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Better Implementation of Innovation Projects

A Study of methods and praxises in one company within
the Norwegian pulp and paper process industry

Doctoral thesis

by

Per Kirkebak

Trondheim March 2000

INSTITUTT FOR INDUSTRIELL ØKONOMI OG TEKNOLOGILEDELSE
NORGES TEKNISK – NATURVITENSKAPELIGE UNIVERSITET

DEPARTMENT OF INDUSTRIAL ECONOMICS AND TECHNOLOGY MANAGEMENT
NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY

Preface

The last four years I have been working with my PhD within management and organisational development, with the focus on how to improve the implementation of innovation projects. During this time I have been connected to the Department of Industrial Economics and Technology Management at the Norwegian University of Science. I have, however, not been a part of any research programme at the university. During one and a half year I have been a full time student. In rest of the time I have been studying while being in full time job as a manager of development at Peterson Linerboard AS, Moss.

I am grateful to my company, making it possible to do this PhD project, and especially to the Executive Vice President of Peterson Linerboard, AS Jan Erik Edvardsen, for his thoroughly quality checking my empirical material and his valuable contributions in discussions. I am also indebted to the manager of human resources of M. Peterson & Søn, AS Harald Neset, who I have had the opportunity to interact with.

I am especially grateful to my advisor, Professor Morten Levin, for guiding me through the process. He has been of great support and has given me excellent feedback in the developing of the thesis.

I want to thank Ragnhild Sødahl for the excellently checking my English writing, Jorid Øyen for the practical coordination in the finalising of my PhD study, and director of Oestfold Research Foundation, Knut Aarvak, for his reading through my preliminary drafts and for giving me critical feedback.

This work has been carried out at the expense of my own free time and my family. My wife Hanne – Marie Lundeby Kirkebak and our children Ingvild and Jakob have been very patient with me and have provided the space and encouragement necessary to bring this project to its completion. Without them this thesis would never have seen daylight.

My research is made at Peterson Linerboard AS, Moss, being my employer during the last 10 years. The empirical material is covering the time period from 1985 to 1995. It is important

to emphasise that the situation of today regarding implementation of innovation projects is somewhat improved as to what is described in my empirical material.

Råde, March 2000

Per Kirkebak

A handwritten signature in black ink, appearing to read 'Per Kirkebak', with a small vertical line at the end.

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Abbreviations

Cleaner Production:	A methodology developed by EPA for reducing polluted effluents by internal measures
EMAS:	Eco Management and Audit Scheme
EPA:	The US Environmental Protection Agency Cleaner Production
Fluting paper:	Paper which is utilised as the middle layer in a corrugated box
Kraft liner:	Liner manufactured from mostly kraft pulp
Kraft pulp:	Sulphate pulp for kraft paper and other product with high strengths
Liner:	Paper intended for lining the surface of another board material, as for example of fluted paper in a corrugated box.
NFR:	The Norwegian Research Council
NTNF:	The Royal Norwegian Council for Scientific and technological Research
PFI:	The Norwegian Pulp & Paper Research Institute
S-Curve:	A curve showing the product value against the cumulative R&D effort
Testliner:	Liner manufactured from waste paper

Chapter 1 - Introduction

1.1 Innovations Represent Problems /Challenges to Peterson Linerboard AS.

Peterson Linerboard AS, Moss has in a historical perspective completed many innovations, both smaller and bigger ones. The company has been at the front edge of the technological development in some fields. I shall highlight two examples of this.

1. Early in the 1970s the prototype of the continuous pulp digester together with a continuous washing diffuser from Kamyr were installed in the pulp mill. These installations made the pulping process much more efficient, compared to the batch digesting pulping process. Today continuous pulp digesting with equipment from Kamyr represents the state of the art in this field.
2. In the mid 1980s a two-stage oxygen delignification process was installed in the pulp mill in a joint venture project between Kamyr and Peterson. This two-stage process was the first of its kind in the world. It made delignification to low kappa numbers possible without losing too much strength properties of the pulp

The above examples represent successful innovations that took place in a close co-operation with external companies that were rich in resources. High installation costs were involved in the two examples above.

In a historical perspective there are several examples of successful process innovations at the company in which high installation costs have been involved. Examples of this are rebuilding of paper machines. In these projects the suppliers have had the total responsibility for their own installations, and external professional project management teams have had the responsibility for the project management. In these type of process innovations a thorough pre – project has always been done. The up-stream planning has normally taken 1-2 years. The machine suppliers, with their great experience as to what is required for successfully removing old equipment and for instalment and up-start of new process units, have been heavily involved in the bigger innovation projects.

During the last 10 – 15 years several process and product innovations have been implemented at Peterson Linerboard AS, Moss, normally with the project management of the enterprise in Moss and a strong involvement of internal resources. The share of R&D work has often been considerable, and the risk of not to achieving the project goals has been high. Most of these projects may often be characterised as low - budget projects, with the opinion among the management that the innovation should not cost too much money

There are many examples on unsuccessful results among the internal kinds of smaller innovation projects described above. There is evidence that they have been terminated before the project goal had been achieved or before the results have been implemented in the organisation. This represents a serious problem to the enterprise in Moss, due to the fact that most innovation processes in the future will possess the character of being relatively small and with a strong involvement of limited internal resources that have to be given a high priority.

1.2 Elaboration on the Importance of Improving the Efficiency in the Implementation of Innovation Processes

The enterprise is still struggling with the integration of the former companies Peterson Moss AS and Peterson Ranheim AS in the framework of Peterson Linerboard AS. The aim of the work is to take out as much as possible of the potential synergy between the two companies in different fields as product, technology and market, and to develop the management systems and company culture to achieve this. Much of this work will take place within the project framework.

Peterson Linerboard AS, Moss implemented in 1999 a major reconstruction of one of the paper machines at the company. This made it technically possible to develop new and interesting future products on the machine. During the 1990s technical equipment worth about NOK 1 billion has been invested in the mill. Now it is time to utilise the investments regarding development of new products and optimisation of the processes.

A generally increasing trend is to aim at offering the customers performance at lower costs in a dynamic market. It seems to be more important to satisfy the demands of the customers in an efficient way at a satisfactory level of quality. Working in projects will get a central role.

There will be a need for a strong capability in innovation work, in order to reduce the time to market and to improve the achievement of the project goals.

Among the challenges Peterson Linerboard AS, Moss will meet are:

- How to increase the paper performance in line with development of faster and more demanding processes downstream the value chain?
- How to reduce the quality variations in the company's products and processes?
- How to develop new products in niche markets?
- How to improve the reliability of product supplies to the customers?
- How to improve the production flexibility of liner products to the customers towards more tailor-made products?
- How to improve the environmental and resource profile of the enterprise in Moss?

1.3 Developing the Problem Approach as regards Unsuccessful Innovations

In a historical perspective there seems to have been different reasons for the failures of the company's internal product and process innovation projects. However, nobody has ever gone deeply into the written project documentation and discussed with actors that have been involved in different projects, in order to try to get a holistic understanding of the main reasons for the many unsuccessful internal innovation projects at the enterprise in Moss.

Central questions to be asked regarding possible explanations to the failures in achieving the project goals are:

- Is there a shortage of good ideas in the organisation for initiating good product and process innovation projects?
- Are the creative processes upstream the innovation projects, which ideas should be taken further in the innovation process, and to calculate if an actual innovation will result in a successful business for the enterprise
- Are technical innovations well rooted in the organisation?
- Is the company strategy well communicated to the organisation?

- Does learning take place during the innovation projects and in downstream evaluation of the project results, to support the innovation processes?
- Is any systematic innovation model applied in the implementation of technical innovations?
- Do innovations fail because of negative conflicts in the organisation?

The above questions have both organisational and management implications, for instance regarding which type of organisational model and management style to be applied.

1.4 Construction of the Thesis

The construction of the thesis is based on the following logics:

Three Perspectives on Innovation are developed

To try to create a more complete understanding of innovation systems, the five projects involved in my thesis are analysed, applying the following three theory perspectives:

- The structure theory
- The knowledge creation theory
- The social constructivist theory

Structure theory – This theoretical position opens up with a presentation of the sociotechnical system perspective. A new discourse follows of the traditional pull – push of technology, basic research applied technological development based on linear innovation models, Rosenberg (1991), Galbraith (1982). This theory perspective concludes with a presentation of a theory of the dynamics of innovations, Utterback (1994) and a discourse of integrated engineering models, Andreasen, Hein, Kirkegård & Sant (1989), Rommel, Kluge, Kempis, Diederichs & Bruck (1995). All models that are presented in the structure theory perspective are based on the assumption of harmony and conflict - free development of technology, in which interested actors are not present.

Knowledge creation theory – This theoretical position opens up with a presentation of knowledge creation as a process of uncertainty reduction. A discourse follows of two

model approaches of knowledge creation, one with a collective learning approach, Gibbons (1994), Elden & Levin (1991) and another with the approach of description how knowledge is created through four modes of knowledge conversion through the interaction of tacit and explicit knowledge, Nonaka & Takeuchi (1995). A theory is presented on how to put integrated teams to work. Finally, different elements promoting knowledge creation are discussed.

Social constructivist theory - This part of the theory holds a social constructivist position. Development of new technology is regarded as a social product, involving actors that are socially and politically conscious. Therefore I have termed this theory approach the notation “agent” theory, to signal that interested actors are involved. This position maintains that it is critical to understand the social processes taking place, in order to promote an understanding of the development of new technology, Winner (1993). The focus is on the variety of technical knowledge in question and the social actors involved, rather than on regarding technology development from deterministic and imperative perspectives. In these processes conflicts are natural elements. According to this theoretical position the social and political processes shaping the technology are never neutral ones.

Conflicts do not necessarily mean that a battle is taking place, but are seen as positive and necessary elements for technological development. The existence of a controversy between different groups of actors can mean that they are representing groups of diversity with recognised different views. The social constructivist theory is presented from two well-known approaches: first from the SCOT (social construction of technology) approach and secondly from an ANT (actor network theory approach).

The theory about SCOT was developed by Pinch & Bijker (1989). They chose the empirical program of relativism as their model. This means that the appearance of a new technology must be seen in relation to the different meanings constructed by groups of relevant actors. An artefact’s identity and its functionality are subject to heterogeneous social interactions. Central concepts in this approach are relevant actors, interpretative flexibility, controversies and closure mechanisms ending up with consensus.

In an actor network orientation of social constructivism, Latour (1987), Callon (1989), it is emphasised that the world is composed of actor networks, including both living individuals and nonliving technological entities. In the actor network approach the focus is on micro level on how actors involved in a certain context behave. Latour (1987) points out that his model does not regard how the truth is discovered by the researchers, but how the truth is constructed from the statements that the researchers make through seeking support and creation of alliances. An important methodical principle is to study the involved researches as research – political actors, to follow them through the process in which the politics is formed, Buland (1991).

Each theory perspective ends with a conclusion, which is applied for the construction of my analytical position, formulated as questions to be applied in the analysis of the involved projects.

A conclusion is established at the end of the analysis of the projects from each of the three theoretical approaches, based on important findings from each analysis of the projects.

From the above conclusions, I present my reflections as to which elements are important for developing my integrated innovation model.

A holistic understanding of the innovation processes at the enterprise in Moss is presented through developing an integrated innovation model.

Finally suggestions are put forward regarding which kind of implications my innovation model could have for the organisation of the enterprise in Moss.

2.0 An introduction to M.Peterson & Søn AS

2.1 Introduction

The Peterson Group is the largest fibre- based packaging group in Norway, with the parent company M . Peterson & Søn AS situated in Moss in Norway. The number of employees is 2.200. The total turnover of the company is approx NOK 3.5 billion. Approx 70 percent of the total production is exported. The production facilities are located in Norway, Sweden, Denmark and Finland.

The parent company M. Peterson & Søn AS is family owned, and not listed on the stock exchange. The present president and CEO, Erik Mollat, is sixth generation descendant of the founder.

The vision of the Peterson Group is:

“We will develop the Peterson Group further to provide the greatest possible benefit to the next generation of employees, owners and people in the local communities around our businesses”.

2.2 The History of M. Peterson & Søn AS

2.2.1 The History began in 1801

The Peterson history goes back to 1801, when Momme Peterson opened a general store in Moss, 60 km south of Oslo, which grew into a considerable general shop. In 1928 Momme Peterson brought his son into the business, and it was given the name M. Peterson & Søn.

In 1848, it branched into shipping, and was until 1875 one of Moss’ prominent ship – owning companies.

2.2.2 Further Development of the Firm

Momme Peterson's grandson, Theodor Peterson, then sold the fleet of ships and took over the site of Moss Ironworks. The industrial operations started. Theodor Peterson founded Moss Pulp Mill, where the first digesting of pulp took place in 1883. The pulp mill is today the oldest sulphate pulp mill in the world which is still in operation.

The first two paper machines were installed in 1898.

Until the 1950s, the pulp and paper mill in Moss remained the only operational unit of M. Peterson & Søn AS.

Hans Blom Peterson headed the firm during the period 1901 – 1954. He was a man of modern thinking and took the technological development of the firm a large step further, investing in a new recovery boiler and pulp digester, starting manufacturing of paper sacks, building the new paper machine PM4 and a new sack factory.

Peterson & Søn AS was the first company in Norway to appoint a production committee with participation of management and workers in 1946.

The firm was also in front as regards social welfare efforts among its employees. In 1946 it started a company medical service, and a kinder garden for the employees – still in operation – was opened in 1947. Holiday homes, located close to the sea, were given to the employees in 1951.

2.2.3 From a Mill in Moss to an International Packaging Group

The brothers Ralph (until 1980) and Erik Mollat (present president, CEO) were the main actors in the work of changing the firm to a modern, wholly integrated packaging group.

In 1989 Peterson & Søn AS comprised 10 individual companies. This year the group model was introduced, with M. Peterson & Søn AS as the parent company.

In 1997, a new organisational structure was established, consisting of the four business areas:

- Peterson Linerboard
- Peterson Scanproof
- Peterson Barriere
- Peterson Packaging

The main reasons for this change were to develop a more market- oriented and cost- efficient organisation , and to get a maximum advantage out of the total resources.

Figure 1 shows the organisation of M. Peterson & Søn AS in business areas and subsidiaries together with the product within each business area.

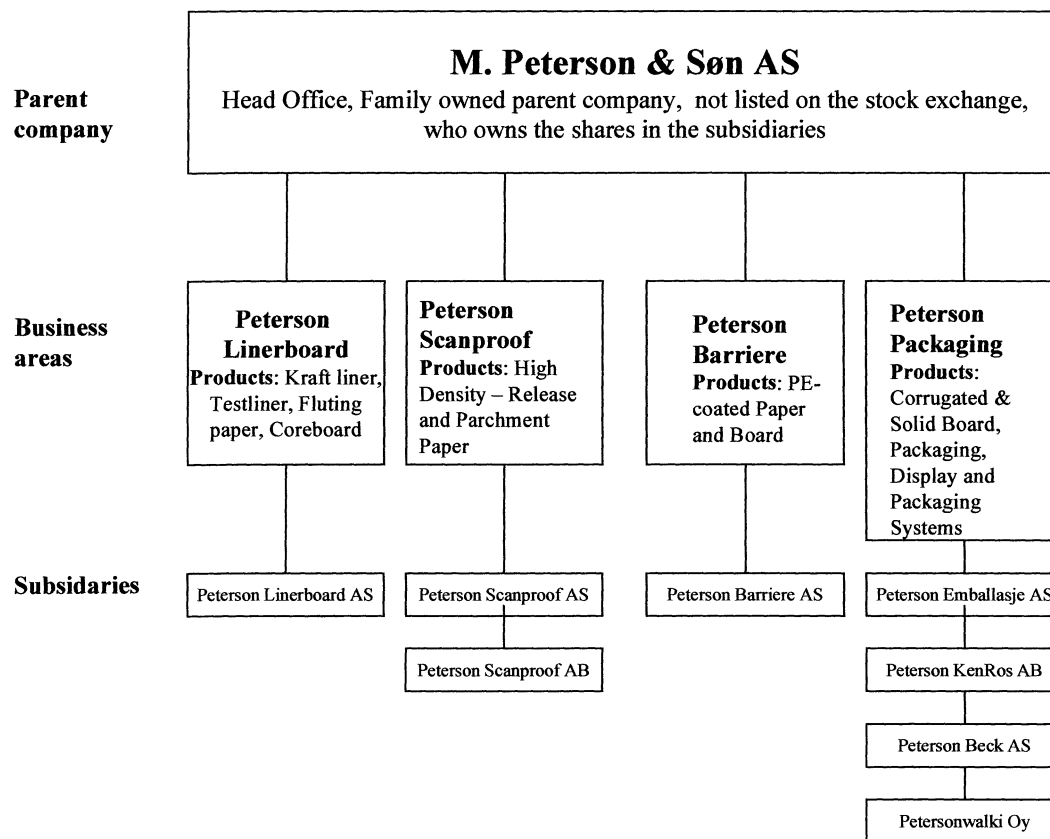


Figure 1: The organisation of M. Peterson & Søn AS

2.3 Peterson Linerboard AS

Peterson Linerboard AS has a turnover of approx NOK 1.100 mill. The business accounts for approx 31 percent of the Peterson Group total turnover. The number of employees is 600.

Peterson Linerboard AS consists of the pulp and paper mill in Moss (Peterson Linerboard AS, Moss) and the paper mill at Ranheim (Peterson Linerboard AS, Ranheim). The organizing of the subsidiary is shown in figure 2, together with the production at each site.

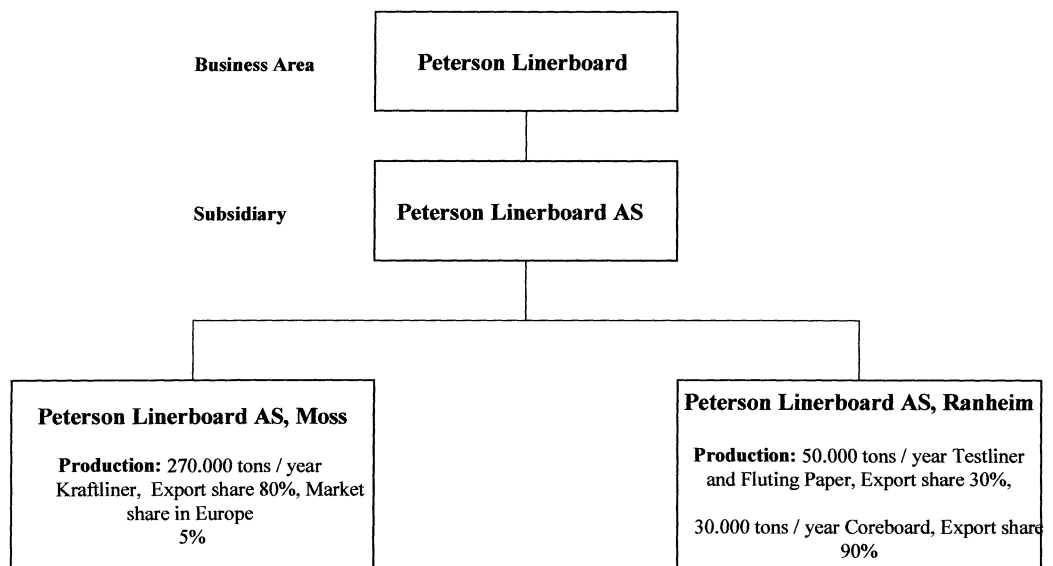


Figure 2: The organisation of Peterson Linerboard AS

Product descriptions

- **Liner:** Paper intended for lining the surface of another board material, as for example of fluted paper in a corrugated board box
- **Kraft liner** Liner manufactured mostly from kraft pulp
- **Kraft Pulp** Sulphate pulp for kraft paper and other products with high strength
- **Testliner** Liner manufactured from waste paper
- **Fluting Paper** Paper for the manufacture of fluted paper, which is utilised as the middle layer in a corrugated box

2.3.1 The present Production Processes

The main present product processes today are the making of pulp and paper. The pulp is used as a raw material in the paper production, and the process is therefore called an integrated pulp & paper process.

The Digesting Process

The sulphate digesting process is based on softwood as the raw material, which comes to Peterson Linerboard AS, Moss by ship, train or truck. Half of the fibre material to the digesting process consists of chips from sawmills. The other half is received as timber and chipped locally.

The chip raw material is together with the cooking liquor, and with sodium and sulphurous components as the active chemicals, heated up at a high temperature and pressure. During the pulping process a part of the original lignin components in the wood is removed

Downstream the digesting process the pulp is beaten in refiners in order to open up the fibre material and to make the fibres more flexible. After washing the pulp it is fed to the paper mill as raw material for the paper production.

The Paper Production Process

The fibre material for producing the strong paper in Moss, which is called Kraft liner, consists of approx 30 percent of recycled fibres. Together with the virgin pulp from the own digesting process the fibre material is beaten in refiners, mixed with a large number of paper chemicals and diluted to a very low consistency before it is transported to the two paper machines.

The paper machines are two-wire machines. This means that two paper layers are initially produced on the wet end of the machine, and afterwards pressed together. With this paper machine design it is possible to produce a paper with different properties in the two paper layers.

The paper machine process can be regarded as a water removal process. The very low pulp consistency at the inlet of the paper machine, is gradually increased through the machine until the finished paper is leaving the paper machine.

To visualise the consumption of raw materials and energy in the pulp and paper production, figures from the year 1997 is given in figure 3.

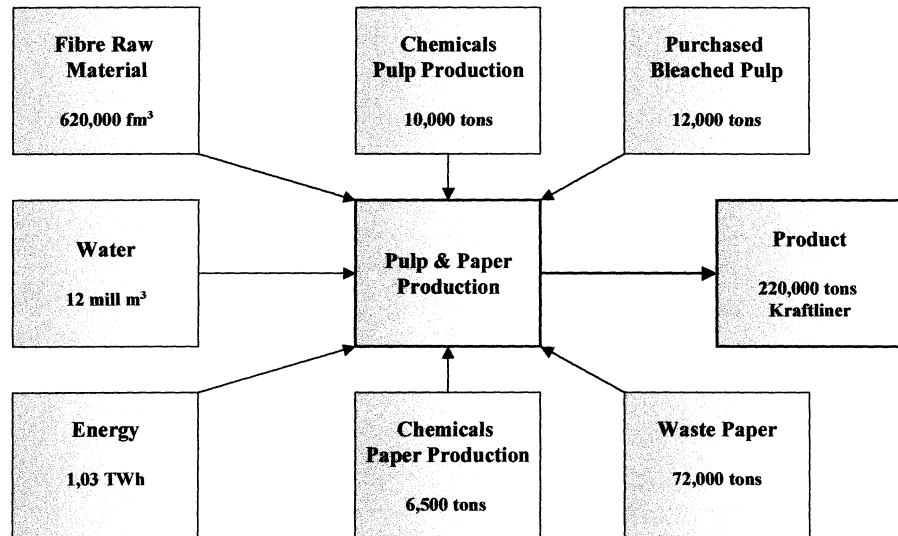


Figure 3: Consumption of raw materials and energy the year 1997 (Source: EMAS Environmental Report 1997, Peterson Linerboard AS, Moss)

2.3.2 The Technical Development

The Industrial Operations began in 1883

The first digesting of pulp at Moss Pulp Mill took place in 1883. The first operations were based on the soda cellulose process, but the mill was rebuilt to a sulphate pulp one half a year later. The pulp was from the start of good quality. In 1984 the mill received the highest distinction at the world's exhibition in Edinburgh in Scotland. The pulp mill was designed for a production of pulp of 4000 tons / year.

The Mill in Moss becomes an integrated Pulp & Paper mill

The next large event in the firm's technological development was the installation of two paper machines in 1898, which should take half the pulp production. From that time Moss Pulp Mill had become an integrated pulp and paper mill.

Heavy Investments after Second World War

Among important installations were an increase in the pulp production capacity to 25,000 – 30,000 tons / year and in 1952 the purchase of the new paper machine PM4, which is still in operation.

A new sack paper machine, PM5, was installed in 1965. This machine is still in operation, but is today rebuilt to a modern linerboard machine.

In 1971 the first prototype of a continuous pulp digester from Kamyr was installed, together with pulp washing equipment from the same company. The production capacity of pulp was by this increased to 110,000 tons / year.

The above installation was the up-start of a period of 20 years with a great deal of innovations and technical investments ahead of the technical development. In periods part of the pulp mill functioned as a full - scale laboratory.

In 1973 the pulp mill started a catalytic process in the chemical recovery plant to oxidize the cooking liquid. The purpose was both to give the pulp special properties and at the same time to increase the pulp yield from the digester. Mead Corporation in USA was the licensee to this process. Apart from Mead the mill in Moss was the first in the world to install the process in full scale.

A two – stage oxygen delignification process was installed in the pulp mill in the middle of the 1980s. This process was based on prototype technology from Kamyr, and was developed in a joint venture project between Kamyr and M. Peterson & AS.

The paper machine PM4 was rebuilt in 1985 to a production capacity of 100,000 tons / year.

The investments in a more efficient and specific process technology with higher capacity continued during the 1990s. During the 1990s NOK 1 billion has been used in installation of new process technology.

The enterprise in Moss was the first company within the Norwegian pulp & paper branch to obtain a certification according to the NS-EN ISO 9001 Quality management and quality assurance standards in 1992, and number two in Scandinavia to obtain an EMAS (Eco Management and Audit Scheme) certification in 1995.

When reading the history of the technological development at the enterprise in Moss, some of the innovations were both pioneering and involving a high risk. It becomes clear that these have been carried through during its history by a few strong and highly competent individuals in the organisation.

2.3.3 The Organisation in the Middle of the 1950s

In the middle of the 1950s the number of employees were totally 735. Of them 680 were working in the technical department and 55 as white collar workers. The whole production was sold in a domestic market. The company was at that time highly technologically oriented.

As described in chapter 2.2.2 M. Peterson & Søn AS was in forefront also regarding social welfare among its employees. It is interesting to examine which kinds of effect the above arrangements had on the organisation of the work and the working conditions in mill. It seems that the working processes were organised according to what was common at that time by applying Taylor's principles of scientific management. In line with his thinking model detailed time studies were initiated in 1947. Insecurity, a reduced work democracy and pressure in the work situation can partly explain the socialization of the workers against the enterprise, as described in **Sverre Lysgaard's book "Arbeiderkollektivet" (1991)**.

This book is about the workers and their relations to the company, and is based on research at M. Peterson & Søn, Moss Pulp Mill in 1954. During the research the degree of formation of a

collective system among subordinates in the work organisation at M. Peterson & Søn AS was analysed.

A total of 252 persons from different departments were interviewed. The research team also worked part time in different departments to gain more knowledge about the enterprise.

Lysgaard's (1991) mainly points out the workers' special situation in that having employment was regarded as a privilege, and yet this employment put a strain on the worker through the insatiability, one-sidedness and inexorableness of the technical/financial system.

It is from this dilemma around the employment that the collective organising system takes shape as a buffer system to protect the employee against the enterprise. Further, the work collective reflects the workers' desire for safety, power and honour which were not possible for them to obtain as individuals in their regular technical/financial roles. The collective can be understood as a principle of equality. Nobody shall obtain special advantages at the expense of other workers. There shall be no difference within the collective regarding each worker's relations to the enterprise and to superiors.

The collective system is a value and a role system, and has an informal character.

According to Lysgaard(1991) the development of a work collective can be explained by several factors. The problem interpretation , identification and interaction processes are understood as the basis processes in the development of a collective system.

Lysgaard (1991) claims that the meaning behind the problem interpretation process is the increasing feeling regarding the dilemma of the employment and the problem situation of which they were a part. This process, resulting in the characteristic view on the enterprise as an opposite party, can take place when problem conditions are present as described above.

The identification and interaction processes focus on the two main human processes of collective action and solidarity, and take place when the conditions for identification and interaction are present. A condition for identification between individuals is the sharing of

common values. Interaction processes take place in situations of closeness between individuals.

The proper conditions for development were there at M. Peterson & Søn AS, Moss Pulp Mill in the middle of the 1950s. The work environment was fairly stable. The work was organised in a way that opened up for interaction. Differences existed between the white collar people and the workers' situation at the enterprise that supported the worker's identification of themselves as "us" and of the white collar people as "them". The piece wage system often created conflicts and irritations in the daily working situation. Finally, the co-operation between the enterprise and employees was still not properly fixed by law.

2.3.4 The present Organisation of Peterson Linerboard AS

Peterson Linerboard AS is a functionally oriented company with 600 employees. There are at present seven levels in the organisation. All employees down to the foreman's level are working according to functional descriptions, which outline the content of each individual's work.

The R&D function is today functionally separated into process and product development, and belongs to the technical department. The main responsibility of the process department is to give support to the operating organisation and to contribute to an optimisation of the different process sections. The manager of the process department, who is also responsible for the laboratory work of the company, is reporting to the technical director. The product development responsibility belongs to the technical director, and is not delegated further down in the organisation. Separate yearly budgets are made for the product and process development functions. These have been based on short-term thinking. During the budget period the requirements on reductions are the same for the product and process development budgets as for other operating budgets.

Peterson Linerboard AS, Moss has not been a change - oriented company. This attitude is based on its strong culture, its many levels of the organisation, the strong functional splitting up of work, the reduced risk orientation and the short term thinking in R&D questions.

2.4 Terms applied

The organisation structure has been changing over the years of development of the company. All projects involved in the thesis, however, have been implemented before the present organisation structure which was established in 1997.

To make it easier for myself in the writing, Peterson Linerboard AS, Moss is, due to different names of the company during the period of time of the implementation of the involved projects, given the term the enterprise in Moss in the following chapters of the thesis M.Peterson & Søn AS is called the parent company.

CHAPTER 3 - THEORY OF INNOVATION

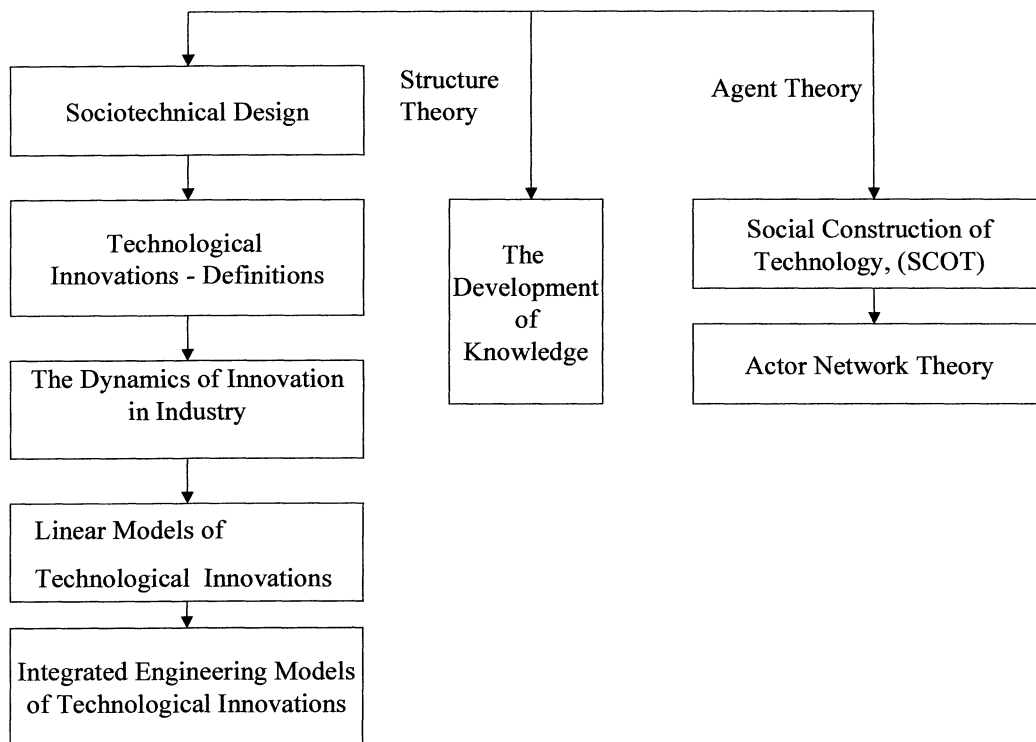
Introduction

In this chapter a relevant basis for analysis of my empirical material is presented. A multi - perspective theory is presented, in order to achieve a deeper understanding of the innovation process and a broader basis for the construction of my analytical position.

The theory is divided into the following three different perspectives:

- A sociotechnical view from the social science field, which is termed “agent” theory.
- A theory about creation of new knowledge
- A macro oriented theory based on systems thinking, which is termed “structure” theory.

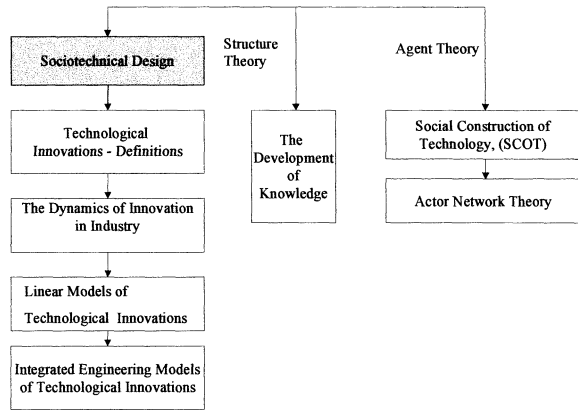
A block diagram of the theoretical framework is shown in figure 4. This figure is also shown at the start of each actual section in the theory, marked with a grey colour, to identify the section of the total theoretical framework.

THE FRAMEWORK OF THEORY**Figure:4 The Framework of the Theory**

3.1 STRUCTURE THEORY

3.1.1 Sociotechnical Design

Until 1950 the manufacturing equipment played a decisive role for the workers on the floor, which did not have any influence on the technical side. This is illustrated in figure 5.



In line with scientific management thinking they had to adapt to the machines and the management. scientific management, Taylor (1967), was a form of management where the division between manual and intellectual work made the basis for organising the production. The management should do the interesting and challenging work, while the routine - based manual tasks were given to the workers. The manual work cycle should only take a few minutes, in order to make the need for training short. In this way the workers were easy interchangeable. In fact the scientific management tried to make a division between the hand and the brain of the workers.

The motivation to do the work on the floor, and to achieve a planned volume, should be secured through a piecework system. Internal quality control of the products was not built into the role of the worker. After the manufacturing of the products by the workers, the product quality was checked through rigid quality - control procedures.

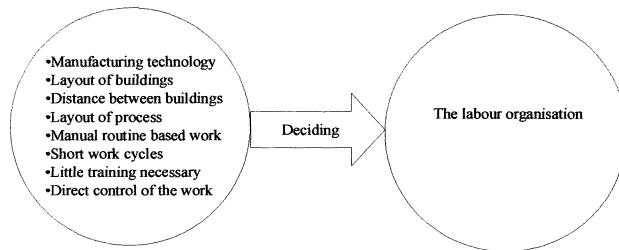


Figure 5: The management's decisive role

In addition to showing the main characteristics of scientific management that were discussed above, figure 5 illustrates a belief that no communication was necessary between the workers, when they were doing their short work cycles. Thus, an integrated approach was not employed in the layout of the processes and the production facilities.

In 1951 the Tavistock Institute began a research program in the coal - mining industry in England. The Tavistock Institute was part of the post-war reconstruction of the British coal - mining industry. In Trist & Bamforth's (1951) study of the coal mining in 1951, the interrelationship between the technical and social subsystems was already discussed. The researchers at Tavistock observed two kinds of working systems: The old "Shortwall" concept of mining, and a new "Longwall" method. According to the first concept multiskilled miners were working closely together in autonomous teams. This was in contrast to the "Longwall" method, where each miner performed a single or a limited number of tasks. The new way of taking out coal, resulted in that the social contact between the established working groups was insufficient, and had a large effect on the well – being, productivity, absenteeism and attitude to the work.

The conclusion of this famous study was that the technological subsystem ought to be jointly optimised together with the human requirements from the social system. This is shown in figure 6.

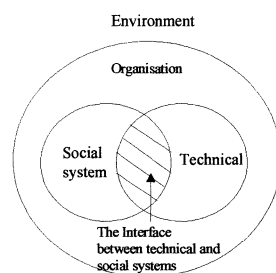


Figure 6: Joint optimisation of the social and technical system.

(From Levin, Fossen, Gjersvik, (1994))

The figure above illustrates some important notions within the sociotechnical design thinking. The organisation is viewed as a system. In line with Bertalanaffy (1998) a

system is a structured assembly of components and sub-systems, which interact through interfaces. The elements and their interactions constitute a total system. Organisations are open systems and interact with their environment. They exhibit the character of steady state, wherein a dynamic interaction of systems elements adjust to changes in the environment.

The main parts in the overall system which we call an organisation are the social and technical sub-systems. The social system is the humans in the organisation and the relations between them. Levin, Fossen & Gjersvik (1994) claim that this has firstly something to do with the individual's needs and wishes related to the his working conditions, and secondly with inter-human relations, as safety, support, involvement, status, power and social networks.

A project organisation, which according to Kolltvet & Reve (1998) is established in order to accomplish tasks that have a goal of their own, a given time and limited resources, represents the social system that is going to be jointly optimised with the technical system. Kolltveit & Reve (1998) claiming that a life cycle of a project can be divided into the three phases:

- The initiation phase, including pre-study and pre-project activities
- The implementation phase
- The closing phase

In the initiation phase the goal is to create a good basis for an efficient project accomplishment. Typical work to be done in this phase is:

- Searching for good business ideas – making choice of ideas
- Carrying out a market survey
- Carrying out a competitor analysis
- Creating a realistic view as to requirements for achieving the project goal.
- Calculate if this project will result in good business for the company.

Kolltveit & Reve (1998) claim that there do not exist any best project organisation forms. However, an overall structure, with a steering group and a project group, is usual when the work is organised in projects. Project organisations are situational. It is argued that a combined systems perspective could be useful in the organisation of project work. This means that a view is created that includes elements from the rational, natural and open system perspectives. The main features of the three systems perspectives are given in table 1.

The rational system perspective	The natural system perspective	The open system perspective
Main Features		
A formal organisation structure	The organisation is regarded as a collective social structure	Change of energy and information with the environment
Rules and procedures	Preoccupied with structure only to a small degree	Organisations as open systems can execute work due to the supply of external resources.
Focus on productivity, effectiveness, optimisation and implementation	Focus on the need for both formal and informal organisation structures	An organisation is situational
Clear and easy to follow-up	There exists internal needs in an organisation	Open systems can maintain themselves with basis in supply of external resources

Table 1: Features of three systems perspectives

Kolltveit & Reve (1998) claim that situations that require creativity, as in the initialisation phase, favour the open system organisation structure. When the requirements to productivity is high, as in the accomplishment and closing phases, a more formal system organisation structure could be more suitable.

Levin, Fossen & Gjersvik (1994) define technology in the following way:

1. Knowledge about the production of artefact or services,
2. Machines and tools for such a production,
3. Routines and methods applied in the artefact and service production.

As Susman (1983) argues, the sociotechnical system design is a search for the best solution, involving at the same time conflicting requirements of the technical and

social systems. This often means that one has to compromise with the requirements of a perfect technology, in order to get a well - functioning social system. It may be necessary to make other technical choices in order to achieve a joint optimisation of the overall system. From this, job design is a compromise between the requirements of the technology and the requirements formulated by the humans in the organisation. According to this approach, the problem solving will always take place in an interplay between humans and machines, in the search for a joint optimisation.

In the sociotechnical systems perspective, one tries to understand problems within an organisation as matters deriving from the relations between the social and technical systems.

3.1.1.1 Requirements of the Technological System

from the literature of Emery.F & Emery.M (1974) it becomes clear that the sociotechnical design concept was to serve as a frame of reference when analysing parts or the whole, of the industrial production at an enterprise. A selection has to be made regarding how to use the technology, independently of its complexity. It is obvious that all technology presents some special requirements in order to function. According to the sociotechnical design approach, these requirements are formulated in minimum critical specifications. This can be understood in the following way: There will always be a number of basic specifications that have to be fulfilled, in order to operate the technology. Beyond that, it will be possible to make different choices. This should be done in a way that opens up for a joint optimisation of the social and technical requirements. Utilising the minimum critical specifications makes it possible to design the user interface more freely, and open up for learning. However, it might be a difficult task to practice broad specifications in carrying out projects, with varying results from organisation to organisation.

Examples of minimum critical specifications of a technical system with influence on the social system, are:

- *Application of information technology.* A strong degree of automation means that knowledge of the users of a technology to a high degree is built into the system, and can lead to a strong control of the users. IT which is used to support the users' actions will motivate teambuilding and an increased communication between involved actors.
- *Physical environment.* Long distances between different work processes, noise and heat may result in reduced contact between actors. Short distances enable communication and collaboration.
- *Technological differences.* Differences in technologies regarding complexity; age and type may influence the social relations in a negative direction.

3.1.1.2 Requirements of the Social System

The social system presents requirements, both on an individual and on a social basis.

A formulation of sociotechnical design is taken from Levin, Fossen & Gjersvik (1994), translated from Norwegian to English:

“A sociotechnical design implies that the human is regarded as a social individual with necessary and important relations to fellow workers, superiors and subordinates. The human being is part of a larger community. He or she has capabilities of both thinking and of carrying out manual tasks; at the same time the individual can develop itself through learning based on new experiences. The technology has to be designed in such a way, that it is only useful when utilised by human beings”, Elden et al (1986).

Physical job demands turned out to be central design criteria in the sociotechnical tradition, as formulated by Emery and Thorsrud (1976) in table 1:

• A meaningful pattern of tasks that gives to each job the sense of a single overall task
• Optimum length of work cycle
• Some scope for setting standards of quantity and quality of production and suitable feedback of knowledge about the results
• The inclusion of some of the auxiliary and preparatory tasks in the job
• The task performed in the job should entail some degree of care, skill, knowledge, or effort that is worthy of respect in the community

• The job should make some perceivable contribution to the utility of the product for the consumer
• Provision for interlocking tasks, job rotation, or physical proximity where there is a necessary interdependence of jobs, or where the individual jobs do not make an obviously perceivable contribution to the utility of the final product
• Where a number of jobs are linked together by interlocking tasks or job rotation, they should be grouped
• Provision of channels of communications so that the minimum requirements of the workers can be fed into the design of new jobs at an early stage
• Provision of channels of promotion to a supervisory rank that are sanctioned by the workers.

Table 2: Physical job demands (Emery and Thorsrud (1976))

3.1.1.3 Physiological Work Requirements

The Tavistock Institute committed itself to do practical research using the sociotechnical system design principles in the Norwegian Democracy Project in the late 1960s. Einar Thorsrud, a former manager of a Norwegian industrial company, and the Tavistock researchers Erik Trist and Fred Emery, designed this project, and the Norwegian Confederation of Employees and Trade Union Council supported it. The Democracy Project carried out a set of experiments at different kinds of industry located both in urban and rural areas, Elden (1979) & Thorsrud (1970).

The work in the Norwegian Democracy Project seems to have had a major impact on the organising of industrial work in Scandinavia. A conclusion from the project was that participative approaches were necessary in order to increase the industrial democracy. Three main concepts emerged from the work:

1. The sociotechnical thinking was building links between the technological system and the organisation. This approach became a design criterion for all interventions in the project. It was found that the technical and social systems could not work independently of each other. A joint optimisation had to take place. From this could be concluded that both the scientific management and the human relation approaches were too limited. The human relation highlighted the importance of human factors in management and that they play an important role in raising the productivity. However, human relations did not develop a theoretical set of ideas, and was absorbed by more traditional way of organising

theoretical set of ideas, and was absorbed by more traditional way of organising companies. Instead, new management ideologies or principles were developed focusing on good social relations, in order to create an effective organisation, Vanebo & Bush (1988).

2. With appropriate conditions it is possible to create semiautonomous groups – linking sociotechnical thinking with psychological work demands.
3. The individual has needs or requirements linked to the tasks that are going to be fulfilled. These were termed physiological work demands by Emery and Thorsrud (1976).

Trist (1981) has summarised the relationship between the Tayloristic thinking and the new sociotechnical paradigms, based on a focus upon individual psychological work demands and working environment. This is shown in table 3.

Old and New Paradigms of Work Organisation	
Scientific Management	Sociotechnical Design
The technological imperative	Joint optimisation
Man as an extension of the machine	Man as complementary to the machine
Man as an expendable spare part	Man as a resource to be developed
Maximum task breakdown, simple narrow skills	Optimum task grouping, multiple broad skills
External controls	Internal controls (self-regulation)
Tall organisation chart, autocratic style	Flat organisation chart, participation style
Competition, gamesmanship	Collaboration, collegiality
Alienation	Commitment
Low risk taking	Innovation

Table 3: Old and new paradigms of work organisation.

The sociotechnical system theory implies a new view of management. Instead of direct control, the focus is on co-ordinating functions and control towards agreed milestones, in order to enable the desired level of self-control within the project group.

From my position the principles behind sociotechnical design remains as valid today as they were in the 1950s. It challenges us to question in our organisations whether we have evaluated the necessary degree of joint optimisation of the social and technical systems in light of a demanding external environment. This approach forms a core understanding of mechanisms that produce improved participation and democratisation at work through joint optimisation of the technical and social systems, within the framework of an enterprise production system. These perspectives are useful in order to improve the understanding of actions performed in an actual case within a company.

3.1.1.4 The Sociotechnical Implication of the Innovation Systems.

From an innovation systems perspective there are different sociotechnical implications:

- An innovation project has to be organised in a way which enables a strong involvement and participation of people with different professional and cultural background, in order to create a joint optimisation. From the sociotechnical position the project groups should function as semi-autonomous groups, with a project management focusing on co-ordinating functions and control at agreed milestones.
- The project specifications should be created in the form of minimum critical specifications with the establishing of broad goals.

3.1.1.5 Discussion of Sociotechnical Design

- The sociotechnical theory seems to some degree to be static. This argument is based on its close connection to the systems theory. From this theory it can be drawn that organisations exist because they are satisfying functions which are important for the participative members and the organisational environment. To achieve a better knowledge in questions of involvement and participation, more dynamic approaches have to be applied.

- The sociotechnical theory is based on the idea of democratic decision-making and self-direction. It is argued that it is characterised by a functionalist approach, emphasizing harmony, cooperation and system preservation. Established sociotechnical systems can thus be regarded as conservative. In this environment conflicts are viewed as dysfunctional phenomena, Hård (1993).
- Abrahamsson (1975) argues that sociotechnical participation was connected to the production in an enterprise. This seems reasonable to me, with the background in the Tavistock projects in the English coalmines and the following documentation of this work. Today these principles can be adapted to any part of a work organisation.

3.1.2 Technological Innovations - Definitions

3.1.2.1 What Technology is

In my thesis I have divided technology into two main categories: process technology and product technology, Utterback (1994) It is a rather simple categorisation, but it draws the attention to that which most enterprises focus on. For a machine manufacturer the machine is

certainly the final product. To the user, however, the machine is part of the process technology, making this final product. To enterprises studying their own technology it becomes clear that one has to distinguish between these.

Utterback (1994) is applying the notion of process and product technology in his work on managing technological innovations. The product technology explains what kind of business an enterprise is a part of, and the process technology explains how an enterprise works to make its final product. The relation between process and product technology is illustrated in figure 7.

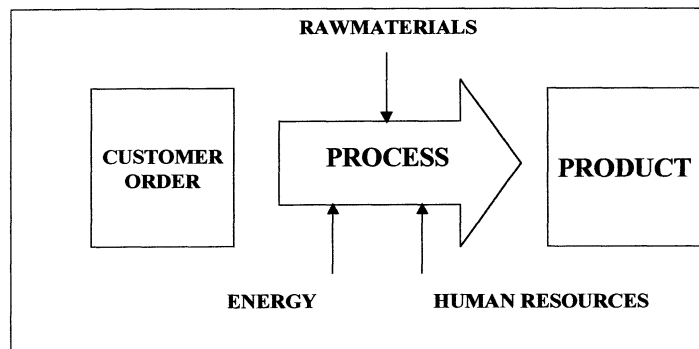
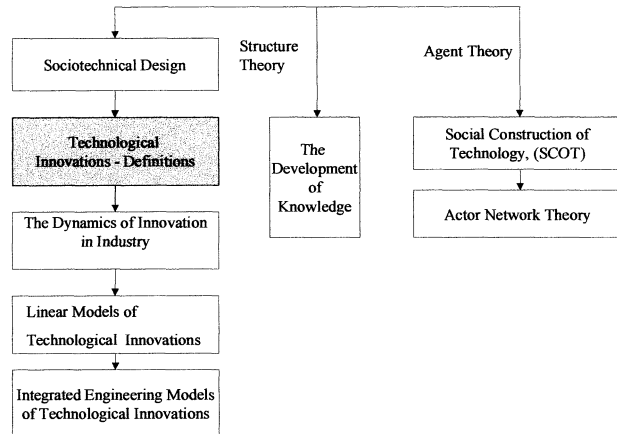


Figure 7: The Relationship between process and product technology.

3.1.2.2 Product Technology

It is the product technology that gives the product its characteristics, both visually and functionally. Within the pulp and paper industry, the product technology takes many forms, as for example refining technology, screening technology, pressing technology and coating technology. The notion of product technology also includes the service we offer to our customers in order to enable a broader customer satisfaction as regards for instance: an effective logistic system from local warehouse at the company to the production location of the customer, just-in-time delivery of products, and knowledge transfer to the customer about product, technology and processes.

3.1.2.3 Process Technology

The customer will not care about how his product is produced, as long as his quality requirements are satisfied. It is an internal affair to measure the quality of a company's process technology. Davenport & Short (1990) claim that important process objectives to be measured are: cost, time, output quality, availability of the process technology and quality of work life. Further, the environmental aspects of the production processes have become important. It seems obvious that the above factors are important to describe the operational effectiveness. A high quality and proper process technology enable a company to develop an operational effectiveness, and at the same time to produce the final product at a stable and satisfactory quality. This is illustrated in figure 8.

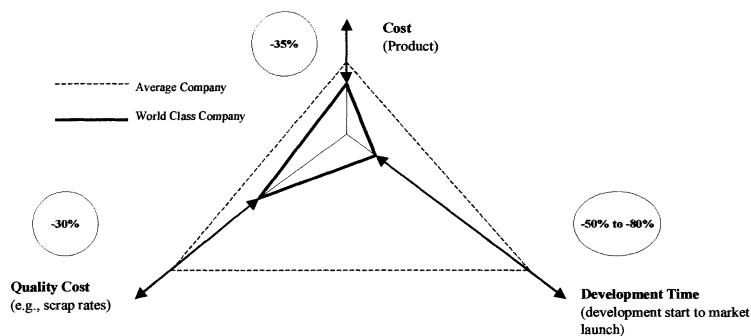


Figure 8: Successful companies do not achieve short development times at the expense of cost and quality (From Rommel, Kluge, Kempis, Diederichs & Bruck (1995))

Figure 8 shows that successful companies typically have a 35 percent manufacturing cost advantage compared to less successful performers and 30 percent lower quality costs. Product design has proved to have a great impact on cost driving complexity in manufacturing, and contributes for locking in a large part of logistics costs.

The technology is by Levin, Fossen & Gjersvik (1994) given the following definition:

1. Knowledge about the production of artefact or services,
2. Machines and tools for such a production,
3. Routines and methods applied in the artefact and service production.

Both product and process technology are closely linked to the strategic field of a company. Markides (1999) claims that a company's strategic position is its answer to the following questions:

“Who should the company target as customers?”

What products or services should the company offer the targeted customers?”

How can the company do this efficiently?”

Strategy means choice as to the three dimensions above. A company makes a competitive strategy if its chosen strategic position differs from those of its competitors, and out of the value the company is able to create for its customers.

3.1.2.4 Product and Process Technology in a Strategic Perspective

Both product and process technology are involved in the above definition of strategic position. It is critical to understand the difference between them in a company's struggle for a competitive advantage. It has to make a choice as to the type of competitive advantage it seeks to obtain and the scope within which it will achieve it

According to Porter (1998) there are two basic types of a competitive advantage a company can possess: low cost or differentiation. These lead to three generic

strategies for achieving a performance above – average: cost leadership, differentiation and focus. The generic strategies are shown in figure 9.

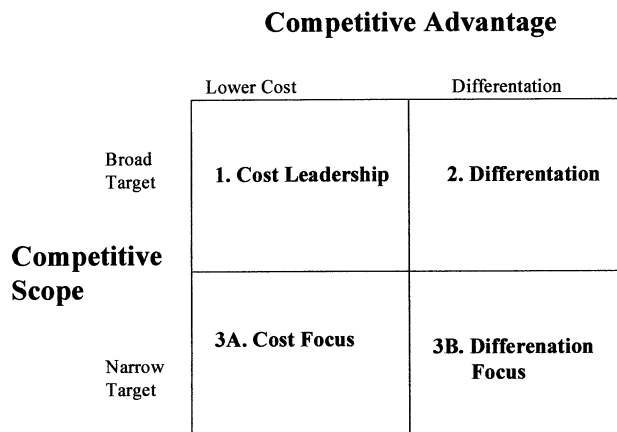


Figure 9: Three generic strategies, (Porter (1998))

Each of the three generic strategies involves fundamentally different ways to competitive advantage. The cost leadership and different strategies seek competitive advantage in broad market segments, while the focus strategies have a goal to achieve cost advantage or differentiation in a narrow segment.

Porter (1998) argues that a company has to make a choice about the type of company strategy it seeks and the scope within which it will achieve it.

3.1.2.5 What a Technological Innovation is

There is no single definition of innovation. However, in line with Grønhaug & Kaufman (1988) there is consensus in the literature that a technical innovation represents something new, and that this can be incremental or radical of character.

According to Utterback (1994) a radical technological innovation can be defined as a technological innovation that invades and finally overwhelms the existing technology during periods of discontinuity. Radical innovations create new business and destroy

existing ones. Incremental innovations take place in a product market with periods of continuity.

The following definition of technical innovation is given by Grønhaug & Kaufman (1988):

“Innovation is the successful implementation of creative ideas about products or processes within an organisation. A product or process is innovative to the extent that appropriate observers independently agree it is innovative”.

The above definition states that an innovation is a social process.

Nelson & Winter (1994) identify a technological innovation in large as new combinations of existing routines. They have given a definition of a technical innovation as:

“Implementation in an organisation of a construction of a new product or a new way of producing the product, including development of new routines in mutual cooperation between its members”.

Nelson & Winter (1994) argue that it is fruitful, in order to understand an innovation process, to look at them as part of a running business, integrated in the company's organisation and interlocked with other activities. In this context the innovation activities have to fight for limited resources in social and political processes. They further have to challenge the normal obliging chains of individual actions and the company's routines. The tension between productivity and renewal and between stability and change will exist in most organisations.

3.1.2.6 What could count as Technological Innovation in a strategic Perspective?

Drawing on the Levin, Fossen & Gjersvik's (1994) extended definition of technology, and the definitions of innovation from Grønhaug & Kaufman (1998), Nelson & Winter

(1994), and Porter (1998) a suggestion is presented in figure 10 of what could count as technical innovations in a strategic perspective.

The business idea is stating the strategic position and the main direction the company is aiming for. The business idea is normally relatively stable.

The business idea in a process industry typically includes statements as to what kind of technology the company shall be based on, and about utilization of the human resources to the best of the company.

In my thinking external signals and external conditions open up for new possibilities both within process and product technology and for change processes within the organisation. These is important input into the strategy process.

A business strategy includes statements about the competitive advantage that the company seeks, Porter (1998). In order to achieve the strategic goals, action plans are defined regarding accomplishment of change processes. Within the technological field strategic goals and action plans for changes of the actual process or product technology may be defined. Together with these, action plans for organisational development have to be included to make the technological changes take place in the organisation.

In line with Levin (1997) product and process transfer enforce learning and thereby organisational development. New ways of cooperation and interaction between members of the organisation have to be established to meet changes in the customer product requirements. I argue that this to some extent have to take place each time a new market challenge is coming up.

Feedback from the customers as to their satisfaction with the supplier's extended product concept, including everything of importance to them regarding the product, is brought in a closed loop as input to the strategy process and the existing product technology. Even the business idea may be changed with basis in feedback from the customers.

Another closed feedback loop, as to technical processes of importance to the customer, is brought as input to the strategy process and the existing process technology. The business idea may also in this case be changed due to important signals from the customer.

In a rapidly changing market these feedback loops may work very fast. A large portion of emerging strategies is coming up to satisfy the customers to try to be ahead of them.

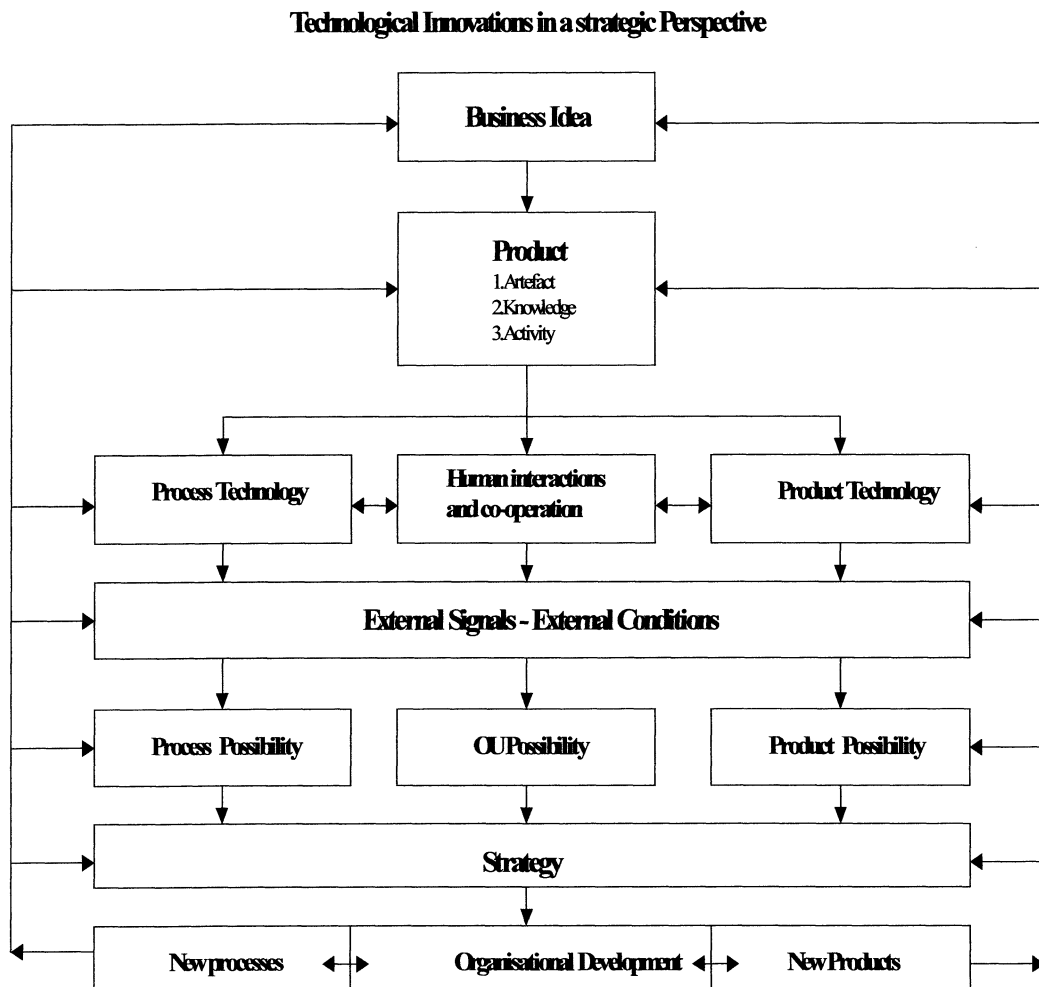


Figure 10: Technological innovations in a strategic perspective

The above suggestion of innovation in a strategic perspective implies an efficient system of knowledge transfer to the strategic process, both from internal and external sources.

