develop goals on different levels and the recommendations in this thesis could be used as a foundation for the goals on management level but we think more concretized goals have to be developed together with involved employees. The result is affected by the change process itself; as well as the timing of the change implementation and different parties interests, therefore we have chosen not to develop complete implementation plans with time and resource allocations since the concerned parties have to be involved even in these phases. Since the process itself affects the result it is difficult to predict the final results and exactly how they are going to affect the co-operation. But we have declared which dimensions of co-operation that could be affected by each action.

We have structured the actions according to a classification. Each action has two scores: one according to difficulty and one according to estimated impact. Difficulty refers to how much effort that is required to perform the action while impact refers to how much the action influences the organization. For each of the scores a scale from one to three was used, one refers to low and three refers to high difficulty or impact.

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258 Ibid p. 266-267.
260 Ibid p. 240-241 & 244.
The actions have according to their scores been structured in a matrix which is showed below. The matrix is divided into three classifications. We recommend to start with the light fields and then continue with the darker ones.

<table>
<thead>
<tr>
<th>Impact</th>
<th>Difficulty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>Improve a Good Quality of the Review Groups</td>
</tr>
<tr>
<td>2</td>
<td>Establish a Knowledgeable and Stronger in the PDP</td>
</tr>
<tr>
<td>3</td>
<td>Train more Project Managers</td>
</tr>
</tbody>
</table>

Figure 34 Classification of Recommendations

Barriers for changes exist in all organizations\textsuperscript{263}. We have identified risks for barriers at both company-wide, management and employee level. After the recommended actions a summary of the actions; there potential effects in the organization and possible barriers for the implementation of that changes is presented. To increase the chance to overcome these barriers, we recommend reading the theories presented about implementation and barriers for change in chapter 4.3 Implementation Strategies.

**Work towards Concurrent Engineering**

We think that SIT AB should go from a sequential approach to a concurrent approach. As previously mentioned the PDP is a sequential process and to enable concurrency we argue that the process has to be changed to a non-sequential process. Many of the parameters are set in an early stage in product development projects hence it is already

in an early phase important to involve other functions, one of them production\textsuperscript{264}. SIT AB move towards larger production volumes and hence it becomes more important to be fast, flexible, productive and efficient which are some of the results one can obtain from Concurrent Engineering\textsuperscript{265}.

A sequential approach tends to result in a poor awareness of each employee’s role, which easily tends to go towards sub-optimization. An integrated approach should integrate procedures, aims, attitudes and methods.\textsuperscript{266} That means, according to us, that by implementing Concurrent Engineering one would with stage overlapping activities improve the timing of activities. The goal optimization should also be affected since aims are integrated and sub-optimization is prevented. Also, the understanding of tasks would be improved since the understanding of the whole and of others would be improved. By working closer together and by being more integrated the attitudes in cross-functional teams would be improved. Concurrent Engineering should also make it possible to from an early phase have high frequency of information transmission. We argue that high frequency is a requirement in order for a concurrent approach to work well, since otherwise it is difficult to work in parallel.

When changing the process design, the starting point of the organizational change is identified as Tools & Technology in Levitt’s Planning Tool\textsuperscript{267}. But one starting point is also in Task & Goals since it should be a goal to use more Concurrent Engineering.

We argue that it would take time to develop a more concurrent product development process since it is a large change. Many researchers claim an evolitional change process is preferable\textsuperscript{268}. But in this case we think a combination between an evolitional and a revolutionary change is the best; revolutionary in the sense that all new projects should follow the new process from one date but evolitional in the sense that ongoing projects should finish according to the old process. During the planning of the new process, we argue that as many concerned employees as possible should be able to give their input and ideas for practical, company adjusted solutions. We think both: Power & Political Management, Issue Management and Management of Perception & Beliefs activities have to be used to succeed with the change. We classify both the difficulty and the impact of this recommendation as three.

\textsuperscript{264} Andreassen & Hein (1985) p. 2-3 & 10.
\textsuperscript{265} Prasad, Biren (1996) p. 1 & 44
\textsuperscript{266} Andreassen & Hein (1985) p. 15 & 37.
\textsuperscript{267} Bakka et al. (2001) p. 255.
\textsuperscript{268} Bakka et al. (2001) p. 252-253.
**Improve the Marketing of and Training in the PDP**

We think that SIT AB should work harder to market the PDP. They should make the PDP available as the correct version both on the Intranet and at the mutual disk. SIT AB also needs to make sure everybody knows where it is published and how they can find it.