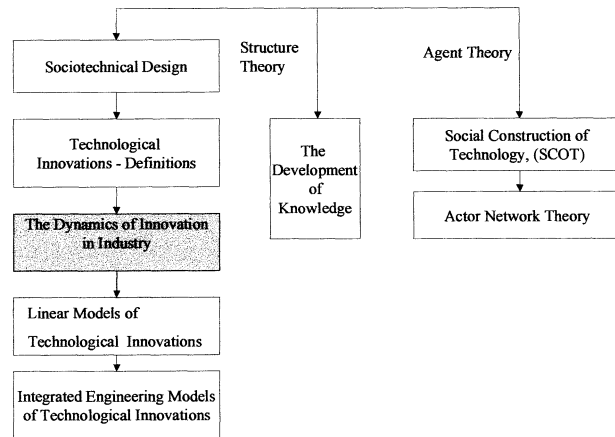
According to Cooper and Kleinschmidt (1986) a well-communicated strategy and open strategy processes, are essential to succeed in technological innovations.

3.1.2.7 Technological Innovations Implications for Innovation Systems

- An innovation can either be a radical innovation or an incremental innovation.
- The result of a product innovation is more than the technological artefact. A broader definition must be applied.
- In a strategic perspective, product / process innovations enforce organisational development, and has impact both on management and technological processes.
- Product innovations have a large impact on cost - driving complexity in production and for locking in a large portion of logistics costs.

3.1.3 The Dynamics of Technological Innovation in Industry

Utterback (1994) has developed a theoretical framework that has contributed to my understanding of the dynamics of innovation in the process industry. From this I argue that forecasting the path of technological evolution is extremely important, for allowing a company to foresee coming technological changes and thereby improve its position.



Utterback's model is shown in figure 11. The ordinate shows the rate of major innovations. The abscissa is divided into the three phases along the time axis: the fluid phase, the transitional phase and the specific phase, i.e.:

- In the fluid phase a lot of changes are taking place at once. It is very uncertain what the results will be in terms of product, process, and structure and management of the company.
- In the transitional phase the product and process innovations are starting to be closely linked. The growing rigidity of operation means that changes can be accomplished only at increasingly greater costs.
- In the specific phase the aim over time is to produce a specific product at a high level of efficiency. There is an

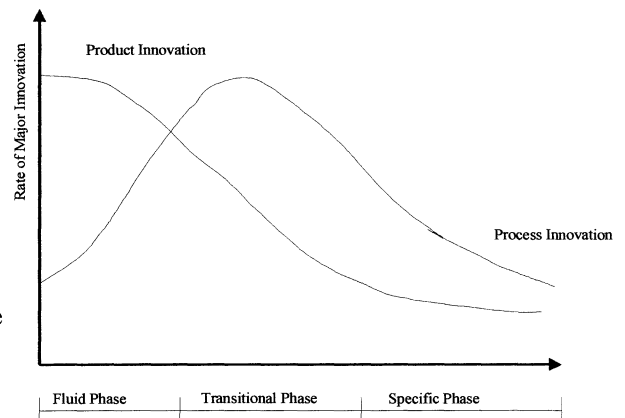


Figure 11: Dynamics of innovation (From Utterback (1994))

extremely strong link between product and process innovation. Any change in either product or process may be difficult and expensive to achieve, and requires a corresponding change in the other.

The model describes technological development and evolution in two dimensions: the development of a single product, and the evolution of an industry. Each approach will be treated separately. The model is first applied to describe the development of a specific product.

When a good product idea appears in the fluid phase of an industry, based on research, market contact, customer demands, visits to exhibitions, etc, rapid changes in product characteristics are expected. The new product technology is being challenged, as it is often crude, general and unreliable. The product development usually takes place in an environment of both uncertainty as regards to a potential market and as regards to the new product technology. In this “fluid phase” there is little focus on process technology. Custom designs and user-adapted designs are common. The conditions are chaotic. The above description is likely to fit most entrepreneurial companies starting up a business on basis of a product idea.

According to Utterback (1994) this will be the situation until a dominant design occurs. A dominant design is defined as follows:

“A dominant design in a product class is, by definition, the one that wins the allegiance of the marketplace, the one that competitors and innovators must adhere to if they hope to command significant market following”

For non-assembled products the term “enabling technology” might be substituted by “dominant design”. It could mean that a new and cost - effective method is found and gradually improved to produce an old product, for example paper. The mechanisms are in principle the same.

Once the dominant design emerges in the transitional phase, the basis of competition is radically changing. The rate of product innovations decreases. The innovations also often change character from being unpredictable and radical to be predictable and

incremental. When a dominant design is established, only a few companies are left to compete, all with a similar design. At the same time the focus changes to process innovation, in order to produce the new product at an acceptable quality in a cost efficient way. One final position may arise when either the end of the product life cycle is reached or the production costs are making the product unprofitable. A new radical process or product innovation may restart the cycle with the fluid, transitional and specific phases.

Factors other than technical play a role when a dominant design is established. According to Utterback (1994) the most important are collateral assets as:

- *Access to market channels or having a brand image*
- *Influence of industry regulation imposing a standard*
- *Strategic manoeuvring at company level. A company's product strategy in comparison to its competitors may decide which company's product design will dominate*
- *Close communication between producers and users*
- *Development of networks*

The second dimension of technological development of Utterback's (1994) is explaining the evolution of an industry. The rates of process and product innovations are interdependent over time. To make a success in continuous incremental improvements, equal emphasis on, and a close integration between product and process design are required. Linked to these, important transformations take place during the evaluation of the industry of the products and process characteristics, competition and organisation. This is illustrated in table 4.

Characteristics	From the fluid phase	To the specific phase
Product	High variety, radical innovations	Incremental innovations on standard products
Process	Manufacturing with heavy reliance on skilled labor and general-purpose equipment	Specialised equipment tended by low-skilled labour
Organisation	Entrepreneurial organic firm	Mechanistic firm with defined tasks and procedures, and few rewards for radical innovation
Market	Fragmented and unstable with diverse products and rapid feedback	Commodity-like with mostly undifferentiated products
Competition	Small firms with unique products	An oligopoly of firms with similar products

Table 4: The stages of evolution of an industry, (From Utterback (1994))

The process industry, including the enterprise in Moss, has a lot of characteristics of the specific phase, as shown in the table above, with a low rate of both product and process innovations. The Pulp & Paper industry is mature in the meaning that those fibre products are well developed and have been used more or less in the same form for a long time, and that they are not high technology. Therefore the industry is not likely to be subject to a revolutionary technological breakthrough in the manufacturing processes and the use of the products.

A special perspective of the process industry, which does not seem to be included in Utterback's (1994) theory, is the strong tendency for Greenfield process plants to jump directly into the specific phase of his innovation model. The installation costs of a new paper machine are some billion Norwegian kroner. To be competitive, the machines are normally specialised to produce only one paper quality. Further, a paper machine has to be optimised for a cost - effective production. The requirement to do innovations should be strong within this industrial sector, due to the high specialisation of new installations.

The rate of product innovation is often constrained by the existing process technology. However, a new process technology will initiate product innovation. If a dominant design is established, strong mechanisms for further incremental product innovation in the time periods between the appearances of a new process technology are established, fig 12.

It shows that a radical change in the process is likely to be followed by a radical change in the product. Until the next major change in the process takes place there is only room for incremental product changes.

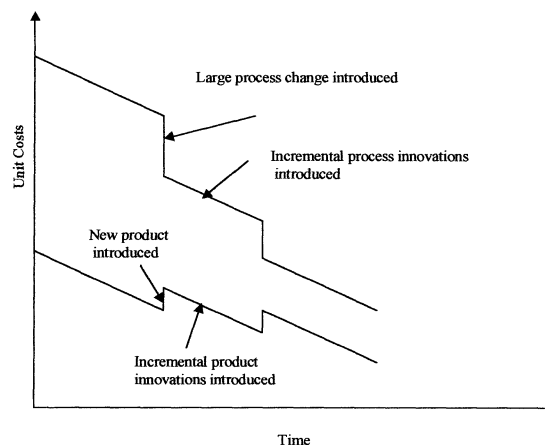


Figure 12: The strong link between process - and product innovations

It is critical for managers responsible for both technological and organisational development, and for a management responsible of operational strategies, to understand the mechanisms between evaluation of an industry and the dynamics within it. It is important to remember that, independent of the innovation rate, the mechanisms and relations between development of product and process technology are the same. In the fluid phase of a company's development, new product technology initiates process innovations. Mechanisms behind dominant design are strong forces in product innovations. For a process industry in the specific phase, product innovations are more likely to follow process innovations, as both the technology and the members of the organisation become more specialised. This becomes the end station for many companies.

Radical product innovations that enable companies to come back to the fluid phase, often comes from outsiders. According to Utterback (1994) they create new business and transform or destroy existing ones. The invading technology is often capable of delivering much better product performance or lower production costs or both. The mature industry often tries to fight back, often without luck, by trying to improve the quality of the existing product.

3.1.3.1 Mechanisms to deal with Technological Innovations within Process Industry, in the specific phase of Evolution.

Is the specific phase the end station for a company, as asked above, or are there possible ways out of this highly capitalised, highly controlled and generally not innovative mode of production? Is it only the financially strongest companies with the capability of continuously making the production process more effective that will survive? Some suggestions are put forward.

- One way of maintaining a competitive advantage for a company in the specific phase could be to continue to strongly focus on a cost - efficient manufacturing of existing products, creating a stiff manufacturing organisation with specialised knowledge only within this field. This perspective seems to

have been left out of Utterback's (1994) innovation model. The R&D work is, in line with the STEP – group (1997), (Studies of technology and innovations and economical politics), to a large extent left to be done by the external network

This type of strategy may function over a short or long time span, depending on factors like the degree of turbulence, which the individual company is experiencing in his market. Different negative consequences can be stated:

- External institutions, political and technological, can decide the premises for future operation of own enterprise, due to lack of knowledge in the product, the market and the technology.
 - The competitiveness advantage of a company can disappear. To show an example, a major machine supplier will deliver the same kind of technology to as many customers as possible
 - The total innovative potential may not be explored due to only larger steps on the technological S-curve are taken by external actors
 - Enterprises operating in turbulent markets can experience problems in adopting to changing market conditions, due to stiff and efficient production organisations. Fast changes in market demands often require flexible organisations with a capability of a quick response.
 - Enterprises which have made themselves dependent on external institutions, may face problems in putting new technology into use, due to lack of a system for receiving knowledge of new technology.
- Due to recent innovations in flexible manufacturing in Japan, the almost “natural law” about mass production is defied: that long production runs of standard products and low unit costs give the highest profitability. Japanese auto companies keep low unit costs, while producing a greater variety in smaller runs. A strategy of mass customisation seems to offer a way out of the dead end of the specific phase, Utterback (1994). This concept involves both

producing a greater variety of products in smaller runs, and the creation of unique products from standard product platforms and near customer – tailoring of products to individual specifications.

- The management's appreciation of people who have the capability to learn and to adapt to a changing and challenging environment, and who build and sustain their companies, seems to offer a way out of the dead end of the specific phase. It opens up for building special competence into the products or the production processes. It further enables the company to follow up discontinuous innovations taking place, in order to take action at an early stage.

Hamel & Prahalad (1994) claim that a fundamental approach to renewal and continuous innovation is to develop core competencies that can provide tomorrow's opportunities, as well as discover new applications from the current core competencies. According to Hamel & Prahalad (1994), there are three important criteria for establishing a sustainable competitive advantage based on core competence:

1. A significant final product benefit to the perceived customer
2. A potential access to a wide variety of markets is provided
3. A core competence which is difficult to imitate.

Core competence is the collective learning in the organisation, especially how to coordinate different production skills and integrate multiple streams of technology. It also concerns the organisation of work and the delivery of value. Prahalad & Hamel (1994) argue that it is necessary, in order to bring the core competence to the product, to ensure that technologists, engineers and marketers have a shared understanding of customer needs and of technological possibilities.

3.1.3.2 Implications of the Dynamics of Innovations on the Innovation Systems

- It is extremely important to allow a company to foresee future technological changes and thereby improve its position through accomplishment of the most promising innovations.
- To execute a successful innovation, several collateral factors play an important role
- Independent of the innovation rate, the mechanisms and relations between product and process innovations are the same within each phase of a company's technological development.
- The process industry, including the pulp and paper industry, has several characteristics of the specific phase:
 - Mostly incremental innovations
 - Product innovations are more likely to follow process innovations
 - Specialised equipment
 - Mechanistic organisation structure
 - Commodity – like products

3.1.4 Linear Models of Technological Innovations

3.1.4.1 Introduction – The present Situation regarding Modelling of technical Systems

I have chosen to illustrate the present situation today in Europe as regards modelling of technical systems by a typical school or theoretical basis, the WDK school. The theory of technical systems, written by Hubka and Eder (1984), is an important contribution within WDK.

WDK means Workshop – Design –

Construction. It is an informal

international society for the science of

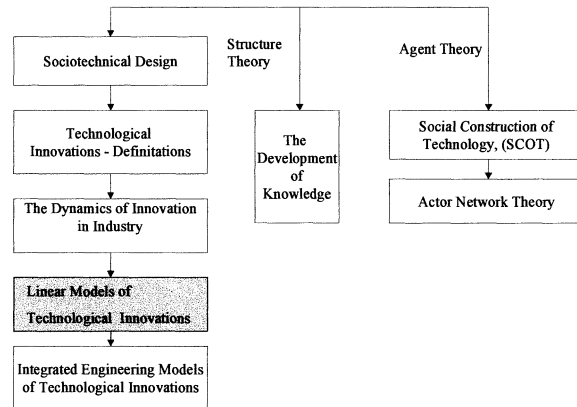
engineering design based on a common interest in the subject. The WDK has

established a basis and a frame of reference within design science, through arranging

workshops and a series of WDK publications. The illustration of the present situation

regarding modelling of technical systems and theoretical approach in this chapter is

based on this design theory.



According to Buur & Andreasen (1989), a model is a reproduction of properties of an object to be brought into being or the analysis of an already existing object. It is normally based on a theory, and on either implicit or explicit knowledge. Buur & Andreasen (1989) argue that experimental investigation utilising a model can be done in less time and at less cost than through direct manipulation of the object itself. This is particularly true when it is not possible to manipulate reality through the model, or when manipulations are costly and disruptive, as with complex industrial systems. Buur & Andreasen (1989) claim that the design process is propagation from model to model. The designer is utilising a large number of models for a mechanical design, which is reproducing the product. Each model has a set of properties in common with the object. The variations between the models are due to the different properties they

reproduce, the degree of abstraction, the number of technical details in the models, etc. Figure 13 from Buur & Andreasen (1989) illustrates the relation between object and model, as seen from a mechanical design approach.

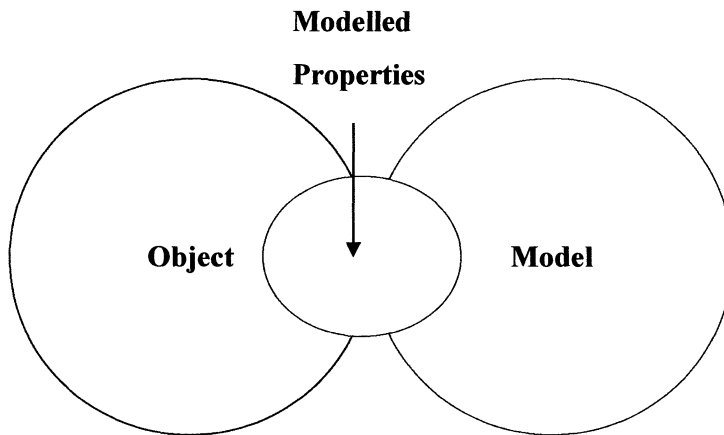


Figure 13: The relation between object and model

It was not before the mid 60's the development of modern design methodology gathered headway towards the creation of design models. The first models were strongly technologically oriented. At the mid 70's the human perspective began to be included, Hubka (1976) mainly through the systematic development of the Design Methodology for mechanical equipment.

The aim of development of a Design Methodology was to increase the efficiency of the design process, to do the design more transparent and to make it easier to learn the design activity. One reason behind the intensifying of the development of the Design Methodology seems to be that the industry began to realise that a high and stable product quality was important in some markets at the first entrance into the markets.

3.1.4.2 Hubka's Model

According to Hubka (1988) a mechanical design can be viewed as activities within and between four domains:

- A system of processes or transformations, which correspond to the technology where the product is a part
- A system of functions, which give the effects needed for the process
- A system of organs, which create the necessary effects
- A system of machine parts, which constitute the machine or the product.

Figure 14 illustrates design as activities within the four domains presented above. A linear thinking model is applied in the gradually decomposing towards a higher degree of detailing.

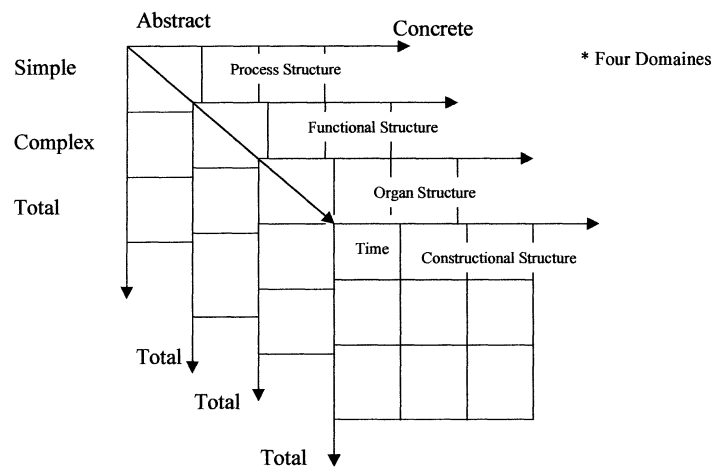


Figure 14: Design activities within four domains, (Hubka & Eder (1984))

According to Andreasen (1991) important assumptions regarding the design process are that it can be decomposed into sub-steps, that principles of variation and combination can be applied, and that a selection of the best solution can be done, based on appropriate criteria established before up-start of the design task. I argue that neither a straight decomposing of a system nor making specific definitions of design criteria upstream the design process are possible with complex systems.

A weak element is the “human activity” during the design process, which is poorly reflected. The interaction between technical and social processes taking place in the development of new products or processes is not included in the theory.

There are not any interested actors in the model, which must be regarded to be a conflict-free model.

Hubka's (1984) model can be understood as a model of the Transformation System through the four domains, a process structure, a functional structure, an organ structure and a construction structure, with level of increased detailing and concretising. Figure 15 shows a general model of a transformation system.

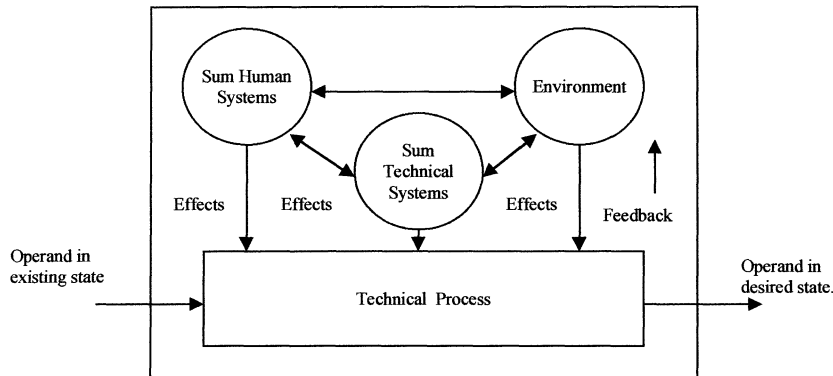


Figure 15: A general model of transformation systems, (From Hubka & Eder (1984))

The operand can belong to one or more of the following classes: biological material, non-biological material, energy and information. The technical process can for example be machining of a work piece.

The sum of elements and influences, and the relations between them that participate in the transformation is called a transformation system. The model is according to Hubka (1984) built on the following premises:

“The necessary transformation of operands is achieved by applying specific effects which may be classified into material, energy and information types. These three types of effects are delivered to any transformation from the following sources: a set of humans, a set of technical systems, a set of information systems, a set of management a set of goal systems, and the active environment”.

of humans, a set of technical systems, a set of information systems, a set of management a set of goal systems, and the active environment”.

The active environment comprises effects exerted by the environment, and which are linked to the elements of transformation.

The industry has generally shown little interest in utilising results from research within the field of Design Methodology, as Hubka's (1984) model for design of mechanical products, Andreasen (1991). Pragmatic methods based on the linear thinking and accidental approaches that in a historical perspective have been dominating, are even today widespread and of great significance. Hubka's (1984) model with his strong engagement within the WDK, indicates that the development of a design theory of technical systems does not seem to have come as regards an integration of social and technical systems in the modelling of technical processes, and that it is based on a linear model of thinking of technological development.

For development of mechanical products, the model developed by Hubka (1988) represents a useful guidance for the designer of an artefact.

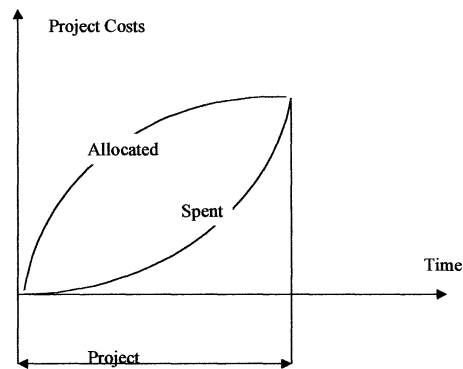
It is especially useful in cases when a system can be decomposed into subsystems and elements without making any large mistakes. It does not seem to deal that well with complex systems with non-linear relationships.

The theoretical approach can be utilised in design technical systems within other technical field than within mechanical engineering.

In designing complex technical systems, requiring a strong involvement from the social system, Hubka's (1984) model suffers from several drawbacks. One of the main drawbacks of the model is the lack of integration between the technical and social systems, as discussed above. In my opinion, another drawback is the lack of proper risk assessment and evaluation of critical functions in design work.

3.1.4.3 Uncertainty and Risk in Innovation Processes

According to Andreasen & Hein (1987), the main part of the project costs is allocated in the early phases of the innovation process, when usually few resources are spent on the project. At this stage there is normally a high degree of uncertainty. Figure 16 illustrates the high rate project costs allocated at the early phases of an innovation project,



compared to very low rate of money spent. **Figure 16: The connection between allocated and spent costs, (From Andreasen & Hein (1986))**

This means that the early activities taking place during the concept work of an innovation project should be carefully planned and accomplished, in order to avoid budget overrun. This may be difficult to handle when a project is run according to a linear innovation model approach, due to poor coordination and integration of the innovation activities.

In the next chapter, discussions of the linear models and their implications to innovation systems are given on a more general basis.

3.1.4.4 Linear Models of Technological Innovations

A rigorous and categorised linear model of innovation is roughly describing the innovation process as a sequence of separate stages, with minor transitions to make adjustments between stages. A traditional position on innovation is that technology development starts from basic research, via applied research, through engineering design and ending up with a process of development and implementation at the company level. A general linear model of innovation with a linear scientific track is shown in figure 17.

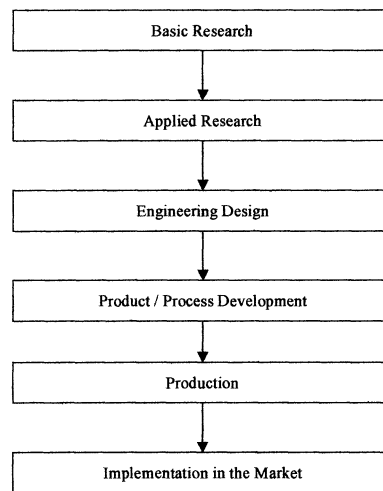


Figure 17: A general linear model of innovation (From Pinch & Bijker (1989))

According to the linear model thinking the project is clearly defined and controlled before the project up-start, and the project progress is controlled against previously established milestones . The development work takes place only in one direction. Feedback loops to make corrections between milestones are only to small degree parts of the model.

The application of the linear model thinking in technological development often mirrors a hierarchical working pattern within an organisation. The different tasks in the innovation process are passed from department to department according to a pre-designed pattern without an extensive cooperation between them.

This model is challenged. Rosenberg (1991) argues that the linear model is both naïve and simplistic to the extreme. The relation between science and technology interface is usually complex, with a two – way traffic across the interface. Who is the scientist and who is the technologist is to a great extent depending upon the circumstances. It can often be seen that the need for basic research comes from the technology development. Scientific results, which may be quite old, are also often seen to be

utilised in technology development. Scientific teams from many disciplines often cooperate in achieving new scientific results. It may seem to be accidental whom in the team wins most honour and prestige. This can clearly be seen when it comes to who is awarded the Nobel Prize. It can thus be concluded that the science and technological development does not follow a linear track.

Galbraith (1982) has presented two main variations of the linear, sequential model of the technology driven and the market pull models in fig 18:

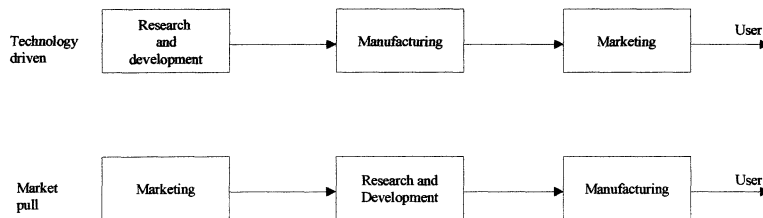


Figure 18: Linear technological driven -- and market pull models

According to the technology driven model the ideas are produced in the technical department, sent to the R&D department and manufacturing for design and production of the innovation, and then to the marketing for sales and distribution. The company does not really know if the market wants the innovation before it is produced, because no market contact has been established early in the project. Following this model, it is not unusual that a product is developed which is not accepted in the market. The human and financial resources needed may be miscalculated, when the R&D and the implementation of a new process of technology are viewed as separate sequential activities, because of lack of knowledge in either discipline. Time and resources may be wasted, with a low goal fulfilment as the result.

When the innovation is done according to a technology driven model, the whole innovation process often is managed from the manufacturing department. Since this department controls the production machinery, the whole R&D phase may be left out and replaced by large-scale trial and error efforts run directly on the production machinery. The larger machines are normally less flexible for utilising for testing

purposes. This means that an important possibility of finding solutions may be left out.

When the main focus is on utilising the technical potential of a machine, applying mostly resources from the manufacturing department, it can often be seen that problem solving according to this model is done as a part of the department's normal work, and not solved in the framework of a project.

Technology driven innovation models were more or less the only innovation models applied until the 1980s, when there was a general need for all kinds of products, with a relatively low focus on product quality. However, this model is also extensively used today, when companies are searching for proper production of new products on existing machines with a minimum of required investments.

According to the market pull model the ideas are generated in interaction with the market, sent to the R&D department for further development, and then the engineering and manufacturing departments for production. The main focus in the early phase of the project is to satisfy the need for a new product in the market, in which the customer asks for quality. To find a proper technology to manufacture the product is a secondary question. This model seems to be attractive to companies, which are facing a heavy competition in a turbulent market.

It may seem that users of the linear innovation models think that they in this way are reducing the risk and complexity of the innovation project. This seems to be a wrong conclusion. The complexity is present, but not taken into account.

Successful utilization of the linear model is reported from technology projects with a low degree of new technology, as well as a low demand for new knowledge in the project.

3.1.4.5 Discussion Linear Innovation Models

- Because they are simple, linear models are much in use in the industry to make innovation projects. One reason for their popularity may be that many quality systems in use define innovation procedures based on linear thinking. The innovation effort may turn out to be a systematic exercise in order to fulfil the requirements of a design procedure, instead of a creative and flexible innovation process.
- Because of lack of a holistic perspective, one department may initiate and push the project, with improper coordination of other tasks as a possible result. That could for example be the marketing/sales department. The sale of the product is started before the product is designed and produced. It may turn out that it is not possible to produce the product within the required quality specifications from the market. This is illustrated in figure 19.

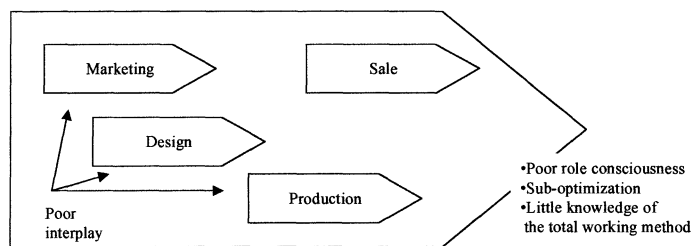


Figure 19 : An unfortunate sequence of activities (From Andreasen & Hein, (1986))

- The project members' lack of a holistic perspective with knowledge in his or her function in the project may strongly reduce the motivation and will to participate, Van De Ven (1986).
- In line with Andreasen & Hein (1986) linear models do not give any knowledge about the necessary technical and social processes inside the project for creating successful innovations, like the required internal and external working environment, the required knowledge system, and the institutional framework, which the project is a part of. The linear innovation models must thus be regarded to be macro models.

3.1.4.6 Linear Model Implication on Innovation Systems

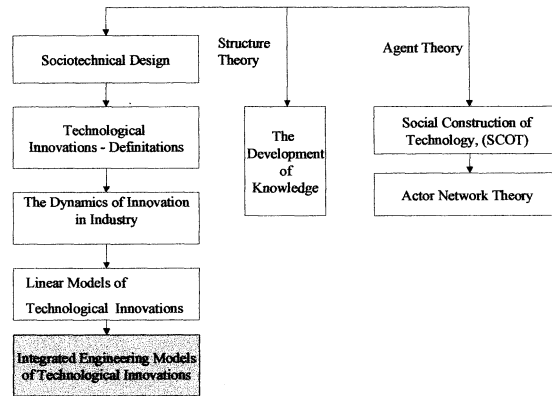
Applying of linear models in project systems can according to Hein & Andreasen (1986) can result in:

- Increased innovation time due to improper co-ordination and poor integration, and minor transitions to make adjustments between stages, because of a sequential accomplishment of the project.
- Decreased success rate due to a high risk throughout the project, and too little knowledge within the project, partly because of lack of a holistic project perspective.
- Not using sufficient resources in the early project phases, due to a lack of understanding that 70 – 80 percent of the total project costs are allocated here, and increased possibility for choice of conceptual solutions with unknown cost structures in early phase of the project.

3.1.5 Integrated Engineering Models of Technological Innovations

3.1.5.1 Introduction

In line with Jakobsen (1995) there was a change of paradigm around 1990 regarding how to do innovation projects. The focus was turned towards more integrated approaches of performing innovation activities, named simultaneously engineering, concurrent engineering and integrated product development. The terms simultaneously and concurrent engineering are often used synonymously, Sheer (1994). The new paradigm signalled a need for a more structured approach and a new way of organising innovation projects, with focus on increased quality and reduced costs and development time. The focus was on combining knowledge and competence across functional and hierarchical boundaries.



The new paradigms of innovation models signals represent a large step forward compared to earlier sequential and linear approaches. They surely reflect more flexible and effective ways of doing innovation projects. A short description is given of the two integrating approaches mentioned above: simultaneous engineering and integrated product development.

3.1.5.2 Simultaneous Engineering

This method of design focuses on reducing the development time though performing activities in parallel that have traditionally been done sequentially, Sheer (1994). Today the method includes all activities involved in the development process. The ultimate goal of the design method is to shorten innovation cycles, and represent a strategy for achieving the most simultaneously possible coordinated interaction between actors with influence on the innovation process. The application of CAD/CAM systems is according to this approach essential for storage and handling of

models and data and for human communication, giving support to integrated information systems. It attempts to adopt specific simulation techniques to ensure that the design is optimised from every aspect, like manufacture, maintenance, servicing, recycling and finally, human communication.

In the Norwegian ship - building industry simultaneous engineering is currently being implemented as the way of working.

3.1.5.3 Integrated Product Development

Integrated product development structures the product development process, and forms a systematic framework for integrating methods. Andreasen & Hein (1986) define integrated product development as a process where many parallel activities are running at the same time, with the product development process divided into defined phases. They look at product development as an interplay between a market, a product and a manufacturing system. All three elements have to be present and shall constitute an optimal unit.

According to Rommel, Kluge, Kempis, Diederichs & Bruck (1995) the focus is on concentrated application of competence through combining knowledge and skills across functional and hierarchical boundaries, demanding partner - like interactions both internally and externally, working in multifunctional teams in projects based on consensus, characterised by an open communication and information structure. They argue that a company can achieve quantum leap improvements by "easy-to-design" through a concentrated application of competence. It is argued that involved actors must behave as they were stakeholders or owners in their own businesses.

The above approach calls, according to Rommel et. al (1995), for a strong focus on customer wishes, clarification of technology and realistic planning upstream the main project, based on a clear and accepted project goal. Further, strategic involvement of suppliers and customers must take place across the entire development process. The

internally interfaces have to be drastically reduced and integration increased. Finally, powerful and effective tools have to be applied to support the quantum leap in performance. To secure a successful evolution towards more integration of the product development activities, Rommel et.al (1995) argue that action plans for changing the company's culture have to be included in the strategy plan. This is illustrated in figure 20.

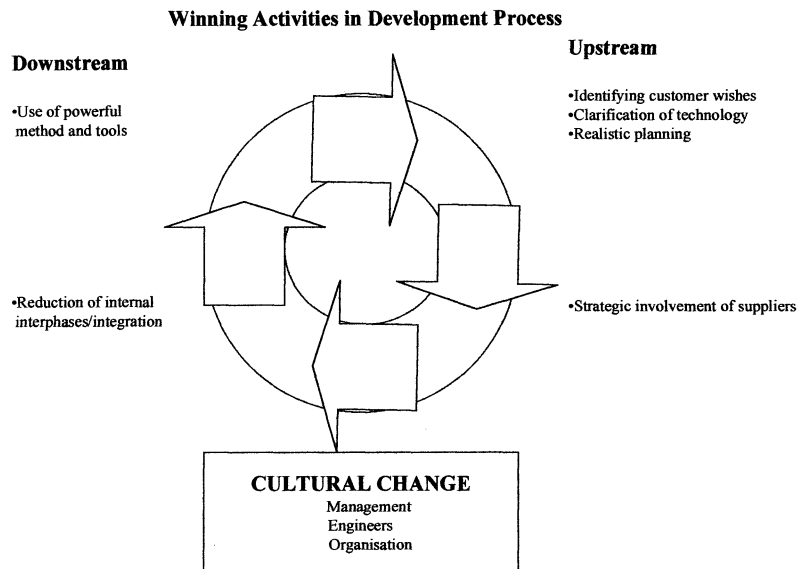


Figure 20: Winning activities in development process

Rommel et.al (1995) argue that simplification and breakdown of interfaces are done through an integration of suppliers, customers and internal functions into the product development teams. Evaluation of progress, using the principle of milestones between each main step of the development, including all necessary knowledge to take the best possible decisions, secure shorter feedback loops of potentially less waste of resources.

Kolltveit & Reve (1998) have discussed the organisational consequences of the innovation process. They argue that mechanistic and organic organisational types can be regarded as end points along a continuous line. The organic organisation type

could be stimulating for the important creative phases in integrated product development, while the mechanistic organisation type could be suitable in the implementation phase of the innovation project, where high productivity is given priority. Kolltveit & Reve (1998) emphasise that the organisational form of an innovation ideally ought to be changed during the project accomplishment.

A proper organisation of the creative phases of the project seems to be extremely important. As Stevens, Burley & Divine (1999) argue, recent studies have shown that a significant difference between successful products and unsuccessful products is caused by the quality of the execution of the first few creative stages of an integrated product development process. They claim that the first few steps of the game seem to decide the outcome.

Cooper (1988), Cooper (1993) & Stevens, Burley & Divine (1999) further suggest that this means one can only get things only half right by placing creative people in product development roles without letting them work within the framework of an excellent product development model, to boost productivity and speed of the product development process. Without the required training and coaching in effective product development processes and methods, the behaviour of creative people would likely lead to destroying value instead of creating it. However, the emphasis is on an excellent innovation model, which covers all project phases including the project evaluation.

It is claimed that research results have shown that when the human success factors are included with the best existing product development thinking, the productivity and speed can be improved by an order of magnitude shown by the way in which linear product development systems are typically done today.

3.1.5.4 Vertical Integration

The integrated model of product development couples development strategy with corporate strategy through vertical integration, securing a strong commitment from the top management. Rommel et.al (1995) claim that this is achieved through

integrated innovation teams, including representatives from all relevant functions and divisions, contributing experience, ideas and solutions as equal partners. A broad openness about the strategy is a must.

Andreasen, Hein, Kirkegård & Sant (1989) argue that a continuous goal and plan structure has to be created, to establish a vertical connection between the business ideas, the strategy plan and short term plans. This is illustrated in the figure 21, showing a goal/action plan breakdown from 5 years strategy plans down to operating plans.



Figure 21: A vertical continuity in R&D activities, (from Andreasen, Hein, and Kirkegård & Sant (1989).

3.1.5.5 The tactics of Small-Step Innovations

In integrated product development projects, successful German companies often practice, according to Rommel et. al (1995) the tactic of “small step” innovation commanding a premier price for the customer. Doing small step-innovations with an integrating approach is reducing the risk of the company and the strain on the development teams, because the development process will be building on past experience and optimising on existing equipment and all relevant and accessible knowledge. The latest technology may be kept to the next generation product development. The above seems especially to be the case within process industry, with

highly specialised and expensive production equipment. To secure the optimum product/process/market fit optimally within the existing technical framework, the internal development procedures can generally be kept simpler, creating short feedback loops.

Rommel et. al (1995) further argue that companies using this tactic will have the better product on the market in the long run, because of a faster increase of a product value added / applied resources than companies that go for big new developments and improvements in long intervals. Development in small steps allows for a better exploration of the potential technical progress. This is illustrated in figure 22.

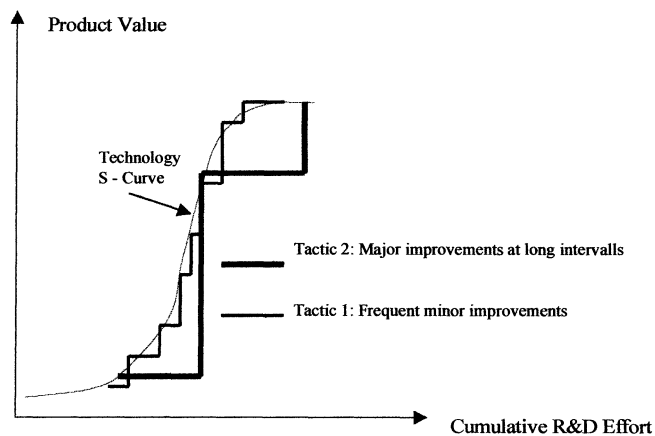


Figure 22: Tactics along Technology S-Curves, (from Rommel et. al, (1995))

The figure above shows that the tactic of doing small innovation steps allows a better exploration of the technological S-curve, than when major innovation steps are chosen. The technological S-curve is a graphical presentation of the product value versus cumulative R&D efforts. The start of the S-Curve is representing the start of the product life cycle. The curve is fairly flat, indicating what is normal, that little added value is achieved even with the application of large R&D efforts. After some time a way out on the product life cycle curve has been reached. The S-curve is steep, indicating large increases in product value with little extra R&D efforts applied. At

the end of the product life cycle, the S-curve is flattening out, indication that no more product value can be achieved, even with large R&D efforts applied.

A condition for success with the tactics of small - step innovation is a thorough knowledge of the different life cycles of key product components. The time span of each minor improvement must obviously be less than the life cycles of the most important of these.

3.1.5.6 The Integrated Engineering Model Implications to Innovation Systems

The integrated engineering models have several implications to innovation systems, Andreasen et.al (1989), Rommel, Kluge, Kempis, Diederichs & Bruck (1995)

- Lower manufacturing cost, due to an improved design for manufacture
- Shorter development time due to better integration of development activities
- Less mistakes during the development process, due to improved specifications and effective means to minimize risks.
- Reduced development costs, due to better integration and shorter development time
- Improved product quality, due to an integrated design
- Applying of more resources early in the project, due to recognition that 70 – 80 percent of the product costs are disposed in earlier phases.
- Coupling of development strategy and corporate strategy, due to an integration of goals and action plans at different levels of the organisation
- Small - step innovations allowing a better exploration of the technological S-Curve at reduced risk and need for investments.

3.1.5.7 Discussion Integrated Engineering Models

- The integrated innovation models can roughly be divided into two groups: simultaneous engineering and integrated product development. Both of them open up for accomplishment of parallel and integrated activities.
- Within simultaneous engineering, IT is an important tool for managing the desired integration, with little room for human reflection, due to a pre-designed communication structure
- The existing simultaneous engineering and integrated product development are both conflict - free models without conscious actors. The social processes are not much focused upon.

3.1.5.7 Conclusion

Kolltveit & Reve (1998) claim that a project organisation is established to accomplish tasks, which have the following characteristics:

- A specific goal
- Low frequency
- Limited time and resources

They argue that mechanistic and organic organisation types can be regarded during an innovation project as end points along a continuous line. It is emphasised that the organisational form ideally ought to be changed during the project accomplishment. The organic type could be stimulating during the creative phases of the innovation, while the mechanistic organisation type could be more suitable in the implementation phase, where high productivity is given priority.

The project is viewed as a system. In line with Bertalanaffy (1998) and Kolltveit & Reve (1998) a project organisation can be characterised from a combined systems

approach of the three systems perspectives: formal systems, natural systems and formal systems.

Trist & Bamforth (1951) concluded, as a result of their famous study of the coalmining in England, that the technological subsystem in an organisation ought to be joint optimised together with the human requirements from the social system. Based on experience from the Norwegian Democracy Project in the late 1960s, it was concluded that participative approaches were necessary for succeeding in building links between the technological system and the organisation.

The sociotechnical system theory involves a new form of management thinking. Instead of direct control, the focus is on coordinating functions and control towards agreed limits, in order to enable the desired level of self-control among involved actors in a project. Emery (1974) further suggests that the principle of minimum critical specifications should be applied, making it possible to enable to more freely design of the technical / social interface and to open up for learning.

Innovation projects can be carried out according to different innovation models. In the theory the following two types of models are discussed:

- The linear model of technological innovation
- Integrated engineering models of technological innovation
 - Simultaneous engineering
 - Integrated product development.

The linear innovation model involved a traditional position on innovation. According to this view the technological development follows a linear track from basic research via applied research, through engineering design and is ending up with a process of technical development and implementation of the new technology, Pinch & Bijker (1989).

The integrated models reflect that innovations are complex. The sources of knowledge may be many, and the sequence of the development course may vary. Rommel et.al

(1995) argue that in integrated product development the focus is on concentrated application of competence through combining knowledge and skills across functional and hierarchical boundaries in multifunctional teams characterised by an open communication and information structure.

Stevens, Burley & Divine (1999) emphasise that an excellent total innovation model is an important success criterion in the execution of a product innovation project. It is further argued that a proper organisation of the creative phases seems to be extremely important to boost productivity and speed of the product development process.

Rommel et.al (1995) & Andreasen et.al (1989) emphasise that the integrated model of product development couples, through vertical integration, development strategy with corporate strategy. This is achieved through integrated innovation teams, including representatives from all relevant functions and organisational levels, sharing experience, ideas and solutions as equal partners. To succeed, openness about all involved processes, including the strategy process, is essential.

3.1.6 Questions to be included in the Analysis of the Projects

Based on the conclusion of sociotechnical design and structure theory, the following questions in table 5 are chosen as the construction of analytical position within this part of the theory. A reference chain to the earlier sections is created.

Questions from the structure theory to be applied in the analysis of the empirical material.

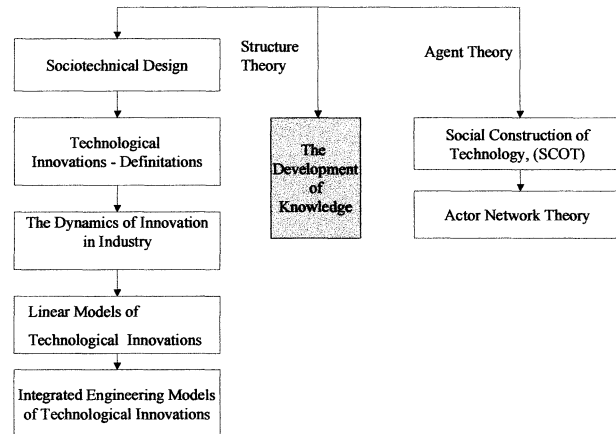
- **Project Organising**
- Did the project organising include the following elements:
 - Steering group?
 - Project group?
 - Reference group?
 - Co-operation with external users/suppliers/research institutes?
 - An innovation model utilised?
- **Systems Approach**
- Was the following elements included:
 - Pre -study?
 - Pre-project?
 - Proper economical calculations done?
- **Project follow-up**
- Was the following elements included?
 - A project plan?
 - Goal formulation?
 - Clear?
 - Broad?
 - Detailed?
 - Long-term/short-term?
 - Specification?
 - Broad?
 - Detailed?
 - Long-term/short-term?
- **Vertical anchoring of project**
- **Strategy**
 - Was the strategy known in the organisation?
 - Was the strategy used as a working tool in the organisation?
 - Did the employees partipitate in the strategic process?
 - Were the overall strategic goals systematically made operational in the organisation
- **Management Commitment**
 - Was the management committed in the project?
- **Communication/Information structure**
 - Vertical communication?
 - Horizontal communication?
 - Informal communication?
 - Information about the project in the organisation?
- **Involvement**
 - Degree of employee involvement?
- **Termination of project**
 - Terminated before results had been implemented?
 - Terminated before project goal had been achieved?
- **Project evaluation**
 - Was any project evaluation done after finish of the project?

Table 5: Construction of my analytical position within the structure theory, formulated as questions to be applied in the analysis of five projects

3.2 The Development of new Knowledge

3.2.1 Introduction

In line with the definition of an innovation in this thesis, creating an innovation may be considered as production of new knowledge, and is from my point of view the main fuel in the innovation process. This argument is based on the understanding of the characteristics of these processes as creating something new.



In the theory of knowledge creation the processes of creativity and motivation are included. From my position these are strongly interrelated processes. I discuss processes, models and mechanisms, which benefit development of new knowledge and learning.

I regard it important to understand that these processes can never be directly controlled, but can only be influenced in preparation of suitable conditions for knowledge creation.

3.2.2 Knowledge Creation - A Process of Uncertainty Reduction

Certain degrees of uncertainty and risk may be involved at the start of an innovation, especially at a radical innovation. I really see knowledge creation taking place through an innovation as a process of reducing uncertainty through learning.

Before up-start of a project, the following division different types of questions should be raised: why is this a problem, what is the problem and how is this problem going to be solved?

Sometimes an innovation project is started trying to solve the wrong problem, and sometimes the project should not have been started at all. Unfortunately it can often be seen that the project team is jumping to the main project without any pre-study or pre-project. A system evaluation is not done to see if this is a business for the company or not, or to evaluate the core problem to be solved.

It can often be seen that decisions on how to solve a problem are taken at an early stage of a project or even upstream a project. In a typical engineer way of working, it seems like an unrealistic attempt at removing the uncertainty at an early stage. As soon as an actor has established a Gant diagram with activities and milestones, he believes that the uncertainty of the project has gone. This is often due to a wrong use of the systems theory, decomposing a given problem without caution. When a problem is decomposed, you are really decomposing a selected solution. Accordingly, some capacity of solving the problems is lost. Another consequence may be waste of valuable resources and time.

Ryle (1949) is applying a term “knowing how and knowing that”. He argues that how to know that implies that intelligent performance involves the observance of rules or the applications of criteria. The actor must first go through the internal process as to what has to be done, only then he can execute his performance in accordance with those dictates. A chess player must for example run over in his head all the relevant and tactical maxims of the game, before he can make correct and skilful moves. Ryle argues that we are learning how by practice, taught by criticism and example, but often unaided by any lesson in the theory. Our knowledge how is exercised primarily in the moves we make, and in the moves we avoid.

If you connect the above theory of Ryle (1949) to the innovation systems, it means that a condition for making a decision on how to solve different problems at an early stage of a project would be to involve the necessary tacit knowledge in the project. Further, the specifications have to be made broad to open up for learning during the project.

3.2.3 Integrated Knowledge Creation

I take the position that the knowledge produced to solve problems in innovation projects is context oriented, and is dependent on creative activity and learning. I strongly believe, in line with Gibbons (1994) that knowledge creation in innovation projects has to take place in an integrated manner, and that the production has to be both of a heterogeneous and dynamic character, and is a result of participant - based negotiation processes.

Gibbons (1994) is defining two modes of knowledge creation. The first, which he calls **Mode 1**, is to me the creation of scientific knowledge, which takes place mainly at the university. Gibbons (1994) has characterised Mode 1 knowledge creation by a disciplinary orientation, homogeneity, hierarchical production, and communication of the results through institutional channels. Quality control is based on peer review of specialists. The other form of knowledge creation, which Gibbons (1994) has called **Mode 2**, take place in an interdisciplinary, social and economical context of application. Mode 2 knowledge creation is characterised by a heterogeneous, dynamic and context orientation, and communication of the results to participating actors, and finally implemented as a part of the organisation's knowledge base. The quality control of Mode 2 knowledge creation is context and use – dependent, and is often defined in terms of the contribution the work has made to solve the overall problem. Success is defined differently in Mode 2 than in Mode 1. It includes criteria additional to the traditional ones of scientific excellence, such as efficiency and usefulness.

In line with Gibbons (1994), innovation projects are to a high degree problem oriented. Efficiency and flexibility during the problem-solving are important factors, in order to achieve the established goals within a given framework of use of resources and time.

With basis in the above discussion, I will argue that it is of little value for most innovation projects to define detailed long-term goals. However, in Norway requirements to define long-term goals with a detailed specification for the whole

project duration can especially be seen in projects financing by external institutions and organisations. The main task in these projects might be to adapt to the specified project plan instead of developing optimised innovation results.

The integrated form of accomplishment of innovation projects discussed above is an example of action research. This is a form of research which aims, through the whole innovation process, at developing theories within the actual coherent context, and thereafter testing these in practice. Action research is a cogenerative social process, where knowledge creation in innovation projects is performed in collectively learning processes, and takes place in an integrated interplay between involved actors. I shall argue that managing broad involvement and participation among actors represents the key challenge for achieving successful results in innovation projects, as a way to mobilise the knowledge of each involved actor. I further take the position, in line with Elden and Levin (1991) that to run an innovation project as action research should be a way of empowering participants, demanding a change in the power relations in the project organisation towards more power equality among involved actors and towards a more democratic dialogue. In this way the problem owners may not simply be sources of data and consulted in each phase of the innovation process, but participating as co-creators.

From my experience the practitioners, who mostly are the problem owners, most often open up and bring in their knowledge into the discussion when:

- They are seriously listened to
- The facilitators/project leaders are approaching the practitioners with a humble attitude
- The discussions take place in an atmosphere of mutual respect.
- The practitioners see that the practical results are in line with what has been agreed on in discussions in the projects.

One mechanism behind collective learning is, as discussed above, communication according to democratic principles, because it identifies actions of meaning to the actor practising it. According to Adler & Winograd (1991), it is the project leader's

responsibility to create a common meaningful language for all participants. This might represent a serious problem when actors with different backgrounds and cultures meet. Actors may get the roles as hostages because of lack of a proper arena of communication. Another mechanism of collective learning is to make involved actors more professional in communication and working in teams.

The integrated approach discussed above challenges the orthodox, linear thinking model, discussed earlier in the theory. This thinking is based on a sequence of separate stages, which roughly speaking follows the same hierarchical pattern of functional division in an organisation. According to the linear thinking, it is a requirement that a clear project definition is established before project up-start. Further the progress of the project shall be controlled against milestones established at the start of the project.

3.2.4 Putting the integrated Team to Work

Lembke and Wilson (1998) argue that introducing teamwork and integrated activities into an organisation is a complex process. Interactive processes involved that are often difficult to control. Research has often focused on how to manage teams without describing what teamwork really is. The emotional and cognitive processes involved with teamwork are often forgotten. For management of teams, a theory about the psychological process involved in teamwork is necessary.

Lembke and Wilson (1998) have identified social identity theory as a compelling model for understanding teamwork in organisations. This theory describes a dynamic social contextual process as to how team members are processing information and are motivated to work in teams. Lembke and Wilson (1998) argue that in order to identify with a work team, the individual must desire membership in the team and what it involves

The social identity theory addresses the team as a unit, a collection of individuals who classify, define and evaluate themselves in terms of a common social membership, and a change in attitude and thinking style.

Lembke and Wilson (1998) argue that a cognitive change and an emotional investment need to be part of the unification process, to stop individuals from following their personal motives and agendas, and to truly unify team behaviour.

The process of adopting a social identity, becoming a team member, requires that the individuals are made conscious of their social category, and to assure that they could fit into this category. This argument is based on the assumption that individuals feel that they can make a valuable contribution to the purpose of the team if the chosen category is matching their personality. Lembke and Wilson (1998) argue that only one identity can be dominant at one time, because the identity determines how information is interpreted and responded to.

The psychology of identification with a work team is illustrated in the figure 23.

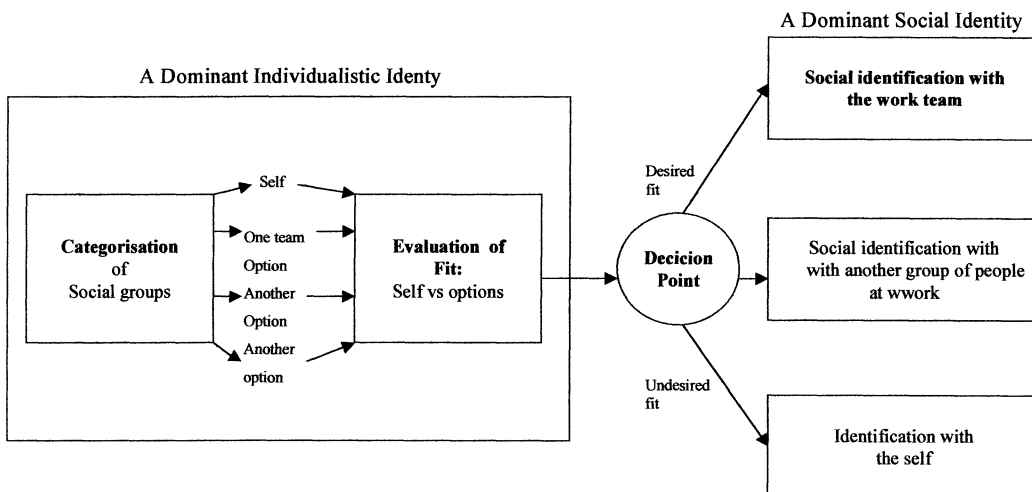


Figure 23: The psychology of identification with a work team, (Lembke & Wilson (1999))

Self categorisation is the psychological process, which makes it possible to evaluate as to whether or not oneself can be a team member. The figure above shows how self categorisation is the first step for the individual to identify with a social category. The individual's understanding of contribution changes from "my tasks" and "my

purpose” to a common unified approach, if one of the options for self categorisation is the most pleasant option, and is selected and guides behaviour towards social identification with teamwork. To maintain a coherent identity within a team, the self-perception lines up with the perceptions of others. Understanding is made easier through developing the right sort of mutual expectations.

Belbin (1993) argues that useful patterns and unsuccessful patterns in teams could be explained through the grouping of people. He argues that synergy is achieved if a good combination of actors is obtained. This means that the team achieves more than the individuals might have done by their own.

Belbin (1993) claims that a team requires talented and skilful people that can apply their strength, who at the same time are able to combine well with the other actors in the team. According to Belbin (1993) it is improbable that one actor possess all the required qualities and skills in a team. To build a well-balanced team, sufficient diversity of talents and team roles are needed. Belbin (1993) has identified nine different team roles. An individual does not necessarily possess only one good natural team role. It is more usual to have two, three or four good natural team roles that can be applied in different situations. Belbin’s nine team roles are given in table 6.

Team Role	Characteristics
Plant	Creative, imaginative, unorthodox. Solves difficult problems
Resource Investigator	Extrovert, enthusiastic, communicative. Explores opportunities. Develops contacts
Co-ordinator	Mature, confident, a good chairperson. Clarifies goals, promotes decision – making, delegates well.
Shaper	Challenging, dynamic, thrives on pressure. Has the drive to overcome obstacles
Monitor evaluator	Sober, strategic and discerning. Sees all options. Judges accurately
Team worker	Cooperative, mild, perceptive and diplomatic. Listen, builds, averts friction, calms the waters.
Implementer	Disciplined, reliable, conservative and efficient. Turns ideas into practical action
Completer	Painstaking, conscientious, anxious. Delivers on time
Specialist	Single-minded, self-starting, dedicated. Provides knowledge and skills in rare supply

Table 6: Belbin’s nine team roles, (From Belbin (1993))

3.2.5 Two Dimensions of Knowledge Creation

Two dimensions of knowledge creation can be made from the distinction between two kinds of knowledge: explicit knowledge and tacit knowledge. Explicit knowledge is according to Polanyi (1958) the type of knowledge that can be expressed in a formal and systematic way. Tacit knowledge on the other hand has a personal quality and is hard to communicate. Nonaka & Takeuchi (1995) point out that tacit knowledge is deeply rooted in action, commitment and involvement in a special context. Tacit knowledge can be divided into two dimensions:

- A technical dimension – which includes informal skills called “know-how”
- A cognitive dimension – which includes mental models, beliefs and values that we take for granted.

Based on experience from Japanese companies, it is argued by Nonaka & Takeuchi, (1995), that knowledge is primarily tacit, and is developed through intelligent actions in job training, through experience and through interactions with other actors.

According to Schon (1991) tacit knowledge cannot be separated from the work and acquired independently from it. To be useful for the organisation, it has to be converted into words or numbers that everyone can understand.

Argyris & Schon (1996) argue for the skilful practitioner’s great importance in the creation of new knowledge. He is especially interested in building mental models to explain actions taking place in his own working situation. The closeness to the situation which the skilful practitioner is trying to understand, enables him in many cases to experiment on the spot, and thus to make a link between theory creation and action as a seamless web. For him the only existing knowledge is the action-oriented knowledge. Argyris & Schon (1978) argue that behaviour in organisations is controlled by the user theories that the members have about what are effective action strategies in different contexts. Through a type of trial and error learning process the practitioner’s mental models gradually develop over time, both in extent and quality. As a resource and as a corrective to the explicit knowledge in innovation projects, the skilful practitioner may be of great importance. It is thus important to keep this in mind when organising innovation projects.

Nonaka & Takeuchi, (1995), point out that new knowledge is created in an interaction process between tacit and explicit knowledge. This argument has the implication that it is not enough to possess either explicit knowledge or tacit knowledge within an organisation, in order to create new knowledge. Neither is ever present without the other. The interaction between these two forms of knowledge is the key dynamics of knowledge development. Nonaka & Takeuchi, (1995), call this interaction “knowledge conversion”, and emphasise that it is a social process between individuals.

3.2.6 A Theory of Knowledge Creation

A theory of organisational knowledge creation is developed by Nonaka & Takeuchi, (1995). The core of the theory lies in describing how knowledge is created through four modes of knowledge conversion that are created when tacit and explicit knowledge interact with each other. When these interactions take place, an innovation emerges. It is argued that the four modes: socialisation, externalisation, combination and internalisation comprise the driving force of the entire knowledge creation process. They are not independent, but produce over time a spiral. The four modes of knowledge conversions are illustrated in figure 24, and are described in some detail.

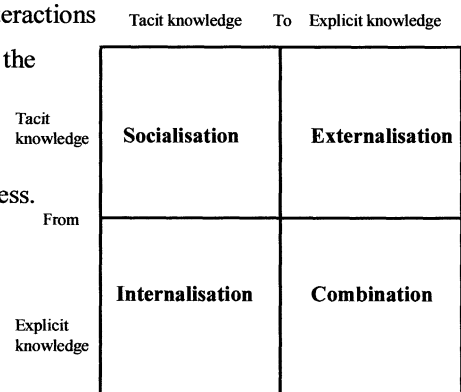


Figure 24: The four modes of knowledge conversion, (Nonaka & Takeuchi (1995))

3.2.6.1 Socialisation: from tacit to tacit Knowledge

Socialisation is the process, where new tacit knowledge is created through sharing of experiences, such as shared mental models and technical skills, between individuals. This can be done through observation and imitation without using language. However, Nonaka and Takeuchi (1995) point out that without some kind of shared experience, it

will be difficult for an individual to gain tacit knowledge from others. Practical training on the job uses this principle.

3.2.6.2 Externalisation: from tacit to explicit Knowledge

Among the four modes of knowledge conversion, externalisation is the most important of them to knowledge creation, because externalisation develops new explicit concepts from tacit knowledge. For conceptualising an image of tacit knowledge to explicit knowledge, collective reflection and interaction between individuals become important. Using the language, it may be possible to find suitable expressions for an image during the dialogue. If not, nonanalytical methods have to be taken into use. Metaphor and/or analogy often drive the process of externalisation. Attractive metaphors and/or analogies may be effective to create commitment to the creative process.

As Nonaka & Takeuchi (1995) point out; a metaphor is a way to intuitively understand one thing by imaging another thing symbolically. Examples of metaphors, taken from Morgan (1988) are the organisation as machine, the organisation as organism and the organisation as political systems. Association through analogy takes place by rational thinking, where it is focused on similarities between two things.

3.2.6.3 Combination: from explicit to explicit Knowledge

This mode of knowledge conversion involves the combining, linking and reconfiguration of different types of existing knowledge through media such as documents, meetings and e-mail. Such processes can lead to new knowledge. Two examples for illustration are taken from Nonaka & Takeuchi (1995). The combination mode of knowledge creation can be seen when middle managers break down and operationalize corporate visions and strategies. The combination mode is realised at the top management level, when mid-range concepts are combined with and integrated into a corporate vision.

3.2.6.4 Internalisation: from explicit to tacit Knowledge

This is the process of embodying explicit knowledge into tacit knowledge. This mode of knowledge creation is according to Nonaka & Takeuchi (1995) closely related to “learning by doing”. Examples of internalisation are re-experiencing others’ experiences indirectly by reading written documentation or by having access to knowledge database about a certain subject. To share the obtained tacit knowledge with other individuals, groups and the organisation, socialisation has to take place. The knowledge spiral makes a new turn.

The main arguments of Nonaka & Takeuchi (1995) is from my position given in fig 25. Knowledge creation is a spiral process through four modes of knowledge conversion: socialization, externalisation, combination and internalisation within a framework of field building and dialogue. The concept “field building” means establishing an arena for dialogue and socialisation.

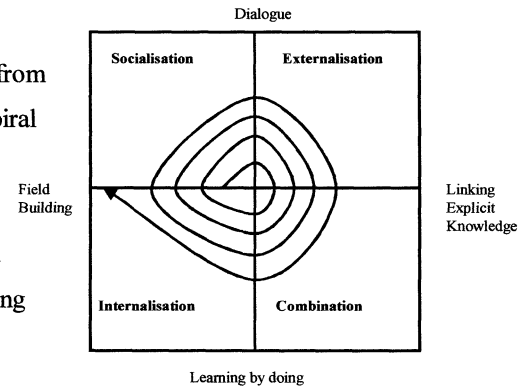


Figure 25: The knowledge spiral

To develop shared mental models or technical know-how within an organisation, to be applied for example in R&D projects, it seems to be important for the management to prepare favourable conditions for internalising experiences from earlier projects as tacit knowledge through the processes socialisation, externalisation, combination and internalisation.

From my position Nonaka & Takeuchi’s (1995) theory of organisational knowledge creation goes a practical step further than the more principle discussions of integrated knowledge creation and the importance of participation in these processes, as argued by Gibbons (1994) and Greenwood & Levin (1998). What they all have in common is the strong focus on the importance of creating a proper arena for interaction, and of the close dialogue itself.

3.2.7 Enabling Conditions of Organisational Knowledge Creation

Nonaka & Takeuchi (1995) propose five conditions enabling the creation of knowledge: intention, autonomy, creative chaos, and redundancy and requisite variety. A discussion of the significance of these is given below.

3.2.7.1 Intention

The outcome of an innovation process is very much governed by its signals or goals from the management with regard to the accomplishment of a project. The capacity and priority as regards the initiating of a new innovation, is normally dependent upon the company's vision and strategy. In order to commit the members of the project team and to give the innovation project the necessary prestige within the rest of the organisation, positive signals from the management are very important. If the organisational purpose and interest in the project is unclear or low, it may be difficult to judge the value of the knowledge created. In such frameworks, an innovation project will often not be initiated.

3.2.7.2 Autonomy

Trist, (1981), has largely developed the principle of autonomously work groups, which are by definition self-organising and follows the management principle of minimum intervention. This implies that the project group, within an overall goal and given boundary conditions, is allowed to self-organise and to choose its own ways of actions. It is argued that by allowing the members of the project team to act autonomously their capacity to solve unexpected problems is increased. According to Nonaka & Takeuchi(1995), such a project organisation may maintain greater flexibility in acquiring, interpreting and relating information. In line with Van de Ven (1986) the capacity of involved actors will increase a global thinking while they act locally. This means that when working within an autonomous group the probability of developing a holistic perspective of the project group, will increase. This may be a considerable motivation factor for the individual member of the group to participate.

3.2.7.3 Creative Chaos

Nonaka & Takeuchi (1995) suggest creative chaos as a favourable condition for knowledge creation. Chaos within an organisation means that the organisation is brought out of an equilibrium condition to a state of some degree of instability. The organisational members face a breakdown in the normal routines, habits and way of working, giving them a sense of crisis. . A chaotic situation can take place as the result of an unexpected event, or can be intentionally created by the management. According to Nonaka & Takeuchi (1995) introducing creative chaos is a strong tool in the development of the human perception within the organisation. The employees begin to question the validity of basic norms, value and this may trigger off their fundamental ways of thinking.

It is this Argyris & Schon (1996) call double – loop learning. This is a type of learning that results in a change in the values of theory-in-use and its strategies and assumptions. Argyris & Schon (1996) define the theory-in-use as: “ the theory of action which is implicit in the performance of that pattern of activity”. Examples causing creative chaos within a R&D organisation could, according to Nonaka & Takeuchi (1995) be to define ambiguous visions, strategies and project goals, or to establish two different competing innovation teams.

3.2.7.4 Redundant Functions

Nonaka & Takeuchi (1995) focus on the creation of redundant functions with a surplus of information as central elements within a framework of an autonomous project organisation. According to their thinking, it is of great significance for the individual actor to be able to acquire more knowledge than he strictly speaking need to do his work. The added or overlapping knowledge may contribute to strengthen his holistic perspective on his own activities, and the connection between his own knowledge and the knowledge of other members of the project group. This may contribute to an increased understanding and sharing with others redundant knowledge and improved collective learning in a problem solving perspective. Sharing of redundant knowledge contributes to a sharing of tacit knowledge, because

individuals can sense what others are trying to communicate. This process can be instrumental in speeding up knowledge creation and increase the collective learning possibilities.

3.2.7.5 Requisite Variety

Requisite variety means placing critical dimensions of the main organisation into the project organisation, as its variety and complexity. According to Nonaka & Takeuchi (1995) this is essential, in order to cope with the challenges in the main organisation. The project organisation should be able to respond quickly to changes in the main organisation. This principle signals that an innovation organisation must be part of an open system, and not an isolated island with no contact with the rest of the system. If information differentials exist between the main organisation and the project organisation, the members of the two sub-systems cannot interact on equal terms, which may reduce the flexibility, hinder an effective interpretation of information, and thus reduce the knowledge creation capacity.

Sjølander (1983) is focusing on ways of reducing the information gap and lack of cross - communication between the innovation team and different other units in the organisation, especially between the marketing – and manufacturing departments. He is suggesting that the innovation teams could be staffed with actors with broad and different experiences. Actors with a good access to main stakeholders in the main organisation could be recruited to the innovation team.

To my understanding Nonaka & Takeuchi's (1995) theory is based on a harmony perspective, which I see as a weakness. It does not take into account that the learning processes described take place within a social framework, with conscious actors that also have their own interests and priorities.

There will always be someone deciding the legitimacy of created knowledge, which kind of knowledge is rational and beneficial for a company. In line with the discussions above, understandable knowledge must be communicated, as a result of power relations between involved actors. The management can construct accountable knowledge by the transforming of change, inventions,

inventions, innovations and so on. In such a way experimental constraints may be established in the organisation in order to control its future behaviour in line with a company's strategy and vision.

Berger & Luckmann (1966) argue that all knowledge is socially constructed through a circular process, in which institutionalising is defined as a core process to preserve social groups. Berger & Luckmann (1966) describe an ideal process of socialisation, where all actors are equal. Further, they do not reflect sufficiently at the quality of the constructed knowledge. To them, all knowledge is equally important. According to the above discussions, this is obviously too limited.

All public and private organisations are to a certain degree institutionalised through values, norms and abstract knowledge, which are parts of the organisational culture. Thus, parts of the human activities are controlled through pre-defined patterns of behaviour. Full institutionalising means to me sedimentation, and represents a closed system, where change processes will have poor conditions. Further, a process of homogenous institutionalisation of employees will not create proper arenas for innovative activities. From my position a condition for bringing forward innovation in an organisation, is that the innovation team works in a context of a permeable institution, where the atmosphere of the organisation to some degree is characterised by openness and curiosity, and where there is diversity and an acceptance for heterogeneous activities. There will always be a fine balance between the organisation's need to secure a proper creation of knowledge according to its visions and strategies, and the importance of creating conditions for open and free knowledge creation.

3.2.8 The Creation of Parallel Project Organisations

An innovation project has normally two main phases: the R&D phase and the implementation phase. Actors with different kinds of knowledge are required for both phases. In cases where this is not taken into account, the holistic perspective may be lost because of lack of knowledge, and important elements of either of the two phases may be missing.

In my position there should always be a mixture of creative and systematic resources during an innovation project, with a gradual shift in focus from a creative to a more systematic way of working towards the implementation phase.

Kanter (1985) suggests the establishment of a flexible parallel project organisation, organically organised, besides the operating organisation that is carrying out routine tasks and has to be as efficient as possible. The idea is to increase the capacity of integrated knowledge creation between the two sub-systems. The parallel organisation is attached to the operating organisation through flexible and different network mechanisms.

3.2.9 External Sources Generating Knowledge

Accurate understanding of user need is of great importance for developing successful new products. Proper market research analysis is often not available, especially for radical product innovations or in product categories characterised by short lifecycles. Von Hippel (1986) suggests that marketing research analysis should be done with focus on lead users. Lead users are users that present strong needs in advance of the market. Their needs will become general after some months or years. Collaborations with such knowledgeable buyers may result in new ways of applying the technology. Examples of sources of external knowledge are:

- Lead customer
- Research institutes
- Licensing of technology
- Employed experts.

3.2.10 Creativity and Motivation Processes

3.2.10.1 Creativity Processes

In line with Henry & Walker (1991) I see the individual creative thinking as an important part of the total innovation process, from generation of new ideas to searching for creative solutions to complex problems. A great number of creative ideas is often needed to create a commercial product.

Sjølander (1983) argues that creative ideas are born when the individual discovers a gap in performance – a deviation between a possible, desired condition and an actually interpreted condition. The performance gap is from a knowledge perspective positively influenced by a: broad information flow from many different sources, openness, knowledge about direction and goals, possibility of having internal and external contacts and freedom to influence your own work.

Sjølander claims that creative ideas are communicated to colleagues and the organisation within a supporting and performance oriented environment, which gives the individual positive early experiences, otherwise not.

As I see it, creativity contains the ability to imagine new perspectives, and includes elements such as the importance of some talents, explicit and implicit knowledge, cognitive skills, and personality characteristics. I believe that the creative skills to a large extent decide how far the search for solution alternatives will go, as regards the probability for evaluation of creative alternatives.

The relation between creativity and knowledge is demonstrated above. I further believe that creative productivity is strongly linked to the individual's knowledge or skills in the subject. This is what Amabile, (1988), calls domain-relevant skills. They can be regarded as an individual's main constituents for creative productivity.

In my view cognitive skills are of greater value if it is organised according to general principles. They feel natural to link this thinking to the skilled practitioner's ability of

abstract thinking and to combine knowledge in different cognitive maps, Argyris & Schon (1978).

It then makes sense, when it is argued that an individual with a wide experience background is usually a more valuable creative resource than an individual with a highly specialised background. This is simply due to the fact that he has more cognitive maps to play with.

A high creative ability is important in production of new knowledge during an innovation project. I argue from the above discussion that it becomes important, in order to create a high potential within this area, to select people carefully for the innovation team, who represent different arguments in constructive conflicts. I would say that in many cases the desired project results are not reached, because project teams are put together in an arbitrary way.

The link between productions of new knowledge represents mutual relations between external knowledge, the creative component of the external knowledge and the knowledge produced. This is illustrated in the figure 26. New knowledge is produced through mutual interaction between actors involved in creative processes. On the other hand, production of new knowledge and external knowledge are important conditions for initiating and maintaining creative processes.

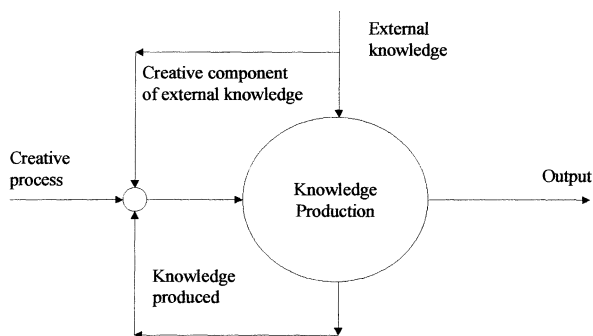


Figure 26: Knowledge produced as mutual relations

3.2.10.2 Motivation Processes

When new products or processes are going to be developed, extraordinary efforts from the members of the organisation are required. What makes us perform something we normally think we cannot accomplish? What kinds of mechanisms are involved in order to motivate actors in innovation projects to initiate and maintain creative processes by use of external knowledge and new knowledge produced during the project? I shall try to answer these and similar questions in this chapter.

In line with Amabile (1988) I strongly believe that not any skill in the domain or in methods of creative thinking can compensate for the lack of motivation to perform an activity. On the contrary a strong task motivation can, to some extent, make up for lack of creative or domain-oriented skills.

Task motivation can be divided into two elements: intrinsic and extrinsic motivation. The first motivation category denotes an individual's ability to motivate him self to carry out a task, not being much concerned about extrinsic motivation factors or constraints from the environment. Because of enjoyment, challenge and interest of being in the centre of complex problems, the individual is more likely to spend the cognitive energy exploring the problems and is normally not much worried about risks involved. Amabile (1988) argues that motivated persons working in an environment of low external controls are most likely to happen to find new and creative solutions.

As for extrinsic motivation factors a different kind of reward systems is involved. McGraw (1978) suggests that rewards will strengthen the performance on algorithmic tasks – tasks where there is a clear and straightforward path to the goal. However, extrinsic motivation will undermine performance on heuristic tasks involving creative activities, tasks where some search for solutions is required.

The main difference between the extrinsic and intrinsic motivation is shown through the freedom from constraints in the immediate working environment and in the individual's interest in a task.

As discussed earlier, knowledge in an innovation project is produced through an integrated process, with a continuous change in creative and non-creative activities. If the task is heuristic and the individual find it intrinsically motivating, then extrinsic pressure should be used with caution. In other cases, extrinsic constraints might be appropriate. For instance, once a creative idea is created, I maintain that some kind of extrinsic pressure is often needed to validate, test and implement the idea.

Applying the most useful motivation mechanisms in different phases of a project represents a management challenge.

Drawing on Sjølander (1983) the following mechanisms of internal motivation in innovation projects drawing are proposed:

- Go slow as to economic or human resources, to create time to examine creative ideas. In a wider perspective this is important for participating in the project. There are several examples of actors being asked by their management in the base project to take part in a project, but not really given time to do so. They have to treat the project work as a left-hand activity, which often gives poor results. It can also lead to stressing situations both at the individual and the organisational level.
- Allow mistakes to be made in an innovation project. Since innovations represent something new, this may seem to be inevitable, but it is not.
- Do not quench new ideas too early. In my view creative ideas might be evaluated, but not with the purpose of prejudging or quenching them. It is much better to allow the idea to be tested by the idea generator himself, giving an important learning effect. Instead of prejudging new ideas, questions, which will be openly asked about all kinds of obstacles, problems and opportunities through the whole project.

3.2.11 Conclusion

In this chapter it has been focused on innovation as:

Creation of new knowledge based on an understanding that innovation processes are characterised by making something new.

A process of uncertainty reduction through learning. It has been discussed why the irrelevant problems often are solved in a project and why decisions on how to solve a problem often are taken at a too early phase. Ryle (1949) is applying the term “knowing how and knowing that”. He argues that the actor must first go through the internal process as to what is to be done, only then he can execute his performance in accordance with what he arrives at there.

Different modes of knowledge creation have been discussed. The importance of achieving participation and involvement through the project accomplishment is emphasised by Gibbons (1994) and Elden & Levin (1991).

A theory on how to put integrated team into teamwork has been presented by Lembke & Wilson (1998). It is emphasised that teamwork and integrated activities are complex process that are often difficult to control, and thus need attention from the management.

According to Nonaka & Takeuchi (1995) knowledge creation has two dimensions: explicit knowledge and tacit knowledge. They argue that new knowledge is created in an interaction process between the two forms of knowledge. Nonaka & Takeuchi (1995) present a theory of knowledge creation, together with the five conditions for enabling organisational knowledge creation: intention, autonomy, creative chaos, redundant functions and requisite variety.

An innovation project can broadly be divided into a R&D phase and an implementation phase. During the project accomplishment there is a gradually shift from a creative to a more systematic mode of working. Kanter (1985) suggests a way

of organising so as to increase the capacity of integrated knowledge creation during the whole project, by establishing a flexible parallel project organisation.

An organisation may not always possess the sufficient knowledge to initiate an innovation project. Von Hippel (1986) suggests that marketing research analysis should be done on lead users that present strong needs and are in ahead of the market.

Finally, creativity and motivation processes are discussed. Sjølander (1983) argues that creative ideas are born when the individual discovers a gap in performance, a deviation between a desired and possible condition and an actual interpreted condition. He further claims that creative ideas are communicated to colleges and to the organisation within a supporting and performance oriented environment, and if the individual has early positive experiences, otherwise not.

The link between creative productivity and knowledge is demonstrated.

It is emphasised when intrinsic and extrinsic motivation factors should be applied. The first motivation category goes on an individual's ability to motivate him to do a task. He is motivated by factors as enjoyment, challenge and interest of being in the centre of complex problems. In extrinsic motivation factors different kinds of reward systems are involved. Amabile (1988) argue that the latter motivation category will strengthen the performance in algorithmic tasks.

Finally, the strong interrelated importance between creative activity and motivation factors and creation of new knowledge is stressed.

3.2.12 Questions to be included in the Analysis of the Projects

Based on the conclusion of the theory of knowledge creation, I have chosen to include the questions as shown in the following table to construct of my analytical position as to this part of the theory.

Questions from the Theory of Knowledge Creation

- **Uncertainty Reduction**
 - Was any pre-study accomplished?
 - Was the principle of minimum specification applied?
 - Did the company possess enough knowledge to develop this product?
- **Knowledge Creation**
 - Did integrated knowledge creation take place?
 - Did actors with different professional background and experience participate ?
 - Were actors with different personalities selected for the project team?
 - Was an autonomous project group created?
 - Were redundant functions found?
 - Was a condition of creative chaos created?
 - Was a common language created?
 - Did practitioners have sufficient skills in communication and team work
 - Was the tacit knowledge of the practitioners utilised?
 - Did the management have a clear intention as to the project?
- **External sources of knowledge**
 - Did the project apply any of the following external sources of knowledge: lead users, customers, suppliers, research institutes, licencing of technology, hired professionals?
- **Creative processes/motivation factors**
 - Was the project environment supporting, performance oriented and open?
 - Did the project consist of members with positive experiences?
 - Was any slack created in the project?
 - Was it acceptable to experiments?
 - Were mistakes allowed?
 - Were any extrinsic motivation factors applied?
 - Were any intrinsic motivation factors applied?
- **Project termination**
 - Was there any project evaluation?

Table 7: The construction of my analytical position within the knowledge creation theory, formulated as questions to be applied in the analysis of five projects.

3.3 Agent Theory

3.3.1. Introduction

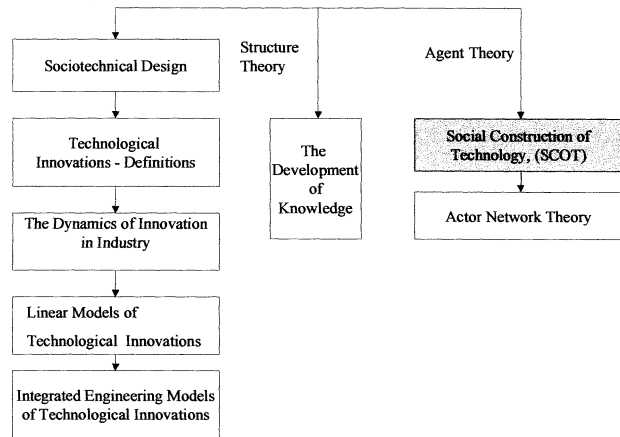
An important goal of the social constructivism mode of inquiry is to see what is really taking place during the construction of technology, by carefully looking at the inner working process taking place, Winner (1993). The focus is on the variety of technical knowledge in question and the social actors involved, rather than through looking at technology development from deterministic and imperative perspectives. What will be a political or a technical problem will depend on the particular context. According to the social constructivism approach, social shaping of technology and technological building of society are aspects of the same matter.

From my position, the basic foundation and viewpoint of social constructivism seems to be fairly consistent. I shall present the social constructivism theory from two well-known approaches: first from the SCOT approach and second from an actor network theory approach.

3.3.2 Social Construction of Technology, (SCOT)

3.3.2.1 Introduction

Pinch & Bijker, (1987), have developed a social construction of technology approach, (SCOT). The model developed is multidirectional. In the SCOT context this means that the construction of new technology is described as a social process of alternation of variation and



selection, until a technical stabilisation and closure take place. This is in contrast to the linear models of technological development, described as a sequence of separate steps. A descriptive, multidirectional model is established from the illustration of the development of a bicycle, to allow us to grasp the complexity of technological development. Applying it to other case studies the generality of the model is tested. At the start of the development process there are different technical alternatives as to what a bicycle should be. Adopting the multidirectional model makes it possible to ask why some variants are left aside and others survive in the social process going on between cyclists and “anticyclists”.

3.3.2.2 Relevant social actor groups

Pinch & Bijker, (1987) take the concept of “relevant social actor groups” as their starting point for understanding the development of technology. When technological development is viewed as a social process, it follows that relevant social actors will be carriers of the process. It is important to describe the artefact through the eyes of the relevant social groups, and the meaning attributed to it, Wiebe (1995).

The concept of “relevant social group” must be viewed as an actor’s category or a group, a group of actors that have certain interests in the technology which is going to

be developed. A key requirement is that all members of a social group share the same set of meanings attached to the same artefact.

Examples of relevant social actor groups from Pinch & Bijker's (1989) study of the social construction of a bicycle are non-users, are women and elderly men and young athletic men. From projects within my own industry the following examples of relevant social actor groups can be mentioned: the management and the employees within the company, actors from research institutions, financial institutions, environmental authorities and different segments of customers.

In their theory of relevant social groups, Pinch & Bijker, (1989), focus on the importance of enrolling actors, representing a large enough diversity to be carriers of different competing technical alternatives. A strong contrast to this approach will be a project group manned with only one actor having a poor network to play on.

3.3.2.3 Interpretative Flexibility

When the concept of relevant social actor groups is used as the starting point for the description, it is possible to demonstrate the interpretative flexibility of artefacts as the consequences of difference in meanings attributed to an artefact by various relevant social groups, Wiebe (1995). It is argued that demonstration of interpretative flexibility is critical with regard to the justification of the existence of any sociology of technology, and for countering and contradicting technological determinism. It shows that neither the identity of an artefact nor its functionality are important internal properties of the artefact itself, but subject to social parameters. This can leave more room for alternatives in technical change than when the constraints are purely technical.

It opens up for an argument that all technical projects in reality should be regarded as sociotechnical design projects, and it can thus be discussed if social researchers or actors with a similar background should be natural members of project groups developing new technology. Within the process industry, this would be a new approach.

The interactions between different relevant social actors groups are in fact, what make the different artefacts, some of which may be hidden within the same thing. They are revealed by an evaluation of the meanings connected to them by the various relevant social groups. The diverging sets of problem specifications and suggested solutions shape the technology.

3.3.2.4 Stabilisation and Closure

The last elements of the social constructivists' descriptive model are the concepts of stabilisation and closure of an artefact. It is through these concepts that the social construction of technology can be traced, following the growing and diminishing stability of the artefacts in different social groups. This approach can be clearly illustrated, using the running of long-term projects as an example. The progress often waves back and forth, and the technical stabilisation is a result of many different events, often of social and political character.

Pinch & Bijker (1987) focus on the development of the artefact itself within one relevant social group in their concept of stabilisation. This regards which kinds of technical solutions one social group would accept, by the meanings attributed to them. To the contrary for the analysis of the concept of closure, it is focused on the meanings attributed to an artefact by different relevant social groups.

A relevant social group introduces a focus the degree of stabilisation as a measure of the acceptance of an artefact. This way of describing the development process can bring out different kinds of conflicts, as: conflicting technical requirements, conflicting solutions to the same problem, conflicting environmental requirements and moral and ethical conflicts.

According to Pinch & Bijker (1989) it is in the project phase that conflicts tend to be most visible. In order to avoid an open fight, which may be harmful for the project, it will be a great challenge for involved actors to create an arena of diversity and positive conflicts, as a necessary condition for change.

The more homogenous the meanings attributed to the artefacts of different relevant social groups, the higher the degree of stabilisation.

To structure the interaction process among the actors of a relevant social group during a process of stabilisation, the theoretical concept of “technological frame” is introduced. In the SCOT descriptive model problems and solutions can be interpreted as generated within a given technological frame. This covers all elements that influence the interaction within relevant social groups that lead to technological choices. I see that a technological frame includes the constraints and opportunities within an organisation, supporting the stabilisation of an artefact, and provides the vocabulary for social interaction and for forming artefacts. With the existence of a technological frame, the freedom of choice in the stabilisation process is narrowed. Examples of elements within a technological frame are company strategy, company values, company culture, procedures, current project plans, goals, and explicit and tacit knowledge within the organisation.

A strategy to increase the group members’ own influence and control of a technological stabilisation process will be to get membership in different relevant social groups that are governed by other technological frames.

The concept closure and stabilisation are closely linked. From the position of Pinch & Bijker (1989), a scientific controversy will end through a process of consensus, once stabilisation around a technological solution has emerged.

Conflict disappears once closure has been achieved. One meaning as attributed by one relevant social group becomes dominant across all relevant social groups. Everybody seems to be happy and content. A redistribution of power takes place. The process of closure is almost irreversible. Pinch & Bijker maintain that it is then hardly possible to imagine the world, as it existed before the closure of the controversy.

Pinch & Bijker (1989) focus on two mechanisms of closure: rhetorical close and closure by redefining the problem.

3.3.2.5 Rhetorical Closure

When a technical controversy is closed, it is not necessary to solve the technical problem causing this controversy. The key point is whether relevant social groups believe from their understanding that a problem is solved. Use of advertising can be an efficient mechanism in the process of social shaping of the meaning which relevant actors give to a new technology. Using rhetorical closure mechanisms, the focus is often on “constructed” product characteristics, for example Ferrari is a safe car. Success of an innovation is thus dependent upon the creation of a common understanding of the technology, making it attractive.

3.3.2.6 Closure by Redefinition of the Problem

This closure strategy may be efficient if some relevant social groups are opposing the closure of a problem. One mechanism could be to reach the

closure, after first moving to another area, solving another problem than the artefact was meant to do. An example is technological equipment frequently used in new and other positions within the process industry it was originally meant to.

3.3.2.7 Discussion

Pinch & Bijker (1989) demonstrate in their concepts of relevant social groups and interpretative flexibility that the linear model of technology is inadequate to use in a social constructivism perspective. This approach offers a step-by-step guidance for doing case studies of a technological innovation, which give a good understanding of how technology comes to being.

A static element seems to be introduced in the social constructivists thinking of construction of technology. There does not seem to be any openings for further development of a technology as a dynamic process once a stabilisation of the technology and closure has taken place.

Winner 's (1993) criticism of social constructivism, can be summarised as follow:

1. The social constructivism approach fails to discuss the social consequences of a technological choice. According to MacKenzie & Wajkman (1985) neglected questions are, “What has shaped the technology that is having effect? What has caused and is causing the technological change, whose impact we are experiencing?” It seems that social constructivists mostly are concerned and satisfied with the provision of clearer, more specific explanations of technological change.
2. The approach of Pinch & Bijker (1989) is far from technological determinism and functionalism. A conflict perspective of innovation is presented, which is demonstrated during the process of stabilisation and destabilisation of technology. There is, however, no suggestion as to how the existing power relations should be treated in this phase. Further, the conflict perspective is dropped once closure has been achieved. This conclusion may be questioned. It does not seem likely that technical closure always will always be of the consensus type, it may also include the use of force.
3. An important concept in Pinch & Bijker’s (1989) social constructivism is the concept “relevant social actors”. However, important questions may be: what are relevant social groups and social interest, what about groups that have no voice or have been deliberately suppressed or excluded during its construction, but that will be effected by the results of a technological change?

I see that creation of relevant social groups will always be a result of existing power relations in a given context.

4. Social constructivism fails to realise that technological change involves dynamics beyond those revealed by studying the characteristics and actions of relevant social groups, such as deeper cultural, intellectual or social choices in technology.

3.3.2.8 SCOT Implications to the Innovation Systems

- Creation of relevant social groups including different meaning attributed to an artefact
- Creation of an arena of mutual interaction
- Structuring the process of stabilisation through utilisation of the concept “technological frame”

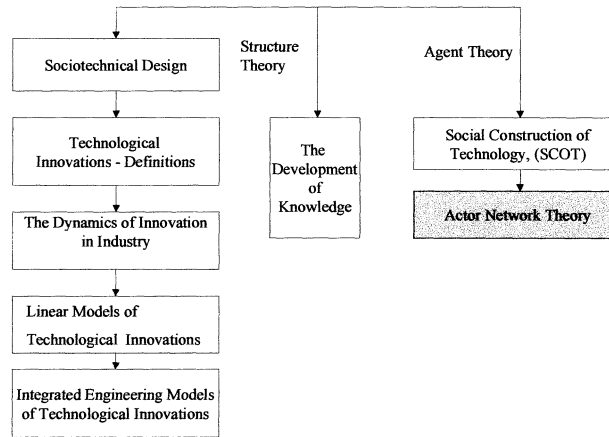
3.3.3 Actor Network Theory

3.3.3.1 What Actor – Network Theory is all about

With his actor network approach, Latour (1987) is breaking down the distinction between human actors and lifeless technological entities. The human actor and artefacts constitute an integrated whole, which is difficult to separate. It is suggested that social interactions are nothing but patterned networks of materials or things, including people, machines,

animals, texts, etc, and thus shape heterogeneous networks. The actor –network theory is assigning properties, powers and effects to technology, and suggests that artefacts can have effects because they can act. For Latour (1987) each element is an actor. The principle of generalised symmetry is employed. This means that any element in the heterogeneous network participation in the stabilisation of a technology has a similar explanatory role. In line with Latour (1987), people are connected to machines, machines to elements, elements to steering groups, steering groups to boards, boards to articles in journals which are written by people, and so on. According to Latour the shaping and being shaped by culture, technology, nature and people is an endless ongoing process.

A characteristic of the actor-network theory is the strong relation to systems thinking. The notion of actor-networks as an interconnection of nodes can be taken further by making use of systems theory, Bertalanaffy (1969). Socio-technical systems are open, made of heterogeneous elements, and are able to change and evolve with time. In my view, this seems to be similar to descriptions of both constructivists' thoughts and actor networks. Both systems theory and the constructivism positions also depend on contextual thinking. On this background, I argue that actor theory regards **systems of elements**.



In the actor – network theory Latour (1987) and Callon (1989) are concerned with the relation between power and knowledge. From their perspective, knowledge is produced in a social system. They argue that when a stable point is challenged, this takes place in political struggle for control and influence. To summarise, actor network theory is all about, as what is shown in the figure 27 below.

3.3.3.2 Construction of Facts and Artefacts

Latour (1987) and Callon (1989) focus on the construction of artefacts by following the actors through their process of construction. Strategies are used to make the artefact. Latour points out that his

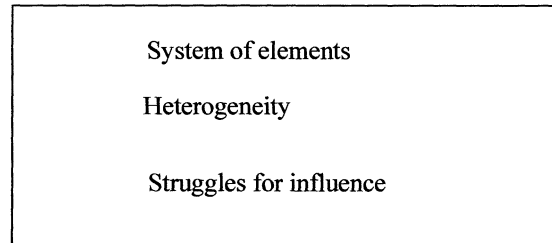


Figure 27: What actor network theory is all about

model does not regard how the truth is discovered by researches, but how the truth is constructed from the statements that the researches make. Roughly speaking, Latour is explaining the process of construction of artefacts in the following way:

The success of the implementation of the technology depends on the degree of stabilisation through the two mechanisms: black boxes and obligatory passage points.

- *A black box* is something we see through its input and output, while its content remains in the dark. Examples are complicated machines and complicated computer software, where only the use for the artefacts is interesting.
- *An obligatory passage point* implies that an actor makes himself indispensable for other groups, and can be seen as the only and best way to pursue the interests and desires of the actor network. All actors wishing to obtain their goal have to attach to the central network builder in one way or another. An actor with the role as an obligatory passage point is controlling a project.

When a destabilisation of a technological status takes place, this can mean that an innovation project has been started, in order to implement a technology in the organisation. The “black box” is opened and a controversy appears, which means that different actors have different claims as to what is truth. A political struggle is taking place, where different actors have their strategies, as they seek to win through with their scenario. Finally, the controversy is settled. The new technology is made during a process of technological stabilisation.

The process of implementing new technology within this framework is shown in figure 28.

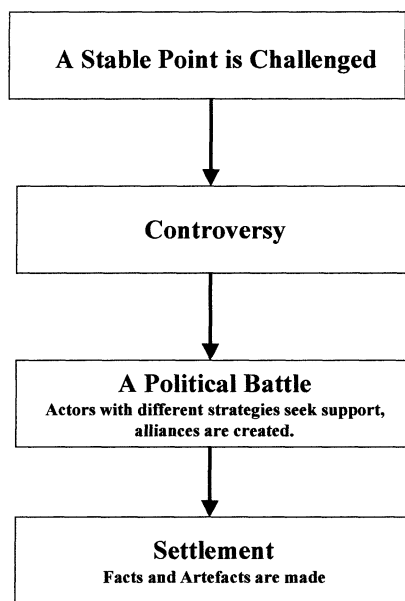


Figure 28: Strategies for successful creation of stabilising mechanisms, (Ulseth (1996))

Latour (1987) has suggested two main strategies in order to establish stabilising mechanisms:

- “1.To enrol others so that they participate in the construction of facts.
- 2.To control their behaviour in order to make their actions predictable”.

To enrol others in your scenario, Latour (1987) suggest the use of different translation mechanisms. The most important of them are described below.

3.3.3.3 Translation

As Latour (1987) points out this solution at first sight seems contradictory and difficult to obtain. If others are enrolled they might transform the demands in unexpected ways, so that it is difficult to control of them, Latour's (1987). The solution to this is the central concept of **translation**. This approach focuses on methods which an actor group utilise to tie others to a project, attempting to convince them that their vision of the future or "scenario" is the best for all interesting parties, and can function as a basis for mobilisation larger actor groups. According to Law (1992) translation is the process that generates effects producing order, such as devices, humans, organisations and other heterogeneous elements. In this way Law (1992) looks at an organisation as the effects of interactions between materials, humans and strategies of the organisation.

Law (1992) suggests two methods of overcoming resistance. The first method regards the fact that some materials are more durable than others, and therefore maintain their relation pattern for a longer time. It is argued that relations will last longer if they are embodied in durable materials. Another method of translation regards making order through space, by mobility. It explores different materials and processes of communication, such as writing, electronic communication, methods of representation, banking systems, etc.

Latour presents different translation strategies, from which I have chosen three that are important for my analysis of the case projects.

Translation 1: I want what you want. The central network builder is showing that his contribution and interests fit with the interests of the other actors he is trying to mobilise.

Translation 2: I want it, why don't you? This strategy is symmetrical to the first one. This type of translation is more complicated to fulfil and is rare. The network builder has to convince others that they should support his scenario even if this is not in line with their own goal. Other actors must be convinced that they cannot achieve their own goal and that the scenario of the network builder is a useful alternative.

Translation 3: If you just make a short detour... This is a powerful strategy. The network builder tries to convince other actors that he wants to mobilise that they cannot reach their goals straight away, but if they come his way, they will reach it faster. Utilizing this strategy does not mean that the actor builder is trying to shift others from their goals. He simply offers to guide them through a short cut. In order to make this detour possible, Latour points out three conditions that have to be fulfilled:

“The main road is clearly blocked

The new detour is well signposted

The detour appears short”

The translation and actor network approach is well suited for studying researchers as research political actors. An overall methodical principle is to follow the actors through the process as the research political actors they really are, exploring mutual relationships between the elements. Each of them has an ability to act and to change the overall constellation of the network. However, the ability to act is a result of his, her or its position in the network.

3.3.3.4 Keeping the Interested Groups in Line

Latour suggests that two things have to be done in order to build a black box: first it is necessary to enrol others, and second their behaviour has to be controlled, to make their behaviour predictable. The last task can be difficult, especially in long - term projects. Latour proposes different strategies to handle this.

(1) A chain is only as strong as its weakest link. One question will be what can be done to bind them more firmly together, and to turn a collection of temporary

interests into a durable whole. Latour suggests that the only way to keep the dissenters in line is to link the claim with so many assembled elements that it will withstand trials to break it apart. There is no way of enrolling interested groups unless other elements are connected to them. From my position this means that established actor networks in projects should be of a size larger than the critical minimum one, in order to make them robust. Preferably some overlapping knowledge should be included in the network. What that network should look like has to be carefully analysed in the actual context, and based on an ongoing analysis through the project of strength and stability of each relation in the network.

(2) Tying up with new unexpected allies. Latour has asked us to understand that it is useless to enrol interested groups unless the elements are tied to them. He further argues that this cannot be done in a random way. Choices have to be made. To carry this argument a bit further, it means to me that the organising of a project should be done after careful evaluation. Every time an ally is abandoned and a new one recruited, the only important question is the following: “is this new association weaker or stronger than that the previous one?” It is argued that fulfilment of strategies based on translation is dependent on the new and unexpected allies that have been made relevant through a series of translations. From this I get a further understanding of the importance of doing project work in an open system framework, and with openness towards receiving new information and knowledge.

3.3.3.5 Discussion

The actor network theory presented in this chapter is based on social constructivism principles. It represents a complementary view to the traditional management of technology theory. The traditional view separates science and technology, and adopts a technological linear and deterministic view. The interactions between science and technology are usually clear and easy to understand. Science and technology have exclusively ownership and roles.

Rather than talking about scientific “discoveries” and technological “progress” as end products, Latour (1987) focuses on the process of the making of technology and the

behaviour of the different elements in a network, to stabilise the technology in a “black box”. Arguments and rhetorics play an important role in deciding which theories and observations are accepted and which are rejected. Latour’s (1987) position is important, because it gives an insight into important mechanisms for initiating actor networks; in order to achieve an organisation’s goals in a project context or to solve other tasks given priority. When reading traditional management literature, you usually gain little knowledge of which practical grasps to take in your own organisation to achieve the results the literature is describing.

The actor network theory focuses on the use of power, political struggles and diversity as necessary constituents, in order to achieve a technological change. This approach may seem to some people both to be cynical and manipulative in its form. However, to me it is a step towards a more realistic direction.

3.3.3.6 Critical Comments to ANT

Some critical comments to ANT given, are as follows:

An ANT actor may alternatively be a power, which enrolls and dominates, or an actor, which allows itself to be enrolled. For Latour any element in a network is an actor. To take this view further, it seems to me that ANT may be too tolerant in the presentation of actors, ending up with actors who are anonymous, ill - defined, passive, and indiscernible. Callon (1997) argues that it is this aspect, which has resulted in the repeated accusation of relativism. An explanation of actors’ necessary competence is missing.

The ANT gives the impression that it is useful for the analysing of any situation, which I do not believe is true. ANT is very useful in situations where it is difficult to separate humans and non-humans, or where this should not be done, as in technical change projects. However, in other cases the situation to be analysed may not be embedded in a network, the system may for instance be clearly limited and all roles well defined. In such a case there is no point in applying ANT.

For Latour the shaping and being shaped by culture, technology, nature and people is an endless ongoing process. One interpretation of his view could be that everything generally is generally uncertain and reversible. From this I understand that construction of new technology always must always be done in an environment of a good understanding of culture, in order to operate it well.

The principle of generalised symmetry is employed in ANT, which means that any element in the heterogeneous network participation in the stabilisation of a technology has a similar explanatory role. From my position it seems that ANT tends to neglect the hierarchies of knowledge distribution as an important factor, when all actor networks are constructed.

The ANT suggests that social interactions are nothing but patterned networks of materials or things, included people, machines, animals, texts, etc, and are thus heterogeneous networks. To my understanding ANT seems to neglect that heterogeneity is quite different to people that are privileged and to those are not. It means that those who are privileged usually have access to larger informal networks, and thus will have an advantage as actors in an actor network. This is an important aspect in order to understand how power is used.

A possible interpretation of Latour is that artefacts are regarded as physical actors in line with human actors. This is wrong to me. In order to physically act, a choice between, a choice between alternatives is needed. As a lifeless thing, an artefact is not embedded in such a pattern of behaviour. To my understanding of ANT as a heterogeneous network of actors, the only real physical actors are the human ones, who intentionally or unintentionally are using the artefacts to guide human behaviour. I give an example to illustrate my position. A bridge is built too low to let buses to pass. The effect would be the same as letting human actors hinder buses to pass to another area, marked by the location of the bridge. The bridge is not in this case an actor, however. It is a socially constructed product. The symbols, signals or guidance of behaviour it creates can either be an intentional result of the construction process, or they may appear in different unexpected ways.

3.3.3.7 Conclusion

The social constructivism is, according to Winner (1993), a mode of inquiry to see what is really taking place during the construction of technology, by carefully looking inside the process taking place. Technology development is here not regarded from deterministic and imperative perspectives, but rather focused on the different types of knowledge in question and the social actors involved.

The social constructivism has been presented from two approaches: first from the SCOT approach and second from the actor network theory approach.

Social Construction of Technology (SCOT)

Pinch & Bijker (1987) have developed a multidirectional descriptive model, SCOT, using the illustration of the development of a bicycle. Central elements in this model are:

- Relevant social actor groups
 - Defined as a group of actors who have certain interests in the technology, and who share the same set of meaning attached to the same technology
- Interpretative flexibility
 - At the start of the development process there are different alternatives as to what the technology should be, due to differences in meanings attributed to the artefact by various social actors, Wiebe (1995)
- Stabilisation and destabilisation of technology
 - It is through these concept that the social construction of technology can be traced, following the growing and diminishing stability of the artefacts within different social groups. A conflict perspective is presented
- Closure
 - Conflict disappears once closure has been achieved. One meaning as attributed to a relevant social group becoming dominant across all the

relevant social groups during a process of consensus, where a majority of actors have the power to say that a certain technology is finally adopted..

Actor Network Theory

Latour (1987) is expounding on his view on technology development in actor networks. He argues that the success of the development of a new technology depends on the degree of stabilisation through the two mechanisms: black boxes and an obligatory passage point.

- A black box is something we relate to its input and output, while its contents remains in the dark
- An obligatory passage point implies that one actor makes himself indispensable to other groups, and can be seen as the only and best way to pursue the interests and desires of the actor network.

When a stable point of the technology is challenged, this means that a technological innovation project is started up. A controversy appears, which means that different actors have different claims as to what is truth. A political battle is taking place, where actors with different strategies seek support, and alliances are created through translations of their interests to fit with others. Finally, a settlement of the controversy is taking place through a process of technological stabilisation. Conscious human actors form the new technology.

The actor network theory focuses on application of power, political struggles and diversity as necessary constituents to achieve a technological change. Latour (1987) points out that his model does not concern how researchers discover the truth, but how the truth is constructed from the statements that the researchers make.

Law (1992) argue that the following will be central questions, when the actor network model is applied in the analysis of a project:

- In what ways is the different heterogeneous network elements created or mobilised?
- How do the networks interact?
- How far do they spread?
- What are the strategies performed through the networks?
- Which are the attempts to create network stability?

3.3.3.8 Questions from the Conclusion of the Agent Theory to be utilised in the Analysis of the empirical Material

Two set of questions are established, one for analysis of the activities both upstream and during the project, which represent the construction of my analytical position within the agent theory. This is done because it seems in some of the case projects that political activity and power have been applied also upstream the main project

Questions of the Actor Network Theory

<ul style="list-style-type: none"> • Upstream Project Any controversy about technological development taking place? 	<ul style="list-style-type: none"> • During Project Accomplishment Any controversy about technological development take place?
Did any mobilising of actors take place?	Did any mobilising of actors take place?
How large was the initial extent of the network?	How large was the initial extent of the network?
Were any translation strategies utilised?	Were any translation strategies utilised??
Were technical artefacts utilised in the network building?	Were technical artefacts utilised in the network building?
How was the openness of the network?	How was the openness of the network?
Was there any development of the network?	Was there any development of the network?
Did any party manage to stabilise the technology?	Did any party manage to stabilise the technology?

Table 8: The construction of my analytical position within the agent theory, formulated as questions to be applied in the analysis of five projects

3.4 Construction of my total analytical Position including all three Theory Perspectives

In the table 9 questions including all three theory perspectives are presented that are applied in the analysis of the projects included in the thesis.

Structure Theory	Theory of Knowledge Creation	Agent Theory
Project Organising	Uncertainty Reduction	Controversy as regards the Technological Development
Systems Approach	Knowledge Creation	Mobilising of Actors
Project Follow - Up	External Sources of Knowledge	The initial Extent of Network
Vertical Base of the Project	Creative Processes / Motivation Factors	Translation Strategies utilised
Management Commitment	Project Termination	Technical Artefacts utilised in the Network Building
Communication / Information Structure		The Openness of the Network
Involvement		The Development of the Network
Termination of the Project		Stabilisation of the Technology
Project Evaluation		

Table 9: The construction of my analytical position, including all three theoretical positions, formulated as questions to be applied in the analysis of five case projects

Chapter 4 - Research Method

4.1 Presentation of Methodology

4.1.1 Field Work

The data material is taken from innovation projects run at the enterprise in Moss. All of them have lasted for several years and were done in the period of 1987 – 1995. There is a vast amount of empirical data. I have been working for more than one year to make the data ready for analysis. Most of the time during the field-work inside and outside of the company has been used for in - depth interviews of internal and external actors in the projects, writing case descriptions and doing a comprehensive quality control of the empirical material which had a central role in the entire project.

The field work in each project always started with a thoroughly research of the formal project documentation. Parts of this documentation were especially important to check out, as:

1. The organisation of the project
2. The actors that participated in the project
3. The number of meetings in the executive and the project groups.
4. The goal formulation
5. The project planning follow –up
6. The documentation of the project.

Based on knowledge from the project documentation and on my experience, as participant either in the project group or the executive group, I possessed a fairly good basis for construction interview questions, where the aim was to fill out the knowledge gap and to broaden up the picture about the events that took place in the different projects.

With minor exceptions all participants in all projects have been interviewed. All individuals that were interviewed got the printout of the interviews, from the Dictaphone back for eventually corrections before their approval.

Based on the knowledge from the project documentation and the approved interviews a project description was written for each project. Some central actors from each project corrected this.

As a final element of the field work, central actors at the top management level from both the enterprise in Moss and the parent company have read my analysis of the projects, and have corrected potential misunderstandings or mistakes on my part of events taking place.

The data material, which has been applied for analyses, comes from 5 projects.

Table 10 below shows the type of projects and my involvement in them.

Case Project no	My position in the project.	Type of Project
1	Project manager during half of the project period	Product innovation
2	Member of the project group, project leader during half of the project period.	Process innovation
3	Member of the project and executive group.	Process innovation
4	Project manager member of the executive group	Product innovation
5	Project manager member of the executive group	Process innovation

Table 10: The type of projects and my involvement in them

As the table above shows I had the roles both as an insider and as an outsider during my work with the empirical material, due to my involvement in the projects that were included in my thesis.

The duration of each project varied from 2-8 years. The projects represent a large variety of product and process innovations, and different ways of project implementations. Three of the projects were partly financed by the Norwegian Research Council or the Norwegian Ministry of the Environment. In all of the projects the enterprise in Moss co-operated with external companies. The three actors were included in my fieldwork. A summary is made in table 11.

Project number	Financed by Norwegian Research Council, (NFR)	Financed by the Norwegian Ministry of the Environment	External cooperating parties.
1			X
2	X		X
3	X		X
4			X
5		X	X

Table 11: A summary of the financing of the projects and external cooperating parties

The fieldwork is summarised in the block diagram below.

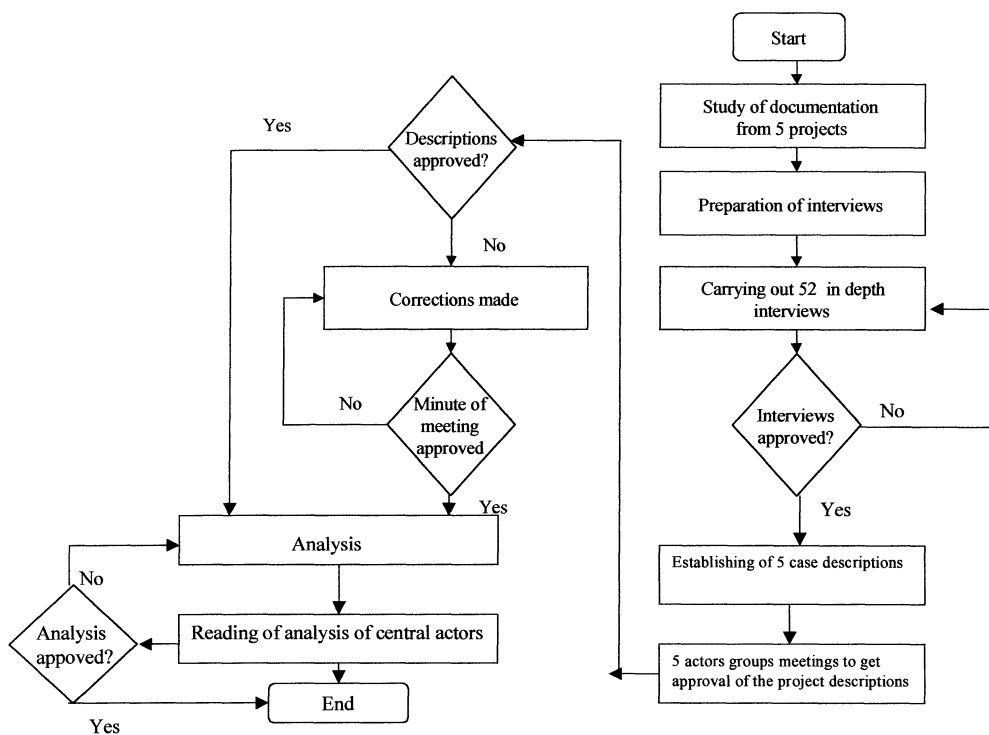


Figure 29: A summary of the field work

4.2 Written Materials

The enterprise in Moss received the ISO 9001 quality certificate in 1992, as the first pulp and paper company in Norway. This system placed a strong requirement on the documentation of innovation projects. Even for projects run before 1992, the documentation of the innovation projects has been, as far as I can judge, very comprehensive. This material has been an important source of knowledge, in order to get an early summary of the processes taking place within each project. Studying the project applications, the progress reports, the correspondence records and minutes from meetings in the project and executive groups have given me insight in important decisions and conclusions made during the project, and the sequence of events during the project.

A Peterson manual of integrated product development has updated my knowledge of our thinking as we developing this manual, and has been a valuable reference in developing the final conclusions in the thesis, STØ (1998).

Reading the organisation handbook of the enterprise in Moss has given me knowledge about the formal organisation at the company.

4.3 Interviews

The other source of knowledge has been interviews of actors that were working either in the project or executive groups or who in other ways were closely attached to the project. All interviews were in - depth interviews with a duration of approx. 2 hours. For all 5 case projects 52 in-depth interviews were done. A dictaphone was used during most of the interviews. Actors from different levels of the organisation, as well as external ones, were interviewed. The interviews were functioning more or less as a basis of conversation between the interview objects and myself. The prepared questions were normally followed during the interviews. However, sometimes the interview might turn into new directions, due to unexpected subjects coming up. The sequence of interviews was carefully planned, in order to verify statements from different interview objects. The interviews were written out of the dictaphone as correctly as possible.

The interviews formed large amount of valuable data material, as shown in table 12

Case Project number	Number of in - depth interviews	Number of pages written out from tape
1	20	60
2	9	45
3	10	39
4	8	30
5	5	27
Total	52	201

Table 12: The number of pages written out from interviews

4.4 My Own Role

Strengths

I have been working in the process industry for the last 25 years. During this period of time I have been working in several organisations within the oil & gas and pulp & paper branches, as a technical expert within these fields, and have taken part in the creation of a new company within IT. During all these years been working with product or process innovations.

At the enterprise in Moss I have had the position as manager of development during the last 9 years. The first two years at the company I was a member of the top management group. From my time of the enterprise in Moss I have gained thorough knowledge about the culture, the norms and values at the enterprise in Moss. I also very well know the individuals I have interviewed. Together with my professional background in pulp & paper this has been a great help in the data gathering, analysing and evaluation of the data material.

Weaknesses

It has been stated earlier in this chapter that I was strongly involved in all of the projects that have been analysed in this thesis. Together with my knowledge about the organisation and the people involved in the projects, I soon realised that this could create a potential weakness in the analysis of the projects, because of problems in treating the empirical material in an objective way. To compensate for a possible bias, a comprehensive scheme of validation was established.

4.5 Analysis of Data

With basis in the written material and print-out from the approved interviews, a process description of each project has been written. Even if all case projects were technical innovation projects, I did not focus especially on technical details. The technology has been described with enough details to show how it appears in a given context, and how it has been interacting with the human actors involved in the case projects. I have tried to describe how different involved actors directly or indirectly influenced the results of the case projects.

My descriptions of the case projects resulted in more than 62 pages of documentation of the processes that have taken place, as shown in table 13.

Case Project number	Number of pages of each process description.
1	19
2	14
3	12
4	10
5	7
Total number of pages	62

Table 13: The number of pages of each project description

Both the case projects and the interviews forming the basis have been thoroughly quality checked for correctness, as described in the following chapter.

4.6 Trustworthiness

As mentioned several times in this chapter I had a central role in all case projects presented in my thesis. I was not a neutral actor in any of them. With this background it was important for me to find good ways of checking the validity of the data material.

4.6.1 Sources of Evidence

Validity discussions of quality research are not easily facilitated, Yin (1994). He focuses on the importance of applying some overriding principles for any data collection, in order to obtain high quality case studies. These include:

- Using multiple sources of evidence, that is evidence from two or more sources, which converge on to the same set of findings
- Creating a case study data base, that is a formal collection of evidence different from the final case study report
- Maintaining a chain of evidence, that is, explicit links between the questions asked, the data collected and the conclusions drawn.

Yin (1994) claims that these principles are relevant to all of the following six sources of evidence, and should be followed whenever possible:

- Documentation, which in this thesis was the formal project documentation
- Records, which in this thesis were the technical specification of a paper machine, the organization manual and the Peterson manual of integrated product development
- Interviews, that in this thesis were 52 in-depths interviews
- Direct observations, which in this thesis covered events in real time and context of events during the interviews
- Participant observation, which in this thesis were observations during the execution of the involved projects
- Physical artefacts which in this thesis were insight in cultural features, technology and technical operations.

As shown above, the data material covered the six sources of evidence suggested by Yin (1994). The three overriding principles, which Yin (1994) claim to be important to any data collection, were fully applied. During the research all six data sources mentioned above were combined to strengthen the conclusions of the findings. The data material also served as a valuable reference data base distinct from the final conclusions of the analysis. Finally, a

chain of evidence was created from the documentation and the records, through the interviews and to the final project descriptions.

4.6.2 Techniques for validity check of the data material

I shall focus on the following three techniques of prolonged engagement, persistent observation and triangulation in order to discuss the validity of my research. Lincoln & Guba (1985) have attached the following meaning to these techniques:

1. *Prolonged engagement* as a way of establishing trustworthiness through spending sufficient time within the research framework in order to understand the context and to build trust. It is focused on the importance of making a prolonged engagement at the location of a research process in order to improve the credibility of data. The logic behind this argument is the importance of getting an improved knowledge about the technology, the organisation of tasks, the key persons and their responsibility, the communication pattern and the organisation culture.
2. *Persistent observation* in order to check out irrelevancies, contradictions and assuring the most important factors of the research context.
3. *Triangulation of data* by using different sources and methods in the research process.

I describe how I used these techniques during my research.

4.6.2.1 Prolonged Engagement

I have been working at the enterprise in Moss for 9 years as a manager of development, and I very well knew the organisation, its culture and the actors involved in my research. The organisation had shown me confidence during my work. However, in spite of this I used more than one year to put all the pieces in the puzzle together to understand the events that took place in the projects involved in my research.

4.6.2.2 Persistent observation

In terms of persistent observation and sorting out important factors in the research, my interviews were partly open-ended. They often took unexpected and interesting directions. In some situations it was interesting to observe the body language, when I slightly pressed the interview objects to continue in a certain direction.

To a certain degree I experienced a communication barrier as the most problematic factor during my fieldwork, when I interviewed some of the actors at the top management level in the organisation at the time when the actual case projects took place. In a few cases the lack of openness resulted in problems in directly checking out the validity of specific statements, or if some actors were mainly using rhetoric or politics. I learned to trust more the data from actors working at lower levels of the organisation. To overcome these problems, I used the method of asking some questions to several actors that I interviewed.

4.6.2.3 Triangulation

To compensate for the situation described above, I used the method of triangulation, in order to improve the probability that my finding and interpretations would be found credible. As described above, six different sources of evidence were applied. Further, an elaborated scheme of quality check was established. This is described below.

Nearly all actors involved in the projects were interviewed. All interviews were quality checked. Each interview was written out as correctly as possible from the tape, and thereafter sent back to the interview object for possible corrections and approval by their signature. This process went mostly smoothly, without any problems. However one actor refused to approve what he had said in the interview with me, and nor was he willing to make any corrections of our conversation. This event was an important contribution to the empirical material. Later, when I had done all the planned interviews about a project, it appeared that this actor was very central, trying to make alliances to stop the project.