We think that employees should be better trained in the process. In general a better knowledge of the process would improve the understanding of others and hence the attitudes in cross-functional teams would be better. A better understanding of the process could also render sub-optimization and make it easier to work towards common goals. Project managers need to know the process in detail in order to run the projects. Project members should know more than just the outlines of the process to be able to fully contribute to the project. GT employees of concern need to know the outlines of the process in order to be able to give input and to be part of the project. If the knowledge of the PDP would increase, GT co-workers could take initiatives and GR employees would better understand the importance of a tight co-operation, hence production aspects would probably be considered in an earlier phase and the timing of activities would be improved. Managers need to know the process to understand their co-workers’ tasks and to refer to the process and their increased knowledge would increase the organizational support. We think it is preferable if the training in the PDP is performed through adjusted in-house training, which goes in line with Andreasen & Hein’s\(^{269}\) opinion.

We argue that this improvement has its starting point in Actors in Levitt’s model\(^{270}\) where the employees are influenced by the increased knowledge of the PDP versions. Further we think the improvement should be implemented in an evolitional way with recurrent marketing. The aim of the increased marketing is to influence both attitudes and behaviors, therefore we argue for activities related to Management of Perception & Beliefs and Power & Political Management\(^{271}\). We classify this recommendation’s difficulty as one and impact as two.

**Improve the Milestone Descriptions**

We think the process is a good organizational support but as mentioned above we think the milestone descriptions should be improved. One should try not to use illogical abridgements, which makes it difficult to understand the process. Further we

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\(^{270}\) Bakka et al. (2001) p. 255.

think the language is complicated and hence difficult to understand and the study shows upon the same result. The milestone descriptions are rather general with no examples or checklists. We think checklists should be added to clarify the process. Also examples showing upon how things can be performed should be added. If the process was clearer it would be easier to understand the whole; others’ tasks; and the goal orientation would be clearer.

This improvement has it starting point in Tools & Technology in Levitt’s model\textsuperscript{272}. We think the improvement should be implemented either in an evolitional way with step-by-step changes or in a revolutionary way with a larger re-launch including many improvements at the same time. The aim of better milestone descriptions is to influence both attitudes and behaviors of the employees, hence we argue that one should use activities related to Management of Perception & Beliefs and Power & Political Management\textsuperscript{273}. We classify this action as difficulty one and impact two.

**Guarantee a Good Quality of the Review Groups**

We think the reviews are a good support in the process but we think SIT AB need a way to guarantee a good quality of the review groups. We want to highlight the importance of all functions being represented at reviews, including production, since some interviewees indicated that it is not always the case. Another problem the study shows upon is that the same persons are called to many projects’ reviews. Some persons found it annoying and felt that sometimes other employees with better competence area would perform better. Chief Engineers Office is responsible for the reviews and for the composition of the review groups. They use mainly their experiences in the organization to identify, what they think are the right persons for the review but they also said they have a competence based list as help. We argue that to decrease the risk for future disturbances or problems the organization should strive toward not being too dependent on single individual’s knowledge. Therefore we suggest that the decision rules for participants in the review groups should be formalized, for example through more and better use of the competence based list. We think one should improve the update of the list and think out of the box when calling to reviews. Another suggestion is to invite competences and then let each manager or the employees themselves decide who best attains the review. It is important to have a good review group in order to guarantee the standard of the reviews and the quality of information.

\textsuperscript{272} Bakka et al. (2001) p. 255.
We think this improvement has its starting point in Tools & Technology in Levitt’s model\textsuperscript{274}. Further we think the improvement should be implemented in an evolitional way since it works well today, but the improvement would decrease a long term risk of disruptions or decreased quality. We aim to influence rational dimensions; therefore we recommend Issue Management activities\textsuperscript{275}. We classify both the difficulty and the impact of this change as one.

\textit{Create a Database with Best Practice}

We found a lack of information regarding previous project activities and experience in the organization and think a database with best practice is a great way to gather this kind of knowledge. In Integrated Product Development the interplay between different projects should have positive effect on one another\textsuperscript{276}. We argue that a database would simplify this interplay and previous experience could be used as an input in projects to prevent possible mistakes from happening again. Also the database could be a help for guidance in uncertain situations.

The database would be an aid in the organization and would work as an organizational support. Depending on the type of experience the database comprises it could also improve the understanding of tasks, goal optimization and other dimensions of cooperation.