A project description was written for each project. To quality check the value as records, I invited central actors that I earlier had interviewed about each case project to a meeting. The discussions in these meetings were of great value, regards the validity checking of the descriptions. The dialogue around the table was sometimes very open and straightforward. I got a clear feedback as to the content of the process descriptions, matters that I had misunderstood, and the meanings which involved actors attached to events that had taken place in the projects.

The minutes from the mutual meetings described above, was approved by one of the actors taking part in the meetings.

The present management at the enterprise in Moss has read through the analysis of the projects in order to sort out any misunderstandings, misinterpretation or mistakes on my part.

4.7 The Openness of the Organisation

It was a requirement from the management at the enterprise in Moss that information given to me in interviews should only be a matter between the interview object and myself. A further requirement was that the case projects had to be concealed to protect individuals in the organisation. Because of this and a confidence showed from the organisation to myself, I felt a high degree of openness during my work with the empirical material. During the interviews and meetings with involved actors, very open and direct messages were given to me. To me this signalled a strong will from the organisation to take part in the project and to eventually learn from it.

The managing director and the director of human behaviour at the enterprise in Moss have been very open and supportive during my research, helping me to get hold of information lacking.

Professor Morten Levin took part in the meeting about quality check of the process description of the first case project, and can confirm this. He was astonished to observe the openness and direct communication in the meeting.

4.8 Concluding Remarks on the Quality of Data

I am confident that there is high probability that the empirical data are credible. The most important factors for achieving this are:

- The large amount of empirical data. In addition to the written material I succeeded in most of the case projects to interview all actors involved, from the top level of the organisation down to the operating level in the mill. They represented a wide span in knowledge about the events that took place during the implementation of the projects. This gave me a possibility for validity checking the empirical data.
- The rigorous validity checking of the data material was a tough, but valuable process. I have learnt what could have been done to make the data material more objective.
- The openness of the organisation at the enterprise in Moss was unexpected. Even if events in some case projects in a historical perspective must have been felt as embarrassing, it seemed that most of the actors really tried to answer the interview questions as well as they could.
- My role as both an experienced outsider and insider gave me an excellent point of departure for my research. My broad experience from working in innovation projects in different organisations within the process industry, together with my knowledge - about the company culture and the actors that were involved my research, my professional background and finally the specific knowledge about the projects, enabled me to create a holistic picture of each case project.

5.0 A Short Description of the five Projects

The complete description of each project, made anonymous to the reader, is presented in appendix. In this chapter a short description is made of each project, with focus on:

- Type of project
- Their most inherent properties, meant to function as a quick reference during the reading of the analysis.
- A short process description
- Achieved project results
- Evaluation of the project results

5.1 *Project no one*

- **Type of project:** Product innovation project
- **Inherent properties:** A paper should be developed. This quality was already a commodity in the market, but new to the enterprise in Moss. The company had to compete against established quality standards in the market. The new paper quality, that was fairly highly priced in the market, made greater demands on a higher and a more even quality that the company was used to before. Greater demands were also made on the technology and on the users that should produce the new paper quality. To succeed, a solid knowledge base was needed regarding product / technology / market.

Key words: radical innovation, high quality product, high product price, high risk of not succeeding.

- **Process description.** One of the paper machines was rebuilt to make it technologically possible to produce the new quality in Moss. The decision to start producing the new product was based on a strategy established by the top management. The innovation process was not run as a project, but as a part of the normal activities in the technical department. No pre-study or pre-project was done. During the first phase of the innovation process, with a duration of three years, the technical department did not manage to

develop a high and stable product quality that could match the existing product qualities in the market. The introduction of the new product to the customers was done before the technical development had started, and the customers were told that Peterson would be a stable supplier of this paper quality.

After a pause of one year, the innovation activities started up again. This second phase lasted for three years. A project and an executive group was established. The project group was working according to the pattern of integrated product development, with actors from the marketing, production and development departments working together in integrated teams. A thorough marketing survey was done shortly after up-start of the second phase of the innovation activities, creating a good knowledge base about the demands of the market on this new paper quality. However, the technical department did not manage to produce a high and stable quality that was acceptable in the market. The project was finally terminated due to low profitability. This was basically due to the need for purchased bleached pulp, and a low production volume giving poor quality.

- **Project result.** This product innovation project was no success. The enterprise in Moss did not manage to develop a Peterson quality of the new product that was acceptable to the market and profitable to the company in the long run, and that was acceptable to the market.
- **Project evaluation.** No evaluation was done to initiate an organisational learning process.

5.2 Project no two

- **Type of project:** Process innovation project
- **Inherent properties:** The goal for the process innovation project was to optimise a process segment in the mill. A process control system should be installed, to establish a screen - based process control. The new technology involved was: a prototype analyser to measure the performance of the process that was not completely developed, a new model based control technology and a new technology based on artificial intelligence. The focus was initially more on R&D than on the implementation of a robust control system to improve the process control on a daily basis. The risk of not succeeding was fairly high in this project.

Key words: Radical innovation, high risk of not succeeding.

- **Process description.** External actors brought in the technology involved in this project to the enterprise in Moss. People in the company did not take part in these discussions, resulting in a reduced ownership at the enterprise in Moss.

A project group with executive and reference groups was established. An external project group participating with the artificial technology did not communicate with very much with the rest of the project organisation. This external project was forced upon the enterprise in Moss by external actors. The results that eventually should be obtained would not be of any interest to the enterprise in Moss. The external actors left the project after a short time.

The Parent company initiated the project. It was not rooted in the enterprise in Moss. The management of the company was not committed. A consequence of this was lack of resources from the basis organisation for participating in the project. After some time the different pieces of equipment got the names of individual actors within the project group.

The operators of the actual process plant were to a fairly high degree involved in the development of the model - based control systems, with the prototype analyser integrated in the control system. All trials were made on-line in the process which at the same time

should produce an output of sufficient quality to a downstream process unit. It was thus negatively influencing the operating process as well, when some of the technology under development failed, influencing the operating process in negative direction. Due to lack of knowledge about the developed system at the enterprise in Moss, it could take some time before external project members managed to put things right.

Very little work was done on the system after configuration and up-start of the project. It gradually became more and more difficult to fix something when failures took place. After the up-start, the project resources were taken away. The interest in the system was not kept alive. This was partly because part of the organisation argued that wrong technology was chosen, that none within the enterprise in Moss had taken part in the choice of technology, and that the enterprise in Moss had very little knowledge about the technology involved in the project.

- **Project results.** The project managed to show that it was possible to obtain the process performance and to run the process in a closed loop mode during short periods of time, but did not manage to make a stable control system that could be applied to keep up the process on a daily basis. The project was thus not a success. The operators however gained a lot of knowledge about their own process through participating in the project, enabling them to operate it in a better way.
- **Project evaluation.** No project evaluation was done after finishing the project to initiate organisation learning.

5.3 Project no three

- **Type of project:** Process/product innovation project
- **Inherent properties.** In this project a new process to treat pulp from the enterprise in Moss should be developed and implemented at either The enterprise in Moss or at one of its associated companies. The R&D work included application of a new type of chemicals, new process conditions and new combinations of process equipment. There was a need to create new knowledge both within the Peterson Group and at the external co-operating partners involved in the project. From an R&D point the project was challenging and scientifically interesting. At the project start of the project the risk of not succeeding was fairly high.

Key words: Radical innovation, high risk of not to succeed

- **Process description.** The project was run as a parent company project. Involved co-operating partners were the enterprise in Moss, a associated company of the enterprise in Moss, research institutes and suppliers of chemicals and process equipment. Within the Peterson group the project had only a weak vertical connection to the enterprise in Moss and a strong connection to the associated company.

The project was divided into two phases:

- A R&D phase where a new process was developed
- A technical phase to calculate the costs of implementation of the new process

Separate project groups were established to implement the two project phases.

The project was run without a steering group in the R&D phase of the project. The project leader also functioned as the steering group. He was reporting progress to the top management within the Peterson group, and kept the contact with the management of the enterprise in Moss and its involved associated company. Further he was writing the project applications and reporting progress in the project to the authorities that partly were financing the project. No pre-study or pre-project was done before up-start of the main project.

The R&D phase of the project lasted for two years. The project succeeded in developing a new process as planned. Internally the project group, including both internal actors from Peterson, suppliers and research institutes, were working very well in teams. The project group lived more or less its own life during the R&D phase, with little disturbances from its environment.

After completion of the R&D work, an engineering study was done in co-operation with several machine suppliers. The purpose was to design a process plant based on the earlier R&D work and the installation costs involved. The financial calculations that were made by the enterprise in Moss, showed that the cost of building a new plant, based on the new developed process, was too high. The project was terminated after three years of work.

- **Project results.** The project failed to achieve one of its goals, to implement a new process plant for treating the pulp within the framework of the project. However, the new knowledge created during the project made it easier to implement a similar process at another Peterson company.
- **Project evaluation.** No evaluation was done after project completion to initiate organisational learning.

5.4 Project no four

- **Type of project:** Product innovation project
- **Inherent properties.** The product to be developed in this project was functionally not new to the market. It was already been produced in a large tonnage in Europe. The enterprise in Moss was aiming at a new and simpler and cheaper process to produce the paper quality, which was new to the company. If the enterprise in Moss succeeded in realising this product idea, it would present a new and interesting product on the market, enabling the company to offer a new high quality product to the market at a lower price than the competitors. The enterprise in Moss had very little knowledge about the product, market and technology for the new product to be developed. To succeed, new knowledge had to be acquired during the project. The risk of not succeeding was fairly high.

Key words: New product technology, high product quality, high product price, high risk of not succeeding.

- **Process description.** The background of the project was a two days creative seminar, arranged by the management of the enterprise in Moss. It was decided that the company should go in for developing a simple and cheap process to manufacture a high performance quality of an existing product in the market. It was further decided at the seminar that the creative ideas resulting from the process, should be kept confidential to the actors participating in the creative seminar.

The first move was to find to run some commercial trials. It turned out that the equipment at the chosen company was not compatible with Peterson's requirements. In this early phase of the project the project group decided that a market survey should be done to uncover needs in the market for the new product. The executive group rejected this, stating that the enterprise in Moss knew the size and characteristics of the market, which the company potentially should penetrate, rejected this. It was further stated that contact with the customers must not be taken on general basis, but should be co-ordinated by the marketing department.

Shortly after the first commercial trials at an external company, a co-operation was initiated between the enterprise in Moss and two of the largest suppliers of raw material to the product to be developed, which should be developed. A secrecy agreement was signed between the enterprise in Moss and the two companies. To sign a secrecy agreement was usual for the large suppliers, and did not restrict their work very much, because of a large internal network and knowledge base within their own companies. For the project group in the R&D phase of five persons at the enterprise in Moss, however, it was different when the members of the group were restricted in the use of their internal and external network. They should only communicate about the project with the executive group, and the two cooperating companies, apart from in their own group.

After approx one year of R&D work, the steering group asked for calculations to be done of layout and installation costs to produce the new product. At this moment the project group was reduced to three persons.

The necessary installation costs were much higher than expected. However the project group only received positive signals. The management stated that the enterprise in Moss wanted to go further with the project, and that a marketing survey of half a year's duration should be started up. Shortly afterwards the project all of a sudden was terminated without any warning.

- **Project results.** The project was not a success. The new product never came into production. During the project most of the technical problems were solved. A lot of new knowledge about the subject was created.
- **Project evaluation.** No evaluation was done after project completion to initiate organisation learning.

5.5 Project no 5

- **Type of project: Process innovation project**
- **Inherent properties.** The project was strategically important in order to meet higher demands from the authorities regarding reduction of the effluents to the sea. The working method that originally came from EPA in USA, was applied at the enterprise in Moss in a large scale as the first one in Norway. The background was an understanding that to reduce the effluents through internal actions were much cheaper and efficient than the traditional end-of-pipe solutions. A success factor for the project was a strong commitment from the top management initiating a strong involvement of the problem owners, to solve problems and to come up with new creative solutions to achieve a demanding project goal. Another success factor was utilisation of external competence, working as a facilitator in the project.
- **Key words: New methodology, fairly high risk of not succeeding.**
- **Process description.** The project was organised with a steering group and a project group. The managing director headed the steering group. It included three external actors, where two of these represented the authorities. It signalled to the enterprise in Moss a new way of working with the authorities as an integrated team, and was a valuable experience to both. The project group had four members. The project leader was an outsider.

An up-start meeting was arranged with participation of the Municipal Manager of Environment in Moss, media, the project -and steering group and key actors within the organisation. This was an important meeting. The managing director was a strong leader of the project. By his involvement he strongly signalled that this project had a high priority and commitment from the top management. The managing director opened up the organisation for the project group, asking it to function as an open network.

During an extensive co-operation between the project group and the rest of the organisation, the cellulose and paper mill were systematically analysed for potential internal sources of reduction of the effluents to the sea. The project leader had agreed with the management that solutions up to a certain economic limit should be implemented as

soon as the project group and the practitioners, that were the problem owners, who owned the problem. through discussions had agreed to do so. This was one of the key success factors in the project. Another success factors were:

- A humble attitude from the outsider, working closely together with the practitioners
- A strong commitment from the management.
- **Project results** This project was a success. The goal of effluent reduction was reached at one third of the costs of traditional end-of-pipe solutions. However, the project organisation did not manage to implement the results in the organisation, so that a lasting environmental – protection system could be developed.
- **Project evaluation.** No project evaluation was done after project completion to initiate organisation learning.

Discussion

It can be concluded from the description of the inherent properties of the five projects that they included new technology. For three of the projects a description is given of the new technology implying radical innovations at the enterprise in Moss. In all projects a fairly a high risk of not succeeding was involved. These features of the projects have implications on how the planning and implementation of them have to be made in order to succeed. This knowledge will be utilised in the analysis of the projects.

6.0 Analysis of five Projects

6.1 Introduction

The empirical material consists of five projects, which have been run at the enterprise in Moss during the period 1987 – 1995. They represent a mixture of process and product development projects.

In this chapter the projects are analysed. Each case is analysed, applying each of the three perspectives in the theory, making up a total of 15 different case analyses.

The five projects within each theory perspective are next analysed and checked for similarities between them. A discussion of the findings is made, linking up to the theory. This is followed by my reflection as to what is important for my innovation model.

6.2 An Analysis of important Characteristics of each Project utilising the Structure Theory.

6.2.1 Project No One

6.2.1.1 Phase One

Project Organising

This project was, according to the established key words above, for the enterprise in Moss a highly innovative project. In spite of this no project organisation was established during the first phase, lasting 3 years. The activities were run as a part of the normal activities in the operating organisation. The consequences of not running the innovation activities within the framework of a project, resulted obviously in no overall control, neither of time and resources spent nor of results obtained during the project according to a project plan. Without a formal project plan, the actions of individual actors were not co-ordinated, and had to some degree the character of being accidental. Without a project organisation external actors were not involved in a proper way, so that they could participate with relevant knowledge.

Systems Approach

In this phase no pre-study or pre-project was done before up-start of the innovation activities, to evaluate if this project potentially would be a business for the enterprise in Moss, with profitability calculations, estimates of what was required to develop a higher quality liner product, a rough marketing survey, and an evaluation of required -technology and competence to produce the product.

The data material shows that the management thought that the introduction of the new product quality was merely a production task of preparation to produce the new quality. They did not realise that any development work was necessary, or that the organisation might need additional knowledge. At the start all involved actors seemed to be optimistic, thinking that this would be an easy task.

Obviously the management's attitude was that it should not cost very much to introduce the new product quality to the market. It seemed to be no strong will to really go in for the new product. At the start of the innovation activities there was a lack of realism regarding the

challenges of obtaining the required product quality on one of the existing paper machines at the enterprise in Moss.

The conditions of the economical calculations done did not change during the innovation activities, mirroring the real situation. No simulations of different economical cases were done. A comprehensive market survey was not carried out during this project phase.

The attitude of the management seemed to be that the market was known, since this product already was a commodity product on the market. To create a more detailed market information to enable the project group to make more accurate profitability calculations and decisions on the technical side was obviously regarded as non-essential. The type of market knowledge could regard the range of acceptable product qualities, any mechanisms between the size of market and the level of product quality, and the level of product quality and product price, the possibility of making a successful product innovation was in reality given by technical constraints after rebuilding one of the paper machines one year earlier.

When I, during my research, started enquiring about details regarding the rebuilding of the paper machine, I had difficulties in getting clear answers. I had to go back to the specifications of the paper machine to draw any conclusions. According to the specifications it was planned to produce the new product after rebuilding the machine, even if this should not be the main product. Pilot trials done at the machine supplier showed that this ought to be possible.

For some reasons these plans were kept secret, and were unknown to others in the organisation than the management. This was probably because of the closed vertical communication structure, and because the main subject for the technical department was to increase the production capacity, and to improve the quality of the existing qualities. This was probably the main reason for not systematically checking the appearance of the test sheets and the specifications of the machine with internal and external actors with knowledge in this area. If this had been done, the organisation would have discovered that the design of the machine was different from design of other machines in the market, which already were producing this product.

Vertical Base

According to the empirical material the strategic thoughts were kept secret to other actors in the organisation than the top management. The strategic thinking was considered to be a top management task. A consequence of the secrecy around the strategy and a poor vertical communication resulted in a lack of a holistic understanding of the innovation activities of involved actors in the organisation, and a reduced motivation to participative.

The secrecy around the strategic thinking of the company had the consequences that the involved actors at the middle and lower level of the origination did not know if the innovation activities were vertical based on the strategy of the company or not, whereas in fact it was. According to the existing strategic thinking one important purpose for rebuilding one paper machine was to enable production of the new paper quality.

Communication

The horizontal communication between the involved actors at the middle and lower level of the organisation was working well, with a fairly high level of informal communication. As the empirical material shows, however, this was not the case at the top management level, where the communication was rather poor between some actors across different functional lines. This signalled a deep disagreement to some actors that were involved in the innovation work regarding the strategic direction of the company. According to the empirical material, it created an uncertainty about the management and whether this was a prioritised innovation activity or not. Under these circumstances an uncertainty about the management commitment was created. There did not seem to exist a common language for communication between some of the actors within the management

In fact, the empirical material shows that the communication across functional lines was so poor at management level that the coordination between marketing, production and development more or less disappeared.

A result of this was that a sales budget of the new product was also planned half a year before the start of technical trials had taken place. Further the new product was introduced to the

company's largest customers at a time when the technical trials had started, and the technical department began to realise the potential difficulties in obtaining the required market product quality. In spite of this the enterprise in Moss promised to its customers that within one year the company would be a stable supplier of the new product.

The full - scale technical trials done on the paper machine gave information about what was required to produce the new quality. Involved actors realised that it would be a problem to use the required raw material specifications on the existing paper machine.

The first phase of the innovation activities was terminated after nearly three years of work. The company had not succeeded in introducing the new product to the customers as promised. That was very embarrassing to the enterprise in Moss. The management formulated the conclusion at a closing meeting:

"We are able to produce the new paper quality. We have no plans to produce the new quality in the nearest future".

6.2.1.2 Phase Two of the Project

The second phase of the project was started up one year after closing the first phase. It must be regarded as an ad-hoc project. The management was motivated for low prices on existing products and an increasing market for the new product at fairly high product prices. It was mainly the sales department that wanted the product.

Project Organising

During the second project phase, the project was more or less run according to a concept of an integrated innovation model. A steering group was established. Comprehensive marketing surveys and economic calculations were done during the accomplishment of the project. A project plan was established with a broad - goal definition and specification, due to uncertainty regarding which product quality it was possible to reach. A close cooperation with one of the company's customers was introduced.

The number of meetings in the steering group was 10 and in the project group more than 28, which was fairly good. It illustrates a much better communication than in the first phase.

Communication

The vertical communication from the management downwards in the organisation was better than in the first phase of the project. However, according to the empirical material it seems that one of the top managers had a tendency to screen information about the project before it reached the level below, having a negative effect on the efficiency of the project accomplishment.

Vertical Base

A new strategy had been made between the first and second phase of the innovation activities. This was also kept secret to most of the members of the organisation. It was not known to the project management that the strategy had been changed, and that the new product was not included any more as a strategic project. According to the empirical material the management was now thinking in other directions of technological development at the enterprise in Moss, which did not include the new product.

It seems to be clear that the second phase of the project did not have a vertical base. The project was running on a weak, slippery and uncertain foundation.

Project Plan

A comprehensive marketing survey was done. The conclusion of this was that our new quality had to be among the best in the market. Only a few product properties could be negotiated. A specification was established, that was a compromise between the qualities that the market wanted and what the project group meant was possible to obtain on the paper machine.

The steering group rejected the specification. It was decided that the company should produce a Peterson quality. This quality should not compete with the best in the market. The quality level could be lower and be sold to a lower price in the market. It was further decided that the new product should be ready for production within one year. This was a signal that only minor technical investments could take place.

The project management of this project was very surprised when it was told not to develop a market quality of the new product, and wondered if the market would accept this approach.

The marketing department was also sceptical. It was known that customers in certain situations wanted to utilise paper qualities from different suppliers in the production of packaging materials. It was then important that the visual properties were similar for the different product qualities. Problems could be expected if we developed a paper quality of very different appearance than the paper from competitors.

During the trials the quality level of the new product was, under pressure from the marketing department, gradually improved to a level close to that the competitors. The consequences of this were higher production costs.

Project Termination

When the project was terminated after a duration of 6 years without reaching the project goal, it was because the management agreed to do that. The company did not manage to keep the required quality. According to the empirical material many factors were not in control regarding the operation of the paper machine. Basically, the product was not profitable any more, due to increasing prices on purchased raw material and low production volumes, resulting in poor paper quality. It was therefore decided not to make the product any more.

When the project was terminated, ordinary sales had been going on for nearly one year. All problems had not been solved, so that the enterprise in Moss would be a stable supplier of the actual product. In line with the empirical material heavy investments on the paper machine were needed.

No evaluation was done, to initiate organitional learning, based on the experiences from the project.

6.2.1.3 Findings

The main findings in the analysis of this project are presented below.

Phase one

- The innovation activities were not run within a project framework
- No innovation model was applied
- A systems approach was not taken – a pre-study / pre-project was not done
- The strategy was kept secret to most employees in the organization
- Poor communication within the management level
- Poor vertical communication
- The management was only partly committed
- Poor co-ordination between the product presentation and the technical development
- The rebuilt paper machine was not designed to produce the new product quality

Phase two

- The innovation activities were run as a project, with an integrated approach
- An innovation model was not utilized.
- A systems approach was partly taken by the project group. A comprehensive market survey together with several profitability analysis were carried out.
- The management decided that the new quality should be a Peterson quality that would be poorer than the market quality

- The main reasons for stopping the project were:
 - The need to purchase bleached pulp at large costs, giving poor profitability
 - Low production volumes, giving poor product quality

6.2.1.4 My Reflections on the above Findings

- In both phases of the project there was a poor climate in the organization for creative work, with a closed communication structure and a strategy that was not communicated to the organization.
- If a pre-project had been done at an early phase within an open system structure, a sufficiently realistic approach could probably have been reached as to what was required to make the new product quality. It would have been more difficult to keep information about that the paper machine was not designed for production of the new product quality as a hidden agenda.
- I argue that an efficient innovation model would not have been of any use in this project. The main reason for the poor co-ordination between the presentation of the new product and the technical trials was poor communication and distrust between central actors.
- A comprehensive market survey was done in phase two with the participation of the company's sales offices in Germany and England, resulting in signals that the quality of the new product most probably had to be high in order to be accepted in the market. It is hard to understand why these recommendations were turned down by the management, who stated that the new quality should be a Peterson quality which was poorer than the market one, and which could be sold to a lower price than the market price. I suggest that this decision could be due to a mixture of the following elements:
 - Poor communication within the management group
 - A too poor creative environment to take these kinds of discussions

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- The technical department knew that it was not possible to make a market quality of the new product on the rebuilt paper machine
 - Prestige had come into the picture on the technical department's side.
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- I argue that a lesson to learn from the project is the fact that it is necessary with a good control of the main raw materials involved in a product, in order to succeed in product innovations. In this project the enterprise in Moss had to purchase increasing amounts of bleached pulp to satisfy customer demands. Only integrated pulp mills with a bleaching plant manage to make the actual product with good profitability over time.
 - Another lesson to learn from the project is that high quality products need long production runs to be profitable. The planned new product quality at the enterprise in Moss was difficult to run. It took longer time to run within specifications. With short production runs, it was problematic to achieve the required product quality.

6.2.2 Project no 2

To the enterprise in Moss this was a highly innovative process development project, with a fairly high risk of not succeeding. The project involved different kinds of new technologies.

Project Organising

The project was a project initiated by the Parent company. It was organised with a steering group, a co-ordinating project leader from the Parent company and three project leaders that were running three different sub projects at the enterprise in Moss:

- An installation sub project
- R&D sub project
- An external R&D project with the aim of demonstrating the new technology, utilising the actual process plant to be optimised. This project was terminated very shortly after project up-start.

To a high degree the project included external actors, both in the R&D and installation phases.

As described above this project had a co-ordinating project leader and three other sub-project leaders. This was not a good solution. As the co-ordinating project leader did not closely follow up the project activities according to an integrated project plan, the consequence was at times sometimes in the project a fight for resources between the sub-project leaders. It seems clear that this arrangement with several project leaders resulted to some degree in an unfortunate spreading of responsibility and reduced the ownership of the problems to be solved and the solutions created at the enterprise in Moss. This argument is based on the fact that no formal discussions between the parent company and the enterprise in Moss took place during the project within the framework of the project organisation. There was for example never held a meeting in the steering group of the project. This may be due to strong disagreements between the parties regarding the own development of the actual process technology at the enterprise in Moss.

The number of project meetings was higher than 15, indicating a high activity level at the project group level.

In this project the external project leader did not have a strong connection to the management level at the enterprise in Moss. According to the data material this seems to have been an important reason for the project failure.

Systems Approach

According to the empirical material, a systems approach was not taken during the initiation and planning of the project. At the start of the project it was not decided that the new developed process technology, if successful, should be implemented. Neither did the project not evaluate if important process variations outside the system limit of the actual process had to be solved first, or if important activities had to be performed before project up-start. The system limits were set too narrow. Later in the project it appeared that it was difficult to create a stable process due to upstream process disturbances outside the chosen system boarder.

As a consequence of the limited system boundaries, the resources needed for implementation were not included in the project budget at the start of the project. The R&D part of the project had the main focus in the project.

During my research I was very surprised to discover the existence of hidden agendas upstream the project, laying important conditions for its accomplishment. These could be traced back to interests within the authorities in Norway to participate in an EU project. In the discussions of whether a project should be started at the enterprise in Moss, not any actor from the enterprise in Moss participated. A natural reaction from central actors at the enterprise in Moss was a reduced feeling of ownership within the organisation to the technology chosen by external actors. The empirical material indicates that nobody in the project organisation in Moss knew the whole story of the hidden agenda, before it was highlighted during my research.

Vertical Base

The project was not vertical based on the company strategy at the enterprise in Moss. It was not mentioned as one of the strategic projects in the strategy plan. Most of the actors in the project organisation did not know anything about it, since the strategy was kept secret to most of the employees in the organisation.

The results of the project were of no use to the enterprise in Moss for its internal production, but it was to an associated company, utilising the product from the enterprise in Moss in its own paper production. The data material indicates that the management in Moss meant that a success of this project, with the obtaining of project goals, would in the long run negatively influence the total profitability at the enterprise in Moss. The project was regarded to be a Parent company project. This can explain why the members of the project organisation felt that this project had a low priority and that the management was not very much committed to it, due to a poor vertical communication between the management and the working groups in the project.

Most of the communication with the management took place via the co-ordinating project leader from the Parent company. He formed the project groups' image of reality.

Application of an Innovation Model

The trials and errors during the R&D part of the project took place more or less on-line on the production equipment. The empirical material indicates that this created frustrating situations among the operators when the equipment did not work. However, no arena was made to discuss about other possibilities to run the project. Such discussions together with choice of technology were made at an earlier stage before project up-start, without the involvement of actors from the enterprise in Moss.

The project was run according to something between an accidental and linear approach, without an efficient innovation model to serve as a guideline during the project accomplishment. It seems to be obvious that the project time was unnecessarily prolonged due to this. However, the course of the project was already laid and the external actors to be

involved were decided upon, when the up-start of the project was initiated, and it would thus have been difficult to create a more optimal way of running the project.

Involvement

The involvement of the users of the new technology was fairly good in this project. A representative from the user group was, in co-operation with the labour union, selected to participate in the project. The operators participated in the design of screen displays and in discussion about developing new technology to optimise the process. However, the empirical material indicates that it was difficult to obtain both a close communication within the project group and with the colleagues each group member was representing. The representative from the users did not always manage to mobilise the large interest with his colleagues for the new technology before it was ready to use.

The data material shows that this is a difficult problem that needs to be solved, in order to utilise the large knowledge base of the users and to get diversity in the discussions.

This was thoroughly discussed in interviews with involved actors. One procedure might be to make these actors more professional in their roles as representatives of the user group of the technology through training them in discussions and team work. This would probably require that the same actors stayed for a longer period of time in their roles as representatives of the users. They could for example be selected on the basis of an internal voting system. The actual choice of participants in this project seems to have been more or less accidental.

Another procedure that was discussed was to create proper conditions in discussions in the project group, to secure that everyone understood the contents of all discussions and really participated in them, through a common language. This would be a challenge to the project leader.

From the empirical material it seems obvious that a proper work to create a common language was not done in this project.

Project Termination

The project managed to show that it was possible to reach the project goal, but only in short periods of time. The project terminated before the results were implemented in the organisation, due to lack of financial resources and interest in the project. The empirical material indicates that there were several reasons for this:

- There was a resistance against the new systems coming from outside and trying to control and optimise the process, which only a few persons at the enterprise in Moss had knowledge about, and where external help was necessary to make any changes. The knowledge transfer process had not gone very well.
- The organisation got three unknown systems to learn and get knowledge from, which were not integrated into one system with a single window towards the operators. This was a problem, especially to the maintenance department with scarce resources, and to the operators, when there were obstacles in the process.
- Part of the organisation argued that wrong technology was chosen, partly because the technology had been forced upon the central actors without their involvement.

No project evaluation was done after project completion to initiate organisation learning from project experiences.

6.2.2.1 Findings

The main findings in the Analysis of this Project are presented below.

- The choice of technology and of external actors to be involved took place up-stream the project without participation of any actor from the enterprise in Moss
- The project was organized with a coordinating project leader with three sub-project leaders
- There was no meeting in the steering group
- The coordinating project leader functioned as an obligatory passage point
- No innovation model was applied
- A systems approach was not taken.
 - Upstream the project it was not decided that the new technology from the R&D phase should be implemented
 - Too narrow system limits were chosen
- The project was not well founded.
 - It was not a strategic project in Moss
 - The administration at the enterprise in Moss was the formal project owner, but was not involved in the project
 - Part of the management at the enterprise in Moss argued that the results of the project could inhibit a further development in Moss
 - According to the management in Moss this was a Parent company project
- The involvement of the users of the technology was fairly good. A common language of communication was not created
- There was resistance against the technology, due to several reasons:
 - Only a few persons at the enterprise in Moss possessed knowledge about the new technology

- The operators had to learn three unknown systems, with different operating windows
- The organisation argued that wrong technology had been chosen

6.2.2.2 My Reflections on the Above Findings

- The coordinating project leader from the Parent company took the initiative to organize this project. Towards the project group he functioned as an obligatory passage point and created the image of reality for this group. I argue that this resulted in an unrealistic view about the chances of succeeding in the project. The possibilities of succeeding would probably have been better if the management at the enterprise in Moss had been integrated in the project and given a role.
- I argue that normally is not wise to organize a project with more than one project leader, due to the chances of reduced motivation, unclear responsibility and inefficient task accomplishment.
- I also argue that the possibility of succeeding would have been much higher if resources for implementing the technology had been included in the resource planning.
- As described above the project was not well founded. I argue that one solution could have been to involve the parent company more strongly together with the associated company of the enterprise in Moss in the processes taking place upstream the project. The strategy of the Parent company should have been applied as the guiding document. If a shared understanding about the actual problems and the proposed solutions proved to difficult to achieve, this project should not have been started up. Other projects could have shown to be more appropriate to run in order to achieve the desired goals.
- A common language of communication was not created in this project. I argue that this limited the involvement of the practitioners. The project management was not aware of the importance of solving this challenging task.

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- There was a resistance towards the project due to several reasons. The lack of knowledge about the technical systems, I argue, that the background was mainly a too little involvement from central actors in the organization at the enterprise in Moss. The three unknown systems to learn for the practitioners, all with different user interfaces, resulted in an insufficient system approach and resource budgeting at the planning stage of the project. I feel that the arguments about that wrong technology had been chosen, easily could have been avoided with proper involvement of actors from the organization at the enterprise in Moss during the upstream activities of the project.

6.2.3 Project no 3

This project was for the enterprise in Moss, according to the established key words, a radical process innovation project with a high risk of not succeeding. The work in the R&D phase of the project took the consequences of this, establishing an integrated type of work form in teams.

Project Organising

The parent company initiated this project. The main co-operating parties were the enterprise in Moss and an associated company in the Peterson Group, chemical and machine suppliers and research institutes. The project was run in two phases, an R&D phase and an engineering phase. The project was partly financed by the Norwegian Research Council. The whole project was accomplished according to linear model thinking.

The R&D phase consisted of a superior project leader from the parent company having mostly a coordinating role in the project, a secondary project leader from the associated company, and a working group with involvement of the cooperating parties described above. The project organization in the R&D phase did not include a steering group.

The set-up of a co-ordinating project leader and a secondary project during the R&D phase was the same as it was the case in project two in the thesis which has already been commented. The R&D project did not include an executive group. The coordinating project leader felt that this was not necessary. He himself functioned as such, and was thus in full control. It was very interesting to observe during my research that most of the actors involved in the project thought there was a steering group in this phase of the project!

During the engineering phase of the project there was an executive group, consisting of members by the two associated companies and the parent company, and the two working groups covering respectively the R&D and the technical parts.

The project was run without the guidance of an innovation model.

In the application to the Norwegian Research Council this project was linked to another project already running at the enterprise in Moss. They were closely connected to each other.

A condition for a success was that the project goals of the other project were achieved. The accounting systems for the two projects were integrated in the reporting to the Norwegian Research Council.

The empirical material shows that it was not wise to integrate an already running project into a new one. It opened up for mixed use of resources. Potential problems could have been created in the follow - up and reporting of progress and costs. The empirical material does not mention any problems in the above area, however.

Another important problem was that the first project was terminated without obtaining the project goals, while the new project was at an early phase. Because of this the new project, did not really have a possibility to succeed, and should have been stopped. This was not taken into consideration of the project management of the R&D phase, and the project continued running according to its plans.

The project application was part of a joint application to the Norwegian Research Council, with participation from most of the pulp and paper industry in Norway. The Norwegian Pulp & Paper Research Institute was the contract partner and figured as the management of the program. The empirical material shows that this kind of joint application might not have been a good solution for NFR. It might have been difficult to the research institution to judge in a proper way the goodness of the program, because of an unknown project management and the organisation of the individual projects. After approval of the joint project the different projects separated with their own project organisations.

Goal Formulation

The empirical material shows that several objectives of this project were presented to the Norwegian Research Council. It is questionable what consequences the different project goals, which partly were contradictory, had for the project result. There was a strong disagreement between the enterprise in Moss and its associated company about some of the goals. It seems that a unclear goal formulation might have influenced the motivation to participate and the progress of the project in a negative direction.

Vertical Basing

The strategy at the enterprise in Moss was unknown to most employees of the organisation. The management at the enterprise in Moss and its associated company did not possess a shared view as to the respective strategies of the companies. It was thus difficult to co-ordinate the action plans of this project in a proper way. The members of the project organisation from Moss did not know if the project was strategically based and given priority.

The empirical material discloses that the project was not well based on the enterprise in Moss. The management looked at the project as a project of the associated company, and was not interested in either covering any expenses during the project or eventually installing a new process plant after completing the project.

It seems obvious that involved actors from lower levels in the organisation at the enterprise in Moss were working in a vacuum in relation to the management, because of a poor vertical communication and a low commitment from the management. Nearly all communication and discussions with the management level went through the co-ordinating project leader from the Parent company.

At the associated company of the enterprise in Moss, the situation was different. The strategy was well communicated to the organisation, and the internal collaboration functioned fairly well.

Communication

The empirical material shows that the very poor communication at the management level between the two associated companies turned after some time out to be destructive for the project. It was not possible to make a positive dialogue to create a common understanding of needed actions to be taken. It was not possible to create a win-win situation for all major actors to succeed in the project.

Systems Approach

A systems approach was not taken in the planning of this project. A preliminary study could have given information if this might be a good business for the Peterson Group or not, and

what the product prices had to be to defend the costs of installation of a new process plant. It took 3 years to terminate the project.

To the project management it was difficult to take a holistic perspective due to the closed information system and strong disagreements within the project. It seemed that a project accomplishment according to linear model thinking, taking one step at the time, was the only way to go.

The R&D part of the project was more or less living its own life. The members of the project organisation from time to time heard rumours about disagreements between the two Peterson Companies. It seems that such rumours only were considered as noise in the R&D work and nothing to bother about. The project group in the R&D phase was more or less protected against negative signals from its environment.

Project Termination

The project was terminated on basis of financial calculations, showing too high costs to implement the solutions. The financial department of the enterprise in Moss did the calculations and laid the conditions of the calculations. These were quite different from what was the point of departure in the project, calculated by the co-ordinating project manager from the parent company. That resulted in a more negative picture of the profitability of the project. One reason why this may happen could be that the two associated companies in the Peterson Group had never agreed upon the foundation of the project

No evaluation was done after completing the project.

6.2.3.1 Findings

The main findings from the analysis of the project are presented below.

- The project was in the R&D phase organized with two levels of project managers
- There was no steering group in the R&D phase
- No innovation model was applied during the project
- The superior project manager positioned himself as an obligatory passage point.
- The project was linked to another project that was already running
- The project application to NTNf was part of a joint application from the pulp& paper industry in Norway.
- The goal formulation was unclear
- The project was not based on the organization of the enterprise in Moss
- There was a very poor communication at the management level between the enterprise in Moss and its associated company.
- No system approach was taken upstream the project to calculate if the results of this project would be a good business
- The conditions of the profitability calculations, which resulted in the termination of the project, were given by the enterprise in Moss.

6.3.2.2 My Reflections on the above Findings

- The superior project manager took the position as an obligatory passage point during the R&D phase of the project, in which he had full control. This changed when the engineering phase started up. In this phase a steering group was created, in which

members from the enterprise in Moss, its associated company and the parent company participated. The project manager came from the enterprise in Moss. The financial department of the enterprise in Moss calculated the profitability on the basis of the financial conditions defined by the enterprise, resulting in the termination of the project. The superior project manager from the parent company lost control when the R&D phase was completed. He did not manage to enroll the management at the enterprise in Moss in his scenario. This was an important lesson to learn from this project.

- A systems approach was not taken upstream the project, to calculate if the project would be good business. I argue that this project would probably not have been initiated had this been done.
- An efficient innovation model was not applied in the R&D phase of this process innovation project. I argue that an experimental design type of an innovation model could have boosted the creative activity.
- This project was closely linked to and depended upon successful results of another project, which was running parallel to it. I argue that this kind of linkage should never have taken place. This increased the risk of this project. When the first project failed to achieve its goal, this project was also in practice doomed to fail.
- The project application was part of a joint application to NTNF from the pulp & paper industry in Norway. I argue that this is generally not wise to do, due to potential problems in evaluating the viability of each individual project.
- The goal formulation was unclear in this project. Several goals were presented in the project application to NTNF. Some of them were contradictory and some were not communicated to all involved actors. I argue that a clear project goal is utmost important to boost project efficiency and to maintain a high motivation during an innovation project.

6.2.4 Project no 4

This innovation project involved a new product technology. The uncertainty and risk of not succeeding was high. In spite of this the project was running with a closed system approach. The company tried to keep the project limited secret within its own organisation and to its external environment in the early phase of the project.

The very background of the project was a two days creative seminar arranged by the management of the company. An external facilitator was invited to lead the creative processes. The intention was to come up with new product ideas for the enterprise in Moss. During the process there emerged an idea of a product, which was new to the company. It was decided that the R&D department should try to develop a simple and cheap product technology to produce the product.

Project Organising

The project was organised from the start with a steering group and a project group of five members. There were four meetings in the executive group, which was low. Most of these took place in an early stage of the project. The number of project group meetings were above ten, signalling a high activity level.

The project was run without guidance from an excellent innovation model.

The project group established a close co-operation with two major chemical suppliers and one machine supplier in Europe. Within this network, the innovation work took place in an open atmosphere focusing on open and direct communication and integrated work in teams.

From the empirical material it seems that a good cooperation between the enterprise in Moss and its external cooperating partners was due to the establishment of a stable network, where close personal relations were created, based on mutual respect and trust.

According to the data material it seems that the management after some time partly lost interest in the project. When the engineering part of the project started up, the number of members in the project group was reduced to three. The size of the steering group was reduced to one person. One manager from the original steering group was pointed out to have

this function. All running communication between the project group and the steering group went through him. Status and milestone reports, however, were distributed to all members of the steering group. There was no creative environment connected to this way of organising the project. Further, with the low number of actors involved, the project could easily be interpreted as an activity of a weak focus, an activity with no purpose.

Systems Approach

According to the empirical material, neither a marketing and competitor analysis nor a technical evaluation was done early in the project. The project organization did not manage to establish a holistic understanding of what was required in the project. During the project it turned out to more and more be a technical project. It was run in a more linear to accidental way. The empirical material shows that this mostly was due to the secrecy around the project, a poor vertical base and strong restrictions in communication.

The linear model thinking is criticised in the theory for its limitation in the executions of innovation projects. However, under the existing framework of poor vertical communication in the organisation as described above, there seems to have been no other alternative than to take a linear approach. The project management had both knowledge and experience in running innovation projects in a more integrated manner. The company's ISO 9001 quality assurance procedure of product design was based on the philosophy of integrated product development. With support of the empirical material I further argue that it was not possible to follow the ISO 9001 product design procedure in this project.

Vertical Base

The strategy of the enterprise in Moss was not known to most actors within the organisation in Moss, including the project manager of this project. However, the empirical material shows that the actual project was initially included as part of the basic strategic direction of the company. However, part of the management gradually lost interest in this project, as described above. The data material indicates that this was partly due to the management partly diversing their attention towards another technological development at the enterprise in Moss, than what was included in the existing strategy.

A situation as described above might be problematic regarding use of resources and giving priority to tasks in the organisation. First, since the official strategy was not known, it could not be an active working tool in the organisation. Second, if a second hidden strategy was known only to part of the management group, this meant that the management was working towards different strategic directions. According to the empirical material this seems to have been the case in this project.

Management Commitment

It was decided that the R&D department should try to develop a simple and cheap product technology to make the product. A low sum of money was mentioned as a limit for how much it should cost to develop the new technology. At this phase an impression was given that it would be easy to develop the actual process. It seems, in line with the empirical material, that these statements were put forward without any technical evaluations or deep reasoning of any kind for what was required to produce the actual high quality product. Coming up with the above statements, the management strongly limited the solution room as to the project group. It seemed to be expected that the innovation process only should take a short time, and that both this and the necessary new product technology should only cost a small amount of money. Involved interviewed actors argue that the limitations set by the management at the idea stage of the project signalled that there did not really exist a will to go in for the new process, and that the approach was unrealistic. Within this framework the message from the management could be interpreted in a way that it was ok to do some testing and to evaluate the results, but not to go in for the new product technology.

The empirical material it further shows that it seemed like a surprise to part of the management when the necessary high costs of new product technology were presented at the end of the project.

The project management did not manage to sense the partly unspoken signals from the management in a proper way, in order to ask for a clearer goal and direction before up-start of the project. The focus of the project management was more on the challenging technical problems to be solved in the project, without trying to take a holistic perspective.

Communication

The management decided at an early stage that this innovation project should be kept confidential. The idea behind this was to prevent companies with a much larger capital base to implement the results before the enterprise in Moss, and to take our competitors with surprise.

A secrecy agreement was signed between the enterprise in Moss and two major chemical suppliers in the actual area. These companies looked at this as a sign of a commitment from the enterprise in Moss' side to go in for the project, demonstrating a real interest, and initiated decisions to allocate time and resources on the project.

The secrecy agreement did not restrict the work within the large chemical companies very much. It seemed that they did not need external contacts in the participation of the problem solving in the project, but were applying their own large internal networks and knowledge base as usual.

The empirical material shows that the secrecy around the project changed focus in the local project group from gaining as much relevant knowledge as possible to what kind of actions that was possible to take in order to keep the secrecy. The members of the project group were restricted in their utilization of their internal and external networks of contacts. The project group was for example not allowed to take directly contact with the company's customers at its own initiative!

The instructed secrecy around the project potential inhibited search for the best ideas and solutions. It was of more harm to the enterprise in Moss than the potential negative consequences if competitors should get to know the project. Mainly due to the secrecy no real marketing survey was done in the project. Without feedback from the market, I argue that the project group could never know if the product specifications were matching the market demands. The background for doing proper economic calculations of profitability was also, for the same reason, uncertain.

According to the empirical material the external co-operating partners in the project took contact with the enterprise in Moss with background in rumours in the market. This kind of secrecy in the project was of no use. The only way the company could have created a lead

was because of competence, rooted in the organisation and the involvement of people that were going to carry it out.

The empirical material shows that during the last half a year of the project the project management got only positive feedback from the management. In a strategy meeting two months before the project was terminated, it was stated that the project was interesting and should continue.

It came as a great surprise to both the project manager and the manager from the top management group who was functioning as an executive group when the project was terminated. A reason could be that the project leader had given the project a higher priority than he should have done, and also underestimated the risk.

The termination of the project was announced in a meeting where according to the agenda further progress in the project should have been discussed.

In line with the empirical material a situation as described above is one of the worst the project management can be involved in. It uncovered that the actors involved in the project had been working hard and applied their competence for nothing. That could result in an unwillingness to participate in future innovation projects.

No evaluation was accomplished after the project was completed to initiate organization learning.

6.2.4.1 Findings

The main findings in the analysis of the project are presented below.

- It was stated by the management, upstream the project, that a simple and cheap process to producing the new product should be developed. Signals were given that it should be an easy task to make this product.

- A systems approach was not taken
 - No market survey was done
 - No competitor analysis was accomplished
 - Necessary knowledge was not created to establish a realistic view as to what was required to make the product

- An efficient innovation model was not applied.

- The management tried partly to keep the project secret.

- Part of the management lost interest in the project after some time

6.2.4.2 My Reflections on the above Findings

- The management asked for a simple and cheap process to produce the new product. The actual room of solution was by these statements reduced. I argue that the signals from the management were that it was alright to do some tests, but not to really go in for the new product. If you go in for a product you have to go for it all the way.

- A system approach was not taken. I argue that the project would not have been initiated if proper knowledge had been sought about the product, the market and the technology to establish a realist view as to what was required. The organization would probably realized that it was too small to start producing this high quality product.

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- The project was run in a linear to an accidental way, due to the secrecy around the project with strong restrictions for communicating together with a poor vertical base. I argue that application of a linear thinking model was the only way in the circumstances described above.
 - Part of the management gradually lost interest into the project. I argue that this was partly due to a too low integration of the management in the project work.
 - The management tried to keep the project partly secret. I argue that strategy is very difficult to follow. The only way to gain an advantage is through competence embedded in the organisation and through actors involved in the project.

6.2.5 Project no 5

This project involved a new methodology for reducing the effluents to sea. The concept called “Cleaner Production” was developed by the Environmental Protection Agency in USA, EPA (1988). The enterprise in Moss was one of the first companies in Norway applying this concept in a larger project. This was one of the projects partly financed by the Ministry of the Environment, with the purpose of achieving new knowledge about “Cleaner Production” connected to the environmental policy - making work of the department. An important condition for succeeding in this project was to strongly involve the organisation in the project. This was a challenge to the project organisation, in relation to the hierarchical and functionally based organisation structure at the enterprise in Moss. The risk for not succeeding was considered by some actors within the organisation to be fairly high.

The project was organised according to an experimenting design approach, with mutual reflection and learning as important elements. This functioned very well in order to achieve some of the desired goals.

Project Organising

An executive group was established, headed by the managing director of the company. The group involved external participations. Among these were participants of the Ministry of the Environment, the Norwegian Pollution Control Authority and from Oestfold Research Foundation. According to the empirical material it was important for the Department of Environment to go actively into the project as a user.

Obviously the close co-operation that was established between the enterprise in Moss and the authorities was important in many respects. First, both the enterprise in Moss and the authorities could be looked upon as problem owners. Peterson had to find new and more cost-effective solutions to its pollution problems. The authority wanted to change their environmental policy, and was thus in a searching phase. Both parties were actors in a mutual learning system.

The close co-operation in the steering group opened up for a more open and better relationship between Peterson and the authorities, than what had been the case before.

A small project group of four members was established. The actor selected to be the project manager was an outsider. A working group was established, including practitioners from both the pulp and the paper mill. It was planned that much of the work should be done in a mutual dialogue with actors in this group.

The data material shows that an important factor for achieving success in the project was that the project manager was an outsider who had a broad experience from other organizations and that did not have any ties to the existing culture. The company was used to think in line of traditional end-of-solutions to reduce the effluents from the company. The aim of the project was to achieve the project goal through as many internal measures as possible and through a mobilizing of all creative forces at the company. New thinking was required.

Management Commitment

The empirical material discloses that a condition from the Ministry of the Environment for financing this project was a strong commitment from the management at Peterson. In an up-start meeting the managing director strongly fronted the project. In this meeting the municipal manager of environment in Moss participated, media, the project and executive group and key persons at the enterprise in Moss. The managing director presented the project goal, which was very demanding, and asked the organisation to focus on achieving it. He opened up the organisation that the project group should be allowed to search any where for knowledge anywhere in the organisation.

This was an important meeting. The way the managing director involved himself in the up-start meeting strongly signaled to the organization within the enterprise in Moss and its external environment that this project had a high priority and a strong commitment from the top management. Doing this he aimed at giving the project the best possible working conditions.

Goal Formulation

The project goal was very demanding. As the empirical material shows it was both precise and broad. The goal was precise in the way that everyone understood what were the results to

be achieved in the project, and was broad in the way that it was not broken down into detailed sub-goals. The management in this way kept the room of solution open for the project group and the rest of the organisation to find the proper measures for achieving the project goal.

The empirical material shows that the demanding project goal was determined on basis on intuitive feeling. No calculations were done beforehand. It seems that the management was afraid of stretching the goal to avoid the risk that the organization could feel that it was unattainable and loose confidence in the project.

Systems Approach

No pre-study or pre-project was done at the start of this project. During the project, however, a holistic approach was taken as a dynamic process, when the project group moved from area to area in search for internal measures to reduce the effluents. At each step the system was described, to achieve a common understanding of the situation.

In line with the data material it would be of limited value to do a pre-study or pre-project early in this experimental design project. The project was a continuous learning process, starting with an undetailed and not a detailed specification. The road to the project goal was found during the innovation process. To take a systems approach during the project, with openings for unexpected discoveries and change of direction, was a key factor for succeeding.

Communication

The project was vertically based, which was made visible in the up-start meeting. The enterprise in Moss had to meet requirements on the effluent side from the authorities. The environmental policy also stated that the environmental problems should be solved by internal measures. In line with the empirical material the management realised that beside a strong commitment from their side the whole organisation had to be involved. The project managed to establish a well - functioning network communication structure, creating short and direct links between the project group and the rest of the organisation.

Many actors were strongly involved and participating in this project. According to interviews done during my research, this time they were was mostly due to the fact that they were taken seriously and invited to participate as valuable resource persons. They felt a real ownership to the problems and solutions identified, and to the following implementation of the solutions in the process. This project would not have succeeded without the strong participation from highly competent practitioners at the enterprise in Moss.

Project Results

The project group managed to achieve the project goal regarding effluents from the mill, and at a cost of one third of the costs of traditional end-of-pipe solutions. The project was thus a great success. However, the company did not succeed in achieving the second goal in the project, to implement a durable environmental protection system, based on the principles of Cleaner Production. This system should give continuous learning and improvement. From a management perspective the project group stopped the project too early. The involved actors disappeared and got other primary tasks. A long enough time perspective was not given.

Probably the only way of implementing the project results in the organization would have been to do it through a systematic innovation system, included in the ISO 9001 product design procedure, in the company's budget and the company's strategy, values and norms together with a strong commitment from the management

6.2.5.1 Findings

Main findings in the analysis of this project are presented below.

- A steering group was created with participation from the environmental authorities and from Oestfold Research Foundation, which turned to be an arena for close co-operation between the members of the group.
- A small project group was created with an outsider as the project leader.
- The project was organized as an open network and run according to an experimental design approach
- The managing director signaled a strong commitment to the organization
- The project group was given clear goals to achieve
- The practitioners were strongly involved in the project.

6.2.5.2 My Reflections on the above Findings

- I argue that the participation of the above external actors was extremely important to create an arena of great diversity and creative conflicts. The members co-operated closely to achieve the best possible project results. The group managed to communicate strong and clear visions and goals of the project to the project group.
- In this project I argue that it was important that the project manager was an external actor. As this project was an action research project with a strong need for new creative solutions, the external project manager could play on other types of professional knowledge and experience. He was further not tied up with the culture and ways of thinking at the enterprise in Moss.

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- Organizing the project within the framework of an open network with short and direct links, created an arena for large diversity and creative conflicts during problem - solving discussions. I argue that this was one of main success factors in the project.
 - When the managing director signaled a strong commitment in the kick-off meeting and asked the organization to achieve a highly ambiguous project goal, nobody could lean back and argue that the project tasks were not important.
 - The practitioners in the mill were strongly involved in the project. I argue that the main reason was because they were taken seriously and openly listen to, and because the project management took a humble attitude.

6.2.6 Analysis of important common Characteristics of the Projects on Basis of the “Structure” Theory.**6.2.6.1 Introduction**

At the end of the structure theory my analytical position was presented as key success factors to be utilized in the analysis of the projects. In the matrix below the headings describing the characteristics of the projects are taken from the short project descriptions in chapter 5.

My analytical position was presented at the end of the structure theory as important success factors. These are the same as the questions representing the ordinate in the matrix below. The answers to the questions for each project are representing the abscises in the matrix, which are the results of the findings from the analysis of the projects.

6.2.6.2 A Summary of Characteristics of five Projects –utilising the Structure Theory

Project number	1	2	3	4	5
Type of project	Product Innovation	Process Innovation	Process Innovation	Product Innovation	Process Innovation
External financing	No	Yes	Yes	No	Yes
Key words	Radical innovation, high quality product, high product price, high risk of not succeeding	Radical innovation, high risk not succeeding	Radical innovation, high risk of not succeeding	New product technology, high quality product, high product price, high risk of not succeeding	New methodology of Project accomplishment, Fairly high risk of not to succeeding
Project duration?	6 years	3 years	3 years	2 years	1 year
Project Organising					
Steering group?	In second project phase Number of meetings: 10	Yes. Number of meetings: 0	Yes. Number of meetings: 3	Yes Number of meetings: 4	Yes Number of meetings not documented
Project group?	In second project phase. Number of meetings:>28	Yes. Number of meetings:> 15	Yes. Number of meetings: 7	Yes. Number of meetings: 11	Yes
Ref. group?	No	Yes	No	No	No
External actors involved?	Yes	Yes	Yes	Yes	Yes
Any innovation model utilised?	No. Integrated approach in the second phase of project	No. Linear to ad-hoc approach during the project	No. Linear to ad-hoc approach during the project	No. Linear Approach during the project	No, but integrated approach during the project
Systems approach					
Pre-study?	No	No	No	Yes	No
Pre-project?	No	No	No	No	No
Proper economic analysis done?	In second phase of project	No	In engineering part of project	In engineering part of project	Yes
Project follow - up					
Project plan?	Not in the first phase of project	Yes	Yes	No	Yes
Goal formulation					
• Clear?	Yes, in second phase of project	Yes	No, multiperspective goals	No	Yes
• Broad?	No	No	Yes	Yes	Yes
• Detailed?	Yes	Yes	No	No	No

Project number	1	2	3	4	5
Type of project	Product Innovation	Process Innovation	Process Innovation	Product Innovation	Process Innovation
Key words	Radical innovation, high quality product, high product price, high risk of not succeeding	Radical innovation, high risk off not succeeding	Radical innovation, high risk of not succeeding	New product technology, high quality product, high product price, high risk of not succeeding	New methodology of Project accomplishment, Fairly high risk of not succeeding
• Long term/short term	Short term, developing through whole project period	Long term, valid through the whole project period	Long term, results should meet future requirements	Short term, developing through the project period	Long term, should secure durable org. learning
Specification?					
• Broad?	No	No	Yes	No	Yes
• Detailed?	Yes	Yes	No	Yes	No
• Long term/short term?	Short term, developing during project	Long term, valid through the whole project	Short term, developing during project	Short term, developing during project	Short term, developing during project
Vertical base					
Strategy in Moss known in org?	No. Not to most of the employees	No. Not to most of the employees	No. Not to most of the employees	No. Not to most of the employees	No. Not to most of the employees
Strategy a working tool in organisation?	No	No	No	No	No
Project a part of the given strategic projects?	Not in the second phase of project	No	No	Yes	Yes
Employee participation in the strategy process?	No	No	No	No	No
Strategic goals made operational?	Yes, partly, but unknown to the organisation	No	No	Yes, partly, but unknown to the organisation	Yes, partly, but unknown to the organisation
Management in Moss committed?	No	No	Management was only partly interested in the project	Management was only partly interested in the project	Yes
Communication/information structure					
Vertical communication?	Poor	Poor	Poor	Poor	Good
Horizontal communication?	Good at project org. Poor to moderate at management level.	Good in project org. Moderate at management level	Good in project org. Poor at management level	Poor	Good

Project number	1	2	3	4	5
Type of project	Product Innovation	Process Innovation	Process Innovation	Product Innovation	Process Innovation
Key words	Radical innovation, high quality product, high product price, high risk of not succeeding	Radical innovation, high risk of not succeeding	Radical innovation, high risk of not succeeding	New product technology, high quality product, high product price, high risk of not succeeding	New methodology of Project accomplishment, Fairly high risk not succeeding
Informal communication?	Very much at first phase of project	Much	Much	Much	Very much
Information about project int/extern?	Good	Poor to moderate	Poor to moderate	Poor	Good
Involvement					
Degree of involvement of practitioners?	Poor from lower level of organisation	Moderate to good	Poor	Poor	Good
Marketing survey done?	Not in the first phase of project	No, due to internal supply of product	No	No	No, because this was an internal process
Project results	Failed to reach the project goal	Failed to reach the project goal	Failed to reach the project goal	Failed to reach the project goal	Partly a success
Termination of project					
Termination before achieving project goal?	Yes, at end of first phase. Results obtained in phase two	Yes	No, R&D goal reached	Yes	No
Termination before implementation of results?	Yes	Yes	Yes	Yes	Yes
Project evaluation?					
Any project evaluation done after finishing the project?	No	No	No	No	No

Table 14: Summary of characteristics of five projects – utilising the structure theory

6.2.6.3 Construction of Histograms

In this chapter the five projects analysed together to evaluate potential common characteristics. The matrix of analysis presented early in this chapter is utilised for this purpose. The responses of all projects together to the different questions in the matrix are given a quantitative measure. I have chosen to present common characteristics between the projects by simple graphical tools.

The response of each project to one of the chosen questions in the matrix is either given the mark 0, 0,5 or 1. A mark of 0,5 is given in the case a positive answer to a question only is partly valid for one part of a project, for example for one phase of the project. The separate marks are summed up within the range 0 – 5 to include all five projects.

The average is calculated from each group of questions in the cases where several questions are included in one group. The figures are presented in a histogram to give a rough overview of similarities between the projects. They give information both about the average quality of the responses for each group of questions, and the degree of homogeneity between the projects.

Project Organisation					Systems Approach			
How many projects had an Executive Group?	How many Projects had a Project Group?	How many Projects had a Reference Group?	How many Projects involved external actors?	How many Projects utilised an Integrated innovation Model ?	How many Projects did a Pre-Study?	How many Projects did a Pre-Project?	How many Projects did an Economical Analysis?	How many Projects did a marketing Survey?
4.5	4.5	1	5	1.5	1	0	2.5	0.5
Average mark: 3.3					Average mark: 1			

Project Follow - Up	Goal Formulation			Specification		
How many Projects did have a Project Plan?	How many Projects had Clear Project Goal?	How many Projects had a broad Project Goal?	How many Project had a detailed Project Goal?	How many Projects had a broad and minimum Specification?	How many Projects had a detailed Specification	How many Projects had a Short term Specification developing during the Process?
3.5	2.5	3.	2.	3	2.	4.
	Average: 2.5			Average: 3		

Vertical Anchoring	Commitment	Vertical Communication	Horizontal Communication	Horizontal Communication
In how many Project were the Strategy known in the Organisation?	How many Projects had a good Management Commitment?	How many Projects had a good vertical Communication?	How many Projects had a good horizontal Communication at Management Level?	How many Projects had a good horizontal Communication in the Project Organisation?
0	1	1	1.5	4

Involvement	Termination of Project		Project Evaluation
In how many Projects were the Practitioners involved in a proper Way?	In how many Projects were the goal achieved before project termination?	In how many Projects were the Results Implemented before project termination?	In how many Projects were Project evaluations done?
2	2	0	0

Table 15: Tables for construction of histograms

The results of the calculations are shown in the three following histograms and are used for a further interpretation of the graphs.

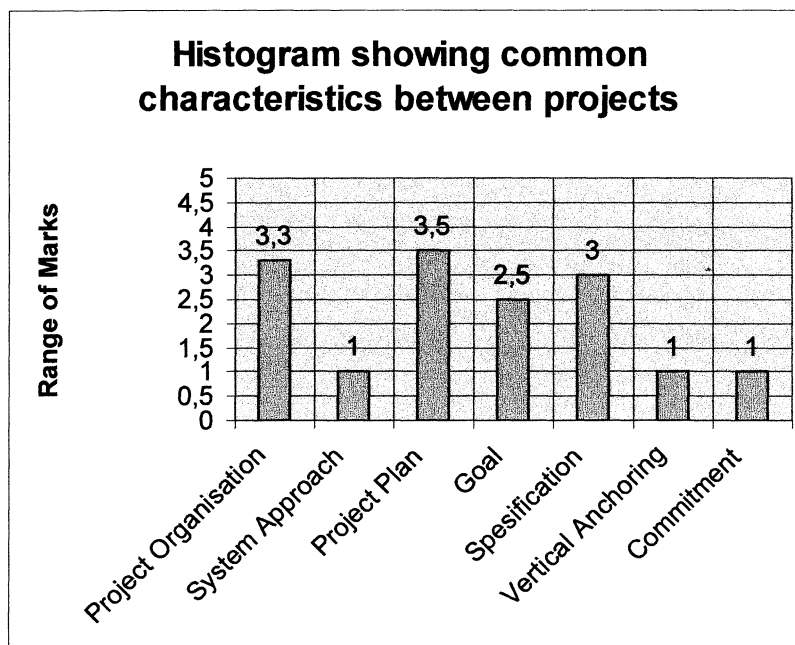


Figure 30: Histogram showing common characteristics of projects – structure theory

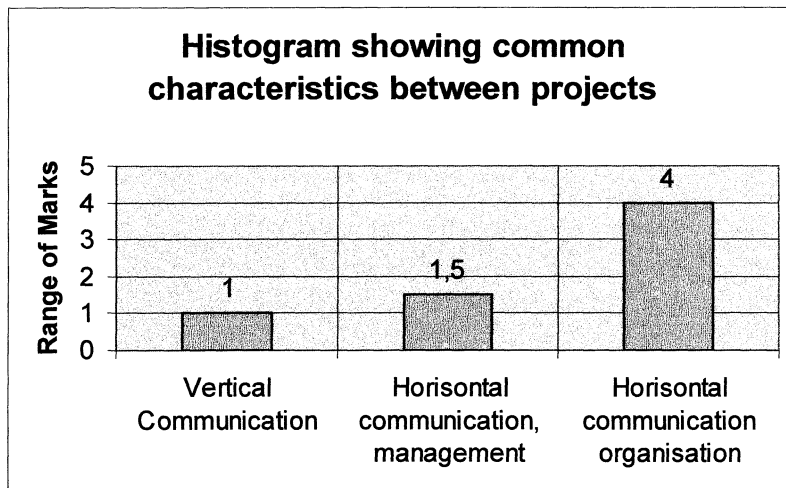


Figure 31: Histogram showing common characteristics of projects – structure theory

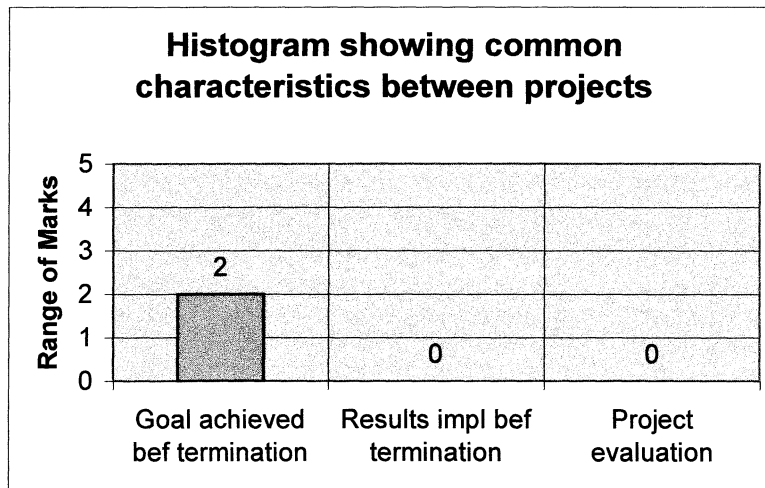


Figure 32: Histograms showing common characteristics of projects – structure theory

6.2.6.4 Conclusion

The diagrams above give a picture of similarities between the projects. With basis in the sociotechnical structure theory, a discussion of similar characteristics of the projects is given.

Project Organising

The majority of projects had a project organization with a project group and a steering group, possessing the characteristics of a project, as claimed by Kolltveit & Reve (1998): an own goal, activities of low frequency and limited time and resources. They argue that the organisation form could change from organic to more mechanistic forms during the progress of a project, when it was moving from a creative stage to a more systematic one. Such a change in the project organisation did not take place in any of the projects with exception of project number 5. The four other projects are missing an early creative phase.

In contrast to the other projects, project number five can be characterized as a process of continuous shifts between a creative and systematic approach, as implementation of technical solutions took place during a large part of the project. Further, project number five, with its strong focus on creative activity, was organized as an open network project. According to the empirical material, this was a key factor to explain why this project was a great success. Kirkegård, Ryding & Aagård (1996) argue with reference to Bang & Olufson about the usefulness of applying a network organisation in the context of creative problem solving. A professional base organisation is established, but at the same time the involved actors look up for different task in all directions.

The product innovation that had the longest duration was during its first phase not run within a project framework, but as a part of the normal work in the operating department. As a consequence, a goal formulation was not made in this phase. This was unfortunate, reducing the motivation for participating in the work.

As described above, the majority of projects were organized with an executive group. However, the empirical material shows that only a few steering – group meetings took place in all of the projects, and no meetings in project no two. This could indicate that a reduced management control and coordination of the projects took place. According to Trist (1981), the sociotechnical thinking implies a focus on coordinating functions and on control at agreed

milestones, in order to enable the desired level of self-control within the project group. This is in line with the thinking of Andreasen & Hein (1985) of integrated product development as a process of many parallel creative activities, controlled at milestones at the end of specified phases.

According to the empirical material it seems that the enterprise in Moss, except for project no 5, strongly focused on the technical system and less on the social system. With basis in weak and unclear goal formulations in half of the projects, the attitude to some degree has been to examine what is possible to develop within the framework of the existing production machinery. Andreasen & Hein (1985) and Rommel, Kluge, Kempis, Diederichs & Bruck (1995) argue for the importance of a clear commonly understood goal formulation to enable realistic planning, to maintain a high motivation of involved actors during the project, and to secure that all disciplines are aiming towards the same goal.

The projects no 2 and 3 were organized with two levels of project managers. This was unfortunate in these projects, and seemed to some degree to reduce motivation, create unclear responsibility and inefficient task accomplishment. The overall project manager had taken the position as an obligatory passage point and was controlling the information flow. There was no doubt that he was the boss when he participated in project meetings, even if the responsibility to run the project activities was delegated to the other project managers.

According to the literature the project manager has an important role, especially in the up-start phase, in the planning of the project. He is responsible to the owner of the project. The areas of his responsibilities have to be clearly defined, belong according to the literature to one person, Kolltveit & Reve (1998).

Project no three was organized together with another project, which was already running. This is in line with the principle of simultaneous engineering, Scheer (1994). This is, however, normally a poor strategy to follow, when the results of the two innovation projects involving a high risk of not succeeding are dependent on each other, as was the case with the projects no two and three.

Application of a Systematic Innovation Model

The analysis of the projects showed that a systematic innovation model was not applied in any of the projects. In three of five cases the projects were run according to something between an accidental to a linear approach, and in the remaining two cases with an integrated approach. However, due to poor conditions in these projects as regards the vertical communication, the vertical base and the knowledge about the strategies, it is not certain that it would been possible to apply an efficient innovation model, as a model of integrated product development, in any case. According to Rommel, Kluge, Kempis, Diederichs & Bruck (1995) the process of integrated product development calls for combining know how and competence across functional and hierarchical limits.

Stevens, Burley & Divine (1999) argue that it is essential to boost productivity and speed of the product development process to let the creative people work within the framework of excellent product development model. If not, they claim, the creative activity might lead to destroying value instead of creating it.

The analysis of project no five demonstrates that innovation projects require different types of innovation models, very much depending on the creative content and uncertainty in a project. In project no 5 with its large content of creative activities, an innovation with an experimental design approach was appropriate to apply.

Systems Approach

The above histograms show that the systems approach has been very low in all five projects, and a holistic perspective was not taken in order to establish the right system boundaries.

Proper calculations were not done upstream any of the projects to examine if the actual innovation project could result in a successful business for the enterprise in Moss. Neither were a pre- project, a pre-study or a market survey done upstream any of the projects. Economic analyses were done in three of the projects. Resources were not included in the project budget to implement the results from the R&D phase.

It is strongly argued in the literature that a high quality of the accomplishment of the first few stages in a product development process is critical to obtain a successful outcome, Rommel, Kluge, Kempis, Diederichs & Bruck (1995) & Steven, Burley & Divine (1999). This is in line with a thinking model of Andreasen & Hein (1987) who are focusing on the fact that often few resources are spent at the early stages of a product development project, when the main part of the project costs are allocated.

Vertical Base

The vertical base was poor in four out of five projects. None of the existing strategies were known to most of the employees at the enterprise in the organisation, covering the time period of nearly 10 years when the projects were run. Only in three of four projects the projects could be said to be included in the actual strategy plan. In these cases the management made, without the knowledge of the rest of the organisation, the strategies partly operational with regard to innovation projects.

Porter (1998) claims that in order to achieve the strategic goals within the technological field, action plans are defined regarding the execution of change processes. According to this, action plans for organizational development have to be included, to make the technological changes come about. To succeed in technological innovations, an open communication about the strategy and involved processes is critical. Cooper & Kleinschmidt argue that a well-communicated strategy is one of the key factors for succeeding in product development.

In four of the five projects the vertical communication was poor. In the same project the management commitment was poor. According to Stevens, Burley & Divine (1999) a reason to this could be a lack of a systematic innovation model in the projects. In project no 4 the secrecy of the project could be another factor for explaining the communication structure, resulting in a prohibition of the project group taking contact with the customers, This thinking is totally against the principles of integrated product development (1986), and hampers the process idea searching and idea selection process upstream the project.

Rommel et.al. (1995) argue that an integrated model of product development couples development strategy with corporate strategy through vertical integration, securing a strong

Rommel et.al. (1995) argue that an integrated model of product development couples development strategy with corporate strategy through vertical integration, securing a strong commitment from the management. Andreasen, Hein, Kirkegård & Sant (1989) argue that a continuous goal and plan structure have to be created, to establish a vertical integration between the business ideas, the strategy plan and the short term plans.

Project Termination

The analysis of the empirical material has shown that, in three of five cases, the projects were terminated before the project goal was achieved. All projects were terminated before the results were implemented in the organisation.

The first reason for a reduced accomplishment of projects was the lack of resources. The analysis shows that actors working on a project had been given other tasks to prioritize before, or when they achieved the technical goal. However, this is a management responsibility, to apply the necessary long-term thinking with a holistic perspective in product development, and to prioritize the resources accordingly. According to Utterback (1994) it is critical for managers of both technological and organizational development to understand the mechanisms behind the development of an industry, the dynamics within it, and the role of product and process development.

6.2.6.5 Major Findings for My Innovation Model

Below I have listed elements from the conclusion above which will be important to my innovation model.

1. An early creative phase has to be included in innovation projects. This argument is based on the fact that both a product or a process innovation represent something new. Before a product idea is concrete enough to start the systematic development of a new product, an upstream creative phase has to take place. This phase includes idea generation, idea screening and concept development of the most promising ideas. Excluding an early creative phase in an innovation project, may result in solution of

irrelevant problems, a high risk at up-start of the main project, and a reduced efficient and more costly project execution.

2. The way of organizing a project have to depend on the creative content of the project or project phase. This argument is based on the differences in the levels of uncertainty and openness in the solution room in these two phases.

Phases of a high level of creative content are commonly dynamic of character and require the existence of an open flow of knowledge. A proper organizing of the work could be to organize according to a dynamic and open network.

At the start of the systematic development of a new product, the room of solution is normally drastically reduced with little possibilities of creativeness left. The aim is to develop a particular product as efficient as possible. To do the systematic work, organizing according to a mechanistic way of organizing could be more appropriate.

3. A project should normally be organized with an executive group and a project group with a project manager, with clearly defined tasks and responsibilities of the two groups. This is to emphasize the importance of maintaining a proper framework during a project, where all rules of the game are known to all involved parties. The main purpose of this is to secure an efficient project execution with an agreed control of progress, and to avoid unnecessary discussions based on misunderstandings and uncertainties.
4. The creative phases of a project requires project managers with different personal characteristics. This argument is based on the project character of the creative and systematic phases of a project. An proper project manager of a creative phase may be an actor who is supportive and open, who is good in coaching and in arranging different tasks, and who has creative skills. Appropriate for a systematic phase may be an actor with a more systematic personality, and who is strong in direct control of progress and as an implementer. These two different required personalities may be difficult to combine in one person.

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5. A clear and commonly understood and accepted goal formulation is important in order to succeed. This argument is based on the instrumental function that a clear and accepted goal has to give the direction at the initiation of an innovation project. The importance of the existence of a clear and accepted overall project goal is proportional to the creative content in a project. In project phases with a high creative content a clear and demanding goal may function as a strong intrinsic motivation factor, and may be the only guidance in the absence of proper specifications in these phases.

While keeping the overall project goal fixed, it may be necessary to change the sub-goals of an innovation project several times due to creation of new knowledge during the project. From this I argue that the creation of a detailed and long term goal structure should commonly be avoided in innovation projects.

6. The principle of connecting several projects running in parallel should be utilized with care in cases of high uncertainty and risk involved. Initiation of a project should not be made dependant on the success of another innovation project, which is already running and not completed.
7. An integrating innovation model should be applied in all innovations to guide the project execution. It has to cover both the creative phases of an innovation, due to its important functions in the both phases of the work. The innovation model must not be too rigid, but sufficiently flexible to match different type of innovation projects. During a creative phase of a project, experimental design approach of a model, based on simple rules of behavior, could be appropriate, while the systematic phase can require a more rigid model approach. Evaluation of the project results should be an integrated part of all types of integrated innovation models.
8. A systems approach should always be taken upstream an innovation project, to calculate if the project will be a good business, to establish the proper system limits of the project, and to plan for both the creative and systematic phases, including the implementation of the project results.

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9. Direct links between the project group, good customers and potential other important potential external network resources should be established. This argument is based on the importance for the project group to receive firsthand and not filtered information from important cooperating actors.

 10. The development strategy must be coupled with the corporate strategy through vertically integration, in order to secure commitment in the organisation to put to work an actual innovation project. From this I argue that an innovation project should not be initiated if it is not included in the corporate strategy.

 11. A well communicated strategy is one of the key factors for success in an innovation project. This argument is based on difficulties which may appear to know the legitimacy of the knowledge created during an innovation project, if the overall direction of the enterprise not is known. The communication of the strategy should be attached to the communicating of the overall project goal.

6.3 An Analysis of important characteristics of each Project utilising the Theory of Knowledge Creation.

6.3.1 Introduction

The five projects that are included in the empirical material are analysed from a knowledge creation perspective. The aim of the analysis is partly to evaluate if conditions were such that they enabled knowledge creation to support the innovation process.

Another aim with the analysis is to evaluate if the existing knowledge structure has been sufficient to match the project requirements. If this is not the case, it could obviously be difficult to terminate the project or alternatively irrelevant problems are solved, or wrong decisions taken during the accomplishment of the project. It could also be difficult to evaluate if the actual innovation project is a good business for the company, if the required creative environment is not there.

Creation of new knowledge through learning during the innovation process only is often not sufficient. A certain amount of relevant knowledge has to be present upstream the main project, if the right decisions shall be taken at the early stages of an innovation project.

The analysis of each project is concluded with a list of the main findings from the analysis and my reflections on these findings.

Finally, a concluding discussion is made including all 5 projects, utilising the theory about knowledge creation.

6.3.2 Project no 1

6.3.2.1 Reducing Uncertainty

Pre - Project

The data material shows that this project represented to the enterprise in Moss a radical innovation, with a high required product quality and with a high risk of not succeeding. In spite of this, a pre-study or a pre-project was not done in phase one, to get a realistic approach to what was necessary in order to achieve the required quality and to check out the level of relevant knowledge at the company.

It is earlier argued that it is important for a company to possess a satisfactory amount of relevant knowledge upstream and in the early phases of the main project. It was shown in the structure theory that about 80 percent of the product costs are allocated in these phases of the project, Andreasen & Hein (1986). It is therefore essential to apply sufficient knowledge to do a proper job at this stage.

It was said in the executive group in phase two of the project that the product should be ready to be presented in the market one year after up-start of second phase. From this message it could be understood that no technical development should take place. Obviously this was a message from the management that the introduction of the new product quality should be based on the existing knowledge. The management meant that it was not necessary to do any pre-study or pre-project.

The low priority of R&D work was obviously due to the fact that the technical department believed that it should be easy to develop a product quality at the enterprise in Moss that the customers would accept. The introduction of the new product quality was viewed as a pure production task

The process of developing a new product quality was not run within a project framework in the first phase, but as a part of the normal operating activities in the paper mill. In the second phase it was partly running according to a more integrated mode.

Early in phase two of the project a thorough market survey was done as part of a pre-study to gain more knowledge about what was required to make the new product. In order to reduce the uncertainty about the product quality properties, a detailed specification for the new product was then worked out on the basis of the market survey. A compromise was made between what the marketing department wanted the quality to be and what the production department thought was possible to produce.

Specifications

Phase One of the Project

A technical specification was made late in phase one, shortly before the technical trials started up. The empirical material shows that the specification was mainly made on basis of knowledge of potential competitors of the product, established through visits to some Swedish and Finnish pulp & paper companies. From then on the uncertainty about the product and how to produce it were reduced.

A detailed specification was made as a starting point to do four full-scale technical trials on one of the paper machines. The data material shows that this strategy was mainly because the introduction of the new product was only regarded as a production task. When the technical department first started up the trials, the department was short of time. Ordinary deliveries of this quality were planned to start up only half a year after the initiation of the first technical trials.

The Level of Relevant Knowledge at the Company

Phase one and two

The empirical material indicates that the company was lacking relevant knowledge within different fields. This can for instance be seen from the message given by the executive group in phase two that a Peterson quality should be produced that was poorer than the market quality was a signal on that. Some of the actors that I interviewed argued that the organisation at the enterprise in Moss was too small to go in for a radical product innovation, as was the case in this project. In order to take realistic decisions where demanding product or processes were going to be developed, a redundant knowledge base within the organisation was needed. This applied to all levels of the organisation.

Interview objects during my research have argued that the creative environment of the enterprise in Moss was too small to go in for this high quality product. When important decisions should be taken, only a few actors with knowledge of the different functions normally participated in the meetings. It could thus be difficult to create a real discussion involving sufficient diversity in the dialogue. Clearly this was becoming worse in this project, when central knowledgeable actors possessed a reduced capability in communication with each other.

The executive group thus decided that the company should introduce a Peterson quality of the product, which was not as good as the market quality, and which would give good profitability for the enterprise in Moss.

6.3.2.2 Integrated Knowledge Creation

Phase one

Phase one of the innovation activities was not organised as a project. A pattern of co-operation was thus not established. The empirical material shows that the closed vertical communication was not enabling integrated knowledge creation. Some kind of integrated co-operation took place, however, during the full-scale trials on one of the paper machine. However, only a few actors from the technical department participated actively in this knowledge generation process.

Phase two

The project group in phase two was organised according to an integrated mode of co-operation. In the actual case this meant that central actors from the R&D, marketing and manufacturing departments participated in the project group and cooperated closely across functional lines. New knowledge was created in a process of collective learning. Milestones for control of the progress of the project were chosen to match the ISO 9000 quality assurance procedure on product design. At these decision points relevant knowledge from all functional areas were involved.

The data material shows that integrated knowledge creating took place within the project group that was a great support to the innovation. The network of integrated knowledge creation did not include, however, the executive group of the project. There were no mutual knowledge creation processes between the project group and executive group.

6.3.2.3 Other enabling Elements for integrated Knowledge Creation

Participation of Actors with different professional Background and Experience

Phase one

The data material shows that the actors involved during the full-scale technical trials had similar professional background. However, the length and type of working experience, the skills and the personal characteristics of the actors varied a great deal. A proper arena for creative problem solution should be present. Actually the management, participating in technical meetings, was to some degree controlling the discussion.

The different personal characteristics of the actors in the working group were not taken into account when the group was organised. It was not consciously composed of actors possessing defined roles, in order to ensure that there was sufficient diversity in skills and talents and personalities were present in the group for production of creative conflicts.

Phase two

During the organising of phase two of the innovation activities, the project manager was conscious that the project group should include members from the R&D, marketing and production as the main actors. The aim, when leaving none of these actors behind, was to increase the efficiency of the project. However, the individuals were not consciously chosen in order to possess defined roles in the project group. It seems obvious that a conscious selection of actors to fill definite roles in the project group could also be a good strategy for controlling the different power relations within the group.

Autonomous Groups

Phase one and two

The empirical material shows that the innovation activities were neither in phase one nor phase two organised within the framework of autonomous groups. During phase one the same control mechanisms were applied as for other types of activities within the technical department. During phase two the main project activities had to be approved by the executive group before any action could be taken.

Redundant Functions

The innovation activities were not consciously organised with redundant functions to trigger creative activities. However, some of the central actors in the groups had similar professional background and had been working consciously together and known each other for years. This should enable them to some degree to share tacit knowledge. However, too unlike skills and experience made this take place only to small degree.

Creative Chaos

According to the data material a condition of creative chaos was not consciously created to trigger creative activity. Situations of creative chaos arose in an unintentional way during the end of phase two, due to a conflict as to whether the enterprise in Moss should terminate the production of the new quality or not. However, this kind of creative chaos was destructive in the project.

Creation of a common Language for Communication

Phase one and two

A common language was created in phase two of the innovation activities, where actors with both technical and mercantile background needed to communicate closely with each other. It seems, however, that this only took place at levels below the top management of the organisation. Within the management level the poor communication seems partly to have been due to lack of a common language.

Management Intention

Phase one and two

The empirical material shows that the organisational purpose and interest in the development activities were unclear, due to conflict at management level of the enterprise in Moss. It could thus be difficult to judge the value of the knowledge that was created in the project

6.3.2.4 External Sources of Knowledge

Phase one and two

During phase one of the project the machine supplier played an important role. The empirical material shows that upstream the rebuilding of one of the paper machines, pilot trials were done on the machine supplier's pilot machine. It was concluded that it should be possible to produce the new paper quality on the rebuilt machine. The machine supplier referred the new quality level to a dated test sample.

The technical department at the enterprise in Moss trusted the machine supplier too much in phase one. This could be due to lack of own relevant knowledge about the new product and the required technology, together with close relations to central actors in the machine supplier's organisation.

Further, both in phase one and two a chemical supplier and an associated company of the enterprise in Moss participated. The data material shows that the co-operation with the associated company was characterised by controversies. The associated company compared all the time the new quality with the best quality in the market, and did not behave as a customer, really interested in sharing its knowledge with a potential supplier.

6.3.2.5 Creative Processes / Motivation Factors

The Project Environment

Phase one and two

During the first phase of the project there was a closed vertical communication. The empirical material shows that there was a situation of conflict at the management level. The

organisation received unclear signals about the commitment of the management. The working environment must thus be characterised as closed. Further, due to lack of a strong base at the management level, the environment was not very performance - oriented, supporting or open.

During the second phase of the project, the working environment within the project group was to some degree entrepreneurial. The members of the project group tried all the time to develop the best product, taking part in different creative activities in a close co-operation. However, at the same time the project group had an excuse, if it did not manage the top quality. The management had decided that the new quality should be a Peterson quality, which should not be as high as the best qualities in the market. The executive group only to a small degree contributed to the positive environment in the project group.

Slack in the Project

Phase one and two

During the both phases of the project any slack was not included in the project plan. The empirical material shows that there was made little room for R&D work in both phase one and two. To make the new product the management only regarded it to be a production matter ready for presentation in the market. The new product quality should be ready within a short time, after the decision was taken.

Experiments during the Project Implementation

Phase one and two

According to the data material there was neither in phase one nor in phase two planned for experimentation to boost the creative activity in the project. Because only full-scale trials were done, except for some laboratory testing at the Technical University in Trondheim, the possibilities for experimentation were limited. It seems that more experiments could have been done in laboratory and pilot scale. However, it did not seem that the enterprise in Moss had a culture for allowing the employees to make experiments and make mistakes.

Extrinsic and intrinsic Motivation Factors

Phase one and two

The data material shows that no extrinsic motivation factors in form of salary increase, more spare time, etc, were applied by the management.

The enterprise in Moss did not have any tradition for applying extrinsic motivation factors based on rewards for motivating an increased effort in phases of the project where systematic work was performed.

Neither were any intrinsic motivation factors applied in this project to increase the creative activity. The empirical material shows that a high creative activity and creation of new knowledge was very important in this project downstream the decision to produce a Peterson quality of the product. It was clear early in the project that the paper machine was not suited for producing the new paper quality. The existing machine, and the fact that no further investments should be made, put strong restrictions on potential solutions to different problems. It seems that application of intrinsic motivation factors could have increased speed of the creative problem solving both within the project group and among practitioners in the paper plant.

6.3.2.7 Project Evaluation

A project evaluation was not done after the termination of the project, to provide learning both from both the positive and negative aspects of the project.

6.3.2.8 Findings

Main findings in the above analysis are presented below:

- No pre-project or pre-study were done. A realistic appraisal of what was required to make the new product was not taken. The enterprise in Moss had to trust the competence of the suppliers. The management argued that the introduction of the new product was a pure production task. Development of new knowledge was not necessary

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- A technical specification was established late in phase one. Then a detailed specification was made based on analyses of competitors. From then on the technical uncertainty seemed to be reduced. In phase two a detailed technical specification came pretty soon after up-start. This was based on a thorough market survey.
 - The executive group neglected the technical specification in phase two of the project. It was decided that a Peterson quality should be produced that was poorer than the market quality, and that could be sold to a lower price.
 - The view of the management was that this was a purely technical project
 - A framework for integrated knowledge creation was not created in phase one. In phase two a more integrated approach was taken within the project group.
 - Not any enabling conditions for knowledge creation were applied, such as: autonomy, redundant functions, creative chaos and an explicit intention.
 - The project groups were not consciously constructed for diversity and creative conflicts
 - The working environment could not be characterised as performance-oriented, supporting or open
 - Not any mechanisms to boost creative activity were initiated
 - No project evaluation was made.

6.3.2.9 My Reflections on the above Findings

- Sufficient knowledge was not created of what was required to make the new product, regarding the market, the product, the technology and how to take the new technology into use. I argue that the project would never have been started up if a proper work had been done up-stream the activities of preparing for a presentation of the new product quality. I further argue that it probably would have become clear that the organisation and its creative environment were too small to make this demanding product.
- During the planning of the rebuilding of a paper machine, the technical department to a great degree trusted the competence of the machine supplier. In a historical perspective it can be argued that the confidence was too high, seen in relation to the fact that they did not check the statements of the supplier that it would be possible to produce the new product quality on the rebuilt machine. I further argue that this example shows that difficulties may appear in the communication with external knowledgeable actors if a proper knowledge base within the actual field does not exist in the own organisation.
- The first specifications that were made in both phases of the project can be characterised as detailed. They were in reality running detailed recipes on the paper machine, describing the raw material input. I argue that the detailed technical focus partly was a result of little time given by the management to have the new potential product quality ready for presentation, which potential reduced the solution room. Only technical specifications were made in this project, I argue mainly due to the fact that this was regarded to be a purely technical project. However, the empirical material shows that one of the main reasons for terminating the project was a severe problem of running the product on the paper machine with a stable quality. From this I argue that in the total specification should a specification of the social sub-system should have been an integrated part.
- From a knowledge perspective it is hard to understand how the decision to produce a Peterson quality of the new product could take place. It was known that the customers

always want to have at least two products at the same level of quality in-house during a production run of corrugated cardboard boxes.

- The conditions for this project were not present, such that they made possible an integrated knowledge creation to support the innovation process. I maintain that this partly may be explained by insufficient knowledge in the effective organising of innovation projects, a lack of a tradition of utilising different motivation factors in projects, and politics involved in the accomplishment of the project.

6.3.3 Project no. 2

6.3.3.1 Reducing Uncertainty

According to the empirical material this project involved three parts:

- Installation of a known process technology
- Development of a model - based control system, including a prototype of an on-line process analyser and much R&D
- Installation of a prototype of an analyser, measuring online important process properties

Pre-Study/Pre-Project

The second and third part of the project represented to the enterprise in Moss a radical innovation, involving a high risk of not to succeeding. However, a pre-study or pre-project was not done to achieve a holistic picture of what should be the project goal, and what would be required to achieve it with regard to necessary knowledge and resources. According to the empirical material it was not decided at start of the project if the new control system, if successful, should be implemented in the process. Accordingly, the necessary human and material resources to do this were not included in the project plan. It also seems that it was not properly arranged for utilisation of the practical results after project finish.

Obviously because of the lack of any up-stream creative activity as a pre-study or pre-project, there was a high degree of uncertainty about the execution of the main project, mainly due to insufficient knowledge within the organisation as regards how to take a holistic approach, and which elements to implements to employ.

Project Specifications

The company possessed knowledge of installation of similar process equipment as should be installed in this project. Consequently, a detailed specification doing this job could be made in co-operation with the supplier, without losing any room of solution. The empirical material further shows that the other parts of the project involved a lot of R&D. Solutions to different

problems had to be developed during a creative problem - solving process during the project accomplishment. To take this into account, and due to lack of knowledge about the new technology, a broad technical specification was made. This seems to have been a wise strategy, keeping the solution room open until more knowledge was created.

The Level of Relevant Knowledge at the Company

The empirical material shows that the enterprise in Moss possessed knowledge at a very high level about the actual chemical processes. However, the company did not at that time have much experience from online model - based control systems and the actual prototype, which should be installed.

It seems to be clear that limited general knowledge about model based control systems within the organisation was an important reason for the final failure of the project. The consultant who developed the control system did not manage to transfer sufficient knowledge to the enterprise in Moss for the company to take the new technology into use, partly because of a too weak knowledge base at the engineering and management level in Moss.

6.3.3.2 Integrated Knowledge Creation

During the first part of the project the known process technology was installed. To the supplier this was a commercial project. Only a small degree of learning took place.

The operators were involved in the configuration of the first version of the system from the supplier. This involvement obviously supported the innovation process. They did not participate when the final updated version was installed. The empirical material problems arose, especially during the up-start of the system. This was to a large extent due to the supplier's lack of process knowledge. At that stage in the project there was a poor atmosphere of communication between the parties. Central actors from the supplier had earlier in the project been moved to other and more profitable projects, and replaced by people with less competence. This resulted in a decreased progress and increased tension between the parties. It was thus difficult for the enterprise in Moss and the supplier to come together and find

acceptable solutions in a mutual learning process on the problems that arose during the up-start of the process control system.

During the R&D phase of the project, the co-operation between the enterprise in Moss and the consultant was, according to the empirical material, functioning very well during the development of the model - based control system. The consultant was working very much in the control room of the actual process plant and strongly involved some of the practitioners in the R&D work. The close and easy communication between the parties and the physical closeness in their work made possible a sharing of knowledge between the two parties. A process of integrated knowledge creation took place within the project group between actors with highly different professional background and experience.

It seems that the integrated knowledge creation had other shortcomings:

The necessary R&D work to make the prototype analyser operative was mainly connected to one person, without the support of a creative environment. According to the empirical material it was difficult, especially this part of the project, to release resources from the operative organisation for participating in the project.

As discussed above, actors in the project group were involved, while other central actors from the top and middle management were not. Thus the project did not manage to connect the project to the management level and create a shared understanding and a ownership of the results the project group was aiming at. It seems that the lack of integration of the management in the knowledge creation process was an important reason for the project failure.

6.3.3.3 Other Elements promoting integrated Knowledge Creation

Autonomous Groups

The project group functioned more or less as an autonomous group. A broad goal had been given. The management of the enterprise in Moss was only partly interested in the project, and did not try to directly control the project activities. The members of the project group were more or less left on their own. The data material shows that this could be an important explanation to the well - function co-operation and high level of creative activity within the

project group. Most of the group's communication with its environment took place through the co-ordinating project manager from the parent company.

Actors external to the project group, however, tried to control the progress of the project through the control of resources to it. As long as these actors did not interfere in the inner life of the project group, it seems that this resulted in a lower activity level.

Creation of a common Language

A representative from the group of practitioners was selected by the labour union to participate in the project. According to the empirical material some problems arose in the demanding role of this actor, in the communication both with the project group and with the operators' representative. The empirical material shows that this to some degree reduced the value of the involvement of the practitioners in the installation of new process technology.. The data material shows that it could be difficult to involve some of the practitioners at an early phase of the problem solving processes. An explanation could be that they found it difficult before they see the real artefact. According to an interview of a very knowledgeable practitioner who was involved in project, an important reason for the minor problems described above was partly due to the insufficient creation of a common language of communication.

Management Intention

According to the data material the purpose of and interest in the project were unclear from the management side. It was thus difficult to judge the value of the knowledge created. During the project this seems to have resulted in a reduced motivation within the project group for putting an extraordinary effort into the project

External Sources of Knowledge

External sources of knowledge had to be applied in order to reach the project results, due to lack of relevant knowledge within the organisation at the enterprise in Moss. Another aspect of the application of external resources was connected to the financing of this project through NTNF. The type of external resources and technology that should be applied was decided

upstream the project, without the knowledge of the enterprise in Moss. The company was not given a chance to evaluate which kind of external knowledge that it was necessary to involve.

6.3.3.4 Creative Processes / Motivation Factors

The Project Environment

This was a project characterised by conflicts. The empirical material shows that the project management had to fight for the necessary resources to the project. The communication between the management and the project group was closed. The project group was not working within a positive environment stimulating to creative activity, that could be characterised to be supporting, performance - oriented and open.

Slack in the Project

It was not planned for any slack in the project, in order to reduce the amount of negative stress and promote creative activity. A tight time schedule was created. It seems that some of the central actors, working part time in the project, felt that the opposite was the case. Their work was not prioritised as part of their normal working time. Obviously the lack of prioritised time to take part in creative knowledge creation process was a major reason for the failure in this project. Some central actors were taken off the project before the project goal was achieved.

Extrinsic and intrinsic Motivation Factors

Not any extrinsic motivation factors were applied in this project. It seems that the company at that time applied various extrinsic motivation factors as a type of reward for past achievements, not as a motivation factor for future ones.

Not any intrinsic motivation factors were applied in this project to motivate for improved creative work. The data material shows that this was partly due to the poor climate in which the project was a part of, and a reduced interest in the potential results of the project among central actors in the organisation.

6.3.3.5 Project Evaluation

A project evaluation was not done after project completion. Any organisation learning was not initiated.

6.3.3.6 Findings

Important finding in the analysis of this project are presented below.

- A holistic perspective was not taken to assure sufficient resources for implementation of the results in the organisation and for choosing the proper system limits.
- Broad specifications were made.
- There was too little knowledge at the enterprise in Moss about model - based control systems
- The activities of one of the suppliers seemed not to be connected to their own organisation.
- It was in parts of the project difficult to release resources for working on the project
- The project was not based on management level.
- Integrated knowledge creation did not take place during the installation phase of the project
- In the R&D phase the project group functioned as an autonomous group
- There was an insufficient creation of a common language
- It could be difficult to involve practitioners at an early stage of the problem - solving processes

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- The management motivation was unclear
 - Some of the involved actors did not get sufficient time from their superiors to work on the project.
 - The choice of technology and resources to be involved in the project was taken upstream the project without the knowledge of the organisation at the enterprise in Moss
 - No intrinsic or extrinsic motivation factors were applied in the project
 - A project evaluation was not done.

6.3.3.7 My Reflections on the above Findings

- I argue that the conflicts during the project arguing about resources for participation in the project could have been avoided by proper planning upstream the project.
- A broad specification was established. I argue that this was the only way to go due to the company's limited knowledge about model - based process control. Since the results from the project should be implemented in an operating control system, a specification of the social system that should take the new technology into use, should have been an integral part of the project plan.
- The project was not properly based on the management level, which showed an unclear motivation from the management side. The management held the view that the project was appearing to be too theoretical and had reduced their expectations to any increased profitability.

I argue that this was the main reason for the reduced integrating knowledge creation-taking place without the involvement of the management as the project owner. I argue that a strong vertical integration would have improved this situation.

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- During the project the resources of one of the suppliers were taken off the project and moved to other projects. This was unfortunate, resulting in conflicting situations. I argue that this could have been avoided by proper project planning upstream the project.
 - The choice of external technology and human resources to be applied in the project was made without the knowledge of the organisation in Moss. I argue that this was a serious mistake. Part of the organisation felt that this technology had been forced upon the enterprise in Moss.
 - There was an insufficient creation of a common language for communication in this project. I argue that the comprehensive communication that took place between the suppliers and the practitioners during a part of the project could have been improved if a common language had been created. I further argue that the project management did not have much knowledge of the thinking behind the creation of a common language of communication.
 - I argue that the difficulties of a proper involvement of practitioners in the project, could partly be due to a too passive participation to trigger any interest to share their knowledge with the rest of the project group. One way of improving this situation could be through a more active management involvement, giving the practitioners the responsibility to solve given tasks on their own, and in this way signal that they were taken seriously.
 - Some of the central actors felt that the participation in this project was stressing, and to some degree resulting in less motivation. They were given little support from their own organisation. Some of the actors were taken off the project before the project goal was reached, and moved to other tasks. They were not given any priority to work in the project. I argue that it is a clear management responsibility to secure that running projects have sufficient resources through all phases.

6.3.4 Project No. 3

6.3.4.1 Reducing Uncertainty

According to the empirical material, the first part of this project represented to the enterprise in Moss a radical innovation with a high risk of not succeeding. During this phase a new process should be developed without the application of a special chemical. The second phase, which was an engineering phase, included mostly implementation of known technology.

The technical department at the parent company came with a concept to the new process. The task of the project group should be to prove this concept. The concept was based on the “state of the art” from the theory, R&D experience from large chemical suppliers and PFI, and own experience at the parent company.

Presenting a concept of a new process could mean a reduction of the total solution room. It was discussed during my research if this was the right approach. However, the actors who came up with the idea of a new process represented some of best available knowledge about the actual subject at that time.

Pre-Project

A realistic approach to the whole project did not develop through the carrying-out of a pre-study or a pre-project. In the creative up-stream processes there was not created enough knowledge as to what was required to reach the final project goal, which was the implementation of a new process plant. No calculations were done to check out if this project would result in a good business for the enterprise in Moss, its associated company and thus for the parent company.

It seems clear that the lack of a realistic attitude and a holistic perspective in the project was an important reason that this project had to be run for three years before it was terminated without any success.

Project Specifications

The specifications for the R&D were based on the given concept of the new process. However, within this technical framework the specifications were made broad, in order not to make any further reduction of the room of solution. The principle of minimum specification was unconsciously applied. During the pre-engineering phase detailed specifications were created, which were all right for the implementation of this systematic phase.

The Level of relevant Knowledge at the Company

According to the data material the enterprise in Moss, its associated Peterson company and the cooperating network possessed high - level knowledge of the involved chemical processes. However, the project group did not involve any professional actor with knowledge in project management that could have taken a systems approach in the establishment of the R&D phase of the project and boosted the creative activity.

6.3.4.2 Integrated Knowledge Creation

The R&D part of the project was composed of actors from: the parent company, the enterprise in Moss, its associated company, chemical suppliers and PFI. They represented different professional backgrounds and experiences, ranging from scientists and process engineers to marketing people. The empirical material shows that the project group should possess sufficient diversity to create creative conflicts involving the different interests necessary for collective learning. However, the project team was not consciously constructed, taking the different personalities into consideration.

During the R&D phase the project group was more or less living its own life. The group was not involved in the conflicts at management level between the enterprise in Moss and another Peterson company. When the group heard any rumours about conflicts, it was only taken as signals of noise, without disturbing the R&D work. During the R&D phase of the project the members of the project group were neither negatively affected by a poor economic situation at the associated company nor negative attitudes to the project at the enterprise in Moss. The project group was working within an environment of artificially reduced complexity.

Obviously some of the knowledge created during integrated processes was not properly embedded in the companies' organisations.

The empirical material shows that the technical departments at the enterprise in Moss and the parent company possessed a very different knowledge perspective of the technical potential at the enterprise in Moss and what the future of the company should be. The central actors did not come together to openly discuss their divergent views, and to try to reach a shared, realistic understanding of some important elements. The technical department at the parent company based the whole project on a much higher production capacity of pulp than the technical department believed that it was possible to reach.

6.3.4.3 Other Elements promoting integrated Knowledge Creation

The project group during the R&D phase functioned as an autonomous group, and managed to take a holistic approach towards the work that should be done within the group. However, this was not possible regarding the project due to the more or less isolation of the group. The empirical material shows that this did not bother the group much. It had got the task of developing a new process. It seems that the group had the understanding that it was decided that this process should go on until the task was completed.

The data material shows that the group became increasingly uncertain and confused during the R&D phase, about the value of the knowledge created. Different and cheaper process alternatives came up to be evaluated at the end of the R&D phase.

Further, the project group in the R&D phase consisted of redundant functions with a surplus of information. Even if the actors had different professional backgrounds and experiences, there were also similarities between them. All of them had an academic background, and some had experience from working in a process industry. This environment opened up for experimentation and sharing of tacit knowledge, which was very necessary in this process.

R&D creating integrated knowledge creation was largely due to the project group was functioning as an autonomous group involving redundant functions.

The second phase of the project consisted of an engineering study, with the purpose of calculating the costs of a process plant. The necessary knowledge was primarily done by four major machine suppliers, which were involved in the project. It was only to a small degree that the enterprise in Moss took part in this knowledge creation process.

Central actors that were questioned if it was necessary to run the second phase of the project. They meant that rough economic calculations were done during the R&D phase. It was a growing feeling within the project towards the end of this phase, that a new process plant would not be installed.

6.3.4.4 Extrinsic and intrinsic Motivation Factors

The R&D phase of the project lasted for two years. According to the empirical material no intrinsic motivation factors were applied during this phase, in order to boost the creative activity.

It was questioned during my research if would have been appropriate to apply some intrinsic motivation factor to boost the creative activity during the R&D phase of this project, with the large involvement of external actors. In a project context these types of motivation factors are collective mechanisms.

No extrinsic motivation factor was applied during the engineering phase of the project.

This would not have had a right. This phase was of a short duration and with tight schedule. Most of the work was done by external actors, and consisted of the making of technical bids.

6.3.4.5 Findings

Important elements from the analysis of this project are presented below.

- No calculations were carried out up-stream the project to evaluate if this project could be a good business for the company
- The specifications were based on a given technical concept. The project should prove that this concept would lead to acceptable solutions. They were created as broad specifications. It was focused only on technical questions
- Within the R&D there was not a high competence in project management
- Integrated knowledge creation took place within the R&D group. Some of the knowledge created was not embraced by the organisation
- Between the management at the enterprise in Moss and its associated company there was no knowledge creation
- It was questioned by involved actors if implementation of the second phase of the project was necessary
- No intrinsic / extrinsic motivation factors were utilised in the project
- Not any evaluation of the project was carried out

6.3.4.6 My Reflections on the above Findings

- I argue that more realism in the project would probably have been created if there had been a proper work up-stream the project. It should not have taken three years to terminate the project.
- The specification in the R&D phase was based on a given concept. Project time and resources could obviously have been saved because the concept turned out to give

reasonable solutions. I argue that this strategy should be applied with care due to a reduction of the room for solutions. Since the results from the R&D phase should be implemented in a new process plant, the total specification should have been included a specification of the social system, which was to take the new technology into use.

- No knowledge creation took place between the management of the enterprise in Moss and its associated company. They did not manage to create a shared understanding of central problems. I argue that this was the main reason for the project failing to achieve its goal.
- I argue that it would probably not have been necessary to carry out the engineering phase to find out that it would be too expensive to install a process plant based on the results from the R&D phase. These calculations could have been carried out with sufficient accuracy in a pre-study or a pre-project.

6.3.5 Project No 4

6.3.5.1 Reducing Uncertainty

The analysis material shows that this project represented to the enterprise in Moss a radical product innovation. There was a high risk of not succeeding. An unsuccessful project result would probably have had large consequences for the Peterson Group. A characteristic of the project was that it should be kept secret to anyone that was not directly involved in the work.

Pre-project

In spite of the high risk involved, the empirical material shows that no pre-study or pre-project was done. The purpose of this should have been to evaluate what was required to reach the project goal, or if the project results would be a good business for the enterprise in Moss. It seems that one reason to this was that the project was developing as it went on, without having a clear project goal. The empirical material shows that the attitude more or less was that the management was more or less willing to do some trials to see what happened, but really not to go in for the project.

According to the empirical material the management decided that this project should be kept secret. It seems that one reason was the wish to take the competitors by surprise. Another reason for the secrecy could be the wish to apply this as a mechanism to reduce the uncertainty of the project in the organisation.

Specifications

There was never established a technical specification upstream the project, that showed what product quality the project was aiming for. When the project group managed to achieve some positive technical results, there was no objective way of saying that it was good enough. A reason for this was difficulties predicting beforehand what could be possible to produce on the paper machine. A broad specification and a broad project goal were established during the project. These were changing because of the results of the technical trials that were obtained.

The data material shows that the new product, which required a high product quality, was expected to be technically demanding to produce. To succeed with this product, it was argued that the company culture and human attitude needed to be changed. The user of the technology would play an important role in the project. Thus a joint optimisation of the technical and social sub-systems could be essential for succeeding in the project.

However, the specification for this project was made purely on basis of technical parameters.

The Level of Relevant Knowledge at the Company

There was a need in this project for creation of a lot of new knowledge at the enterprise in Moss. The enterprise did not have any experience to draw on of a similar product. Further, it did not seem to possess the right human attitudes in its culture that were required to make this product. It seems that the company did not find out upstream the project which kind of knowledge that was needed both of technical and social character.

6.3.5.2 Integrated Knowledge Creation

It was chosen to carry out the analysis for examining if any integrated knowledge creation took place in the actual project in a closed system approach, characterised by secrecy and closed communication systems.

During the R&D phase of the project two major chemical suppliers and one major machine supplier were involved in the project a secrecy agreement between the parties had been signed. The empirical material shows that the suppliers looked at this as a sign of commitment from the enterprise in Moss' side to go in for the project, demonstrating a real interest. On this background they decided to spend time and resource on the project. At a later stage it appeared that the enterprise in Moss had misinterpreted the culture of the large chemical companies.

Between the small internal project group at the enterprise in Moss and the networks of the external suppliers, an open environment of communication was established, based on mutual

respect and confidence. New knowledge was created. However, there was little of collective learning taking place. Mostly there was pure knowledge transfer from the suppliers to central actors at the enterprise in Moss. As already discussed, the enterprise in Moss had very little knowledge about which technology was necessary to make the new product quality. The enterprise in Moss would probably have had problems to take the actual technology into use.

The empirical material shows that the internal project group within the organisation at the enterprise in Moss was not allowed to inform anyone or to search for knowledge within the rest of the organisation. Tacit knowledge from the practitioners was therefore not utilised. The secrecy around the project did not influence the actions of the operating department very much. The department was only involved in the production of test rolls and in some testing. Because of a fairly low enthusiasm, this project was not a subject. Nobody was talking about it. It was therefore not difficult to keep the project confidential.

The analysis above clearly shows that open communication channels are essential conditions for integrated knowledge creation. Because the management was not involved in any knowledge creation process, it was difficult to create a collective learning process, where all central actors participated.

6.3.5.3 Other enabling Elements for integrated Knowledge Creation

Autonomous Groups and Redundant Functions

The data material shows that the next stage of activity had to be clarified by the executive group before any actions could be taken. The attitude was to complete one trial before deciding to make the next. The principle of controlling the progress at agreed milestones was not applied by the executive group. Further, the organisational framework was well suited for the project group to behave as an autonomous group. From the above analysis it seems obvious that a requisite variety was there for promoting knowledge creation. The project group was also not set up as a self-organised team.

Redundant functions were not consciously created in either locally in the project in Moss or in its external network. However, within the external network of suppliers there were many actors involved in this project that represented a surplus of knowledge that was overlapping the competence of the members of the internal project group. Several times the project experienced how a redundancy of knowledge effectively contributed to a sharing of tacit knowledge.

6.3.5.4 Intrinsic and extrinsic Motivation Factors

As discussed during the analysis of project 1-3, there were no intrinsic or extrinsic motivation factors in this project. This could obviously be due to the fact that there was an unclear and low motivation among most of the management.

6.3.5.5 Project Termination

A project evaluation was not done after project completion. No organisation learning was not initiated.

6.5.5.6 Findings

- A realistic picture was not created upstream the project as to what was required to make the new product quality.
- It seemed that it was all right for the management to do some tests, but not really to go in for the product
- A broad specification was developing in a dynamic process during the project implementation. It was based only on technical parameters.
- The enterprise had no experience from a similar product or the kinds of skills and attitudes that were required to make it.

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- Between the internal project group at the enterprise in Moss and its external network knowledge creation took place. This process had mostly the character of knowledge transfer from the suppliers to the enterprise in Moss.
 - Within the own organisation it was difficult to initiate integrated knowledge creation processes
 - The project groups did not function as autonomous groups
 - No extrinsic or intrinsic motivation factors was initiated in the project.

6.3.5.7 My Reflections on the above Findings

- It seemed that the management was willing to have some trials done, but not really to go in for this particular product. I argue that this kind of unclear management motivation signalled that this was a project of low importance and priority.
- A specification was not established upstream the project due to insufficient relevant knowledge. I argue that it was a good solution to create a broad and dynamically changing specification taking into consideration the strong need for creation of new knowledge during the project. I further argue that the progress of the project would have taken another route if the requirements from the social system, had been an integrated part of the specification. This is due to requirements to other skills and attitudes to paper production than the enterprise in Moss possessed.
- It was difficult to make a process of integrated knowledge creation within the own organisation in Moss, partly due to a closed communication as a result of secrecy around the project. I argue that this situation probably could have been improved by better vertical integration in the project.

6.3.6 Project No 5

6.3.6.1 Reducing Uncertainty

The data material shows that a methodology should be applied in the project implementation, which was new to the organisation at the enterprise in Moss. Oestfold Research Foundation that was given the project management had already some experience in the cleaner production methodology from a few smaller projects in the region of Oestfold. This was a complex project, covering all processes within the pulp and paper mills at the enterprise in Moss. The risk of not succeeding was fairly high, due to the new methodology that should be applied in the project. However, the management in Moss meant that sufficient knowledge in process technology could be made available.

Pre-project

The empirical material shows that no pre-study or pre-project was done upstream the main project to reduce the uncertainty and risk of the project. It was not necessary to do a pre-project to evaluate if the results of this project would be a good business for the enterprise in Moss. It was quite clear beforehand that this was a very important project to the enterprise in Moss. It seems that a pre-project would not have clarified the activities to be done and the order of these. The project route during the project had to be decided in a close dialogue between the project group and its network, especially with the practitioners during the progress of the project.

Specifications

A detailed specification was not made in this project. Only a rough framework to establish a starting point of the project was made together with some main subjects to be treated as it was seen upstream the project.

The Level of relevant Knowledge at the Company

In this project the subject of analysis was the process in the pulp – and paper mills. The organisation had a good basic knowledge base of the processes for producing pulp and paper and about the auxiliary processes. It was the methodology of cleaner production that was unknown to the organisation. This was meant to be taken care of by the external project manager from Oestfold Research Foundation.

6.3.6.2 Integrated Knowledge Creation

The data material shows that the project was organised as an interactive network of actors within the organisation.

The project group was free to go anywhere seeking knowledge. A close dialogue was established between the project group and the practitioners shortly after the project up-start. Integrated knowledge creation with a collective learning process was initiated that lasted until the project terminated. Tacit knowledge was shared during the communication between the involved parties.

The involved actors in the collective learning process consisted of actors with different professional background and network experience. A changing composition of the working groups was applied during the various creative processes taking place. In this context it would be useless to try to consciously put together the teams according to the different personalities, skills and professional background. The data material shows that the knowledge creation process functioned well within the framework of a dynamic network organisation. This way of doing the project was obviously one of the main success factors.

Management Intention

The management intention was very clear and strong. It clearly told the organisation that this was a very important project that should be given a high priority.

Project Environment

The data material shows that the project environment was very supporting, performance-oriented and open during the whole project, mainly due to the strong commitment of the management.

External Sources of Knowledge

Except from the project manager, who came from Oestfold Research Foundation, no external resources were applied in the project network. The external project manager brought into the project a different kind of knowledge and competence from what the organisation at the enterprise in Moss possessed, and without any ties to the company culture. The empirical material shows that the application of an outsider as a project manager was a key success factor in the project.

In the executive group, however, external actors from the environmental authorities and from the Oestfold Research Foundation participated. The purpose of their involvement was both to learn about cleaner production and to transfer their knowledge to the project. According to the empirical material this functioned well. Another important factor was the creation of an improved confidence between the environmental authorities and the enterprise in Moss.

6.3.6.3 Extrinsic and intrinsic Motivation Factors

No extrinsic motivation factors were consciously applied during the project. Obviously this would not have been natural to do in this case, due to the fact that implementation of solutions took place parallel to creative activities during most of the project. However, according to the empirical material, the strong commitment from the managing director worked as a considerable intrinsic motivation factor.

6.3.6.4 Project Termination

A project evaluation was not done after the project was finished, to initiate any organisational learning.

6.3.6.5 Findings

Important elements from the analysis of this project are presented below.

- No creative activity upstream the project was carried out
- The specifications had the character of being a rough framework to be applied as a starting point
- There was a strong management commitment in the project
- There was a high level of competence of process technology at the enterprise in Moss, but less knowledge of cleaner production methodology
- Integrated knowledge creation functioned well within the framework of a dynamic network organisation.
- The project environment was supporting, performance - oriented and open
- The application of an outsider as project manager was a key success factor
- The practitioners were strongly involved in the project
- No extrinsic or intrinsic motivation factors were applied in the project.

6.6.3.6 My Reflections on the above Findings

- No creative activity was carried out upstream the project. I argue that a pre study would not in this case have resulted in a more efficient project implementation or an improved goal achievement. Important environmental problems should be solved in a new way in this project. Accordingly, there was little doubt that the project would be a successful business for the enterprise in Moss if the established project goals were reached. Further, the risk was high in this project. I argue that it would have been difficult to reduce the risk and uncertainty through a pre-study or a pre-project. This

could only be done in a continuous learning process during the project, according to the principles of action research. The specifications were for this reason made as a rough framework to have a proper starting point in the project.

- The management commitment was strong in the main project regarding the achievement of the first project goal that was to find solutions to 40 percent reduction of the effluents of dissolved organic material. I argue that this commitment worked as a strong intrinsic motivation factor for the actors involved in the project.
- Regarding the final project goal that was to implement the results in the organisation as a durable environmental protection system, the management commitment was much weaker. I argue that this was the main reason for the closure of the project upstream the initiating of the implementation phase.
- The practitioners were strongly involved in this project, and had a real influence on the progress of the project. I argue that this was decisive for the good project result.
- The integrating knowledge creation process functioned well in this project with a large part of creative activity. I argue that one of the reasons for this was the large diversity through organising the project with an open, dynamic network.

6.3.7 Analysis of important common Characteristics between the Projects – utilising the Knowledge Creation Theory

6.3.7.1 Introduction

At the end of the knowledge creation theory my analytical position was presented as key success factors in the form of questions to be utilised in the analysis of the projects. These are the same as the questions representing the ordinate in the matrix below. The answers to the questions for each project are representing the abscises in the matrix., which are the results of the findings from the analysis of the projects.

In the matrix below the headings to describe the characteristics of the projects are taken from the short project descriptions in chapter 5 in the thesis.