We think this improvement has its starting point in Tools & Technology in Levitt’s model\textsuperscript{277}. Further we argue that the database should be built up from collected experiences in the company why it has to be developed in an evolitional way. By the database, we hope the behavior of the employees should be influenced why Power and Politics Management activities is suggested\textsuperscript{278}. We classify both the impact and the difficulty of this recommendation as one.

\textit{Train more Project Managers}

We argue that SIT AB has too few well trained project managers for product development projects. The project managers have a crucial role in the projects and the well trained project managers are enough only to cover the large projects. Small projects are run by someone from the line organization. One of the conclusions is that the small projects do not work as well as the large projects and one of the reasons

\begin{footnotes}
\footnotetext[274]{Bakka et al (2001) p. 255.}
\footnotetext[275]{De Wit & Meyer (2004) p. 216.}
\footnotetext[276]{Andreasen \& Hein (1985) p. 2-3 & 10.}
\footnotetext[277]{Bakka et al (2001) p. 255.}
\footnotetext[278]{De Wit \& Meyer (2004) p. 216.}
\end{footnotes}
could, as previously mentioned, be that these project managers have less experience, training and knowledge in project management. One advantage of training more project managers is that the product development would not depend on only a few persons and hence it would be less vulnerable. We think one should keep the department including the most senior project managers but the organization should also increase the competence level in project management in the line organization. The training of new project managers should be performed in-house or via external courses but we think it would be an advantage if a whole group from SIT AB is trained at the same time since the course then can be adjusted to SIT AB’s context and the new project managers could be a support for each other further on.

If the organization would comprise more project managers, most of the small projects could be run by a well trained project manager, just as the large projects are. We think this would increase the quality of these projects and improve the co-operation within them. If one would emphasize the importance of co-operation in these trainings all dimension of co-operation could be improved for small projects. Also employees’ knowledge and understanding of the PDP would increase, which would make the conditions for these projects better. As mentioned above quality and attitudes in a team depends strongly on the project manager and the better trained the project managers are the more uniform and the better the quality of the project would be.

We argue that this improvement starts in the Actors in Levitt’s model. Further we think the improvement has to be implemented in an evolitional way since not all potential project managers can be trained at the same time and since training has to be held regularly to keep the knowledge up to date. The project managers have such a crucial role for co-operation that this improvement aim to affect attitudes, behavior and quality which means that all the management variations in Krüger’s Toolbox could be used. We refer this recommendation as difficulty one and impact three.

**Decrease the Physical Distance between Project Members**

The location of project members was a central subject during the interviews. The interviewees had different opinions regarding whether it is most important to sit close to the other project members or to the competence in the line organization. In some large projects the members are located in a specific project area close to each other. We think this is good and recommend that members of large projects who are allocated to one project full time should sit close together to decrease the barriers for co-operation.

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Competences from GT are usually not employed full time on one project and they feel it is important to be close to the line organization as well. In both small and large projects where the members do not work only on one project, this is a dilemma. We suggest that the employees should be located near the persons they co-operate or should co-operate most with and the persons who hold the most important knowledge to be able to perform the tasks. This means that in small projects the members should probably sit near colleagues in the line organization but in large projects near other project members, at least the ones in their own team. In projects where the members are not located within a short physical distance project spaces or project rooms where members can meet and co-operate should exist, which we hope could decrease the physical distance between the project members. A location close to each other would probably increase informal contacts and chats and enable concurrent activities. We think that would be good since the informal contacts are an important part in the organization and it would be good if these contacts were better established between functions. The attitudes in cross-functional teams would also be improved since one would come closer together and be more integrated.

We think that to be located within a short physical distance from each other is a change in the Structure in Levitt’s model. Further we think the improvement has to be implemented in an evolutional way by finding better and better solutions for the localization every time a new project starts. To overcome barriers for physical relocations of employees, we think Power & Political Management has to be used. We classify both this recommendation’s difficulty and impact as two.

*Design Engineers in the Workshop*

Another question regarding employees’ location arose during the interviews. Some, especially GT employees, think it would be great to have one or a few design engineer(s) located in the workshop. Then they could handle small changes and be a support to the workshop at all times. We think this is a good idea, at least to try. The problem that could arise is that they would lack of closeness to their competence in the line organization but we think that the advantages outweigh the disadvantages. We argue that to start with, one or two design engineers should be located in the workshop for a trial period, which is an evolutional implementation strategy. If that works well and if there is a need the number can be increased. Another idea is to locate a few engineers in the workshop parts of their time and initiate a rolling schedule for the work tasks in the workshop so different design engineers spend time in the workshop.