6.3.7.2 The Characterisation of five Project - utilising the Knowledge Creation Theory

Project number	1	2	3	4	5
Type of project	Product Innovation	Process Innovation	Process Innovation	Product Innovation	Process Innovation
Key words	Radical innovation, high quality product, high product price, high risk of not succeeding	Radical innovation, high risk of not succeeding	Radical innovation, high risk not succeeding.	New product technology, high quality product, high product price, high risk of not succeeding	New methodology of Project accomplishment, Fairly high risk of not succeeding
Uncertainty Reduction					
Any pre-study accomplished?	No	No	No	No	No
Was the principle of minimum specification applied?	No. In both phases of the project detailed specif. were made. Only tech. subjects involved	A detailed techn specif. for the installation phase, and a broad spec in the R&D phase	Yes, in the R&D phase this principle was applied. Only technical subjects involved	Yes, it was. It was impossible early in the project to know R&D potent. Techn subjects	Yes, it was. The tech specif. evolved through the collective learning process in the project.
Did the company possess enough knowledge to develop this product/process?	No, it did not. It was difficult to create a realistic view about the project	Yes, in the installation part, but not in the R&D part of the project	Yes it did within the actual subjects in R&D phase. Less in project managm	No, it did not. This was a new product to the enterprise in Moss	Yes, it did. The challenge was to better utilise the existing technology

Type of project	Product Innovation	Process Innovation	Process Innovation	Product Innovation	Process Innovation
Key words	Radical innovation, high quality product, high product price, high risk of not succeeding	Radical innovation, high risk of not succeeding	Radical innovation, high risk of not succeeding	New product technology, high quality product, high product price, high risk of not succeeding	New methodology of Project accomplishment, Fairly high risk of not to succeeding
Knowledge Creation					
Did any new knowledge creation take place?	Yes	Yes, in the R&D phase	Yes, in the R&D phase	Yes	Yes
Did integrated knowledge creation take place?	Not in phase one. Somewhat limited in phase two due to lack of involvement from practitioners	Team work was practised in the R&D phase. Little collective learning. External actors possessed most of the knowledge	Yes, within the project group during the R&D phase, but not cooperating between the two associated Peterson companies	Yes, within the project group and its cooperating external network. However limited due to reduced involvement from management and practitioners	Yes, through the whole project
Were sufficient diversity in skills, professional background, experience and human character present?	No, it was not	Yes, only partly in the R&D phase. For the installation project there was sufficient diversity	Yes, only within the R&D phase to solve the actual technical problems	No, it was not	Yes, it was
Was the project group consciously composed of actors possessing different personalities?	No, it was not	No, it was not	No, it was not	No, it was not	No, it was not. Not actual due to the changing of roles in the dynamic network organisation
Was an autonomous project group created?	No, not in any of the project phases. In the first phase the activities were run as a part of the normal operating work. In the second phase they were very much controlled by the executive group and actors external to the project	No, not intentionally. The work group in the R&D phase functioned partly as an autonomous group	No, not intentionally. The work group in the R&D phase functioned partly as an autonomous group	No, it was not. A linear track was followed. Each main activity had to be clarified by the executive group before any action could be taken.	Yes, it was. The open and dynamic network organisation functioned as a dynamic autonomous group

Type of project	Product Innovation	Process Innovation	Process Innovation	Product Innovation	Process Innovation
Key words	Radical innovation, high quality product, high product price, high risk of not succeeding	Radical innovation, high risk of not succeeding	Radical innovation, high risk of not succeeding	New product technology, high quality product, high product price, high risk of not succeeding	New methodology of Project accomplishment, Fairly high risk of not succeeding
Were redundant functions created?	No, there were not	No, there were not	Yes, in the R&D phase there were, however not deliberated	No, not by purpose. However, some of the main actors had similar professional background and experience	No, it was not. However the professionals and practitioners possessed overlapping knowledge in many areas
Was a condition of creative chaos created?	No, it was not. Conflicting situations arose due to conflicts	No, it was not. Conflicting situations arose due to conflicts.	No, it was not	No, it was not. This should be a secret project. All activities had to be thoroughly planned and clarified before any action was taken	No, not by purpose. Due to a large dynamic in the project situations with creative chaos evolved from time to time
Was a common meaningful language created?	No, it was not. Practitioners did not take part in the project. They did not have sufficient skills	No, it was not. Practitioners did not take part in the project. They did not have sufficient skills	Not it was not. Practitioners did not take part in the project. They did not have sufficient skills	No, it was not. Practitioners did not take part in the project. They did not have sufficient skills	Yes, it was. This was one of the largest challenges to the external project manager
Did practitioners have sufficient skills in communication and working in teams?	Not any practitioners participated in the project	No, they had not sufficient task knowledge skills in communication and team working	Yes, they had. The practitioners were only involved in questions about location of equipment.	Not any practitioners participated in the project	Yes, they had. They were used to participate in similar projects in the mill
Was the tacit knowledge of the practitioners utilised?	No, it was not.	There was a good communication between the operators and the external consult, working in the R&D phase. Tacit know was shared	Yes, to some degree, in the questions that they were involved in.	No, it was not	Yes, tacit knowledge was to a high degree utilised. This was the key success factor in the project

Project number	1	2	3	4	5
Type of project	Product Innovation	Process Innovation	Process Innovation	Product Innovation	Process Innovation
Key words	Radical innovation, high quality product, high product price, high risk of not succeeding	Radical innovation, high risk of not succeeding	Radical innovation, high risk of not succeeding	New product technology, high quality product, high product price, high risk of not succeeding	New methodology of Project implementation, Fairly high risk of not succeeding
Did the management have a clear intention with the project?	No. The management had different views about the initiation and progress of the project, and a low commitment	No, the management was only to a low degree committed to the project	No, the management was to a low degree committed in the project Different Views in the two associated Peterson companies	No, it did not have. The management was not strongly committed to the project	Yes it had. The management was strongly committed
External sources of knowledge					
Did the project apply one of the following sources of external knowledge: Lead users? Customers? Suppliers? Research institutes? Licensing of technology? Hiring of professionals?	Yes. Customers, machine and chemical suppliers, together with knowledge from an associated company were applied	Yes, external consultants, suppliers of process control equipment and chemical analyser were involved with their knowledge	Yes. Machine and chemical suppliers, together with a research institute were involved with their knowledge	Yes. Chemical and machine suppliers were involved with their knowledge	Yes, external sources of knowledge were utilised. Knowledge from Oestfold Research Foundation, The Ministry of the Environm and from the Norway Pollution Control Authority
Creative proc/ motiv. factors					
Was the project environment supporting, performance-oriented and open?	In the first phase it was a closed vertical communication, and neither performance-oriented nor supporting. In the second phase it was open within the project group, but closed betw executive project groups. The envirm was neither support nor perf oriented	This was a project with conflicts. The project had to fight for necessary resources. Only the technical dept at Parent company was interested in the project. There was not an open communication between management and project Moss	The R&D part of the project was living its own live. Within this framework the environment was supporting, performance-oriented and open. The co-ordinating project leader inspired and motivated the members of the working group in the R&D phase to perform.	Yes, it was within the project group and towards the representative of the executive group. Towards the rest of the executive group and the management the situation for the project group was opposite	Yes, the environment was very supporting, performance-oriented and open during the whole project

Project number	1	2	3	4	5
Type of project	Product Innovation	Process Innovation	Process Innovation	Product Innovation	Process Innovation
Key words	Radical innovation, high quality product, high product price, high risk of not succeeding	Radical innovation, high risk of not succeeding	Radical innovation, high risk of not succeeding	New product technology, high quality product, high product price, high risk of not to succeeding	New methodology of Project accomplishment, Fairly high risk of not succeeding
Did the project group consist of members with positive experiences?	Yes, it did	Yes, it did	Yes, it did	Yes, it did	Yes, it did. However, some of the members also had poor experience due to roles as hostages in earlier projects
Was any slack created in the project?	No, the time for product presentation was short in both phases of the project	No, it was not	No, no it was not. The project however had pauses due to absence of people at an associated company being involved in the project	Yes, it was, due to time to wait for getting access to pilot trial machines	No, it was not. Still in a very dynamic project situation the project was working in a creative mode most of the time
Was it acceptable to do experiments?	No, it was not due to short time limits	Yes, to some degree in the R&D phase	Yes, in the R&D part of the project it was. In fact, experiments had to be done	Yes, experiments were a necessary part of the R&D activities	Yes, it was accepted. The project group was allowed to make its own priorities. However, due to short time limits, the project group in most cases went straight on, taking decisions in close co-operation with the practitioners without any trials.
Were mistakes allowed?	No, mistakes could delay the presentation of the project	Yes, to some degree, in the R&D part.	Yes, it was in the R&D phase	Yes, mistakes were allowed	Yes, it was
Were any extrinsic motivation factors applied?	No, not any. There was no culture at The enterprise in Moss for utilising such motivation factor	No, not any	No, not any	No, not any	No, not any

Project number	1	2	3	4	5
Type of project	Product Innovation	Process Innovation	Process Innovation	Product Innovation	Process Innovation
Key words	Radical innovation, high quality product, high product price, high risk of not succeeding	Radical innovation, high risk of not succeeding	Radical innovation, high risk of not succeeding	New product technology, high quality product, high product price, high risk of not succeeding	New methodology of Project implementation, fairly high risk of not to succeeding
Were any intrinsic motivation factor applied?	No, not any, partly due to low commitment from the management	No, not any, partly due to low commitment from the management and conflicts	No, not in a conscious way from the management. However, in the R&D part the actors seems to have been were motivated by challenging problems to be solved	No, not in a conscious way from the management. However, the close and open co-operation between the project group and the practitioners were very inspiring and motivating for all actors involved	No, not in a conscious way from the management. However the strong management commitment worked as an intrinsic motivation factor.
Project termination					
Was any project development accomplished?	No, it was not	No, it was not	No, it was not	No, it was not	No, it was not

Table 16: Characteristics of five projects – utilising the knowledge creation theory

6.3.7.3 Creation of Histograms

The response of each project to one of the questions in the matrix, chapter 6.3.7.2, is either given the mark 0, 0,5 or 1. The mark 0,5 is given if the question matches only a part of a project. The separate marks are summed up within the range 0-5 to include all five projects. The results are shown in the tables below.

Uncertainty Reduction		
Were any pre-study or pre-project accomplished?	Did the company possess enough knowledge to develop this product/process?	Was the principle of minimum critical specification and a broad but clear specification applied during implementation of projects with uncertainty?
0	2.5	3.5

Knowledge Creation					
Did integrated knowledge creation take place?	Did sufficient diversity and creative conflicts exist within the project groups?	Were the project groups consciously composed of actors possessing defined roles?	Were the project groups organised as autonomous groups?	Were redundant functions created in the project groups?	Was a condition of creative chaos created in the project groups?
3.0	2.0	0	1.0	0	0

Communication			
Was a common language created in the project?	Did practitioners possess sufficient skills in communication and working in teams?	Did the project utilise tacit knowledge from the practitioners?	Did the management possess a clear enough purpose to secure a clear understanding in the project group of the value of the knowledge created?
1.0	2.0	3.0	1.0

External Sources of Knowledge
Did the project apply one of the following sources of external knowledge: lead users, customers, suppliers, research institutes, licensing of technology, hiring of professionals?
4.0

Creative Processes / Motivation Factors						
Was the project environment supporting, performance-oriented and open?	Did the project consist of members with positive experience from participation in creative processes?	Was any slack created in the projects?	Was it acceptable to do experiments?	Were it allowed to do mistakes in the projects?	Was any extrinsic motivation factors applied?	Was any intrinsic motivation factors applied?
1.5	5.0	1.0	4.0	4.0	0	0

Project Termination
Was any project evolution created to initiate organisational learning?
0

Table 17: Tables for construction of histograms

Common Characteristics between projects - Uncertainty reduction

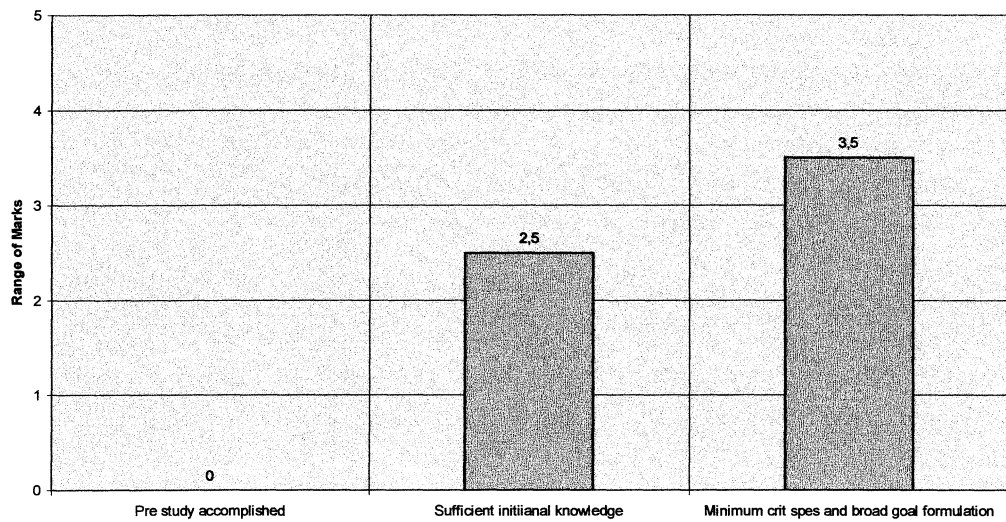


Figure 33: Common characteristics of projects – knowledge creation theory

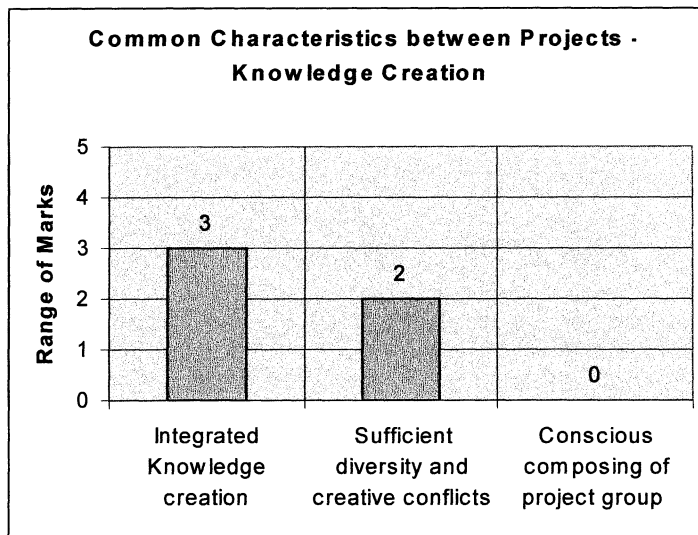


Figure 34: Common characteristics of projects – knowledge creation theory

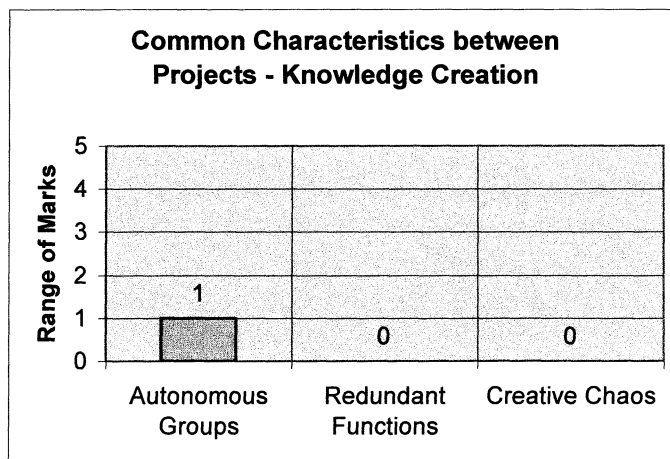


Figure 35: common characteristics of projects – knowledge creation theory

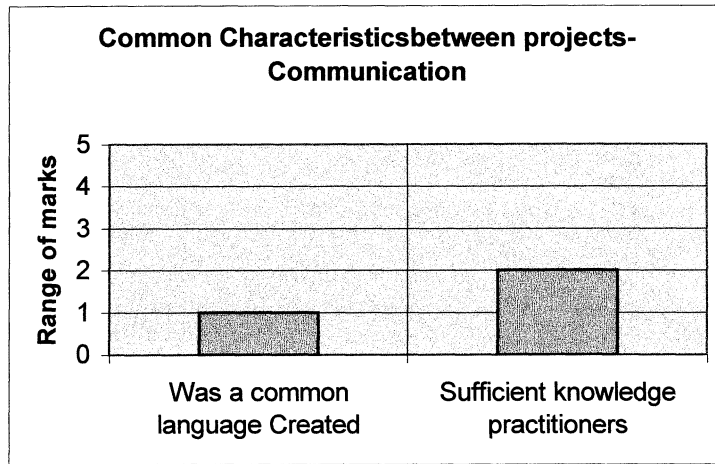


Figure 36: Common characteristics of projects - knowledge creation theory

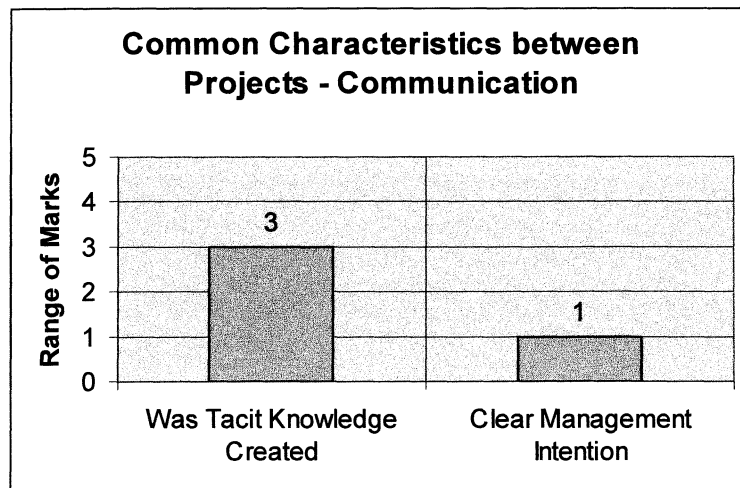


Figure 37: Common characteristics of projects – knowledge creation theory

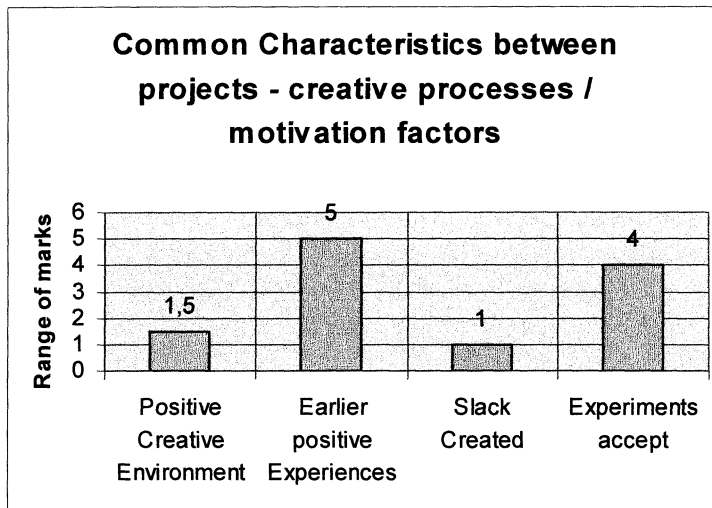


Figure 38: Common characteristics of projects – knowledge creation theory

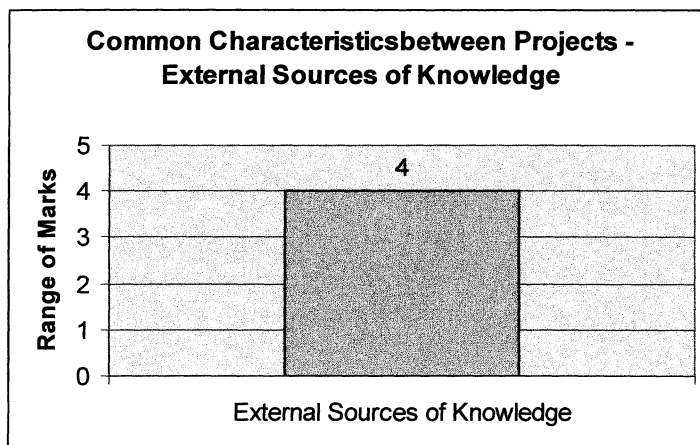


Fig 39: Common characteristics of projects – knowledge creation theory

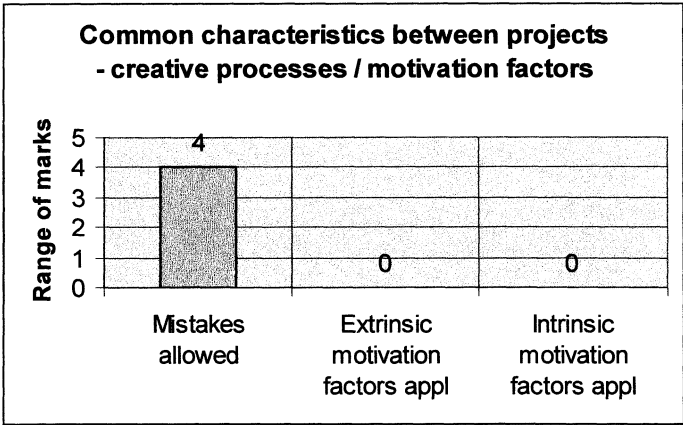


Figure 40: Common characteristics of projects – knowledge creation theory

6.3.7.4 Conclusion

From the chapters 6.3.7.2 and 6.3.7.3, I have made a selection of elements to be included in the conclusion of the analysis of the projects.

Uncertainty Reduction

Rommel et.al (1995) emphasises the importance of doing a proper job upstream an innovation project, stating that the foundation of the project is established at an early stage. The main thinking behind this is to reduce the risk and uncertainty in the project through creation of a solid knowledge base upstream the project.

The analysis of the projects shows that none of them included an early creative phase taking a holistic approach, with special relevance for the projects number 1-4. The following typical activities were not done in a pre-study or pre-project: search for market demands / customer demand, search for product ideas, screening of ideas, Amabile (1988), evaluation to see if an actual project would result in a good business for the company, choosing the proper systems limits, clarification of technology and allocating resources and time to promote a proper implementation of both the creative – and systematic project phases.

The analysis of the projects shows that the enterprise in Moss was jumping into the main projects, while keeping a fairly high level of uncertainty and risk of not succeeding at the project initiation. A realistic picture was not created in any of the projects as to what kind of knowledge that was required regarding product, market and technology for achieving the project goals. This was especially the case for projects number one and four, which included product innovations.

Emery (1974) suggests the formulation of a minimum critical specification to open up for learning. Especially in projects involving a high degree of uncertainty it seems important not to reduce the solution room too early, before the problem is defined and the solution is found. The histograms show that broad specifications were established in three of five projects, partly due to lack of knowledge. In project number one, which was not run as part of the normal operating activities, detailed specifications were established in both phases of the innovation activities. An explanation could be the view that the introduction of the new

product quality merely was a production task. In project number three the technical specifications were based on a technical concept, given by the project management as the best point of departure.

The results from all five projects should finally be implemented in the organisation. However, requirements from the users of the new technology were not included in any of the project specifications to achieve a joint optimisation of the technical and social sub-systems as suggested by Levin, Fossen & Gjersvik (1994).

Elden & Levin (1991) and Gibbons (1994) claim that knowledge creation takes place in an integrated manner during a project. However, the analysis of the projects indicates that it may not be enough only to create knowledge during the project implementation. It seems that a certain level of relevant knowledge has to be present as to the technology at the up-start of the project, in order to achieve the necessary realism in what is required in order to achieve the project goal, and to lay the ground for proper decisions in the early phases of a project. In the two projects in which development of new product technology was involved, the lack of sufficient initial knowledge of the subject in question seems to have been one of the major factors causing the unsuccessful project results.

Creation of New Knowledge

The analysis of the projects shows that new knowledge was created in all five projects, but only in the R&D phases for projects number two and three.

Nonaka & Takeuchi (1995) argue that knowledge is primarily tacit and is developed through experience and interaction with others. It is further argued that new knowledge is created in an interaction process between tacit and explicit knowledge, and none of them is present without the other. It is emphasised that this is a social process between individuals with a strong focus on the importance of creation a proper arena for interaction.

I have made use of Nonaka & Takeuchi's (1995) in the following discussions of knowledge creation in the product innovation projects number one and four.

Project 1

In phase one of project number one, there was not created a proper arena for an open dialogue. To the contrary, the innovation activities took place in an atmosphere of conflicts. The communication within the management level was mostly through writing memos. The vertical communication was closed. The middle management was first involved during the competitor analysis and the performance of four technical trials. In phase two cooperation between the parties took place in more integrated forms. Practitioners from the paper mill were not involved in either phase one or phase two of the project.

Applying the thinking model of Nonaka & Takeuchi (1995) new knowledge was created in the interaction process within the middle management. Some of the actors had similar professional background and experience, and possessed a potential for sharing tacit knowledge. However, tacit knowledge from the practitioners working in the mill was not included in the knowledge creation process. The solution room thus became reduced and the learning somewhat limited. This turned out to become decisive for the project result. Partly due to lack of proper involvement of the practitioners, the project management did not create the realistic view that this higher quality product required more knowledge in the operating organisation to make possible the production of a stable product quality. Accordingly, no special training of the practitioners was given to make the new quality. This created a difficult situation for the practitioners.

Project 4

Project 4 may be characterised by the strong requirement of secrecy around the whole innovation process. Only a few actors from the enterprise in Moss were involved in the project. The local project group consisted of professionals from the middle management. New knowledge was created in a close interaction process with professionals from machine and chemical suppliers. The knowledge created regarded which raw material recipe and process conditions to choose, in order to produce the required quality, which kind of process equipment was needed, and how to solve technical problems during the innovation process. Due to a reduced relevant knowledge within the own organisation, the knowledge creation had more the character of a pure knowledge transfer from the suppliers to the enterprise in Moss.

In line with the thinking model of Nonaka & Takeuchi (1995) this knowledge creation process was somewhat limited. The practitioners that were the potential users of the new technology were not invited to take part in the knowledge creation process to share their tacit knowledge with the project group.

Integrated Knowledge Creation

In line with Gibbons (1994) I take the position that knowledge creation in innovation projects have to take place in an integrated manner. Further, the knowledge creation process has to be of a heterogeneous and dynamic character, in order to achieve the necessary diversity and flexibility in the problem solution processes. The knowledge creation process is a result of participant- based negotiation processes.

The analysis shows that an integrated knowledge process was initiated shortly after project up-start for project number 5 that lasted during the whole project. For the other four projects, integrated knowledge creation also took place in part of the projects, but only within the project groups.

The analysis of project 5 shows that the main reasons for successful integrated knowledge creation in this project were:

1. A strong commitment from the management, motivating people for participation in integrated teams. This is in line with claims from Lembke & Wilson (1998) that the individual must desire membership in the team and what it involves, in order to identify with a work team. Within a social identity framework, desiring to belong to a social group requires that the individuals evaluate the team purpose and change their cognitive perspective.
2. The application of a dynamic network organisation in the project implementation, opened up for a large diversity in the project discussions of creative problem solving. A professional organisation was established that at the same time was looking for different tasks in all directions. This is in line with Kirkegård, Ryding & Aagård's (1996) experience from network organising of product development projects at Bang & Olufsen.

3. The dynamic network organisation functioned as an autonomous group. As Elden & Levin (1991) suggest, there was a strong focus on empowering the practitioners involved in the innovation project to increase the motivation for participating and involve themselves, and for creating a context of more power equality and democratic dialogue.
4. The strong management commitment together with a demanding project goal functioned as a strong intrinsic motivation factor for creative activity, due to the creation of an environment of low external control in the immediate working environment and the identification of a performance gap, Amabile (1988), Sjølander (1983).
5. The project management succeeded in creating a common meaningful language of communication in this project. Adler & Winograd (1992) claim that the mechanism behind integrated knowledge creation is communication according to democratic principles.
6. The utilization of an outsider as a project manager turned out to be an important success factor, and was done according to recommendations in the procedure of cleaner production from the Environmental Protection Agency in USA.

The analysis shows that integrated knowledge creation took place in parts of the other projects, but only within the project groups, which seems partly to be the result of sufficient creation of diversity and positive conflicts within the project groups. However, none of the project groups, were consciously constructed of actors possessing different personalities as Belbin (1993) suggests.

Central actors at the management level were poorly integrated in the knowledge creation processes in the project groups. This resulted in low and unclear signals about the management's commitment, which made it difficult for the project group to judge the value of the knowledge created. Due to this it seems to have been difficult to communicate different knowledge perspectives and to create a shared understanding of the problems to be solved in the project. Rommel, Kluge, Kempis, Diederichs & Bruck (1995) claim that this could have been

properly managed by application of an integrated model of product development.

It was not possible in the project number two or three to communicate different knowledge perspectives and to create a shared understanding for further progress in the projects number two and three between the management at the enterprise in Moss and its associated Peterson company. This seems partly to have been due to different mental models of central actors as to what the technological development in Moss should be, Argyris & Schon (1996).

External Sources of Knowledge Creation

The analysis of the projects shows that the enterprise in Moss involved external sources of knowledge in four of the five projects.

In project number 1 one of its customers was involved in the second phase of the project in the development of the new product quality. During the R&D phase the cooperation functioned well, the customer opening up for sharing of knowledge and full-scale technical trials in the customer's mill. However, when the new product quality was introduced, the co-operating customer would not accept the new quality. It obviously turned out that he was not genuinely interested in introducing the Peterson quality of the new product together with the enterprise in Moss.

In project number two the choice of technology and external sources of knowledge creation to be utilized in the project was taken upstream the project without the involvement of the organisation at the enterprise in Moss. By this important conditions were given at the project upstart. In line with Sjølander (1983) this clearly reduced the motivation of some actors involved in the project for utilizing the external technology.

Von Hippel (1986) suggests that marketing research should be done with focus on lead users that present strong needs and that are in advance in the market. Their needs will become general months or years in the future. It is a way of avoiding being trapped in one's own market.

Intrinsic and extrinsic Motivation Factors

Mechanisms of task motivation were not applied in any of the five projects involved. According to Amabile (1988) a proper utilization of intrinsic and extrinsic motivation factors in an innovation project could both boost the creative activity in the creative phases and increase the productivity in the systematic phases of the project. This represents clearly a management challenge.

It seems that this could have been useful to increase the efficiency of all projects except for project five. This project with the high creative content had strong intrinsic motivation factors unintentional built into the project as described above.

Project Evaluation

In none of the five projects was a project evaluation created, in order to initiate organisation learning.

6.3.7.5 Major Findings for My Innovation Model

From the above conclusion of the analysis the following major findings are chosen to be included in my innovation model:

- An early creative phase taking a holistic approach, in order to get a realistic picture as to what is required for making a successful innovation and to examine if the innovation will be a profitable business for the enterprise.
- A minimum critical specification, including a joint specification of both the technical and social subsystems.
- Making an arena for integrated knowledge creation, opening up for utilization of the following enabling mechanisms:
 - A strong commitment from the management

-
- Creation of sufficient diversity and creative conflicts in the project organisation
 - Organising of project groups as autonomous groups with redundant functions
 - A strong involvement of the practitioners
 - Creation of a common meaningful language
 - Utilization of an outsider as a project manager
 - Vertical integration of the innovation project to tie the project up to the organisation and to secure a strong management commitment

 - Applying the benchmarks of lead users in the market

6.4 Analysis of Projects applying the Actor Network Theory – following the Actors as Research Political Actors through the Projects.

6.4.1 Introduction

The purpose of this analysis is to see which important developments were taking place in the later construction of technology, and to uncover different interests and political activities taking place in the projects. To do this, I have followed central actors through the projects as research political actors, to examine what kind of strategies, which were applied by different actors, to gain support for their own scenarios, and to gain control and influence of the direction of the projects.

The following structure given in the theory, is utilised in the analysis:

- A stable point is challenged at the up-start of a technological innovation
- A controversy appears. Different actors have different claims as to what is truth
- A political struggle takes place. Different actors try to win through with their scenarios through applications of different strategies through:
 - Enrolling of actors
 - Translation of interests
- A settlement of the controversies is tried to be achieved through
 - Creation obligatory passage points
 - Black box closure

6.4.2 Project 1

6.4.2.1 Upstream the Product Development Work

A stable Point is challenged

The paper machine PM4 was built in 1952. During the first part of the 1980s discussions took place about rebuilding the paper machine to modernize it and increase its production capacity. This important event should turn out to be of great significance to project number one.

A comprehensive marketing survey was done in connection with the planning of the rebuilding. Based on this survey the administration decided by the administration that the paper machine should be rebuilt in order to match the market development, which the marketing survey indicated would come. This included production of a paper quality, which was new to the enterprise in Moss.

Controversies appear of the technological Development at the Company

Two main actor groups could be identified: the administration and the sales department on one side, and the technical department on the other. According to the empirical material these groups had different views about the technological development. However, the communication between the groups was poor. The network was closed. Only a few actors at the management level were involved.

A situation of interpretative flexibility existed. The two actors groups had different claims as to how the technology should develop at the enterprise.

The technical department was technologically push - oriented, focusing on production of the present products, which were suitable for the existing production machinery. The attention was kept on an efficient paper production with as little operational problems as possible. A marketing - oriented approach, i.e, having the customers decide, was rejected.

The administration and the sales department on the other hand were focusing on following important trends in the market, signalling an increasing interest in a new product, not produced at the enterprise in Moss. The product was not new to the market, however. It had

been in the market for some years. According to the empirical material the required quality level of this product was known.

It was the point of departure of the administration and sales department that after rebuilding, the paper machine PM4 should be fit to produce the new product, at a quality acceptable to the market.

A Political Struggle is taking Place

Upstream the rebuilding of the paper machine a technical specification was established. This included a document including technical design data about the machine, guarantee requirements and how the guarantee tests should be done. Making a proper technical specification was clearly the responsibility of the technical department.

In the beginning it was difficult to get a complete picture of the events taking place during the preparations for rebuilding the paper machine. It was necessary to go back to the written documentation of the technical specifications of the machine to get a better understanding.

The technical department obviously followed its own strategy regarding the purpose of the rebuilding of the paper machine. However, it did not discuss its interests regarding the rebuilding of PM4 with the administration and the sales department.

The technical Department's Enrolling of Actors

The technical department enrolled the machine supplier in the discussions for preparation the technical specifications. This network between the machine supplier and the technical department was old and well established. Most of the actors within this network knew each other well. The machine supplier was the technical expert regarding the actual rebuilding.

The enterprise in Moss to a high degree had to trust him regarding the technical calculations, due to lack of sufficient knowledge within the own organisation. However, the conditions of these calculations were given by the technical department.

The paper machine PM4 and the continuous digester in the pulp mill were enrolled as central actors in the technical department's work of translation of interests.

Translation of Interests

The main focus of the technical department was to increase the production capacity, to reduce the energy costs, and to improve the quality of the existing products. The paper machine was designed by the machine supplier according to that.

The technical department as the central network builder at this stage, showed that its interests was coordinated with the interests of the paper machine supplier. Within the given framework of supply, the supplier was interested in rebuilding the machine in a way which would fulfil the specified guarantee requirements in connection with installation of new technology, and to receive as few complaints as possible during the normal operation of the paper machine. The paper machine supplier was interested in making a design based on proven technology.

The technical department chose the important technical design parameters of the machine, limiting the type of products that were suitable for being run on the machine. These were based on economic and not marketing reasons. The network builder based this on a thinking that his interests fitted the interests of the enterprise. The pulp digester enrolled in the actor network, and it was argued that the enterprise achieved the best economical results, when the digester was running at full capacity. There were at this time separate accounting systems for the pulp and paper mills, without taking a systems perspective.

The empirical material did not show that the translation of interests described above and the consequences of the chosen design parameters were communicated out of the existing technological network regarding development of the new product .

According to the empirical material the administration and the sales departments had to believe that when the paper machine was rebuilt, the introduction of the new product was merely a matter of starting to produce it.

The machine supplier included the product that was new to the enterprise in Moss in the technical specification, calculating with a certain production capacity of it. Trials were done

on the machine supplier's pilot machine. The conclusion from the machine supplier was that the new product could potentially be produced on the rebuilt paper machine.

The machine supplier guaranteed the appearance of the new quality, referring to a dated test sample. In this way the machine supplier translated his interests to the supplier chosen by the enterprise in Moss to do the rebuilding of the paper machine, making a reservation regarding quality level of the new product.

It seems that this sample was never checked in the market. Obviously this would have been a crucial point if the technical department really had intentions of producing a market quality of the new product. According to the empirical material it seems to have been known within the technical department that the appearance of the paper, as obtained during the tests in their pilot machine, was not good enough compared to this kind of paper made by other producers in the market. Further, other paper machines were producing this paper quality on other design parameters than those chosen by the enterprise in Moss. It seems that this was known within the technical department at the design stage of the paper machine.

The Creation of the Paper Machine PM4 an obligatory Passage Point

The paper machine with the chosen design parameters was really not designed to produce a market quality of the new paper product. The paper machine was made to an obligatory passage point. The required level of quality could not be reached without heavy investments on the paper machine. The data material indicates that the technical department was not fully aware of this fact, but that they were optimistically thinking that the required product quality could be managed on the rebuilt paper machine.

Figure 41 illustrates the decisions which resulted in the making of the paper machine to an obligatory passage point, together with the lack of proper communication between the administration and the marketing department on the one side and the technical department on the other.

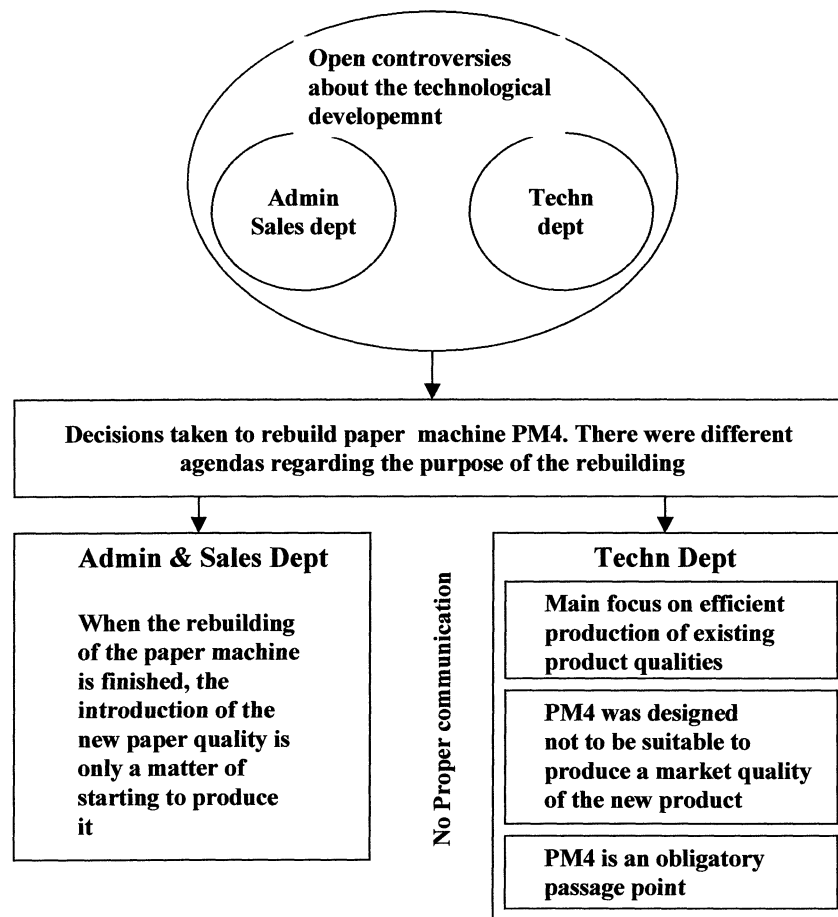


Figure 41: The process of creation of the paper machine PM4 an obligatory passage point

Technological Stabilisation

The controversies seemed to be settled and the new technology stabilised in a black box closure when the installation of the new technology on paper machine PM4 was finished. The technical limitation on the machine seemed to be forgotten. The data material shows that no negative attitudes were communicated between the main actors.

6.4.2.2 Phase one of the Product Development Work

A stable Point is challenged

Shortly after the rebuilding of the paper machine was completed, trials were done on the rebuilt paper machine, producing the new paper product. The quality level was tested on some of the company's customers that did not accept the quality. It became clear that the new technical equipment on the paper machine PM4 was insufficient for producing the new product at a proper quality level.

Controversies appear of the Introduction of the new Paper Product

The administration, the marketing and technical departments jointly created a strategy plan for the following three years. The document was established mainly with background in the plans for producing the new product quality. Scheduled production plans for the new product, covering the whole strategic period, were included in the plan. This indicated that no development work was expected.

In the strategy plan it was referred to necessary technical investments, specified by the technical department, to carry out the planned introduction of the new product quality.

One should expect that the controversy between the two main actor groups could be settled, when the parties created the strategy document together. According to the empirical material this did not happen, however. Potential problems and challenges regarding presentation of the new product quality to the market were not discussed during the strategy work to give the actors a common understanding of these, mainly due to poor communication between the main actor groups and a too small environment to take these kind of discussions. The knowledge of the rest of the organisation was not brought into any of the discussions. In fact the content of the strategy plan and the plans for introducing a new product quality were unknown to most of the organisation.

Obviously the technical department was not very focused on initiating the work of preparing for an introduction of the new product quality. The department asked in a letter to the

administration for an evaluation as to the disadvantages of starting to prepare for production of the new product quality at the scheduled plans. It was argued that it was necessary first to take a detour and focus on other important tasks in the paper mill.

The Enrolling of Actors

The administration at the parent company and the financial department of the enterprise in Moss were enrolled in the network. The administration of the parent company asked in a letter to the marketing department, the technical department and the financial department asked for clarification as to what was necessary before a decision on investments in equipment could be taken, in order to produce the new product at a proper quality level.

The financial department calculated a good profitability to produce the new product, based on single figures of product prices and costs.

The technical department specified the necessary equipment for production of the new product at an acceptable quality, as was stated in the strategy plan established shortly before. The empirical material shows that these investments came pretty fast. There was no preliminary study before these.

At this stage, the administration and the marketing department strongly believed that the introduction of the new product quality was only a matter of starting to make the product on the machine. The technical department also seemed to be optimistic there might be a chance of success, even if they knew that the paper machine was not really designed to produce a proper market quality of the new product.

The two main actor groups, the administration and sales department, and the technical department continued to follow different tracks, to strengthen their positions respectively. The empirical material indicates that the network was very closed at the management level. The empirical material shows that the communication was especially poor between the sales – and technical departments.

The marketing department mobilised the enterprise's sales office in England. According to the empirical material this office to a high degree fronted the work upstream the introduction

of the new paper quality in the market. The technical department on the other hand mobilised the machine supplier to design and install the necessary equipment for producing the new quality and improving the existing product qualities.

Translation of Interests

Based on the results from the agreement in the strategic document about the introduction of the product quality and the specifications of the technical department about the equipment that had to be installed, the sales department started the budget work regarding introduction and ordinary delivery of the new product. This was according to planned production volumes included in the existing strategy plan.

The marketing department took contact with the administration and the technical department at the enterprise in Moss and asked them to clarify that there would not be any problems regarding the product quality, compared to one of the best product qualities in the market, and that the planned delivery time would be realistic.

In its translation strategy the marketing department succeeded in convincing the technical department that it should support this scenario of the introduction of the new product quality even if this was not according to the technical department's own goals. The technical department responded positively to the questions from the sales department. The department confirmed that there would be no problems, regarding the required product quality.

It was stated that one important task before the introduction could take place was the testing/adapting of the product of the enterprise in Moss to the market requirements.

The technical department further informed the sales department that the project so far seemed to be according to schedule, even if the first technical trial was planned to take place more than half a year later.

The empirical material indicates that at this stage the technical department began to understand that there might be some problems regarding the introduction of the new product. A reservation was made even if the technical department supported the scenario of the

marketing department. The sales department was asked to establish a flexible introduction rather than fixing tonnages and dates. It seems that this message was not clearly understood or taken into consideration by the sales department. According to the empirical material this was mainly due to a very poor communication between the sales and technical departments. Obviously the technical department only expressed small reservations to the sales department before any technical trials had taken place, because at this stage they believed that it would be possible to produce a quality which the market could accept.

At approximately the same time the technical department started systematically investigating the quality level of the competitors, and the raw material composition of the competitors' products on the paper machines. These questions were first raised at a broad level only a few months before the planned introduction of the new product should take place.

The empirical material indicates that up to this stage of the development work the network of the administration and the sales department were stronger than the network of the technical department, which had less powerful friends at that time.

The marketing department introduced the product at a seminar, where the main customers of the enterprise in Moss were invited to participate at management level. The top management from the parent company and the enterprise in Moss were present at the seminar. The first full - scale technical trial, however, which was unsuccessful, had just taken place. This did not however influence the market introduction program.

Upstream this seminar there had been an intensive marketing campaign in relevant papers during some time, in order to prepare the market for the new quality that would be introduced by the enterprise in Moss. According to the empirical data it seems that the marketing department tried to create the introduction seminar to an obligatory passage point, signalling that this was the best and only way in which to follow the interests of the actor network.

In the market seminar the technical department had to tell the customers about the production capabilities and qualities of the different liner qualities on the rebuilt paper machine.

Typical figures of the quality of the new product were presented. These were not as good as the best qualities in the market. The technical department tried to translate its scenario,

arguing that their interests were in accordance with the interests of the customers. This meant that the product quality at the enterprise in Moss should be good enough, even if it was not among the best in the market. It was argued that it was difficult to judge by human eye the difference between the existing market qualities of the actual product.

Signals were given from the enterprise in Moss to its customers that there could be problems in producing the new product at the required market quality.

An environmental approach was taken in the argumentation that the lower product quality of the enterprise in Moss was more environmental friendly than the best qualities in the market, due to no need for utilising chemicals in the production, which could have negative environmentally effects.

The timetable for regular production of the new product was presented. Finally, Peterson Moss stated that the company was convinced that it would become a steady supplier of the new product quality, and that the customers should be satisfied with the delivered quality.

The empirical data show no indications that the technical department succeeded in mobilising the customers' support for its scenario.

The technical department was negative to the project from the time it got to know about what was required to produce the quality, started working towards a termination of the project. However, four large-scale technical trials were performed to see how far towards the market qualities it was possible to come. The paper machine supplier, a supplier of filler material and an associated company of the enterprise in Moss were mobilised during the trials. None of the trials were successful. There were problems both with the strength and the appearance of the paper. To succeed, the mass balance on the paper machine had to be different from it was designed for.

The technical department explained the above unsuccessful trials by openly arguing that the paper machine was not designed for producing the existing market qualities. Downstream the technical trials it clearly came to understand that the paper machine was not constructed to make a market quality of the new product.

The empirical material further indicates that it was at this stage of the project a lot of informal communication took place at different levels in the organisation, working to terminate the project.

Creation of the Market Conditions an obligatory Passage Point

The technical department succeeded in translating its interests to a new administration at the enterprise in Moss. According to the empirical material, the department finally got someone to discuss with about these matters

The project was terminated in a meeting shortly after the arrival of the new administration. According to the empirical material the background to this was an increase in the price of an important raw material as well as problems in attaining the market quality. According to the minutes, the conclusion of the meeting was, no plans of producing. The following statement was given in the meeting:

“We are able to produce the new quality. We have no plans to produce the new quality in the nearest future”

Technological Stabilisation

The technical department and the new administration finally took control of the actor network, and managed to settle the controversies through a black box closure of the technology putting the market conditions in focus.

The termination of phase one of the project involved that the new product was not introduced to the market as scheduled and promised to the customers at the introduction seminar. This was very embarrassing to the enterprise in Moss.

6.4.2.3 Phase two of the Development Work

A stable Point is once more challenged

A new strategic direction had been established. This involved a break with the former strategy, and did not include production of the new product. According to the empirical material the strategy was based on a new understanding that an important condition to survive was getting a higher yield from each paper machine. It was focused on an increase of production of existing liner products at high kappa numbers.

The strategy was only to a small extent rooted in the organisation, and was not a living document mirroring the organisation. It was only something which the top management was involved in.

The project that was paused for two years, started up according to the empirical material, more or less accidentally and can be characterised as an ad-hoc project. The initiation of it seems to have been motivated by high prices of the potential new product from the enterprise in Moss and low costs of important raw materials. A systems approach was not taken regarding the cyclic price and cost variations in the pulp and paper branch.

The marketing department wanted the product. According to the empirical material the arguments used was that the market for the new product was increasing, and that more customers wanted to purchase paper from a total supplier of liner products.

It was stated that a Peterson quality of the new product should be developed. This should be a good quality based on conditions of the enterprise in Moss. The product should be able to well on the paper machine. Available resources and the machine's technical condition should limit the project. The market survey should be short. The product should be available in the market within one year, which meant that only minor technical installations on the paper machine could take place.

Technical and organisational problems in phase one of the project were not discussed. No preliminary study was planned. Thorough discussions with involved parties about what was realistic to manage at which investments were not held.

The initial Network

The second phase of the project was initiated by the permanent executive group of the R&D project at the enterprise in Moss, consisting of members of the top management teams at the enterprise in Moss and the parent company. The executive group was headed by the managing director at the enterprise in Moss. A project group was very soon established, that consisted of representatives from the marketing , the production and R&D departments.

The Marketing Department's Enrolling of Actors

The marketing department's representative of the project group mobilised the company's sales offices in England and Germany, making up the reference group of the project.

Translating of Interests

A comprehensive market survey was done. The objective of the marketing department was to provide background information:

- On producing or not producing the new product quality
- Determining the short and long term profitability of the new product
- Promoting a decision on the product quality/type the enterprise in Moss should aim at
- Developing a possible market strategy for Peterson regarding the new quality
- Utilising the reference group as a vehicle by which the department would become more widely involved in the product development.

The conclusion of the market survey was that the Peterson quality ought to aim at being more consistent in quality and performing better than the qualities currently offered in the market. Only a few paper properties could be negotiated. A quality specification was suggested by the project group for the new quality, making a compromise between the markets demands and the capability of the paper machine.

The project group tried to translate its interests regarding the required high product quality to the executive group, arguing that the interests of the project group were in accordance with the interests of the executive group and of the enterprise.

Controversies appear on the Quality Level of the new Product

The quality specification was presented in the executive group for approval, where it was rejected. It was decided that the enterprise in Moss should not compete with the best in the market. The quality could be somewhat lower, and be sold at a lower price. The marketing department doubted if this would be possible. The technical department succeeded in translating its interests to the executive group that it would be difficult to obtain a Scandinavian appearance with the existing production equipment.

As a result of the above discussions, the project group was instructed to find out how the product would have to be in order to give a good profitability on the existing paper machine.

The empirical material shows that the background for the decisions taken in the executive group was violent discussions between the administration and the technical and marketing departments as to what the quality should be. There were big disagreements on this issue. The technical department managed to establish in the organisation that the company was talking about a Peterson quality, and not a market quality, forcing its scenario through. The technical department had learnt from phase one of the project that it was not realistic to try to make a stable production of a market quality of the new product on the existing paper machine. The machine was not designed for it.

Obviously the arguments of the technical department about a Peterson quality was based on a technical aspect. Paper qualities should be made, which were suited to produce on the paper machine in a stable and efficient manner. The market had to accept the actual product qualities from the machine.

According to the data material it seems that the above decision was partly a result of a too limited creative environment within the management network.

The Development of the Network

The empirical material indicates that the alliances changed at management level from phase one to phase two of the project. In phase one the main networks were constituted by the administration and the sales department on one side and the technical department on the other. In phase two of the project it seems that the administration and the technical department had a common view about what the future at the enterprise in Moss should be, somewhat different from the view of the marketing department and the sales offices abroad. Figure 42 illustrates how the main actor network looked like in phase two of this project.

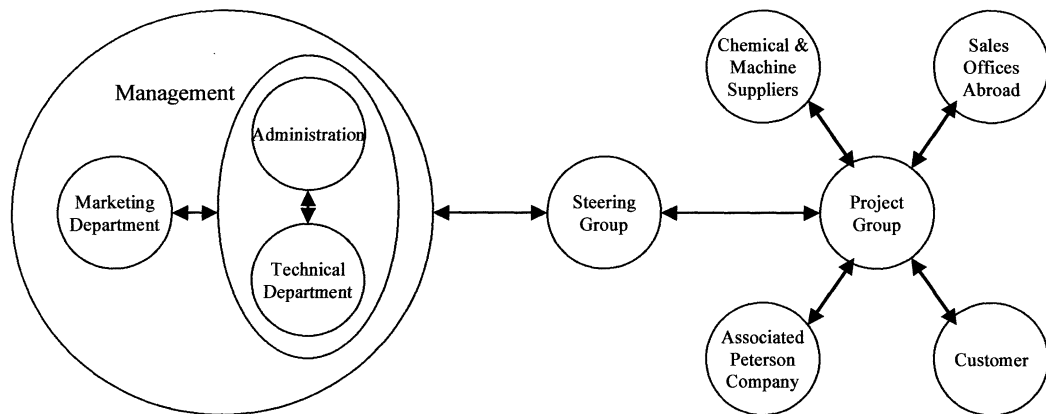


Figure 42: An illustration the main actor network during phase two of this project

According to the empirical material the network of the project group was open and well functioning. There was an integrated team approach to the cooperation between the different actors. Representatives from the R&D marketing and operating departments were members of the project work.

An associated company of the enterprise in Moss was involved to do full- scale printability tests. The company was not an integrated part of the project group, and did not take part in the creative processes within the project group. This part of the network was quite loose. Potential synergic effects were not fully taken out. The associated company was reserved to the product of the enterprise in Moss. The paper quality under development in Moss was always compared with the best in the market, which was frustrating. Positive feedback was

seldom given by the associated company, as to what actions to take to improve the product quality. The empirical material shows that it would have been better to make the necessary tests at an external institution than with the associated company of the enterprise in Moss.

The machine supplier was enrolled to do some technical installations on the paper machine. It was the technical department and the administration that was deciding together with the machine supplier what kind of minor technical solutions that should be selected to improve the product quality. The project group was not a part of this discussion.

The chemical supplier was enrolled to work in an integrated way with the project group and should contribute to an improvement of the surface properties of the new product.

Some good customers of the enterprise in Moss did full- scales tests of the new product. One customer took actively part in the development work of the new Peterson quality that should differ from the existing market qualities.

In the executive group open discussions seldom took place. An atmosphere of supporting creative thinking was not initiated by the group. The empirical material shows that a few strong actors dominated the meetings in the executive group. In most cases it only responded to input from the project group.

The empirical material shows that in these meetings the project management seldom got enough information from the management to achieve a holistic understanding of all the discussions taking place within the executive group and external to it. This created an uncertainty inside and outside the project group of not being in control in regard to the project implementation. It could also be questioned if the project really had its base in the management group.

The empirical material shows that the actor network at management level was more or less closed to the project group. There was little direct communication between the two groups. The project group and the management group did not manage to share knowledge about technology/market/product. Feedback from the management to the project group regarding the progress of the project went through the executive group.

A temporary Settling of Controversies during the Development of the new Product Quality.

During the development phase of the new product quality the controversies seemed to have been settled. The most powerful actors in the network had secured their positions due to successful translations of their interests. It was decided to try to develop the new product according to their views, as a Peterson quality.

Profitability analyses were often done, during the project execution due to the experience of a gradually increasing raw material price, more use of an important raw material than originally estimated, and a reduced production capacity for this product. Profitability reports were distributed to the management. According to the empirical material the management never gave any feedback to the project group during the development regarding what should be the lowest acceptable profitability before the project should be terminated, which would have given the group an important guideline.

After some time of technical development the management required that paper produced during the full-scale trials should be sold in the market. The first feedback from the market was experienced as positive. This was the first real test on the Peterson quality of the new product.

Opening up of Controversies – Translation of Interests.

The controversies opened up again at the up-start of normal production of the new product. The actors controlling the network were changing for a short time. It appeared that the customers did not want the new product. It was a wrong hypothesis that it was possible to sell the new Peterson product with a lower quality than a market quality to a reduced price. Producers of corrugated boxes always wanted to have paper from different suppliers available in-house during production. Accordingly, the differences in paper quality could not be large within the same production run.

The empirical material shows that the marketing department forced through its scenario that a quality improvement towards the market one was necessary in order to have a chance in the

market. During a relatively short period of production, the marketing department took a strong position in the network.

Increasing the product quality, would mean that the paper machine had to be run outside its specifications within many areas. This created a difficult position for the operating department. Many elements were not controlled as regards the operation of the machine and the competence of the operators.

A Black Box Closure of the Project

After a short period of production, the technical department began to argue strongly for terminating the project, due to the difficulties in producing a stable product quality to the customers. The company got a lot of complaints from the customers about an unsatisfactory product quality. According to the empirical material the operating department was blamed for these problems.

Within the technical department discussions were initiated whether it was right to produce this product with such requirements on different quality properties in so small series as the company did. At the same time the price of an important raw material, which had to be purchased, was all the time increasing. The economical contribution of this product was reduced. Corrected for problems with - up-start, running into specifications, broke and customer complaint, it was clear that this product not was a good business for the enterprise in Moss.

In a management meeting there was a broad agreement to terminate the project. It was said:

” When we are now terminating, we are terminating forever”.

That was a permanent decision.

I shall conclude the analysis of this project with a proper comment from one of the central actors from the operating department whom I interviewed: *“It was a nice excuse to stop the project, when the prices of the important raw material were increasing”.*

6.4.2.4 Findings

Phase one of the Project

- Different claims existed among central actors as to what the technological development at the enterprise in Moss should be.
- The rebuilt paper machine was not suitable for producing the new quality
- The enterprise in Moss trusted the machine supplier and his network in his judgement regarding the high probability of producing a new product of proper quality on the machine
- The new product quality was introduced in the market before it was clarified that there would be technical problems in producing a market quality
- The reasons for terminating phase one of the project were high raw material costs and low product prices

Phase two of the Project

- The project started as an ad-hoc project
- It was initially decided that the product should be a Peterson quality, at a lower quality than the market quality. The quality should be sold at a lower price than the market price. This decision was forced through by the technical department at the enterprise in Moss
- It turned out that a market quality would be necessary for promoting sales of the product in the market. At this stage the marketing department took a strong position in the network
- Heavy problems in producing the market quality appeared in the paper mill
- There was finally a broad agreement within the management group to terminate the project, based on low contribution from this product, together with problems with up-start, running into specifications, broke and customer complaints.

6.4.2.5 My Reflections on the above Findings

- The only stable obligatory passage point seemed to be the rebuilt paper machine. A redesign of the machine would be necessary in order to remove this problem

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- I argue that the fact that the new product was introduced into the market before the technical trials were done demonstrated a poor communication between the technical and marketing departments.
 - The second phase of the project started as an ad-hoc project. It seems strange that the technical conclusions regarding what was required to make the product obviously was forgotten within the short time of two years. I argue that the marketing department that mainly wanted the product, did not manage to create a holistic picture of the problem area.
 - It was decided in the executive group that a Peterson quality of the new product should be introduced into the market. It is difficult to understand how this decision could take place. Similar products in the market were of a higher quality. It was further known that a corrugated box producer always wanted to have at least two similar qualities from different suppliers in-house during production.
 - The practitioners in the paper mill were not properly involved in the actor network. I argue that an improved understanding of the technical challenges for running the product could probably have been achieved if this had been done.

6.4.3 Project 2

6.4.3.1 Upstream the Project Start

A stable Point is challenged

A well-known private research institute in Norway was involved in an EU project with 12 European actors. The goal of the project was to strengthen Europe's competitive force against USA and Japan, and to motivate for an increased exchange of technology between the European countries. The Norwegian research institute's role in the project should be to test an application of the new technology in a Norwegian industrial company. The empirical material indicates that the Norwegian Government considered it to be important for Norway to participate in this EU project.

Controversies appear about how to test an EU Technology Application

At that time the Norwegian government had to financial support actors participating in EU project, in contrast to actors within the EU system that were financed through funds.

The private research institute contacted NTNF and asked for financially support to test an application for a new EU technology. The Norwegian research institute needed a sponsor to be involved in the European project. NTNF was mobilised to get financial support.

To make it politically possible to support the Norwegian research institute, NTNF had to give sponsorship through one of its current research programmes. The chosen strategy was to find a Norwegian process industry and involve this in the NTNF program called "Automation in the Process Industry" to promote the testing of the EU application for the new technology.

Enrolling of Actors

The research institute involved in the EU project took contact with PFI. It was asked if the research institute knew about any process industry within the pulp & paper branch, which could be willing to test the application of a new technology. The technical staff at the parent company of the enterprise in Moss was contacted, and agreed to have a demonstration project run at one of the process plants within the enterprise in Moss.

Suppliers of a process control system and an advanced analyser system were enrolled. According to the empirical material technical department at the parent company of the enterprise in Moss had been in contact with the supplier of process control systems before PFI contacted the company regarding the testing of an application of an EU technology.

Translation of Interests

NTNF tried to translate its interests, arguing that the industry and the private research institute would have the same interests regarding a successful test of the application in question.

An open discussion took place in a meeting between NTNF and PFI about the demonstration project in Moss. PFI argued that the demonstration technology could be implemented at the enterprise in Moss. PFI obviously was interested in doing an optimisation project in Moss, utilising some new technology, which was developed at the institute. PFI managed to successfully translate its interests to NTNF that without an optimisation of the process plant in Moss the other technology would have no purpose.

When PFI gave the demonstration project this possibility, NTNF made a detour, allowing PFI to do an optimisation project through participation in the program “Automation in the Process Industry, (AIP)”, on condition that all technology involved had to be Norwegian.

Following this strategy, NTNF argued to the private research institute, which should do the demonstration project of the new EU technology, that it could not reach its goal straight away, but the best and only way would be through participation in the optimisation project at the enterprise in Moss. The parties agreed on this. It was decided to split the project into two parts.

The main interest of NTNF was the implementation of the demonstration project, which was a part of an EU project. The optimisation project at the enterprise in Moss was necessary for implementing the other project.

The controversies were settled through making NTNF an obligatory passage point.

NTNF had managed to find a strategy for testing the application of the EU project technology. PFI had succeeded in getting an important role in the optimising project, which involved development of new technology. A company was outsourced from PFI to work with the optimisation technology.

The above considerations as to the optimisation project at the enterprise in Moss were not known at any time at the enterprise in Moss. The organisation in Moss was not involved in the above actions. Obviously the fact that the technology was chosen above the heads of the organisation at the enterprise in Moss should turn out to have serious consequences for the project results at a later stage. It was very difficult to create any ownership within the organisation to the chosen technology

Each external company that was enrolled, was looking after its own strategic interests to participate. The network of interests is illustrated in the figure 43.

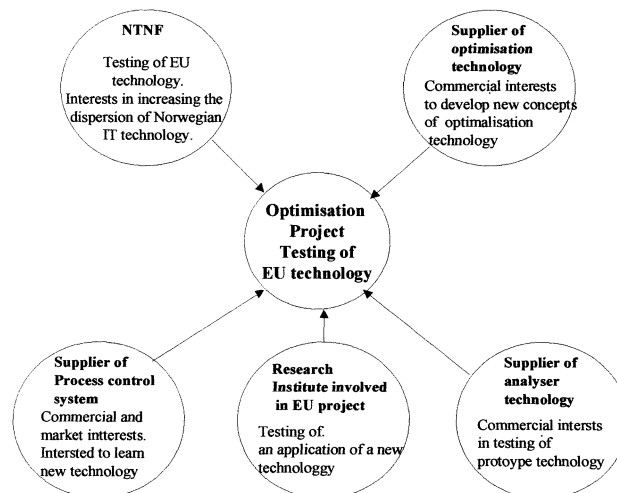


Figure 43: The external network of interests in the optimisation project at the enterprise in Moss

6.4.3.2 A stable Point is challenged at the Introduction of the Optimisation Project at the Enterprise in Moss

The empirical material shows that the enterprise in Moss was not in a position to understand why PFI and the other research institute became central external actors in the optimisation

project in Moss, and why a certain technology already was chosen. The organisation in Moss was not clearly told about the background of the optimisation project.

The enterprise in Moss did not really have any choice, if an optimisation project should be run in Moss. The upstream conditions had to be accepted.

Controversies appear of the Value of the Optimisation Project to the Enterprise in Moss

According to the empirical material this project was not deeply rooted at the management level in the enterprise in Moss. The company felt that this was a project which should be run by the parent company and not by the enterprise in Moss. The enterprise in Moss argued that it would not gain any benefits from the potential project results, but that the associated company would rather do that.

According to the empirical material the management at the enterprise in Moss was negative to the project due to different reasons:

- The technical department had taken the attitude that practical results on the process control side would only be achieved when the enterprise installed systems which were completely developed by the supplier.
- The technical department was sceptical to change to another supplier of process control systems, when the company had good experience with the existing system.
- The management had the view that a continued production of the actual product would hinder the future development in Moss.
- Increased polluting effluent to the sea from the enterprise in Moss would be a negative consequence when operating the actual process plant with the planned optimised process control technology.

There was a situation of conflict and poor atmosphere between the enterprise in Moss and its associated company. The main reason to this was very tough discussions regarding the prices on the product, which was produced in Moss and sold to the associated company. The

conditions for initiating the optimisation project were not the best, due to the existing controversies.

Enrolling of Actors – Translation of Interests

It seems that the technical department at the parent company had strong scientific interest in running the optimisation project, beside the interests of promoting the supply of the new product quality to the the associated company of the enterprise in Moss.

The technical staff at the parent company tried to transfer its interests to the enterprise in Moss, that it would be advantageous for this mill as well to do the project. The administration at the enterprise in Moss was persuaded to go in for the optimalisation project, even if it was not in line with its own goals.

The administration at the enterprise further agreed to be the formally responsible for the project. This meant that it was formally the enterprise in Moss' project. The administration at the enterprise in Moss was responsible towards its own board and the NTNf. The application to the board of the enterprise in Moss for financial support, was written by the technical department at the parent company, and showed a high potential return of the investments. It was at that stage impossible to check the reality of these figures, due to the fairly high risk of not achieving the project goal.

As a consequence of the strong enrolment in the scenarios of the technical staff at the parent company possessing the role as formally responsible for the project, the administration in Moss held a legitimate position to influence the progress of the project through a strong commitment of the management. However, this did not take place.

The project was organised with a executive group and a co-ordinating project leader from the technical staff of the parent company to follow up the different subprojects: installation of a new process control system, development of an optimal, model- based control system.

For the testing of an application for a new EU technology, an external project manager was enrolled from the research institute working in the EU project.

A reference group from the industry was established, in which several central actors were enrolled.

Once established, the project network did not develop much, apart from the mobilising of internal actors from the organisation in Moss.

It seems that the enterprise in Moss was not very interested in the testing of the application for a new EU technology. The reason to this could be that the project organisation was asked by NTNF to involve in the project the actual research institute that was working in an EU project. The empirical material shows a low degree of communication between the two networks. The research institute did not succeed in translating its interests regarding the testing of an application for the new EU technology to the project organisation that the support of its scenario would also be beneficial to the enterprise in Moss.

Further, the external supplier of process control equipment in this project did not believe very much in the EU technology. As a result, no implementation of the application for the technology took place at the enterprise in Moss. The research institute left the project at an early stage.

The empirical material shows that it could be questioned what the private research institute's real purpose behind the short involvement in the optimisation project at the enterprise in Moss was. The controversies described above should have been solved upstream the project through clarifying if the research institute either should not be involved in the project at all or should participate with its knowledge in another way. On the other hand, if the research institute had not been involved, it is not certain that the optimisation project in Moss had been initiated at all, due to the given conditions of NTNF upstream the project.

An Effort to settle the Controversies through Creation of an obligatory Passage Point

The technical department at the parent company had the role both as chairman of the executive group and co-ordinating project leader. There was never held a meeting in the executive group during the project. If any coordinating at the management level between the parent company and the enterprise in Moss took place during the project, this seems to have been done in informal ways.

The technical staff at the parent company managed to control important communication channels:

- Between the management at the enterprise in Moss. It soon became clear that the management at the enterprise in Moss was negative to the project and was not very interested in following up the project work. Due to this there was very little contact during the project between the management in Moss and the project group. The communication went through the technical staff of the parent company, as the only party interested in discussing project related matters with the project group.
- Between the enterprise in Moss and NTNF. As described above, the administration of the enterprise in Moss was responsible for the project towards NTNF, and was responsible to make progress reports as agreed in the contract. However, the technical staff of the parent company, as the coordinating project manager, had taken this role in a direct communication with the network within NTNF.
- Between the external reference group and the project group

The technical staff of the parent company had positioned itself as an obligatory passage point. Due to the control of important communication channels, the department was shaping the project group image of reality. This may at an early stage have hindered an open dialogue about the progress of the project.

Figure 44 illustrates the project network and the positioning of the technical staff of the parent company as an obligatory passage point.

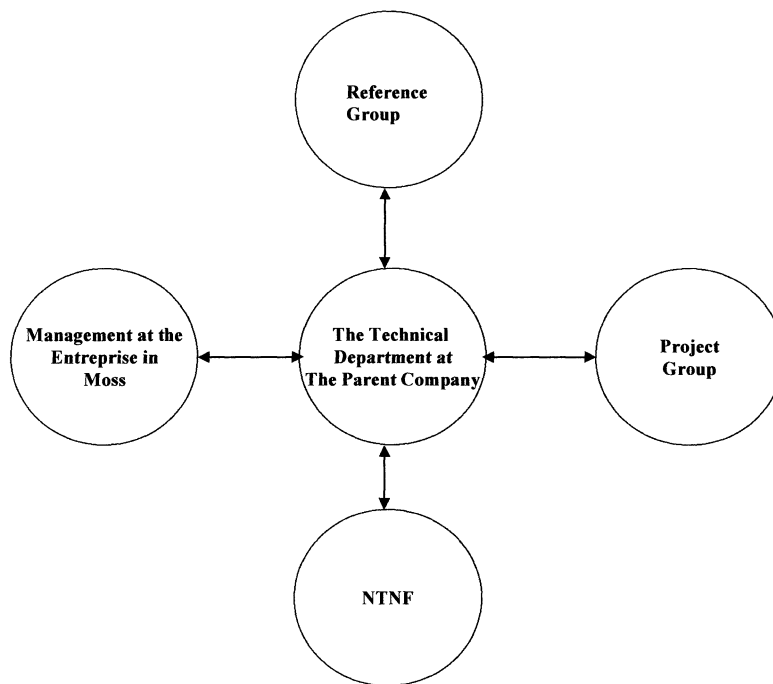


Figure 44: The positioning of the technical staff at the parent company as an obligatory passage point

The empirical material indicates that the strong role of the technical department at the parent company resulted in a reduced ownership at the enterprise in Moss. From the above it may seem that the parent company had full control of the project.

Later in the project it turned out that the network constructed above to hold the position as an obligatory passage point was too limited. An important actor group was forgotten. This was the technical department, controlling the utilisation of the technical resources in the project that were not agreed upon at the project initiation. This became an important factor towards the end of the project.

The communication between the project group and the maintenance department about resources was formal in the implementation of one of the sub-projects, where it was agreed in

the organising of the project that this functional area should take the responsibility. Informal contacts were taken more or less on ad-hoc basis, when unexpected problems had to be solved.

Opening up of Controversies – Translation of Interests

Different mutually dependent technologies were involved in the project. Both internal and external actors focused on making the new technology work.

During the installation of the process control system, an open controversy broke out. The data material shows that this was mainly due to technical problems during configuration and up-start of the process control system. The organisation in Moss felt that one important reason for this was lack of knowledge of involved actors from the supplier about the relevant technical processes in Moss.

Involved local actors did not succeed in transferring their interests to the supplier regarding their scenario that they were dissatisfied about the supplier's behaviour and unwillingness to improve the situation.

After some time central actors within the suppliers' organisation were moved to other more profitable projects, and replaced by others. According to the empirical material this resulted in a reduced progress in the project and tensions in the cooperation between the supplier and the enterprise in Moss. It could be questioned if this project was really tied up with the management in the supplier's organisation.

According to the empirical material the maintenance department felt that the technology in question was forced upon the organisation. The effect of "not invented here" was getting more visible at the end of the project. There was a reduced feeling of ownership and motivation for participating, because others had chosen the technology involved in the project. A part of the organisation argued that a wrong technology had been chosen.

After some time the configuration and maintenance of parts of the system were left with a few actors from the project group and the maintenance department, and with their names on

the technology. It was considered to be their equipment. If anything went wrong with it, they were the only actors to be contacted.

A part of the new technology required a close follow-up, nearly every day with cleaning and calibration. According to the empirical material, the maintenance department was not willing to give priority to spend time and resources on this job. The installation got disproportionately expensive, due to too little experience in the project group of handling arising problems.

The empirical material indicates that the maintenance department's gradually reduced its participation in the project mainly was a result of a successful translation of interests from the technical department to the maintenance department regarding its scenario that this project should be given a low priority.

Making the technical Department at the Enterprise in Moss to the final obligatory Passage Point

After finishing the configuration and up-start work very little was done. Central actors got the system at a distance. It gradually became more and more difficult to fix something, when things went wrong.

When the operating organisation started to take the technical equipment into use during normal operation, the resources working in the project were taken away before the implementation of the project results was completed. The project had at this stage managed to show that it was possible to achieve the project goal, but only during shorter periods of time.

The interest in the system was not kept alive and given attention.

6.4.3.3 Findings

- Several translation strategies were applied by central actors upstream the project. Some of these were partly hidden.
- The background of the decisions to initiate a project at the enterprise in Moss was not known by the organisation in Moss.
- The enterprise in Moss was not involved in the choice of external actors and technology that should be used in the project.
- There were efforts to settle the controversies through the creation of an obligatory passage point. This turned out not to be strong enough to push the project towards achieving the project goal.

6.4.3.4 My Reflections on the Above Findings

- The actions upstream the project resulting in the initiation of a project for the enterprise in Moss, did not seem to have any negative consequences to the enterprise. However, I argue that it was a disaster for the project that the choice of external technology to be involved in the project had been taken without the involvement of the organisation in Moss. Central actors felt that the technology was forced upon them.
- An obligatory passage point was created without success in an effort to settle the controversies. It turned out that the network was too small, and did not include all central actors that had the power to stop the project.

6.4.4 Project no 3

6.4.4.1 Upstream the Project

A stable Point is challenged

One associated company of the enterprise in Moss was during the 1980s operating a bleaching process pulp, which was based on the bleaching chemical elementary chlorine. This process resulted in fairly high effluents of the chemical compound AOX, which was toxic at a low level. Requirements were issued by the authorities from the 1980's regarding a reduction in the effluents of AOX. These requirements were expected to gradually be made stricter.

Some work had been started up late in the 1980's at the associated company of the enterprise in Moss to reduce the AOX levels to the recipients.

Controversies appear as to the Level of the Effluents of AOX

Early in the 1990's the associated company received strict limits on the amount of toxic organic effluents to the sea. The Norwegian Pollution Control Authority had given the company a permission of a maximum emission of AOX that meant they would have to cut the effluent level to the half in a very short period of time.

Enrolling of Actors

The technical department of the parent company had taken the initiative to try to solve the existing environmental problems by meeting the above requirements from the authorities. The technical staff of the parent company possessed at that time knowledge of bleaching of pulp which represented the state of the art. Internal actors were enrolled to participate in the problem- solving work, together with major external chemical suppliers that already had a close cooperation with the associated company of the enterprise in Moss.

Figure 45 shows the involved actors and their interests for participating in this work.

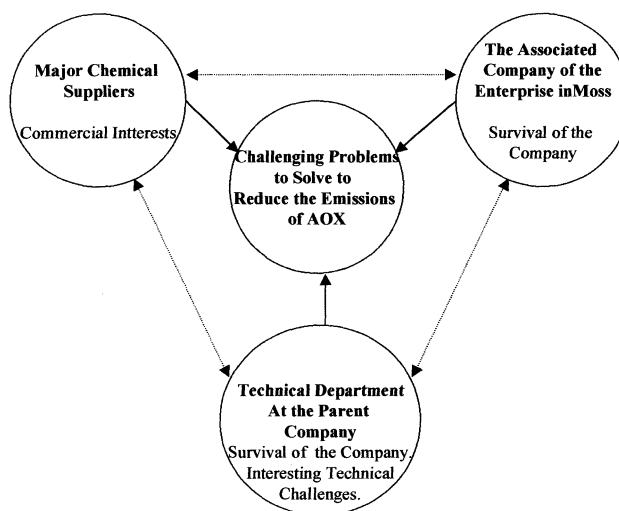


Figure 45: The actor network upstream the project.

Translation of Interests

The technical staff of the parent company managed successfully to translate its interests to the external actors that its scenario about the importance of solving the existing process problems in reducing the effluent of AOX was in accordance with their own interests. The external chemical suppliers contributed in the project of commercial interests. They saw the possibilities of selling more bleaching chemicals to the company as a result of their participation in the project.

For the associated company of the enterprise in Moss this project was a matter of survival. It was therefore not difficult to persuade central actors from this company to participate.

Settling of the Controversies through a Black Box Closure

The implementation of new process units in the bleaching mill solved the challenging problems of reducing the AOX effluent to an acceptable level. The project managed to find solutions to meet the effluent permission within the given time. The Norwegian Pollution Control Authority turned out not to be interested in details about the technical solutions. The settling of the controversies took place through black box closure mechanisms.

A condition for success was the supply of a certain quality pulp from the enterprise in Moss.

The improvement activities had so far been run as an internal project. A NTNF financed project was started up with the duration of three years.

This project, was a parent company project.

6.4.4.2 Planning of the main Project

Controversies appear of the Value of the Project

The controversies taking place in this project had, according to the empirical material, a background in very different views regarding the technical development at the enterprise in Moss between the technical department of the parent company and the management of the enterprise in Moss. The communication at management level between the two Peterson companies was very poor. A shared strategic understanding between the parties has not been achieved.

For the technical staff of the parent company the main goal was to develop a new process for production of a pulp that would be suitable for the paper production at the associated company of the enterprise in Moss and as a top layer on corrugated board. A large part of the production plant should, according to the thinking of the technical department of the parent company, be located at the enterprise in Moss. This project was regarded to be a premise for future paper production at the associated company, and for utilisation of the production capacity of the pulp mill in Moss.

It was communicated in the organisation that a strategic decision should have been made in the parent company that use of elementary chlorine in pulp bleaching, which resulted in AOX effluents, should be terminated as from a given time. This decision was based on expected stricter regulations from the authorities. It has not been possible to verify if the strategic decision mentioned above, really was made or not.

The technical department of the parent company argued that there was a large extra production capacity in the pulp mill that was not utilised.

On the other hand, the technical department at the enterprise in Moss argued that there was no such extra pulp capacity. If more pulp should be produced, expensive investments in the pulp mill had to be made. It was argued that the new process would hinder the technical development in Moss, and negatively influence the profitability.

The project was regarded to be a parent company project, which had to find a solution to secure the future existence of the associated company of the enterprise in Moss. In line with this thinking important decisions had to be taken by the parent company. One question was regarding the physical location of the new process plant.

It should turn out that not to be a good solution for the parent company to pressurize other Peterson companies, forcing something upon them against their will.

The strong disagreements described above, did not create the best conditions for initiating this project.

Enrolling of Actors / Translation of Interests to achieve financial Support from NTNF

A Joint Project Application to NTNF

A project application was sent to NTNF, asking for financial support. This application was a part of a joint application from the pulp and paper industry to a NTNF program called "Industrial Research Pulp & Paper", enrolling the most central actors within the pulp & paper industry. PFI was the contract partner towards NTNF and should manage the programme.

Obviously one purpose of this collective action of the pulp & paper companies was to make the application stronger than would be possible for a single company. Speaking with one voice the pulp & paper branch succeeded in translating its interests to NTNF regarding

its scenario that this would suit the NTNF interests, as this coordinated application would be the best alternative for creating a new research program of high quality. One other purpose of the coordinated application could be to make it easier to sell an actual project within the own organisation, utilization translation mechanisms as the shared responsibilities of the involved companies in the application for getting the collective project application through.

To make the application of this project more interesting to NTNF, different mechanisms of translation of interests were applied:

1. The enterprise in Moss was enrolled in the application. It was written that the new process should be developed in cooperation with the enterprise in Moss. Obviously this was an effort to translate the interests to NTNF that the scenario of the parent company of involving the mill in Moss suited the interests to NTNF of reducing the project risk.
2. It was written in the application that a large part of the treated pulp in the new process that should be developed should be applied as a top layer in one of the linerboard products produced at the enterprise in Moss. This was clearly an effort to translate the interests of the parent company to NTNF that its scenario that a high production volume of the new process was important to achieve a high profitability of the investments fitted the interests of NTNF of an increased user value in the project.

According to the empirical material it does not seem that the management of the enterprise in Moss had been asked, in any of the two above translations where the enterprise was involved.

3. It was pointed out that the research results from this project would be of general use for other Norwegian pulp & paper companies. The technical staff of the parent company, as the network builder, tried to mobilize NTNF that it could not reach its goal of an increased knowledge transfer in Norway of the new process straight away, but could reach it faster if it followed the scenario of the technical staff at the parent company.

The controversies were still open when the project was initiated. The network builder had not managed upstream the project to settle these through the above translations.

6.4.4.3 Implementing the R&D Phase of the Project

Enrolling of Actors / Translation Interests in Participating in the R&D Phase of the Project

The project was organised with a project group enrolling actors from the middle management of the enterprise in Moss, its associated company and an external chemical suppliers, while central actors from the management at the enterprise in Moss were not involved. An executive group was not included in the project organisation. The overall project manager from the technical staff of the parent company did not find it necessary.

The project management successfully transferred its interests about its scenario to the involved actors in the project group that the technical concept was given, and that the main task in the R&D phase was to prove this concept.

According to the empirical material there was not much communication between the two parties during the R&D phase of the project. The project management had the attitude that it was not really necessary to involve the management of the enterprise in Moss. The process concept was given, and the project should prove that this concept was right.

About one year after project up-start, discussions became more intense about the location of the process plant, which should be based on the results from the R&D phase. The data material shows that the administration of the enterprise in Moss was informed in a letter about the progress of the project, and that it would be natural to locate part of the process plant in Moss.

It became clear that this was the first time that the administration of the enterprise in Moss was involved in the project. Strong signals were given to the technical department of the enterprise that the enterprise in Moss was neither interested in covering any costs during the project nor any investment costs in a new process plant in Moss.

The data material shows that the associated company to the enterprise in Moss strongly believed that a decision had been taken that the location of the new process plant should be in Moss

A better communication between the management of the enterprise in Moss and its associated company and the project management could obviously have led to a more realistic attitude in the project and made them question at an earlier stage if it was right to go further with the project or not.

Settling the Controversies through making an obligatory Passage Point

The data material shows that to some degree the project management managed to settle the controversies through partly achieving control of the communication channels. This is illustrated in figure 46.

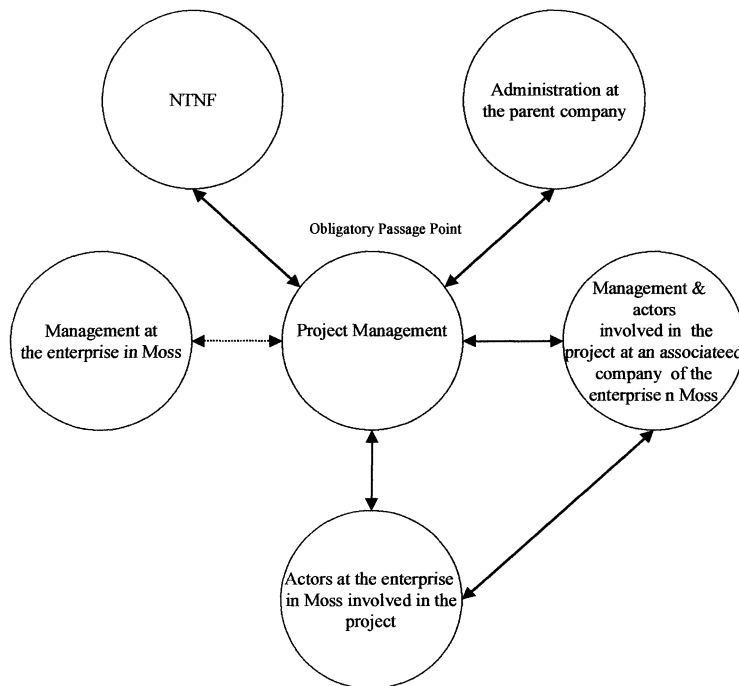


Figure 46: The creation of an obligatory passage point during the R&D Phase

Figure 46 shows that the creation of an obligatory passage point made it possible for the project management to some degree to construct different images of reality within the different actors involved through control the main information channels.

The project management reported to the administration of the parent company and to NTNf.

The project actors from the enterprise in Moss communicated to the project management and with involved actors at the associated company, and only to a small degree with the own management at the enterprise in Moss. The actors involved from the mill in Moss got poor feedback from the management due to a low interest in the project. To the project actors it was only the project management that was interested in having any discussions with the project group about the project. creating the image of reality among the project actors from Moss.

The project management communicated well with the other members of the project group from its associated company. The actors working in the project group did not know much about the thinking of the management, due to strategies that were not widely known within the organisation.

The poor communication between the above actors can explain the relatively long project period without achieving the project goals. With a closer contact and more knowledge about the innovation system, it would have been possible to have fruitful discussions about the basis of the project, and the progress of it.

The associated company of the enterprise in Moss believed that a decision had been taken that the location of a new process plant should be in Moss. According to the empirical material this would not have taken place if the company had not been forced to do it.

The empirical material shows that equipment costs were calculated during the R&D phase of the project. Some ideas of the costs of a new process plant were known at a relatively early stage.

It seems clear that one important reason as to why nobody seem to have asked critical questions about further progress of the project, to a large degree could be caused by the project management's construction of different images of realities among the central actor project groups involved.

6.4.4.4 The Pre- Engineering Phase

Final Settling of Controversies in the Making of the Costs an Obligatory Passage Point

An engineering phase was done to calculate the costs of a process plant based on the new process concept that was developed during the R&D phase. The engineering work included different localisation alternatives of the equipment.

Four machine suppliers were involved in the engineering phase, doing detailed engineering.

A executive group was established with representatives from the parent company, the enterprise in Moss and its associated company. Both the appointed project leader for this phase and the financial department, doing the profitability analysis, came from the mill in Moss.

The management in Moss decided the conditions of the engineering calculation, which was important for the results of the profitability analysis. The amount of pulp chosen as input to the process plant was half the amount of what had been the project management's originally condition

. The calculated production capacity of the new process plant was too small to make the investment profitable.

6.4.4.5 Findings

- There were great disagreements between the enterprise in Moss and the associated company about the value of the project.
- There were also different views existed as to the technological development in Moss and the production capacities of the pulp mill
- The enterprise in Moss was enrolled in the project application to NTNF without being asked
- The project was regarded to be a project of the parent company, which had to find a solution to secure the future existence of the associated company of the enterprise in Moss
- The project management tried to settle the controversies through the creation of an obligatory passage point.
- The conditions for the profitability calculations were given by the enterprise in Moss.

6.4.4.6 My Reflections on the above Findings

- I argue that the strong disagreements about important questions relevant to the project combined with a poor communication between central actors, were the main reasons of the unsuccessful project results. In this situation a stronger involvement of the parent company could probably have reduced the conflicts and increased the possibility of gaining a shared understanding of the problems and the best ways of solving these.
- The technical staff of the parent company did not find it necessary to involve the administration during the innovation process. I argue that this was not a wise strategy.
- An obligatory passage point was created to settle controversies. The network turned out to be too small to control the network. Central actors at the enterprise in Moss with power were not included. I argue that a systems approach must be taken if this is possible, when an obligatory passage point is made, in order to include all relevant actors.

6.4.5 Project no 4

6.4.5.1 Upstream the Project

A stable Point is challenged in the Creation of a creative Seminar

In the current strategy it was stated that the enterprise in Moss should focus on products with more added value than the existing bulk products that the company was producing. This was in line with the strategy of the parent company. According to this the aim was to use an average of 1.5 percent of the turnover in each Peterson Company on product development.

A two days creative seminar with an external facilitator was arranged. The purpose of the seminar was to come up with ideas to new products. The initial network consisted of members of the top management and the organisational level below. The actors involved represented different opinions about the technological development at the enterprise in Moss. The external facilitator had an important role, creating an open and friendly atmosphere in the group.

As one of the potential products, the idea to the new product emerged, that resulted in this innovation project.

The idea to the new product came from the management. It was said that we should try to find a simple and cheap way of producing the new product, that already was a bulk product in the market. A certain sum of money was mentioned. It could clearly seem that the message from the management was to do some testing and to evaluate the results, but not really go in for the product.

Controversies appear of the Openness of a Product Innovation Project

During the seminar, the management decided that the resulting product ideas from the seminar should be kept confidential. According to the empirical material this had never happened to the external facilitator. The idea behind was, if the company succeeded, to prevent companies with a larger capital base to implement the results before the enterprise in Moss. On the condition that the enterprise in Moss could develop a quality profitable to the enterprise in Moss, it was expected that the selling of the product would be no problems if the price was right. The empirical material indicates that it was unrealistic to believe that it would be possible to keep the development phase secret until the presentation in the market.

Shortly downstream the creative seminar, it was decided in a top management meeting that the development of the new product should have top priority among different R&D projects. The project group should start the work with a marketing survey, in order to uncover needs in the market for this product and interesting product variants of it. However, the management refused that the project group on their own initiative taking an open dialogue with the customers. Concrete discussions between participants in the innovation project and the customers had to be co-ordinated by the marketing department. A market survey was never done during the project.

The project group was given the task to do a market survey, and was at the same time denied direct access to the market. Due to this it was obvious that the innovation project could not be expected to be truly market oriented. Clearly the restrictions put on the project group regarding taking customer contacts, promoted the management to influence the project network through control of the communication channels.

Enrolling of Actors / Translating Interests during early technical Trials

The management had got information that a Norwegian company had the necessary equipment and capacity for testing the enterprise's product idea in full scale. It was decided in the executive group to enrol this external company. If the trials were successful, it was possible that the company could produce the new product for the enterprise in Moss.

The actor network developed to include actors from the external company, the project group of five members, and the executive group with the managing director as chairman.

The enterprise in Moss succeeded in translating its interests regarding the scenario that the potential early production of the new quality for the enterprise fitted the interests of the external company for utilising its production capacity.

The full-scale trials at the external company were not very successful, however. The empirical material shows that the main reason for this was a lack of relevant knowledge in their potential product and not suitable technical equipment at the external company. It seems that this could have been checked out upstream the testing at the company.

It could be understood on basis of the communication with the company and the high price it wanted for doing the technical trials that the company saw the enterprise in Moss' potential product as a competitor to its own products. The cooperation between the enterprise in Moss and the external company was terminated shortly after the technical trials had taken place.

The executive group asked the project group to find other relevant companies with the necessary equipment in order to evaluate if a commercial cooperation could be established with any of them. The empirical material shows that it was difficult for the project group to do a proper job on this, because of prohibition against taking contact with customers and competitors.

Two major chemical companies in the market observed the testing of the product idea at the external company. These companies were delivering chemicals to the company where the testing for the enterprise in Moss took place.

This clearly showed that it should be difficult for a long time to keep the innovation project secret to either external or internal sources. To achieve sufficient knowledge in the project, it is often needed to utilise an actor network, as it was in this case, where the involved actors had their own interests as a part of their business in keeping the market up-dated as to what is going on in certain areas. In line with the empirical material this kind of secrecy is in most cases useless. It is not very dangerous if other companies know what kind of product that is under development. The only way to create a lead is through competence, rooted in the organisation and involvement of the people that are going to implement it.

The executive group of the project took the consequences regarding the chemical suppliers' knowledge about the innovation work at the enterprise in Moss, and asked the project group to take contact with them, to discuss a potential cooperation with the enterprise in Moss. It was, however, emphasised that the secrecy around the project should be maintained.

The data material shows that it was the internal project group that felt the main effect of the restrictions in communication, with working conditions that were difficult from time to time. The focus in the group changed more or less from gaining as much knowledge as possible to what kind of actions to take in order to keep the secrecy.

6.4.5.2 The Implementation of the Project

Enrolling of Actors / Translating Interests

Two major chemical suppliers were enrolled. It was stated in agreement between these companies and the enterprise in Moss that the three companies should cooperate in developing the new product quality, involving one of the paper machines in Moss. The enterprise in Moss managed to successfully translate its interests to the suppliers regarding the importance of initiating a confidential knowledge transfer process to the company. This fitted the interests of the suppliers to potentially gain advantages in the market. A secrecy agreement was signed between the three parties, based on the above agreement.

According to the empirical material, a secrecy agreement was very usual for large chemical companies. It did not restrict their work very much due to the large internal network and the knowledge within their companies.

A major paper machine supplier enrolled at a later stage to calculate the necessary equipment for producing the new product quality on the paper machine. He had also to sign a secrecy agreement with the enterprise in Moss

Controversies of the Relevance of the Project

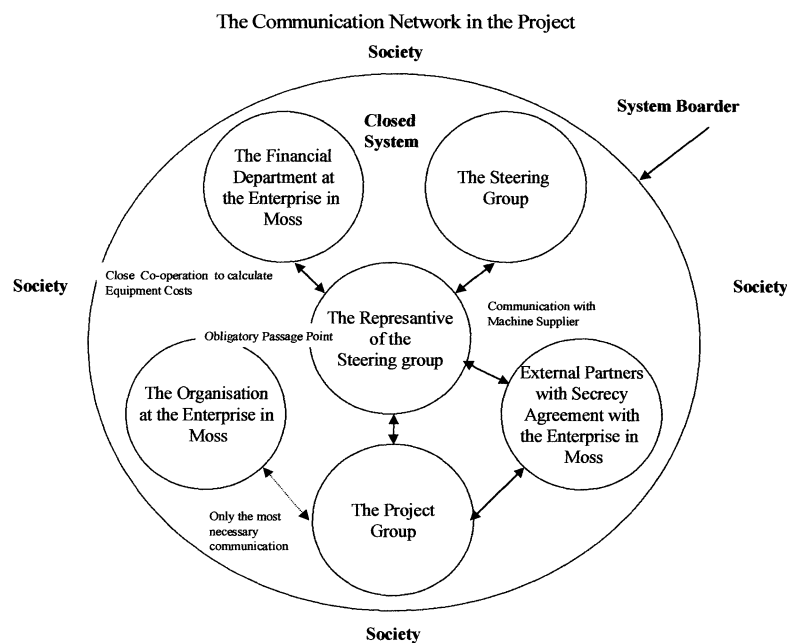
The chemical suppliers looked at the secrecy agreement as a sign of commitment and interest in going in for the project. The suppliers decided to allocate time and resources for the project. A large sum of money was employed on technical trials.

According to the empirical material the management after some time showed a reduced interest in the project. It seems that part of the management instead was thinking of another technological development at the enterprise in Moss. From the start of the R&D phase to the termination of the project, there was only one meeting in the executive group and one presentation of the project in a strategy meeting. All status and milestone reports were distributed to the members of the executive group. The project group was given little feedback from the executive group on the progress reports.

Control of main Communication Channels to an obligatory Passage Point

A management decision was taken at the start of the engineering phase to let one representative from the executive group, that was a member of the management group, function as the executive group. Obviously this was a signal of a reduced interest in the project among the management. At the same time the number of members in the project group was reduced to three, resulting in further closures of communication channels.

The actor functioning as the executive group positioned himself as an obligatory passage point, taking control of the main communication channels. Figure 47 shows the communication network after up-start of the engineering study.



Figur 47: The creation of an obligatory passage point in the project

The figure above shows that three formal communication channels were open to the project group:

Towards the organisation at the enterprise in Moss. Only the necessary communication was taken due to strong restrictions described above. As a consequence the potential users of the technology were not involved in the project.

Towards external partners with secrecy agreement signed with the enterprise in Moss. The project group handled the communication with partners given priority. The cooperation functioned well. The group was working together in an integrated manner. A strong network was established between the chemical suppliers and the enterprise in Moss.

The representative for the executive group communicated directly with the machine supplier at management level. He handled the important task of calculating the equipment costs himself in cooperation with the financial department. The project group was not involved in this work.

The empirical material shows that a change in interests during the project from part of the management was not communicated to the project group and its network of cooperating partners. The members of this network thought that the enterprise still was committed to go in for the project until it was suddenly stopped without any notice.

6.4.5.3 Settlement of Controversies through a Black Box Closure of the Technology

The first figures on the installation costs were known nearly half a year before the project termination. The final profitability calculations were ready three months afterwards. A milestone report was made, and was distributed to the management. Shortly afterwards, the project group took part in a strategy meeting where this report was a part of the agenda. The feedback was positive. The message to the project group was to continue the work.

About three months later the project manager was invited to a meeting. The whole management group and some actors from an associated company of the enterprise in Moss were invited.

The purpose of the meeting was according to the agenda to discuss further progress of the project. During the meeting the project was stopped due to a high costs and a high risk. It was

argued that the parent company would have faced serious difficulties if it had become clear that it was not possible to develop a product which was acceptable to the market and at the same time was a profitable business to the enterprise in Moss.

The administration and the marketing department meant that not all sides of the project had been opened up, and argued that important information had been held back.

Neither the representative of the executive group nor the project manager were prepared for the decision to terminate the project.

In the meeting nobody was interested in discussing details within the product technology, but remained as input / output relations. The settlement of the controversies was thus based on black box closure mechanisms.

According to the empirical material communication in the organisation was not good enough. Further, the project was too long run as a pre-engineering project, instead of with a stronger focus on the R&D activities.

6.4.5.4 Findings

- It was decided at a creative seminar that a simple and cheap way of producing the new product should be found.
- A market survey was never done
- Restrictions were put on the project group regarding direct access to customers
- It was decided that the project should be kept partly secret. All external cooperating parties had to sign a secrecy agreement with the enterprise in Moss.
- The representative of the executive group created an obligatory passage and achieved in this way control of the main communication channels.
- The project organisation was not prepared when the decision to terminate the project was taken.
- The executive group accused at a late stage the project group of not having presented the project in a proper way.

6.4.5.5 My Reflections on the Above Findings

- I argue that the decisions that a simple and cheap technical solution should be found to produce the new product could be a signal that the management was not really committed to go in for the new product
- The lack of a market survey and the restriction on direct access to customers seemed to limit the room of solution in the project, due to reduced input from the market.
- It turned out that the decision of secrecy around the project had no value. Major chemical suppliers very soon discovered that technical trials were going on. I argue that the only way a lead can be created is through competence and the people involved in the work.

-
- The representative of the executive group made himself an obligatory passage point. This did not create any problems to the project group due to a direct and open communication between the two parties.
 - I argue that the fact that the project organisation was not prepared for the decision to terminate the project and was accused to have held back information, signalled an unsatisfactory communication in the organisation.

6.4.6 Project no 5

6.4.6.1 Upstream the Project

A stable Point is challenged

In the 1980's the environmental policy in Norway was very traditional and based on end-of-pipe solutions involving external measures. The Norwegian Pollution Control Authority mostly took a police - like role, and had a clear control function with regard to the companies' compliance to the effluent permits issued.

The enterprise in Moss had had heavy discussions with the environmental authorities for some years about polluted effluents to the sea. The atmosphere between the two parties was not very good. At that time the effluents of dissolved organic material from the pulp and paper mill to the sea was only just within the given effluent limits.

Controversies about the Amounts of organic Effluents to the Recipient

An audit was done by the Norwegian Pollution Control Authority at the enterprise in Moss at the end of the 1980's. As a result the enterprise in Moss was asked to evaluate solutions for a 50 percent reduction of the effluents of dissolved organic material. No demands for a real reduction of 50 percent of the effluents to the sea was given, but the enterprise in Moss expected, based on earlier experience, that this would come within a few years.

According to the empirical material it was a requirement from the Norwegian Pollution Control Authority that the evaluation should be done by an external consultancy. The enterprise in Moss suggested using a certain consultancy that was approved by the Norwegian Pollution Control Authority in a meeting with the enterprise.

The consultancy came up with traditional end-of-pipe solutions that were very expensive to implement. According to the managing director the costs were totally unacceptable. Further, the external cleaning solutions were against the environmental policy of the parent company. In this it was stated that the environmental problems should be solved as far as possible by closing of the water systems in the mill. A new creative solution had to come up.

Enrolling of Actors / Translating Interests to promote Project Initiation

At that time there was a strong international focus on Cleaner Production, especially in USA and the Netherlands. The principles behind Cleaner Production was based on an understanding that it was in most cases cheaper and more efficient to take care of the internal resources and to solve the problems at the sources than to implement measures based on external cleaning.

According to the empirical material the Cleaner Production projects were introduced in Norway by Oestfold Research Foundation, working in the environmental area of the region of Oestfold in Norway, EPA (1988).

The technical department of the parent company was responsible for environmental questions in the group, and had knowledge about the Cleaner Production principles. The department was pushing for initiating a Cleaner Production project in Moss. The managing director at the enterprise in Moss followed up and was positive to see new possibilities.

When the Cleaner Production philosophy was presented by Oestfold Research Foundation to the enterprise in Moss, the management understood the possibilities of solving the environmental problems in a cheaper and more efficient way. The research foundation was enrolled to take the responsibility for the accomplishment of a Cleaner Production project at the enterprise. This coordinated with the interests of Oestfold Research Foundation, which was recently established to develop competence within this area.

The managing director committed himself strongly for the initiation of the project. He was the obvious owner of it. The data material shows that there were some negative forces in the organisation that were working against the project initiation. Because of the strong engagement of the managing director these were not able to get any strong influence.

The pilot project at the enterprise in Moss was one of the first in Norway before a Cleaner Technology program was established in Norway. The work was attached to the UN environmental program in Paris.

Oestfold Research Foundation enrolled the Ministry of the Environment and the Norwegian Pollution Control Authority to participate in the project as members of the executive group. Its scenario that this project could be good opportunity to learn about the Cleaner Production methodology suited the interests of the authorities. The Ministry of the Environment was working on a new environmental policy towards the industry, and was interested in some pilot projects on Cleaner Production to be done. The project was thus financially supported of the Ministry of the Environment.

The project fitted well into the interests of the Norwegian Pollution Control Authority regarding an increased focus on doing systems audits in the industry, and less focus on audits based on physical control of the production processes followed up of instructions about concrete actions to take.

Figure 48 is showing actor the extent of the network upstream the project.

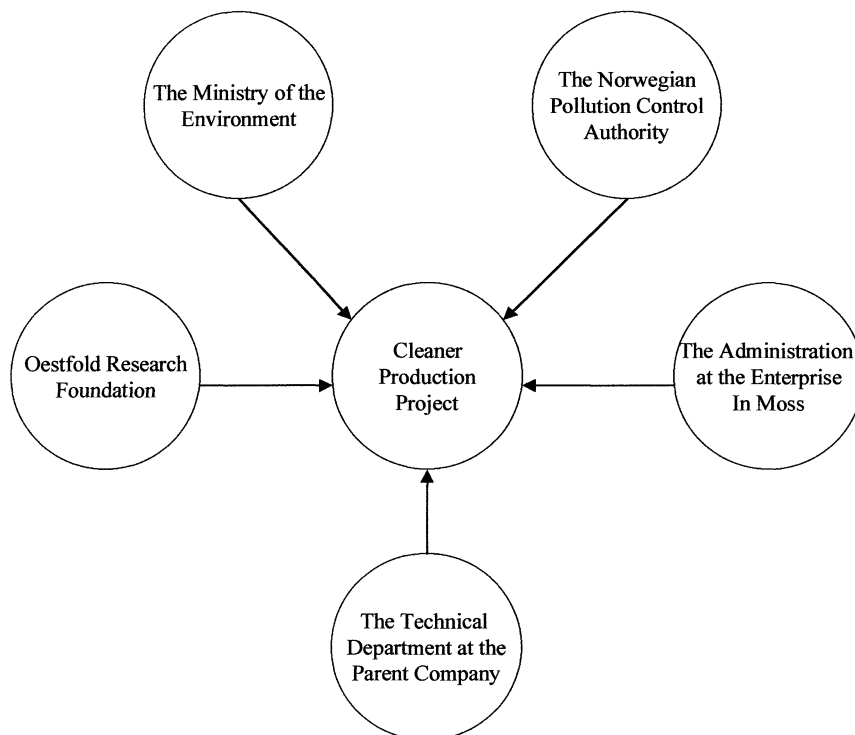


Figure 48: The actor network upstream the project

6.4.6.2 Enrolling of Actors / Translating Interests during Project Implementation

The project started up with a kick-off meeting at the company. The managing director headed the meeting. Several actors were mobilised in this meeting, among these were: the manager of environment in the municipality of Moss, journalists from the local newspapers, representatives from the Ministry of the Environment and the Norwegian Pollution Control Authority, the executive group and project group, and other key personnel in the organisation at the enterprise in Moss.

The managing director fronted strongly the project, and translated successfully to the organisation his interests regarding the scenario that this was an important project with a high priority, requiring a strong involvement of the organisation. The data material shows that the strong commitment from the managing director was decisive for achieving a successful project result.

The ambitious goals were presented in the kick-off meeting to find solutions for a 40 percent reduction of effluents of dissolved organic material to the sea and to implement an environmental control system at the company. He asked the organisation to focus on achieving this. It seems that the clear and ambitious project goals strongly motivated for participation.

The executive group was presented. The group was headed by the managing director, and of external actors had been enrolled from the Ministry of the Environment, the Norwegian Pollution Control Authority and from Oestfold Research Foundation.

Oestfold Research Foundation got the contract to do the Cleaner Production project. A small project group was established. A project manager from the research foundation was enrolled to run the project. The management strongly signalled to the organisation that the project manager as an outsider with no binding to the existing culture, could be a key factor to success of the project.

A working group was established, enrolling practitioners from the pulp & paper mill. It was planned that most of the decisions should be taken in dialogue between the project team and the working group.

The managing director opened up the organisation for the project group that was allowed to go anywhere in the organisation to enrol central actors, in the search for knowledge. He wanted the project organisation to function as an open network communication structure, which it really did during the project.

Controversies appear

The managing director had a positive attitude to look for new possibilities to solve the environmental problems at the company. However, according to the empirical material the Ministry of the Environment regarded a strong commitment from the management in the project to be so important that it was one of the conditions in order to get financial support. The authorities that participated in the executive group, defined more concrete conditions for obtaining financial support than the industry was used to. However the management at the enterprise in Moss did not feel that this was any problem.

According to the empirical material there were some counter forces, where not all of them positive. The project manager in this project could feel at the start of the project that certain people in the organisation negative to it, and strongly believed in traditional solutions.

The empirical material shows that a great part of the effluents to the sea were irregular and discontinuous ones. The executive group believed that this kind of effluents could be highly reduced, when the actors that had ownership to the problems were involved in a proper way. To reduce the discontinuous effluents was regarded as a management challenge. The project manager was instructed to approach the practitioners in a proper way to achieve an open dialogue about these problems and to avoid difficult discussions on individual level about discontinuous effluents.

The empirical material shows that some practitioners at the start were sceptical towards being involved in the project. They had experience from earlier projects, where they had felt that other actors were not really interested in their competence, but that they were expected to

function as hostages in the projects. It was important to achieve a good dialogue with the practitioners already in the first meeting, and that they really feel that the project is needing their resources.

The project group realised very soon that it was important to run the project in way that could make most of the organisation positive, taking a supporting role. It was decided to show a humble attitude, when the project group should approach the practitioners.

To learn the process the project work started with reading documentation and speaking with actors working in the mill. At the first meeting with the established working group, the project manager presented the project and its background. He managed to translate the enterprise's interests to the practitioners about the scenario that it was important for both the enterprise and all employees to gain an improved environmental image.

The practitioners were told that the project manager wanted to share his knowledge and experience with them, and regarded them as important resources for the project. The data material shows that one of the practitioners argued that experience was connected to the real action, and that to be competent meant that knowledge was translated into action. He considered nothing else to be competence.

Through close communication and checking out with the workers, the members of the project group gradually achieved an increased knowledge about the process.

Due to the project group, taking a humble attitude, confidence was gradually built up between the project group and the practitioners, who felt that they were taken seriously and had good influence in the project. The project group did not try to force any pre-decided solution on them. The controversies gradually disappeared. During an extensive cooperation with the practitioners and the technical and maintenance departments, the pulp and paper processes were systematically analysed, with focus on potential internal solutions to reduce the effluents of dissolved organic material to the sea.

The executive group had given the authorization and power to the project group to implement solutions up to a certain financial limits at once the project group and the practitioners had agreed to do so. Implementation of solutions took place during the accomplishment of the

project. Clearly this strongly increased the motivation among the practitioners, stimulating to further work. It signalled to the practitioners that this project was more than a theoretical project ending up with a report.

A Settlement of Controversies through Black Box Closure.

Solutions were identified and implemented which resulted in a reduction of the effluent of dissolved organic material by 40 percent. It was according to one of the established project goals. This was achieved at a cost of 1/3 of the cost originally calculated by an external consulting firm upstream the project implementation. According to the empirical material the certification of the enterprise in Moss according to the Eco Management and Audit Scheme, (EMAS) would have come much later if the enterprise had not done this Cleaner Production project. The enterprise in Moss was number one in Norway and number two in the Nordic countries achieving this certificate.

The project goal of identifying solutions to reduce the polluted effluents by 40 percent was achieved. However, the project group did not manage to implement a lasting environmental control system, which was the final goal. According to the empirical material it should have been a management responsibility to ensure such an implementation, and to allocate resources and set priorities.

In this project, plans for implementation of the results were included in the project plan. However, the resources were taken away from the project when the sub goal of reducing the polluted effluents by 40 percent was achieved. The conditions for improved interdisciplinary cooperation in the organisation that were created during the project, were soon forgotten. This Cleaner Production project could thus more or less be regarded as just a happening.

The people soon lost interest in the measures that been fulfilled during the project and what which was inside the Cleaner Production black box

6.4.5.4 Findings

- There was a strong management commitment in the project
- An open and dynamic network organisation framework was created to run the project
- Practitioners were strongly involved in the project
- The project manager was an outsider
- The final project goal of implementing the results in the organisation was not reached.

6.4.5.5 My Reflections on the Above Findings

- I argue that the strong management commitment motivated people to participate in reaching the project goal, as a clear and demanding goal was identified, and the organisation strongly urged in achieving it. The management further focused on the importance of this project to the enterprise and all its employees. I further argue that the way of organising the project as an open and dynamic network was motivating. The project network functioned as an autonomous group of dynamically variable size. The composition of the group was matched to the actual problem solving processes that were going on.
- In this project the practitioners were strongly involved. They were taken seriously and listened to. Collective learning took place between the practitioners and the project management. I argue that the strong involvement of practitioners was decisive for the good project result
- An outsider, with a different professional background and experience, and with no ties to the existing enterprise culture, was utilised as a project manager. I argue that in this case this case this was a key success factor.

6.4.7 Analysis of important common Characteristics of the Projects on basis of the Agent Theory.

6.4.7.1 Introduction

At the end of the agent theory my analytical position was presented as key success factors in the form of questions to be utilised in the analysis of the projects. These are identical to the questions representing the ordinate in the matrix below. The answers to the questions for each project are found in the abscises of the matrix.

In the matrix below, the headings describing the characteristics of the projects are taken from the short project descriptions given in chapter 5 of the thesis.

6.4.7.2 A Summary of Characterisation of five Projects – utilising the Agent Theory

Project number	1	2	3	4	5
Type of project	Product Innovation	Process Innovation	Process Innovation	Product Innovation	Process Innovation
Key words	Radical innovation, high quality product, high product price, high risk of not succeeding	Radical innovation, high risk of not succeeding	Radical innovation, high risk of not succeeding	New product technology, high quality product, high product price, high risk of not succeeding	New methodology of Project implementation, Fairly high risk of not succeeding
Upstream project					
Any controversy about technological development taking place?	Yes. The Controversies were hidden to some of the involved actors	Yes. Controversies and the hidden agendas were unknown to the enterprise in Moss	Yes. Open controversies between a associated company of the enterprise in Moss and authorities regarding the	Yes. There were different views about the technological development at the enterprise	Yes. Conflicts between the admin and technical department of the enterprise in Moss, and the environmental authorities

Project number	1	2	3	4	5
Type of project	Product Innovation	Process Innovation	Process Innovation	Product Innovation	Process Innovation
Key words	Radical innovation, high quality product, high product price, high risk of not succeeding	Radical innovation, high risk of not succeeding	Radical innovation, high risk of not succeeding	New product technology, high quality product, high product price, high risk of not succeeding.	New methodology of Project implementation, Fairly high risk of not succeeding
Did mobilising of actors take place?	Yes. The paper machine supplier, the continuous digester, the paper machine	Yes, technical suppliers, PFI, a private research institute, and the parent company	Yes. Chemical suppliers and actors from the associated company of the enterprise in Moss	Yes. The top – and part of middle management and external paper producer	Yes.. Ministry of the Environment, the Norwegian Pollution Control Authority, Oestfold Research Foundation, the technical staff at the parent company.
How large was the initial extent of the Network?	Tech. Dept, Admin and the Marketing Dept of the Enterprise in Moss	NTNF and a private research Institute	The tech staff at parent company and the admin at associated company of The enterprise in Moss	Admin at the enterprise in Moss and admin external paper producer	Admin and technical staff at Parent company. Administration at the enterprise in Moss
Were translation strategies utilised?	Yes, it was	Yes. different translation strategies were applied.	Yes, several.	Yes, it was	Yes, it was
Were technical artefacts utilised in network building?	Yes, a paper machine, and a continuous digester	Yes, a process plant at the enterprise in Moss, and a new instrumentation technology	Yes. A Process plant at the associated company of the enterprise in Moss	Yes. A process plant at external paper producer	Yes. end of pipe technology to reduce effluents to the sea
How was the openness of network?	It was very closed, consisting only of representatives from the top management	It was open. The existence of the network was hidden to the enterprise in Moss	It was open	It was very closed	It was closed within Peterson. Open between Peterson and external actors
Was it any development of the network?	No development took place in this phase	Yes. With the actors mobilised and the technical artefacts involved	Yes. With the actors mobilised and the technical artefacts involved	Yes. With the actors mobilised and the technical artefacts involved	Yes. With actors mobilised, and technical artefacts involved
Did any party succeed to stabil the techn through creation of an obligat passage point or black box closure?	Yes, they did	Yes, NTNF	Yes, the technical staff at parent company	Yes. Admin of the enterprise in Moss	Yes. Admin of the enterprise in Moss

Project number	1	2	3	4	5
Type of project	Product Innovation	Process Innovation	Process Innovation	Product Innovation	Process Innovation
Key words	Radical innovation, high quality product, high product price, high risk of not succeeding	Radical innovation, high risk of not succeeding	Radical innovation, high risk of not succeeding	New product technology, high quality product, high product price, high risk of not succeeding	New methodology of Project accomplishment, Fairly high risk of not to succeeding
During project accomplishment					
Did any controversy about the technical project take place?	Yes, it did. There were different views about the technical development at the enterprise in Moss.	Yes. There were different views about the development of the technology at the enterprise in Moss	Yes. There were strong conflicts about the development of the technology	Yes. At start of project. Managm. Gradually lost the interest in project. Gradually different views of tech development in Moss appeared	Yes. There were controversies about choice of technical solutions between the project group and the network organisation.
Did any mobilising of actors take place?	Yes. Financial Dept. Admin, Users of the new technology, customers, machine / chemical suppliers, competitors, an associated Peterson Company, sales offices in England and Germany	Yes. Suppliers of technology, PFI, the project group, users of the new technology, the technical dept.	Yes. PFI, machine & chemical suppliers, the project group, admin and financial dept of the enterprise in Moss	Yes. Chemical and machine suppliers. Associated company of the enterprise in Moss	Yes. The press, representatives of the local environment and the organisation of the enterprise in Moss
How large was the initial extent of the network?	Admin, technical dept, marketing dept. at the enterprise in Moss,	Admin at the enterprise in Moss, the technical staff at the parent company	Tech staff at parent company, Actors from the enterprise in Moss and its associated company and chem. supplier	Members of the Project and executive groups	Members of project and executive groups.
Was any translation strategy utilised?	Yes, different strategies were utilised	Yes, different strategies were utilised	Yes, different strategies were utilised	Yes, they were	Yes, they were
Were technical artefacts utilised in network building	Yes, a paper machine, extra investments on paper machine to improve paper appearance, equipment to test the prod quality?	Yes. A process plant, a new instrumentation technology, a process control system and a pulp digester	Yes. A process plant and a pulp digester at the enterprise in Moss, and a process plant at its associated company.	Yes. Pilot machines for prod of paper and for printing, full -scale equipment for production of Corrug board.	Yes. Different technical artefacts in the pulp and paper mill in Moss were utilised

Project number	1	2	3	4	5
Type of project	Product Innovation	Process Innovation	Process Innovation	Product Innovation	Process Innovation
Key words	Radical innovation, high quality product, high product price, high risk of not succeeding	Radical innovation, high risk of not succeeding	Radical innovation, high risk of not succeeding	New product technology, high quality product, high product price, high risk of not succeeding	New methodology of Project accomplishment, Fairly high risk of not succeeding
How was the openness of the network?	Open at project org level, closed at management level.	Open at project org level, closed at management level.	Open at project organisation level, closed at management level.	Very closed	Very open
Was it any development of network?	Yes. The network developed with the actors mobilised and the technical artefacts involved	Yes. The network developed with the actors mobilised and the technical artefacts involved	Yes. The network developed with the actors mobilised and the technical artefacts involved	Yes. The network developed with the actors mobilised and the technical artefacts involved	Yes. The network developed with the actors mobilised and the technical artefacts involved
Did any party succeed to stabilise the technology through creation of an obligatory passage point or black box closure?	Yes, they did.. Admin and marketing dept initially controlled the network . Technical dept. and the administration took the final control and terminated the innovation project	Yes. The tech. staff at the parent company was controlling the network initially. Tech dept. at the enterprise in Moss took the final control and terminated the innovation project	Yes. The tech. staff at parent company was controlling the network initially. Admin at The enterprise in Moss took the final control and terminated the innovation project in the creation of the final obligatory passage point	Yes. The Project group and a repr of the executive group seemed initially to have control of the network during the running of the project Finally admin at the enterprise in Moss took control and terminated the project	Yes. Admin at the enterprise in Moss had control during the whole project and ensured through a strong commitment a partly successful result of the project.

Table 18: A summary of the characterisation of projects – utilising the actor network theory

6.4.7.3 Construction of Histogram

The response of each project to one of the chosen questions in the matrix, chapter 6.4.7.2, is either given the mark 0, 0.5 or 1. The mark 0,5 is given if the question can be answered in the affirmative for a part of a project. The separate marks are summed up within the range 0-5 to include all five projects, and are shown in tables below.

Upstream Project						
Did any controversy take place?	Did any mobilising of actors take place?	Were translation strategies utilised?	Were technical artefacts utilised in the network building?	Was the network open?	Was there any development of the network?	Did any party manage to stabilize the technology ?
5	5	5	5	2.5	4	5

The mark 2.5 for network openness is given a mark of 0,5 to project 5, because of the communication was closed within the organisation and open between the enterprise in Moss and the external environment.

During Project Accomplishment						
Did any controversy take place?	Did any mobilising of actors take place?	Were translation strategies utilised?	Were technical artefacts utilised in the network building?	Was the network open?	Was there any development of the network?	Did any party manage to stabilize the technology?
5	5	5	5	2.5	5	5

Table 19: Tables for construction of histograms

The mark of 2.5 for network openness is due an open communication at organisation level and a closed communication at management level for the three first projects. Thus, each of these is given the mark 0,5.

The results of the calculations are shown in the following histograms, and are used for further discussion of the common characteristics, utilising the theory.