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Placing design engineers in the workshop would probably increase the response to GT; the timing of activities, the frequency and richness of information transmission and the direction of horizontal communication. Also informal chats between functions would increase and improve the understanding of others, the goal orientation, and the attitudes to one another.

This is a change in the localization of the employees which we classify as a change in the Structure in Levitt’s model, exactly as the decreased physical distances within projects. To overcome barriers of acceptance for physical moves of employees, we think Power & Political Management has to be used. We classify both the difficulty and the impact of this change as two.

**Workshop Practice for Design Engineers**

We recommend that all design engineers should have workshop practice. We think all new employees should have this in the beginning of their employment but workshop practice would be good also for experienced employees. The study indicates that some problems are pushed forward in the chain and that one sometimes put the blame on someone earlier in the chain when something goes wrong. To render these problems it is important for the employees to create an understanding of the whole business and of others’ tasks. Workshop practice is one way for design engineers to understand downstream activities. We argue that also GT employees should benefit from having some kind of practice at GR in order for them to understand the upstream activities. Long term work rotation is another way to improve the understanding of the whole business. If one creates a better understanding of the whole, problems could be solved together and one could easily work towards the same goals. Workshop practice would increase employees’ understanding of others and hence help them in their work. Also, attitudes in cross-functional teams could be improved. Another good aspect of these workshop practices is that contacts between functions are established, meaning that it is easier to know who to contact.

We think this improvement could be classified as a change in Task & Goals in Levitt’s model. Further we argue that the improvement should be implemented in an evolitional way and effective methods for the practice should be developed by trail practice periods. This change aim to change attitudes and behavior of the employees why we think Power & Political Management and Management of Perception &

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Beliefs activities should be used. We classify this action’s both difficulty and impact as two.

**Spread Information about Ongoing Projects**

We think it is important to spread information about ongoing development projects. One way to accomplish this is for managers at a “three-letters”-level to meet more frequently with an informative purpose. They could bring the information back to their employees and the timing of activities could be improved. We think that if these managers get together more often they would develop a better understanding which they transfer to their employees. It is difficult to get involved in a project before one knows it exists why this is the first step to involvement. Information regarding ongoing projects could be sent out by email or be published on the Intranet but the risk is that the information would be ignored since it is not aimed for one specific person.

We classify this change in Task & Goals in Levitt’s model. Further we argue that this should be improved continuously and therefore the implementation naturally is of an evolitional character. We classify both the impact and the difficulty of this change as one.

**Improve/Initiate Contact Lists**

One problem the study indicates is that it is often difficult to know who in the organization to contact. Employees change tasks and responsibility areas and often it is diffuse who should be contacted and who could answer a question. In some parts of the organization contact lists have been established as a formal way to find the right contacts. These lists are established at GT including responsible for each main group of the machine. We recommend SIT AB to further develop these lists to also include the GR organization. But in order for the lists to work well they need to be updated frequently and a person must be responsible for the update to ensure it happens frequently.

We classify this improvement as a change in Tools & Technology in Levitt’s model. Since the contact lists has to be developed and regularly updated we think the implementation should be evolitional. This change aim to change attitudes and behavior of the employees why we think Power & Political Management and

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288 Ibid, p. 255
Management of Perception & Beliefs should be used\textsuperscript{289}. We classify the impact of this recommendation as two and the difficulty as one.

**Improve Netwise**

Netwise is SIT AB’s telephone directory at the Intranet. We think it is great to have a telephone directory but we do not think it fills all its possible purposes. We think this, just as the contact lists, is a great way to formalize the communication. All employees are included in the directory but the searchable key words about their responsibilities are not standardized and hence not useful for search. We think it would be a good idea to develop a standard for these key words so it would be possible to use Netwise in an efficient way when finding who to call in a commission.

We think this improvement is a change in Tools & Technology in Levitt’s model\textsuperscript{290}. We think each person should update its own information according to a suggested design or keyword why the implementation is evolutional. This change also aims to change attitudes and behavior of the employees why we think Power & Political Management and Management of Perception & Beliefs should be used\textsuperscript{291}. We classify both the impact and the difficulty of this change as two.

**Inform about the Importance of Piece-by-piece Information**

The study shows that the frequency of information transmission is a problem, particularly in small projects where all information sometimes is sent in one shot and hence difficult to work on. We argue that information should be transmitted more piece-by-piece. It has been showed that the distance between employees affect how often they talk to each other\textsuperscript{292}. Members of a large project often sit close together and then naturally talk frequently. But in small projects they are located at different places and easily miss a high frequency of information transmission. By initiating a contact at an early phase the timing of activities would be improved. But then the contact need to be kept and information should be sent in small pieces and frequently. In order to be better at this, project members and project managers need to be informed about the importance of piece-by-piece information. In all projects it should be highlighted that information to other functions also should be sent in small pieces.

\textsuperscript{290} Bakka et al. (2001) p. 255.
\textsuperscript{292} Andreasen & Hein (1987) p. 96.
We argue this improvement is classified as a change in Task & Goals or in Actors in Levitt’s model\textsuperscript{293} since it aims to improve the employee’s attitude and behavior. Therefore we think it should be performed through activities related to Power & Political Management and Management of Perception & Beliefs\textsuperscript{294}. We classify both the difficulty and the impact of this recommendation as one.

**Give More and Better Explanations**

The empirical study shows that sometimes there is a lack of explanations why decisions are made as they are. We find this a rather simple thing to do something about. Better explanations would affect the quality of information in a good way and also the direction of communication would be improved since it would facilitate a two-way communication. Employees should keep in mind that everybody has different expertise which needs to be turned to the best account. For example if a decision which not is in line with a recommendation from GT is made at GR the reason why the choice has been made needs to be explained. Otherwise, the person at GT would feel completely disregarded. By giving explanations, a better understanding of others and their tasks would be worn out. The person from GT would also get a chance to understand and comment the new solutions and would probably feel more motivated to do so. We argue that richer status reports should make it easier for other functions to comment and understand decisions and the procedure. The attitudes in cross-functional teams would be improved as well by going from negativism and individualism towards mutual help and integration. By explaining why things are done as they are and why something can not be done in a specific way, individuals and departments get similar apprehensions and the goal optimization should be improved. More and better explanations would be possible for everybody to give, as long as they are aware of the importance and understands the other part, why we think information to employees is the key to a better result.

We think this improvement has its starting point in Actors in Levitt’s model\textsuperscript{295} since it aims to affect the employees’ behavior. Since the employees have to change their behavior we think the change should be evolutional. This change also aims to change attitudes and behavior of the employees why we think Power & Political Management and Management of Perception & Beliefs activities should be used\textsuperscript{296}. We classify the difficulty of this action as one and the impact as two.

\textsuperscript{295} Bakka et al. (2001) p. 255.
Better Convey Goals

The empirical study shows a divergence between whether the employees feel they have mutual goals or not. We think it is a big problem that some employees feel they have divergent goals within the organization. One way to render this is as mentioned above to improve the employees’ understanding of the whole and of each other. Another way is to better communicate goals. We think managers and project managers should take more time to communicate goals and objectives. “Three-letters”-level managers have as previously mentioned little contact. We think that if these managers get together more often they would create a better picture of other departments, which they could transfer to their own employees.

Our opinion is that this improvement starts in Goals & Tasks in Levitt’s model\textsuperscript{297}. Since it aims to improve attitudes we think Power & Political Management activities should be used\textsuperscript{298}. We classify both the impact and the difficulty of this recommendation as two.

Use 3D-models at GT

We think the fact that GR handles 3D-models and GT drawings is a big problem. It makes it difficult for Integrated Product Development and Concurrent Engineering to be introduced. We argue that GT employees should learn how to examine 3D-models and not just drawings. This would make it much easier for more co-operations in early phases, which is really important when going from a sequential procedure to a concurrent approach. Also, this would render a higher frequency of information transmission with higher richness since one could discuss the same model. We understand that it would take time for GT employees to be comfortable with this but mean that one has to start somewhere, for example with in-house courses and training time during work hours. Another solution is to integrate the system so that it becomes easier to convert a 3D-model to a drawing. The compatibility between computer systems for 3D-models and drawings is at the moment looked over in a project run at SIT AB. We conclude that this improvement is a change in Tools & Technology in Levitt’s model\textsuperscript{299}. Since the improvement aims to change employees’ behavior we think it should be implemented step-by-step with use of Power & Political Management and Management of Perception & Beliefs\textsuperscript{300}. We classify both the difficulty and the impact of this change as two.

\textsuperscript{297} Bakka et al. (2001) p. 255.
\textsuperscript{299} Bakka et al. (2001) p. 255.
\textsuperscript{300} De Wit & Meyer (2004) p. 216.


**Establish Comparable Business Ratios**

Another problem found regarding goals is that departments have different priorities which sometimes conflicts. Lead-time, performance, quality and cost are some of them. Different priorities could easily lead to sub-optimization. We think one should create business ratios which are comparable in order to simplify prioritizations and to create an understanding of why choices are made as they are.

We think this improvement starts of in Tools & Technology in Levitt’s model\(^{301}\) and aims to affect both rational and behavioral dimensions why we think Issue Management and Power & Political Management should be used\(^{302}\). We classify the difficulty of this action as two and the impact as three.

**Mentor for New Employees**

There are many informal circles of contacts in the organization. The empirical study shows that it for new employees can be difficult to become acquainted with the organization. An improvement of contact lists and Netwise would simplify for all employees but new employees in particular. We also argue that new employees should have a mentor to guide them into the organization. This could be seen as an aid for establishing a good understanding of the organization and knowledge of the people in it.

We think this change starts in both Structure; Task & Goals; and Actors in Levitt’s model\(^{303}\) and we argue it should be implemented evolutionally by trying different mentor programs on different new employees to end up with a good program. This change mainly aims to change the behavior of the employees but also the attitudes why we think Power & Political Management and Management of Perception & Beliefs should be used\(^{304}\). We classify both the difficulty and the impact of this change as one.

**Initiate Meetings to Solve Resource Conflicts**

The empirical study indicates that resource conflicts between different projects and between projects and the line organization sometimes arise in the organization. GR have introduced meetings between project managers and “four-letters”-level managers aiming to solve these problems. If these meetings can not solve the problems they go further to a meeting between “three-letters”-level managers. We think this is a good way of solving the problems and think that one could introduce the method in other

\(^{301}\) Bakka et al. (2001) p. 255.


\(^{303}\) Bakka et al. (2001) p. 255.

parts of the organization as well if similar problems arise there. Further we think the managers should give clear directions in this question and that it is unfair for individuals to coop with these prioritizations.

We think this improvement is a change in Task & Goals and in Tools & Technology in Levitt’s model\textsuperscript{305}. Since it already is implemented in the GR organization we argue that the following implementation should be evolitional. We classify both the difficulty and the impact of this change as one.

\textit{Continue and Improve Quality Culture}

Quality Culture is an initiative at SIT AB in order to create a better understanding of others and what others expect from one another by looking at internal customers and suppliers. We think this is a good step in the right direction but that it need to be followed up continuously not to lose its meaning. Further we think the concept should be extended to include customers’ customer and suppliers’ supplier and so forth.

Our opinion is that this improvement is a change in Tools & Technology; Actors; as well as Task and Goals in Levitt’s model\textsuperscript{306}. To improve and expand Quality Culture we think activities in both Power & Political Management and Management of Perception & Beliefs should be used\textsuperscript{307}. We classify both the difficulty and the impact of this recommendation as one.

\textbf{9.1.1 \textit{SUMMARY OF EFFECTS AND BARRIERS}}

A summary of the recommended actions and the potential effects of the changes are presented in the table below. But the effects are affected by the implementation process and the barriers for the change in the organization. We have highlighted the barriers we think are the most powerful ones for each recommendation. We argue it is important to include potential barriers in the planning of the implementation. Therefore this table aims to facilitate for the management to adjust the implementation process to the organization and understand the potential difficulties with the implementation.

\begin{footnotesize}
\begin{enumerate}
\item Bakka et al. (2001) p. 255.
\item Ibid. p. 255.
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<tr>
<th>Recommendations</th>
<th>Potential Effects</th>
<th>Potential Barriers</th>
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<tbody>
<tr>
<td>Work toward Concurrent Engineering</td>
<td>Shorter TTM</td>
<td>Uncertainty of the change</td>
</tr>
<tr>
<td></td>
<td>Decreased costs by better set of parameters in early phases</td>
<td>Uncertainty of own competence</td>
</tr>
<tr>
<td></td>
<td>Less sub-optimization</td>
<td>More work</td>
</tr>
<tr>
<td></td>
<td>Better understanding of others and the whole</td>
<td>Lack of problem insight</td>
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<td>Better attitudes to cross-functional teams</td>
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| Decrease the Physical Distance between  | ▪ More frequent and richer information transmission  
| Project Members                         | ▪ Better team spirit  
|                                         | ▪ Less sub-optimization  
|                                         | ▪ Better understanding of others and the whole                                     | ▪ Confusion  
|                                         |                                                                                  | ▪ Surprised of the change  
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|                                         |                                                                                  | ▪ Lack of motivation |
| Design Engineers in the Workshop        | ▪ Better understanding of others and the whole  
|                                         | ▪ More and better cross-functional co-operation and communication  
|                                         | ▪ Better timing of activities                                                    | ▪ Confusion  
|                                         |                                                                                  | ▪ Uncertainty of the change  
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| Workshop Practice for Design Engineers  | ▪ Better understanding of others and the whole  
|                                         | ▪ Better understanding of downstream activities  
|                                         | ▪ Establishment of many informal, cross-functional contacts                       | ▪ Uncertainty of the change  
|                                         |                                                                                  | ▪ Uncertainty of own competence  
|                                         |                                                                                  | ▪ More work  
|                                         |                                                                                  | ▪ Lack of problem insight  
|                                         |                                                                                  | ▪ Lack of motivation |
| Spread Information about Ongoing Projects| ▪ Improved timing of activities  
|                                         | ▪ Better understanding of others and the whole  
|                                         | ▪ More initiatives from GT                                                        | ▪ Uncertainty of the change  
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| Improve/Initiate Contact Lists          | ▪ More efficient contact initiations  
|                                         | ▪ Better balance between informal and formal communication paths                 | ▪ Uncertainty of the change  
|                                         |                                                                                  | ▪ Lost of control and influence  
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**Interviews**

Isberg, Stefan: Manager of Production Development. Interview held 2007-01-31

Rådeklint, Ulf: Manager of Core Components. Interview held 2007-01-16
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APPENDIX 2 A: INTERVIEW QUESTIONS (ENGLISH)

The interview questions were a support for the interviewers rather than a questionnaire where all questions must be asked and asked in the written order. The question headings represent the different areas of interest for the interviewer. The interviewee could choose to talk freely about the subjects or more strictly answer our questions and sub-questions.

How do you work with product development?
(Product development = new development, larger updates and larger changes.)
Please, tell us how it works from idea to product in production.
When and how do you co-operate? Why do you co-operate when you do? Motive, reason, circumstances, forcing etc?

Do you know what the PDP (Product Development Process) is?
Do you use it? How? When? Why? Does it work as described? Is it well implemented in the business? Is it easy to understand?

Where in the process are you active and how?
How are ideas to larger improvements initiated? How and when are you involved? What kind of responsibilities do you have?

How, and to whom are information spread/flow within product development projects?
Which information is spread? When and to whom? How is it spread? How often is it spread? How is feedback taken care of?

Do you have contact with GT (or GR) in the product development?
Who? Why? When?

To GT: Do you think GR contact you in right questions/about right aspects? Is it good timing?
Do you want the co-operation in the existing way or in any other way?

How do you experience that the communication between and within GT and GR works?
What is easy and what is difficult? How does the organization facilitate co-operation between and within departments? Is it easier/more difficult to work with some groups
or departments? Do conditions for good co-operation between departments exist? How/what kind of conditions? Why not?

**When is the co-operation regulated and when is it on own initiative?**
Is it settled by the PDP? Settled by the project group? Informal or formal contacts? Does it work satisfactory in the existing way? Advantages/Disadvantages? Why do you co-operate as you do? Motive, reasons, coincidences, forces etc?

**Do you think that you have common goals as those you co-operate with?**
Do you have individual goals with your work? Why do you work as you do? Do other persons understand or share these goals? Do the departments have common goals? Do you know the company’s / the department’s goals?

**Does everybody have understanding of other’s tasks?**
Does everybody understand the reasons for arising questions and co-operations? Attitudes? Cross-functional teams?

**Do you understand your role in the business/your contribution?**
Is understanding of the wholeness important? Do you understand how you contribute? Do you know what others expect from you?

**Special Questions to the Process Owners**

Who are included in the project group? Who choose these ones? From which criteria? Why?

Who are included in the Review Groups? Who choose these ones? From which criterias? Why? What are their tasks before, during and after the Review meetings?

Have GT project leaders existed in earlier development projects (except from the New Platform project)?

How did you implement the PDP in the business? How and to whom do you spread information about the PDP today?

Who should know about the PDP? Who should work as it describes? How deep understanding do they need about the process?
APPENDIX 2 B: INTERVIEW QUESTIONS (SWEDISH)


Hur arbetar ni med produktutveckling?
(Produktutveckling = nyutveckling, större uppdateringar och större förändringar.)
Berätta gärna hur det fungerar från idé till produkt i produktion.
När och hur samarbetar ni? Varför samarbetar ni när ni gör det? Motiv, anledning, tillfällighet, påvingat etc?

Vet du vad PDPn (Product Development Process) är?

Var i processen arbetar du/är du aktiv?

Hur, och till vilka, sprids/flödar information inom produktutvecklingsprojekt?

Har du i produktutvecklingen kontakt med GT (alt. GR)?
Vem? Vilka? Varför?

Till GT: Tycker du att du blir tillfrågad av GR i rätt aspekter? Vid rätt tillfällen?
Vill man ha samarbetet på det sättet? Eller på något annat sätt?

Hur upplever du att kommunikationen mellan och inom GT och GR fungerar?
När är samarbetet reglerat respektive på eget initiativ?
Reglerat genom PDPn eller överenskommelser i projektgruppen etc.? Informella/Formella kontakter? Är det bra som det fungerar? För- och nackdelar? Varför samarbetar ni när ni gör det? Motiv, anledning, tillfällighet, påtvingat etc?

Tycker du att de du samarbetar med har gemensamma mål med dig?

Har man en förståelse för varandras jobb?
Förstår man anledningen till frågor och samarbeten? Attityder? Cross-functional teams?

Förstår du din del i helhet (verksamheten)?
Är helheten viktig? Förstår du hur du bidrar? Vet du vad andra förväntar sig av dig?

SPECIELLA FRÅGOR TILL PROCESSÄGARNA
Vilka ingår i en projektgrupp? Vem väljer ut dessa? På vilka kriterier? Varför?


Har det funnits en projektledare från GT i tidigare projekt (förutom i GTX-projektet)?

Hur gick/går implementeringen av PDPn till? Hur och till vilka spreds/spred information?

Vilka bör känna till PDPn? Vilka bör arbeta efter den?
APPENDIX 3: THE FULL VERSION OF THE PDP

## APPENDIX 4: REVIEWS

<table>
<thead>
<tr>
<th>Code</th>
<th>Review Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>R0</td>
<td>Product Strategy</td>
<td>Product strategy based on market needs, customer structure, market position and strategies, strategic success drivers to determine technical, qualitative and cost-related requirements risks.</td>
</tr>
<tr>
<td>R1</td>
<td>Product Requirement Specification</td>
<td>Future market scenarios, customer requirements, benchmarks, thermal cycle process analyzes, legal requirements.</td>
</tr>
<tr>
<td>PDB</td>
<td>Design Brief</td>
<td>Feasibility, milestone plan, project plan, budget, resources, project risks and communication plans.</td>
</tr>
<tr>
<td>R2</td>
<td>Product Design</td>
<td>Conceptual design, ensure validity of design concepts, acceptance of design targets by Engineering, manufacturing and procurement and risk assessment.</td>
</tr>
<tr>
<td>R3</td>
<td>Design (preliminary)</td>
<td>Design guidelines, function description, design specification, preliminary layouts, interfaces, boundary conditions, manufacturing concepts and serviceability.</td>
</tr>
<tr>
<td>R4</td>
<td>Commercialization</td>
<td>Commercialization plans to ensure an effective commercial realization with acceptable risk.</td>
</tr>
<tr>
<td>R5</td>
<td>Design (Final)</td>
<td>Final review of drawings, theoretical and experimental results prior to manufacturing, prototype tests planned, manufacturability, serviceability, product cost and design performance.</td>
</tr>
<tr>
<td>R6</td>
<td>Procurement</td>
<td>Order documentation, product documentation and feedback from procurement process.</td>
</tr>
<tr>
<td>R7</td>
<td>Product</td>
<td>Prototype manufacturing, assembly, quality data following first product, component cost, test installation and experimental test results.</td>
</tr>
<tr>
<td>R8a</td>
<td>Commissioning</td>
<td>Feedback from erection and commissioning and feedback on the lessons learned.</td>
</tr>
<tr>
<td>R8b</td>
<td>Verification</td>
<td>Feedback from first prototype, conformance to design, performance, expected life, potential problem areas, and risk analysis.</td>
</tr>
<tr>
<td>R9</td>
<td>Product monitoring</td>
<td>Feedback from first sites, operating data, operation experience, inspection results and feedback on lessons learned.</td>
</tr>
<tr>
<td>R10</td>
<td>Performance, Reliability, Serviceability</td>
<td>Feedback from commercial operations and completes the validation of the product versus design requirements.</td>
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