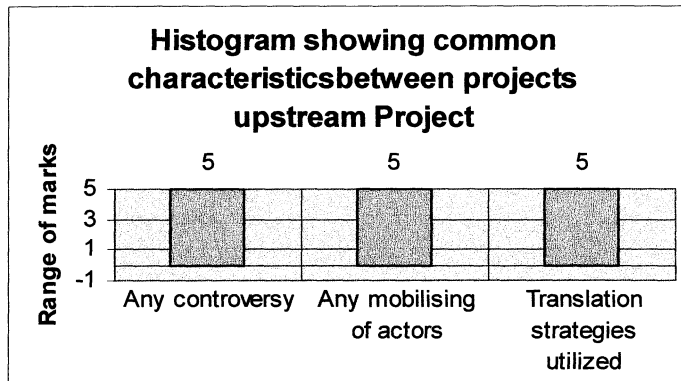


Figure 49: Common characteristics of projects – actor network theory

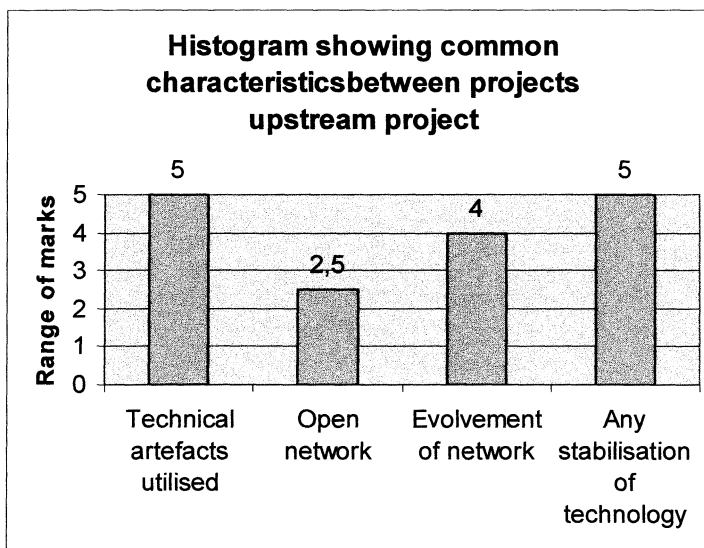


Figure 50: Common characteristics of projects – actor network theory

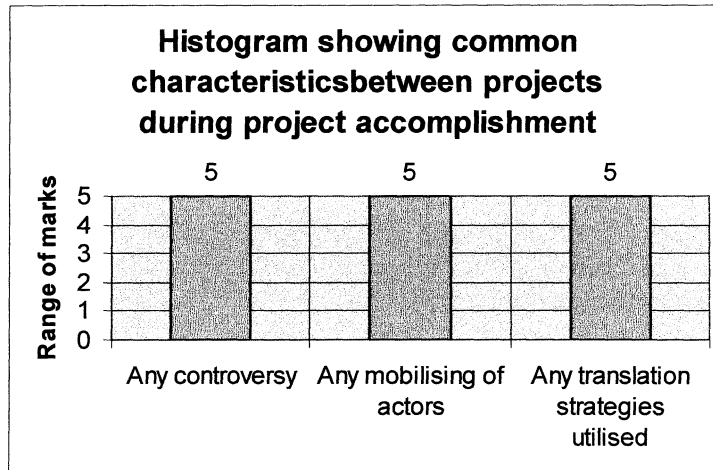


Figure 51: Common characteristics of projects – actor network theory

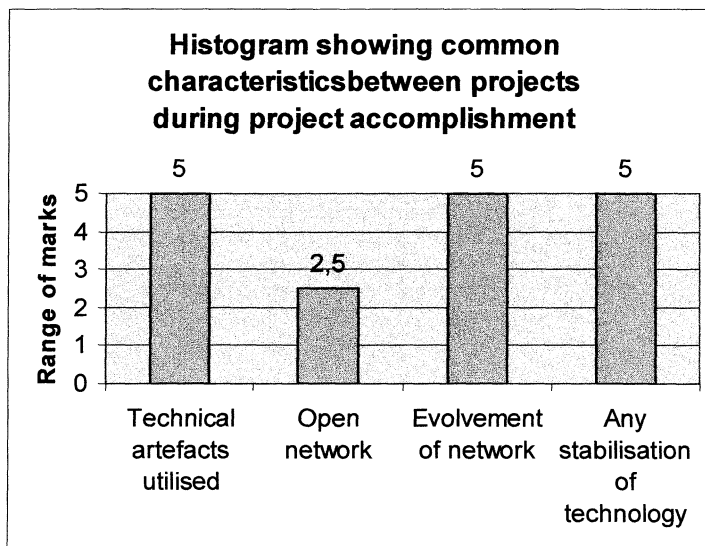


Figure 52: Common characteristics of projects – actor network theory

6.4.7.4 Conclusion

Introduction

In the following discussion the same structure has been applied as for the analysis of the projects, which is illustrated in figure 24 in chapter 3 of the thesis.

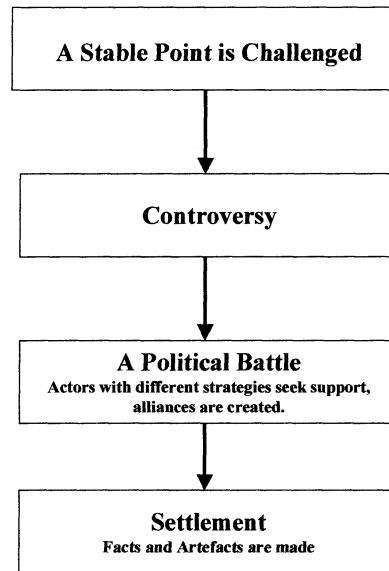


Figure 53: Strategies for successful creation of stabilising mechanisms, Ulseth (1996)

As was shown in chapter 6.4.7.3, the main characteristics of the projects were the same both upstream and during the projects. The following discussions therefore include both phases.

Controversies

In all five projects a stable point in the organisation at the enterprise in Moss was challenged at the initiation of the projects, because actors had different claims about what was truth. If the initial controversies are open, as was the case for projects 3-5, this results in important and necessary processes upstream the innovation projects, which help to create the right focus on the innovation processes.

In the thinking model of Pinch & Bijker (1989) open controversies exist between relevant groups of actors that have certain interests in the technology. The closure takes place in a process of consensus. Downstream the closure all disagreements seem to have been forgotten.

In line with Latour (1987) the closure mechanisms in all five projects included in the thesis were more based on a process of stabilisation of the technology where conscious human actors with power decided what the technology, should be.

The projects two and three were characterised by hidden agendas both upstream and during the innovation processes, resulting in negative and destructive conflicts during the executions of the innovation processes. Mechanisms were not initiated to promote an opening of hidden agendas upstream and during the innovation projects.

Enrolling of Actors

To seek support the network builders in all five projects enrolled actors to strengthen their networks, basically as a platform for further translation of interests. Pinch & Bijker (1989) focus on the challenge for the network builder to enrol actors representing diversity and positive conflicts as a necessary condition for change, and of creating a realistic picture about what is required to succeed in a technical innovation. One example of the opposite can be taken from project no 1. The enterprise in Moss only went to one machine supplier when the rebuilding of the paper machine should take place, and trusted very much his judgement regarding the possibilities of producing a new product quality on the rebuilt machine.

Technical artefacts were enrolled in the actor network. They did not function as heterogeneous system elements equal with human actors, as Latour (1987) claims, but rather as strong mechanisms to guide human behaviour. A good example of this is the technical solutions chosen in the rebuilding of the paper machine, described in project one. The redesigned paper machine was not suitable for produce the planned new paper quality. Little could be done with this without a change in the paper machine design.

Translation of Interests

According to the analysis different translation strategies were utilised in the projects. All of the following three strategies were applied:

Translation 1: I want what you want

Translation 2: I want it, why do not you?

Translation 3: If you just make a short detour...

Of the three strategies, translation 1 was most frequently used strategy, and applied in all five projects. The analysis of the projects indicates that a condition for a successful application of translation 2 is the use of external pressure. One example on this is the role of the administration of the enterprise in Moss as the formal project owner in project no two, even if it was neither interested in the project nor involved in it.

With reference to project no 1, in which the new product quality was introduced in the market upstream the carrying out of large scale technical trials, indicates that an open communication is a necessary and important condition for succeeding with any translation strategy.

A part from the application of different translation strategies to enrol others so they participate in the construction of facts, Latour (1987) claims that it is equally important to create strategies to control their behaviour in order to make their actions predictable. This was not done in any of the projects of the thesis.

Creation of an obligatory Passage Point

Latour (1987) suggests the making an obligatory passage point is a strong mechanism for stabilisation the technology. According to the analysis, this was proved in all five projects. The obligatory passage points that were created during the projects function well in the control of behaviour of the actors in the network.

However, the analysis showed that they were not strong enough in project 1 – 4 to manage the final technological stabilisation according to the scenario of the main network builder. It seems that a proper systems limit was not made when the obligatory passage points were constructed. Central actors with power to strongly influence the progress of the innovation processes, including both management and practitioners, were not included.

6.4.7.5 Major Finding for My Innovation Model

From the above conclusion, including findings from each project, I have made a choice as to major findings I want to include in my innovation model:

- Mechanisms to open up hidden agendas upstream and during innovations
- Enrolling of actors representing a diversity and creative conflicts as a conscious process
- Open communication as a condition for success in any translation strategy
- Strategies to control the behaviour of enrolled actors, in order to make their actions predictable
- Stabilisation of technology by making obligatory passage points or by black box closure. Proper systems limits to be taken in the making of an obligatory passage point.

6.5 Major Findings to be Included in my Innovation Model from the Analysis of the Projects, based on the three Theory Perspective included in my Thesis

The major findings to be included in my innovation model from the analyses of the projects are based on my choices, and are presented together in the table below.

Structure Theory	Knowledge Creation Theory	Agent Theory
A project organising consisting of an executive group and a project group with clearly defined tasks and responsibilities	A realistic picture should be taken upstream the project, based on existing knowledge and creative environment, as to what is required to make a successful innovation	Mechanisms should be applied for opening up the hidden agendas
A well communicated strategy	The principles of minimum critical specifications should be applied	The enrolling of actors of the project group that are representing sufficient diversity and creative conflicts should be done in a conscious process of construction
Coupling of R&D strategy with the enterprise strategy	A clear and accepted project goal should be made. This should to be divided into a long term overall goal and short term goals for giving direction during the project implementation	Strategies should be applied to control the behaviour of enrolled actors, in order to make their actions predictable
Utilization of dedicated resources	Integrated knowledge creation should be promoted though:	Mechanisms for stabilisation of the technology should be considered, either through the creation of an obligatory passage point or through a black box closure Proper system limits has to decided in the creation of an obligatory passage
A strong prioritisation of each innovation project which is planned to be run	<ul style="list-style-type: none"> • A strong management commitment • Vertical integration of the project work • Autonomous project groups with redundant functions • Sufficient diversity and creative conflicts in the project group • A strong involvement of central actors • A meaningful common language • Open communication and information structure • An outsider as a project manager 	

Structure Theory	Knowledge Creation Theory	Agent Theory
An early creative phase should be a part of all innovation projects	Intrinsic and extrinsic motivation factors should be applied when appropriate	
A system approach to be taken in the planning and following-up of all innovation projects	An evaluation should be done after the completion of an innovation project	
The best way of project organising an innovation project will depend on the creative content of the project		
The project should be organised for implementation of the results in the organisation and in the market		
The application of different project managers should be considered in the running of the creative and systematic project phases		
An integrated innovation model covering both the creative and systematic project phases should be an integral part of all innovation projects.		
It is important to the project group to get direct communication links in innovation projects between the customers, the suppliers, the research institutes and other external actors of importance for achieving the project goals.		
It should be considered to make a joint optimisation of the technical and social sub-systems when the project specifications are made		
Benchmarking of lead users should be done in the efforts for creating an advantage in the market		

Table 20: Major findings to be included in my innovation model, included all three theory perspectives involved

7.0 Final Conclusion – Suggestion of a new Innovation Model

7.1 Introduction

I chapter 6,5 I have presented my choice of important elements from the conclusions of the analysis of the projects to be included in my innovation model. The choice is based on the findings from the analysis of the projects together with my own experience of 25 years of work within the innovation field.

I realise that there are many ways of running an innovation project, due to the fact that all innovation projects are different. I take the position that a successful innovation very much Depends on how people are motivated to participate in creative activities. I strongly argue that it is not possible for any management to force an innovation process through by detailed instructions and procedures or through direct control of the creative activities. It is not possible to order an individual to come up with a creative input. The best is, in line with biological metaphors, to promote good conditions for creative activities during the innovation process, and then just hope for the best.

From the above I argue that , from a management perspective, this represents a challenge to all managers. A manager is judged by the results he/she manages to achieve through others. The management goals are normally known. With reference to the analysis of the projects included in my thesis, I argue that goal fulfilment in any innovation project to a great extend is a matter of applying the various strengths and techniques of involving participants in the organisation. This can be done both as information and participation, or by more or less manipulating involved actors.

I argue that my suggestion of an innovation model presented in this chapter, is representing new perspectives for achieving an improved understanding of the innovation processes. My main argument in the model is based on the view of innovations as knowledge creation in presence of controversies and conflicts as necessary conditions to achieve the given project goals.

7.2 A Systems Perspective

7.2.1 Implementation of Innovation Processes in a Sociotechnical Perspective

I take the position that to do an technical innovation in a sociotechnical perspective implies putting an integrated focus on both technical and social factors involved, with the aim of finding the best combined solution that satisfy important requirements from both the technical and social sub-systems. This is illustrated in figure 54 below.

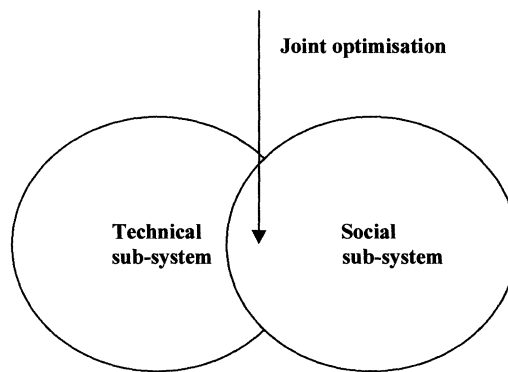


Figure 54: Joint optimisation of technical and social sub-systems

I suggest that a joint technical / social project specification should be considered in a technical innovation. The existing project procedures should open up for evaluation of input and requirements from the social sub-system as a continuous process during a technical innovation. This seems to be important for avoiding problems in taking the new technology into use, or where the organisation is forced to do some organisational development to make the new technology to function.

Technical innovation projects are normally heavily manned by engineers with a high technical competence. I suggest that actors with a high competence in human behaviour from the human resources management functions in the organisation also be involved in the innovation processes, to promote teambuilding and communication across functional boundaries and to make the sociotechnical discussions easier to fulfil. I suggest that actors from the human resources management functions could promote a good involvement of practitioners and a

well communicated Act of Work Environment and other Norwegian laws and regulations on the human issues in an innovation project.

The human resources management at the enterprise in Moss have been thinking along these lines for some time, having had the position as project manager during the implementation phase of a large IT project that recently has been completed.

7.2.2 Different Phases of an Innovation Process

I suppose that the innovation consists of different networks, which are coupled to each other. The character, content and function of each network will vary with the type and complexity of each innovation process, and has to be adapted to fit an actual purpose in the execution of an innovation process. I suggest that some of the creative networks will be part of a continuous ongoing process within an organisation, and will not be connected to any concrete project implementation.

My suggestion of a framework of the main phases of an innovation process is illustrated in figure 55 below.

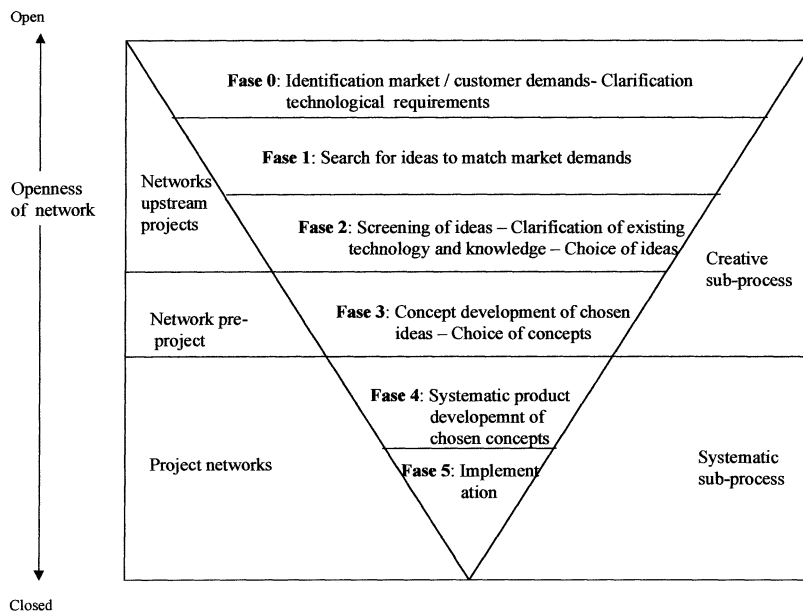


Figure 55: Phases of an innovation process

I have chosen to divide the innovation process into creative and systematic sub – processes. The phases 0-3, with a large creative content, are included in the creative sub-process, while the phases 4-5, characterised by a strong demand on systematic work and a high productivity, are included in the systematic sub-process. I suggest that a creative sub-process should be included in all innovation processes. The main purpose will be to concretise many important elements before a systematic product development work can be started up. With reference to the projects involved in my thesis, an organisation should never jump into the main project without doing a proper work upstream of it.

Normally there is not a clear - cut division between the creative and systematic activities. I suggest that even during the systematic product development phases a change between a creative and systematic mode of working normally take place all along the problem - solving activities This is illustrated in figure 56. The management style and the way the project work is organised in the systematic phases must open up for the changing working modes described above.

The Creative Phases 0-2

As shown in figure 56, I suggest that the work within the creative phases 0-2 is going on as a continuous activity upstream an innovation project in the organisation. Connected to these phases creative activities take place to create a knowledge base of ideas a potential new product. An important element in this work will be a strong market orientation, in order to be able to take a proactive position to meet customers needs and to offer added values to the products introduced in the market. Benchmarking of lead users could be an important tool to be able to take a lead.

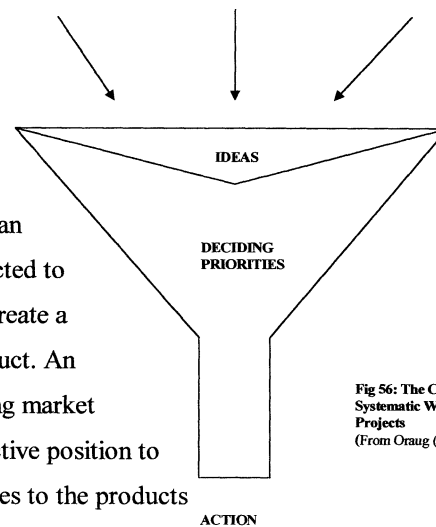


Fig 56: The Change of Creative and Systematic Working Modes in Innovation Projects
(From Oraug (1999))

I suggest that the output from these upstream creative networks is a list of product ideas, given a strong priority, to maintain a focus on a few innovation projects, and to reduce the risk of shortage of resources in the projects.

Based on the above thinking, I suggest that the networks involved in the creative phases of an innovation process are organised as open and dynamic systems: both towards the market to gather a sufficient amount of market information, to create valuable market knowledge from the market information in the own organisation, and finally to communicate this knowledge in an efficient way to the own organisation in order to take proper action. This is illustrated in figure 57.

I suggest that a well communicated strategy is a matter of decisive importance for success in the creative work, in order to create a proper communication with the strategic goals as a basis. A well communicated strategy also seems to be important to promote a proper coupling of the R&D strategy with the enterprise strategy, to make the strategic goals operational at lower levels of the organisation.

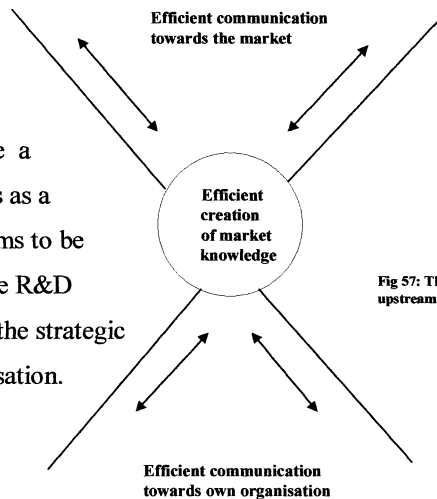


Fig 57: The open character of networks upstream innovation projects

Phase 3 - The Concept Development

Within the network connected to the concept development phase, various solutions are developed for the chosen products in accordance with a given overall product goal. This requires a high level of creative activity, a strong internal integration and close and direct cooperation with external suppliers, the customer network and other relevant external parties, in order to clarify different alternative solutions.

I suggest that a systems approach is taken in this phase of the innovation. Calculations should be done to clarify if the implementation of an actual innovation process will result in a successful business to the enterprise. A realistic view should be taken, based on existing knowledge base and creative environment in the organisation, as to what is required to make a successful innovation, to avoid that an innovation project is initiated from a too weak knowledge and resource basis in the organisation.

Calculations of the proper systems limits should be done in the concept development phase. With reference to the projects involved in my thesis it is especially important to avoid too

narrow systems limits, making it difficult to achieve the project goal, due to process noise external to the chosen system limits or due to a too small extent of the project.

I suggest that it is planned for the implementation of the innovation results as for the need for resources and time as part of the activities taking a systems approach in this phase.

The Systematic Phases 4-5

The network in which the systematic product development and the implementation work take place is suggested to be relative closed, and mostly composed by systematic and result - oriented actors. Upstream this phase the choice of product concepts have been done. Much of the uncertainty in the project is normally reduced. At this stage the aim is to develop and implement the new product as efficiently as possible at a high productivity.

Based on the above arguments, I suggest that a formal project organisation is established to carry out systematic phases based on a mechanistic approach of organisation. The project organisation should include an executive group and a project group with clearly defined tasks and responsibilities between the two parties, in order to avoid any potential project delays due to unclear responsibilities and misunderstanding. I suggest dedicated resources to be utilised during the systematic project phases, participating in problem - solving activities in agreed periods of time, in order to create a more efficient contribution from the involved actors.

An innovation project is not completed before the results are implemented in the organisation and then in the market. With reference to the projects involved in my thesis this seems to be a problem. The project organisation seems to terminate an innovation process too fast, at a stage when the preliminary project goals are achieved. I suggest that the project organisation is made responsible for the product until it is ready for ordinary sale in the market. This would mean that the project could be responsible for selling a certain number of tons of the new product before the project is completed, securing a strong market orientation during the product development. This way of working to secure a proper implementation of the innovation results has been successfully implemented at Peterson Scanproof AS , and has been an integrated part of the product development activities for some years.

The Management of Innovation Processes

Most of the work within the open networks including the phases 0-3 shown in figure 1 will be of a creative character. To manage the creative work, I suggest that actors who have strong creative skills, a strong capability of creative problem - solving, and of managing through coaching, are more suitable for this position.

To run the systematic project phases I suggest that individuals with personal strengths in autocratic control of project activities, possessing the attitude of a completer of projects, are best suited as project managers.

When different project managers are utilised to run different phases of an innovation process, I suggest that an overlap between the two roles should be considered. This could reduce potential problems in the change from creative work to systematic product development in an innovation project due to lack of proper communication at the interface between the two main project phases.

The utilisation of an integrated Innovation Model

An innovation model is a kind of guidance or procedure on how to accomplish an innovation process. I suggest that this tool should be applied in all innovation systems.. Due to the fact that all innovation projects are different, as describe above, an innovation model should be flexible and possible to adapt to an actual context. An innovation model should guide the behaviour through both the creative and systematic phases of an innovation process

I suggest that the requirement of flexibility and integration is increasing at a higher creative content in an innovation process, due to the need for open communication and knowledge transfer across functional boundaries in a highly dynamic context. For application of an innovation model during the implementation of the systematic phases, a more rigid and linear model approach could be more appropriate, due to strong requirements of efficiency and high productivity in these phases.

In figure 55 the increasing closeness of the networks from phase 0 down to phase 5 was illustrated

7.3 Technological Innovation as Knowledge Creation in Presence of Controversies

7.3.1 Introduction

I maintain that an innovation as a process where new knowledge is created in presence of controversies as necessary conditions to achieve this. I suggest that innovation processes are organised and managed according to this approach. In figure 58 controversies are illustrated as integrated parts of a sociotechnical design framework. This position will be further elaborated.

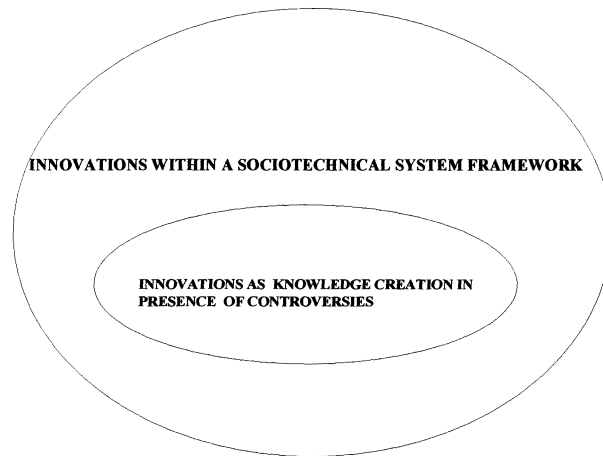


Figure 58: My position of an innovation processes

7.3.2 The Nature of an Innovation Process

A technological innovation represents something new, indicating that new knowledge has to be created during the innovation process. The learning that takes place normally does not follow a linear track, but is usually a non-linear process. By-products that for instance are discovered during an product innovation may end up as the main products.

7.3.3 Minimum Critical Specifications

Based on the above description of an innovation as a non-linear knowledge creation process, I suggest that the principles of minimum critical specifications are applied in innovation

processes. This can be understood in the following way: For all technology there are always certain requirements for it to function. Beyond that it will always be possible to make choices. Utilising the principle of minimum critical specifications makes it possible to design the technological content more freely, and open up for learning. The creation of a detailed specification upstream an innovation project may result in solving of irrelevant problems and concealing uncertainty and risks in the project.

7.3.4 The Goal Formulation

I suggest that the principle of a clear and demanding overall goal is applied, with a large room of possibilities for performance. This seems to be a strong motivating factor for creative activity. Apart from the overall goal, covering the whole project period, I further suggest that short term goals are established at the initiation of the innovation project, to allow for the direction to be changed during the innovation process, as a result of an learning process.

The overall and demanding goals are defined by the executive group, while the short - term project goals are determined by the project group with the detailed knowledge of the activities to be done in the project.

The principle of minimum critical specification and short term dynamic project goals are serving the same important purpose: to open up for an increased room of solutions and for learning during the innovation process.

7.3.4 Integrated Knowledge Creation

Innovation projects are most often problem - oriented. To succeed in innovations there is a need for different kinds of knowledge. I suggest that it is important to create an arena where new knowledge is created in a dynamic interplay between involved actors in collective learning processes.

The principles of collective learning have been applied with success in various contexts at the enterprise in Moss for some time. One example is meetings held every morning in connection with big maintenance tasks at the enterprise. In these meetings all actors from the maintenance functions involved in some special tasks participate. They all get the same

information and are all taken seriously and listened to. Another example is the good experience of arranging search conferences during many years at the enterprise in Moss. These conferences have been applied to open up for collective planning and designs of action aimed at problem solving relevant to practitioners in the mills.

Creation of a Common Meaningful Language

An important mechanism for creating the collective learning processes seems to be communication according to democratic principles. In the participation in innovation projects actors of different background often meet, for example with regard to professional background, work experience, age, sex and culture.

I suggest that creation of a meaningful common language is essential in this context, and that it is an important part of the total responsibility of a project manager to promote conditions for all involved actors to be able to communicate on equal terms.

I argue that problems with an insufficient common language are mostly related to practitioners who are participating in projects as representatives of their colleges. These actors are selected due to their high competence in subjects of relevance, which is the reason for their involvement. Possible negative consequences due to an insufficient common language is an inability to participate in the work groups, a feeling of being a hostage and difficulties in getting feedback from the colleagues.

I suggest that the role as a representative of other practitioners is made more professional through training in communication and teamwork, learning about the differences in working in a project and in the basis organisation. This work has been started up at the enterprise in Moss. Internal courses have been arranged during the last two years.

To improve the feedback from the practitioners I further suggest focusing on a strong involvement of these actors through responsibility for certain concrete tasks in an innovation project. I finally suggest that the period of time of involvement of practitioners should be considered in innovation projects of a long duration, to keep up a high interest for participating high.

Involvement of Relevant Actors in an Innovation Process

I suggest that a strong involvement and participation of relevant actors are among the key challenges to achieve successful results in innovation projects, as a way of mobilising the knowledge of each involved actor. This subject is too important to let the involvement take place in a random way. The process has to be consciously organised and managed.

I suggest that the work in innovation projects should be organised according to the principle of autonomous work. This implies that the project group within an overall goal and given boundary conditions is allowed on its own to organise and choose its way of action. It is argued that this way of organising the work will increase the capacity for solving unexpected problems and motivating members to participate.

I further suggest that redundant functions with a surplus of knowledge be present within the framework of autonomous work groups, as important factors for sharing of tacit knowledge between individuals.

To create a well - functioning integrated knowledge creation process take place, I suggest that it is important to involve the management or its representatives in the project together with other central actors in the network through vertical and horizontal integration. The knowledge created will be of little value if central actors with power to influence the results are left out. An important role of the management will be to improve the communication with networks external to the project group through a gate - keeping function, utilising its network contacts.

I suggest that intrinsic and extrinsic motivation factors are applied to speed up the innovation process. The extrinsic motivation factors based on some kind of reward system seem to strengthen the performance of tasks where there is a clear path to the goal, while the intrinsic motivation factors with focus on the strengthening of heuristic tasks involving creative activities. They pertain to the individual's ability to motivate himself for doing a task. Utilisation of the proper mechanisms of motivation in different phases of an innovation project represents a management challenge.

How to Put Integrated Teams to Work

I suggest that the above title of this chapter touches several important elements regarding the proper functioning of integrated teams. I have chosen to focus on the following:

- Creating sufficient diversity in the innovation team for promoting creative activity
- Keeping actors in line to make their actions predictable.
- Mechanisms of stabilisation of the technology.

The above integrated process is illustrated in figure 59 below

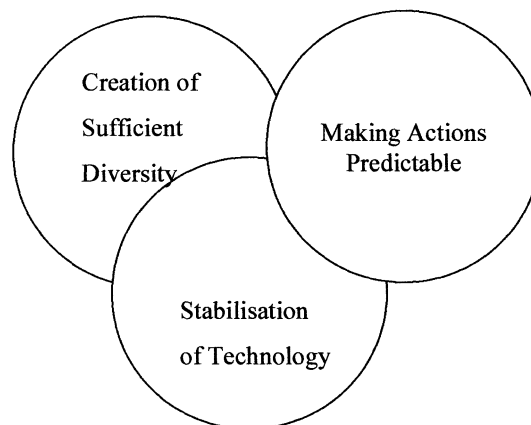


Figure 59: Critical processes for putting integrated teams to work

Creating sufficient Diversity

I suggest that sufficient diversity has to be present in an integrated team, to spark off creative activity. This is too important to let it take place in a random way. It is the responsibility of the management to consciously construct a functional team of actors possessing the necessary difference in skills, talents and social categories.

The mechanisms for creating the necessary diversity seems to be different, dependent on the type of networks involved:

For stable and well - defined networks I suggest that the diversity be created through involving actors of different functions within the organisation and from its external environment, and in this way set the scene for necessary inter-human conflicts to create creative activity. Different team - building techniques can be applied, for example Belbin (1993) to find the strengths and the weaknesses of actors. When these techniques are utilised, it seems to be important to focus on the positive qualities of the individual and to reduce the negative ones.

For a dynamic and open network project organisation, the necessary diversity is created through a dynamic change of involved actors through the innovation process. With reference to project 5 included in the thesis I suggest that one mechanism for getting creative activity in this setting is through a strong management commitment and the definition of a demanding project goal.

Keeping Actors in Line and making their Actions predictable

When an integrated team is constructed with sufficient diversity, I suggest that the next important issue for the project manager is to make an evaluation regarding which kinds of functions and roles that are critical to be taken care of in the project. Plans should be made for actors that are leaving the project team to be replaced by others.

Stabilisation of the Technology through Making Obligatory Passage Points

An obligatory passage point implies that an actor is making himself indispensable to other groups of actors, and can be seen as the only and best way of pursuing the interests and desires of the rest of the actor network. I argue that a project manager always aims at control of his project. Making himself an obligatory passage point is a strong tool for obtaining that. To be efficient, proper system limits have to be taken, in order to include all central actors with power to influence the project.

I suggest that the process of making an obligatory passage point is kept open to avoid manipulation due to hidden agendas.

7.3.6 Mechanisms to avoid Manipulation in Innovation Projects

I argue, due to differences in personal interests, that is difficult to totally avoid manipulation by actors. To reduce this problem which can destroy projects, I suggest that the only way is to run open processes in projects through:

- Linking central actors strongly to the integrated work in projects to make it difficult to maintain hidden agendas over a long time.
- A well - communicated strategy and vision will give signals to the organisation if a given project goal is rooted in the overall direction of the enterprise
- An open communication and information system reduces the filtering of information and potentially give members of the organisation the same information

To achieve the above I suggest that it is important that the project owner is giving the same message all the time, and not signalling a change in direction over time through its communication to the organisation.

7.4 Project Evaluation

I argue that doing a proper evaluation of an innovation project is important, to learn from positive and negative actions during the project implementation. In this way a historical knowledge base could gradually develop, giving the basis for a more efficient implementation of downstream projects.

With reference to all five projects involved in my thesis this does not seem to be easy to manage. It seems to be easier to forget the whole project and to do the same mistakes over again in the next one.

I suggest that experiences from innovation projects be systematically gathered in an electronic data base, which should be constructed in such a way that is possible to search for different key subjects through many projects.

The access to the project data base should be kept open to anybody interested in innovation processes in the organisation, as a guide for everyone initiating and participating in innovation projects. The innovation data base could thus serve as a basis for organisation learning.

7.5 Summary of My Innovation Model

A summary of my innovation model is given in figure 7. The systems model is decoupled into the systems elements: “integrated knowledge creation” and “how to put integrated teams to work” It is shown how the different elements are connected to each other.

Technological Innovations in a Sociotechnical System Design Perspective

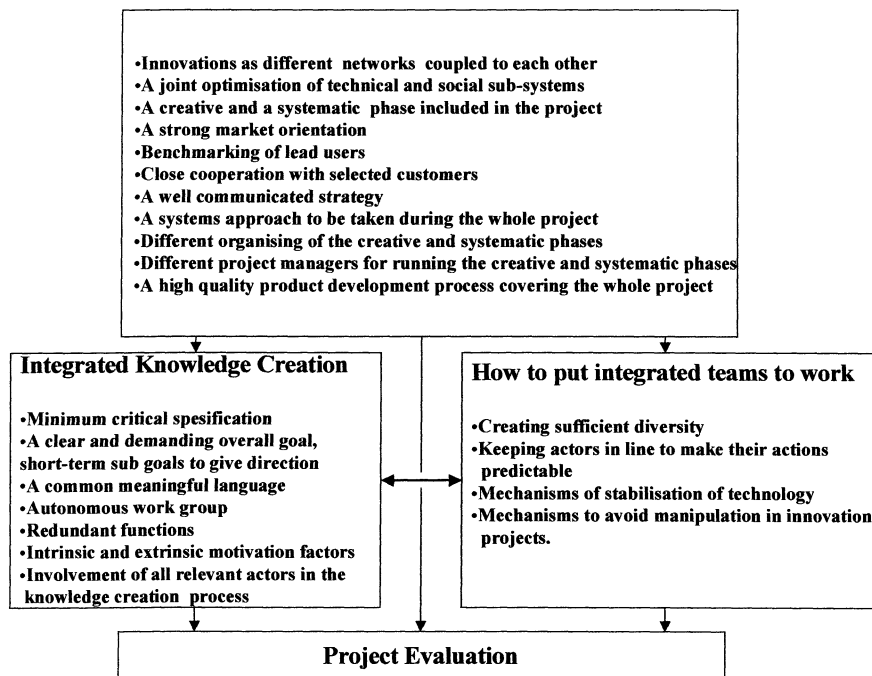


Figure 60: Suggestion of a new innovation model

The above figure illustrates the strong links that are necessary to establish between important elements from a knowledge creation perspective. This perspective pertains to organising and managing innovation projects for promoting creative activities in the linking of a constructivist position involving questions of how facts and artefacts are produced by people, rather than taking them as conditions and objective end products.

8.0 Implications of my Innovation Model for the Enterprise in Moss

Based on my innovation model presented in chapter 7, as well as on my theoretical position, I shall in this chapter put forward some suggestions to organising factors that are likely to promote a more creative behaviour in the organisation and improve the chance of accomplishing successful innovations. My suggestions are based on the existing organisation structure, culture and climate during the time period 1985 – 1995, when the involved innovation projects were implemented.

Input from the management literature is applied in the below discussion.

In my opinion organisational factors of significance for creative processes and innovation include the formal structures of the enterprise, as the formal organising of the enterprise, strategies, management systems and procedures, as well as the soft aspects, like climate and culture. The formal structures and climate and culture interact.

8.1 Segmented versus Innovative Organisation Structures

I argue that the organizational structure at the enterprise in Moss during the period of time of implementation of the projects involved in my thesis had a character of what Kanter (1985) terms segmented structures. These structures are typically characterized by a sequence thinking, as a consequence of an organisation divided into functions, high fences between departments, formal reporting and control, and an orientation towards viewing problems as narrowly as possible, independently of a possible given connection with other problems. In such systems it is often argued that problems are best solved when they are splitted into sub-problems and solved sequentially by specialists working in isolation.

An enterprise where segmentalism is dominating, will face problems when trying to be innovative and to manage change, because it is basically organized to keep the enterprise on a steady course, and to protect itself towards unnecessary changes. Such an organization has a tendency to repeat what it already knows.

Should an innovation be created as a result of a process where innovative actors have had the opportunity to do creative activities within special segments, it often turns out to be difficult

to implement the new solutions, due to potential conflicts with given priorities of the company.

Kanter (1985) claims that segmented structures have the tendencies to focus on routine - based tasks, defending existing systems, and they are characterized by insufficient cooperation across functional lines in the organisation. Control of information is an often applied instrument of power. Less innovative enterprises are characterized by attempt to force through changes by dictation from the top management.

From my position it is a basic supposition, in order to create innovations, that the management is willing to open up and search for new perspectives to find holistic solutions to problems, and to arrange for access to new experiences and knowledge in the organisation. To create attention to the need for the creation of new ideas is the basis for all innovation processes, and this represents a management challenge.

To increase its innovative potential at the enterprise in Moss I suggest that the organization gradually be changed to promote a stronger focus on the above thinking.

Kanter (1985) argues that this most probably will take place in change - oriented enterprises of a dynamic character. This organization structure is loosely coupled, flexible and network based, with integrated structures and cultures. Such companies have their own integrated mechanisms that encourage a free flow of ideas, change of information across functional lines, and a decentralized decision structure with overlapping areas of responsibilities, competence and tasks. Within this environment learning and innovation will have good conditions.

Important management qualities in stimulating integrated innovation environments are the capability to motivate others to invest in knowledge, and the solving of problems by applying teams and participation of the members of the organisation.

Reward systems in the more innovative enterprises are in general more investing and future-oriented on the human level. Focus is on motivating the members of the organisation to gain success in existing and future projects, and not on what an individual already has gained.

8.2 Organizational Climate / Culture

I suggest that potential changes towards a more change - oriented organization has to take place at the enterprise in Moss through the change of the organizational climate and cultural variables.

Ekvald (1991) claims that these are the most important parameters that influence organizational processes as communication, problem solving, decision making, learning and motivation. There is a mutual connection between the culture and its members. Bang (1988) argues that the members are creating, maintaining and changing the culture, and that the culture at the same time is forming its members. The cultural norms and values clearly influence the behavior and development in an organisation

8.3 Integrating Mechanisms to promote Innovations

It has become clear in the analysis of the projects included in my thesis that one challenge at the enterprise in Moss is to improve the integrated forms of work.

Kanter (1985) has found that many innovative companies in USA have integrated the following three mechanisms to promote innovations in their organisations: open communication systems, the creation of internal and external networks and decentralization of resources.

Open Communication Systems

Open communication systems are supporting potential innovators in their creative work to accomplish innovations. Havn (1991) argues that all information should in principle be available to the organisation. Open communication means that both problems and successes in the organisation cannot be hidden for a long time, and function as a means of reducing the functional barriers.

Creation of Networks

Rosenfeldt & Servo (1991) claim that a broad network of actors and resources are often needed in order to create an innovation from an idea to the final product. To improve the network cooperation in an organisation in a perspective means in practice vertically and horizontally to construct integrating forms of cooperation in the basis organization. This is essential when sufficient diversity is going to be created in project group in innovation project groups. Different integrating mechanisms can help the formation of networks, from where I have chosen to highlight the following tree:

- Circulation between different positions in the organization
- Making each person feel safe regarding his/her own work situation
- Mechanisms to open up for ideas of potential innovations from all employees.

Circulation between different Positions in the Organization

The purpose of a systematic rotation between different positions in an enterprise is serving different purposes. Kanter (1985) and Havn (1991) claim that the circulation between different functions and between staff and operating tasks mostly is a mechanism which is extending the network perspective of the individual. Actors who are moving around in the organisation are in principle carriers of information and function as integrating links. Havn (1991) claims that a consequence of this is an overlap in competence between different functions. This strengthens the motivation towards a further development of an integrated form of working, both in the basis organisation and in autonomous groups in the innovation projects.

Bang (1988) claims that circulation of the employees also has a cultural perspective, and contributes to form an integrated culture.

Havn (1991) suggests that a systematic rotation could be a part of a career plan, to prepare an individual for future integrated work within R&D. It seems that different career ladders are necessary to keep actors motivated over time to rotate to different positions in the organisation.

Creation of safety of the own Work Situation

It becomes clear in the analysis of the projects involved in my thesis that one challenge at the enterprise in Moss will be to improve the integrated cooperation, in order to strengthen the innovative potential.

Kanter (1985) argues that it is not possible to get through any innovations at an enterprise if the members of the organisation are feeling unsafe regarding their own work situation. In a traditional enterprise the safety is based on stability and control. To live with changes in an innovative organisation does not have to result in uncertainty, but may rather develop of new ways of feeling sure. In line with Kanter (1985) it will be increasingly important to an organization to be flexible, and to be able to react quickly to unexpected internal and external changes. To each individual safety will come from the identification with an open, integrated culture, where the direction of the enterprise is well communicated in the organization, the enterprise committed to invest in the future, and the employees regarded as the most important resources of the enterprise.

Mechanisms to open up for Ideas of potential Innovations of all Employees

I suggest that it represents a challenge to the enterprise in Moss to increase the creation of ideas of potential new innovations and to establish a system for handling ideas coming up.

Kanter (1985) has found that a common practice among innovative and vigorous enterprises in USA and Japan is to have many channels for new ideas, to be very open towards the environment and to focus on the individual initiative. In line with Kanter (1985) one important mechanism for motivating creative activities locally in the organization is to allow each innovator to test out the creative idea, utilizing resources from the enterprise without any obligations. It has been found that this measure can contribute to an increased commitment to focus on the ownership of the source of the creative idea.

Introduction of Quality Circles in the Organisation

The last integrating mechanism I have chosen to discuss is the introduction of quality circles in the organisation in the ISO 9001 quality system at the enterprise in Moss. This has not been an integrated part of the existing quality system.

Schea (1991) claims that quality circles serve different purposes for mobilizing the organisation to participate in solving of specific problems and to continuously improve the capability of an enterprise in problem solving.

The introduction of quality circles can be an efficient driving force, through which the vertical integration that takes place, to improve the communication, develop the teamwork as a way of collective learning, and to change the culture towards an increased integration.

8.4 Implementation of Innovation Projects as a means to promote Organizational Development

I have in the chapters 8.1 – 8.3 put forward different suggestions to promote a change in the organizational framework of innovation projects at the enterprise in Moss. Ekvald (1991) claims that this has to take place through a change of the organizational climate and cultural variables that influence the organizational processes:

- The communication across functional lines
- The creative problem solving in integrated teams
- The motivation for participating in innovation projects
- Organizational learning

I suggest that implementation of innovation projects can be a strong means to promote the necessary organizational development. A better way of organizing and innovation projects is suggested, based on my innovation model, the empirical material of two of the involved projects, and the present organizational climate and culture. In this way I try to connect this suggestion of project implementation to the empirical material and the problem formulation presented in chapter one.

The Choice of two Innovation Projects to be compared

I have chosen the projects number one and five for the comparison of important features between them. In my view they represent the extreme points regarding the organizing and the managing of the involved projects in my thesis. The result of the comparison is shown in the following table, together with chosen parameters.

Chosen parameters for comparison	Project no one	Project no five
Project organisation	In the first phase there was no project organizing. In the second phase a small project group and an executive group was established	An open dynamic network approach was applied in the project organizing. The project organisation consisted of an executive group and a small project group that was free to seek for knowledge in the organisation
System approach	A systems approach was not taken either upstream the project or during the implementation	A systems approach was taken during the implementation in the seeking for new solutions in various process units coming up as a dynamic process
The definition of responsibility and of tasks to be carried out in the executive group and the project group	The roles of the executive and the project were defined in the ISO 9001 quality assurance procedure. The executive group strongly influenced the direction of the project	The executive group was actively following up the progress, but was not involved in the creative problem solving- process
Goal formulation	In the first phase a project goal was not defined. The goal which was formulated in phase two was unclear and unrealistic to achieve	A clear, broad and demanding project goal was formulated.
The existence of a creative phase	There was no creative phase in this project	There was a dynamic alternation between the creative and systematic phases through the whole project
Management commitment	The management was weakly commitment in the both project phases.	There was a strong management commitment both upstream the project and during the implementation of it.
Participation of practitioners	Practitioners did not participate in the project	The practitioners were actively involved in the problem-solving work during the whole project
Collective learning	A collective learning process was not created in phase two. In phase two a more integrated approach was taken.	A collective learning process took place
Creation of sufficient diversity in the project	There was not a sufficient diversity in the project organisation	A sufficient diversity was unconsciously created within the framework of the open and dynamic network
Creation of a common language	A common language was not created.	A common language was created in the communication between the

		project management and the practitioners
Applying of motivation factors in the project	Neither intrinsic or extrinsic motivation factors were applied in the project	A strong intrinsic motivation was created through the management commitment and the presentation of a broad and demanding goal.
Communication	There was a closed vertically communication , but open across functional boundaries at lower levels of the organisation.	There was an open communication throughout the project
Applying of a high quality product development model	A product development model was not applied	A written product development method was not applied. Would not have been suitable in this project due to the experimental design of the project work.
The existence of power structures	Powerful actors were involved that negatively influenced the project	Due to a strong commitment of the managing director, there was little room for working against the project.
Project results	The project group failed to meet the project goal of introducing a new paper product quality.	The project successfully met the project goal, but failed to implement the results in a durable environmental protection system.
Project evaluation	No project evaluation took place	No project evaluation took place

Table 21: A comparison of two innovation projects

The way of organizing and managing project no five as an open and dynamic network, a strong management commitment, an actively involved executive group, a broad and demanding project goal and the participation of the practitioners as the key success factors, and are clearly in line with my innovation model.. Obviously, the way of organizing and managing project number one does not create a valuable path to follow.

8.5 Lessons learnt regarding a better Way of Implementing technological Innovation Projects at the present organizational Climate and Culture at the Enterprise in Moss

Based on my innovation model I present some elements, which in my opinion can be important to utilize, in order to increase the success rate at the implementation of an innovation project at the present organizational climate and culture.

8.5.1 Including a Creative Phase in all Innovation Projects

There is a trend at the enterprise in Moss of jumping directly into the main project without making a proper upstream work in a creative phase. In my opinion this may lead to several

negative consequences. A project may for instance be initiated which should not have been started at all, or irrelevant problems are chosen to be solved.

I suggest that a creative phase should be included in future innovation projects at the enterprise in Moss. These should be organized as open and dynamic networks and overall control of progress at agreed milestones. The emphasis should be put on:

- *The creation of a market for product ideas that can potentially result in a successful business to the enterprise.*
 - Several functional groups are working to coordinate their efforts within different areas, such as marketing, product development, purchasing and IT. All groups have, from different approaches, a common interest in our customers. I would give priority to the creation of an arena for a better communication across the functional lines to increase the amount of new product ideas created.
 - The enterprise should to a larger degree, both internally and externally, view itself as a customer-satisfying process and not a good-producing process. The management should in innovation projects open up for a direct customer contact at different levels of the organisation. This would probably improve the understanding as to what the requirements in the market are regarding to new products, and probably result in an increase of the creation of new product ideas.
- *Checking out through an systems approach if it is right to initiate a certain innovation project*
 - I would make proper system calculations to evaluate if an innovation project would result in a good business to the enterprise in Moss. Simplified process models could be applied, involving calculations of the required resources for the carrying out of both the creative and the systematic project phases.

- The proper systems boundaries would be calculated to avoid that the project neither is made unnecessary large nor too small and thus potentially would include process noise.
- Clarifications of the knowledge base and a creative environment at the enterprise as to what is required in order to go in for an actual project have to be done upstream an innovation project
- Calculations as to what is required regarding new technology to implement the innovation project have to be done. The necessary new technology may involve too costly investments to make the project realistic to carry out.

8.5.2 The Systematic Phase of an Innovation Project

- Implementation of future innovation projects would take place in a close cooperation with selected customers, in order to increase the closeness to the market and to share the risks involved in the product development
- The responsibilities of the executive group and the project group would be proper clarified to avoid misunderstandings and project delays. Representatives of the management would be included in the executive group of an innovation project to make the necessary overall decisions .
- A strong management commitment would be a necessary condition to initiate an innovation project. When the management goes in for a project it must do it all the way through the project implementation. It would be a management responsibility to secure that sufficient resources are available to carry out the whole project.
- For innovation projects of a long duration, the financing would normally include the whole project period, and not be tied up to yearly budgets.
- A realistic project plan would be established. The spesification would seek to involve a joint optimisation of the technical and social sub-systems, and be done according to

the principles of an minimum critical specification. The goal structure would be split into two. The overall goal would be made clear and demanding, while short-term sub-goals would be created to give the direction of the project.

- The project should always involve more than one actor. Belbin (1993) analysis would be applied to characterize the different roles of the project group, and if possible to make the sufficient diversity.
- Practitioners would be full time involved in the problem-solving during chosen parts of the project without the presence of their superiors.
- A proper project evaluation would be performed after the completion of the project.

In my opinion it may be difficult at the present organizational climate and culture to organize and manage the project groups as suggested in my innovation model

9.0 Further Research

My focus has been on how to increase the effectiveness of future innovation, based on analysis of projects that were accomplished from five to fifteen years ago, in order to improve the success rate regarding to goal achievement

I have through the analysis of the projects documented the need for a joint optimisation of the technical and social sub systems in technical innovation projects. I have, however, not gone into any details on how actors with knowledge within human resources management should be involved in innovation projects for achieving this. It would be interesting to follow the process of different ways of involving actors from human resources management functions and to study what effects this would have on the efficiency of the projects and on the achieved project results.

I have in my innovation model focused on the need for the creation of a market place upstream an innovation project for sharing and coordinating market knowledge to select ideas to potential innovations. It would be important to study in more detail how this could be done in practice. What effect would the application of an knowledge base have on the knowledge creation process, and eventually what type of knowledge base would be most appropriate?

The need for a proper idea handling system in the organisation is highlighted. I have not gone into any detail about the design of such a system. It would be important to try out different design approaches and evaluate the effects on the idea generation process.

The need to organise an innovation project for implementation of the project results in the own organisation and in the market seems to be obvious through the analysis of the projects, represents one of the most demanding management tasks in an innovation project. I have presented a model utilised by one of the divisions within the Peterson Group. In my opinion it would be important to study different approaches of organising and managing the implementation phase of project results.

I have focused on the importance of applying the principle of minimum critical spesification to open up for a more freely design of the technological content and learning. It would be

interesting to design a set of design parameters that would in most cases be sufficient to design in innovation projects.

Another area in which important research could be done is in the development of a model including the three integrated processes: creation of sufficient diversity, making actions predictable and stabilisation of technology that is valid in both the creative and systematic phases of an innovation project.

It seems to be difficult to involve practitioners in a proper way and get the proper feedback at an early stage. It would be important to study what the reasons to this might be and what kind of actions which could be taken.

10. APPENDIX

DESCRIPTION OF FIVE PROJECTS

PROJECT NO 1

10.0 Case Description

10.1 Project no 1

10.1.1 Introduction

A new product quality should be developed. The product was a commodity one, but new to the enterprise in Moss. There were strong requirements of a high and even quality of this product, which was fairly highly priced in the market.

The project started in the middle of the 1980s, and was run in two phases. It was terminated after a project duration of 7 years.

During the fairly long period of product development, a change of central actors at the enterprise in Moss took place:

- Managing director
- Technical director
- Financial director
- Mill manager
- Customer service manager
- Laboratory manager
- Manager customer service

A position as manager of the product development was established at the start of the second phase of development.

During the period of development, two strategies were created, concurrently with the two project phases.

The period of product development was long enough to cover the total market cycle, that means total price cycles for the new product quality and the required fibre raw material.

10.1.2 Empirical Material

There were 25 central actors participating in the project. Out of these 20 actors were interviewed. The involved human actors are shown in table 22 according to their function.

Project no 1	
Project phase no 1	Project phase no 2
Managing director at the enterprise in Moss	Managing director at the enterprise in Moss
Director of technical development at the Parent company	Mill manager at the enterprise in Moss
Technical director at the enterprise in Moss	Technical director at the enterprise in Moss
Marketing director at the enterprise in Moss	Marketing director at the enterprise in Moss
Financial director at the enterprise in Moss	Financial director at the enterprise in Moss
Laboratory manager at the enterprise in Moss	Director of technical development at the parent company
Laboratory engineer at the enterprise in Moss	Manager of development at the enterprise in Moss
Production engineer at the enterprise in Moss	Quality manager at the enterprise in Moss
Laboratory engineer from an associate company of the enterprise in Moss	Maintenance manager at the enterprise in Moss
Department manager at a chemical supplier	Department maintenance manger at the enterprise in Moss
	Sales manager at the enterprise in Moss
	Project engineer at the enterprise in Moss
	Customer service manager at the enterprise in Moss
	Laboratory engineer from an associated company of the enterprise in Moss
	Dep. Manager at a chemical supplier

Table 22: Actors involved in project no one according to their positions

The paper machine with its system components is defined as an actor, because of the important role the design and operation of it played in the development of the new product quality.

10.1.3 The strategic Background of the Product Development

The strategic aim behind the rebuilding of one of the paper machines mid 1980s at the enterprise in Moss were to reduce the dependency upon a sinking sack paper market. The chosen plan of action was to increase the production capacity of the existing paper qualities, reduce the energy consumption, and to start production of the new paper quality. Thus, one of the main purposes behind the planned rebuilding of one of the paper machines was to make it suitable to produce the new paper quality. All central actors stood behind the decision of rebuilding the actual paper machine. There seemed to be no other alternatives. The machine was built early in the 1950s. Some of the equipment was beginning to be out-of-date. There were from time to time a problem of keeping a stable quality of the products produced on the machine.

The administration and the marketing and sales departments shared the above plans of a stronger focus on the new product quality. Market surveys had shown that the market for this quality was in strong growth, and stronger than for the other liner qualities, which were produced at the enterprise in Moss. Further, the prices of the new product quality seemed to follow a growing trend, and were more stable than for other liner products produced in the mill.

The market quality level of the new product , regarding brightness and appearance, were known by the enterprise in Moss at the time when the rebuilding of the paper machine took place. However, it does not seem that production of the new product quality was any big issue at the technical department when the machine specifications were fixed. The main issue was to increase the capacity of the paper machine, to reduce the energy consumption, and to improve the product qualities of the existing products. The paper machine design was optimised to match this goal.

The chosen amount of bleached pulp on the top wire of the paper machine was fairly low. It was chosen by the technical department for economical and not marketing reasons. It was believed that application of more bleached pulp would reduce the profitability of the pulp mill, due to a reduced demand for pulp from the pulp digester.

The strategic thinking was considered to be a top management task that was not communicated to the organisation. Thus the employees had very little influence on the planning of rebuilding the paper machine. The organisation did not know about the plans to produce the new quality on the machine.

Based on the chosen design figures the paper machine supplier made tests on the pilot scale. He concluded that it ought to be possible to produce the new quality on the rebuilt paper machine with a certain degree of quality. Guarantee trials were planned, with a quality at least as good as samples handed over to the enterprise in Moss from the machine supplier. These were never implemented. This quality level was never checked out in the market. No competitive analysis was done. The enterprise in Moss trusted to a high degree the machine supplier with his broad technological knowledge.

With the low design value of bleached pulp on the top wire of the paper machine, it was in reality not designed to produce the new quality.

The strategic document was made shortly after the rebuilding of the paper machine. It seems that no reservations were made by the technical department during the preparation of the strategic document, that it might be difficult to reach a market quality with the chosen design parameters on the machine, apart from some small necessary technical investments that had to be made. With the background in the contract with the machine supplier that had designed the paper machine for production of the new quality, the management did not demand any examinations at an early stage as to what was required to develop the higher quality liner product at the enterprise in Moss. It was not strange that the administration believed that it was a pure production task to prepare for the production of the new product. No development work seemed to be necessary, and sufficient knowledge was considered to be available in the organisation. Production plans for the new product were included in the strategic document.

The strategic plans were kept secret with the top management, and were not communicated to the organisation. These thoughts did not represent a complete strategic plan, including a proper strategic analysis. It seems that the enterprise in Moss did not possess proper written strategic guidelines at that time.

10.1.4 Phase one of the Project

The preparations for producing the new product quality started one year after the rebuilding of the paper machine was completed. According to the plans, the enterprise in Moss should be a stable supplier of the new product quality one and a half year later.

10.1.4.1 Organisation of the Work

The work was not organised as a project, but rather as a part of the operating work with the technical department, with little engagement from the administration and the marketing department. This way of organising the work was due to the view that the introduction of the new product quality would only be a production task with no need for development. An executive group and a project group together with a plan of the work to be done were missing. The technical department possessed all knowledge, which was included in the work.

10.1.4.2 Optimism in the Organisation

It seems that most of the actors at the start thought that this would be easy, and that it was unlikely to foresee any technical problems. According to the technical department some extra investments of approx. NOK 20 m, as mentioned at an earlier stage in the strategic document, were necessary to produce the new quality at the enterprise in Moss. The success of the project was only a matter of making these investments. It seems that the vertical communication at that time was poor, and mostly written. The employees were in most cases involved after central decisions had been taken by the management.

A profitability analysis for the new product quality was carried out one year after the preparations for producing the new product had been started up. The results of the analysis showed positive figures for production of this product. The analysis was, however, based on single chosen figures for the different cost parameters and product prices. Long-term simulations under varying conditions were not done, taking into account variations in costs and product prices over some life cycles. In the pulp and paper branch the product prices variations follow the shape of a sinusoidal function with periods of a few years. Thus, the profitability analysis done

was of limited value.

10.1.4.3 Introduction of the new Product Quality in the Market

One year after the preparations for producing the new product quality had commenced, the sales office started to preparing the sales budget for it. A few thousand tons of the new product were included in the plans. This was very early compared how short the technical preparations had come. The full - scale technical trials were planned to start half a year later.

However, the marketing department asked the technical department in writing if the quality would be alright compared to the best in the market, and if the time schedule would be kept. The technical department gave a positive answer to both questions, but with the following comments:

“The note from the sales department regarding introduction of the new product quality is a good guide for the start-up. However, many unexpected events may take place and disturb such an up-start. For this reason the sales department should aim at a flexible introduction, rather than cementing tonnage and dates”.

It seems that this was the first attempt from the technical department to translate its interests, trying to make the marketing department understand that technical problems could appear. This attempt from the technical side was not clearly understood by the marketing department, and also not when the same message was given by the technical department several times at later stages in the work of introducing the new product quality in the market. It seems that this could be due to poor communication between the two departments, that they were not talking the same language, representing different cultures, and that there were some tensions between actors in the technical and marketing departments.

10.1.4.4 Preliminary Study

Some months after the contact between the marketing and technical departments regarding production plans for the new product, the technical department took the initiative to make the first preliminary study since the up-start of the introduction work, but was limited to include

only technical items. It seems that this work should have been done upstream the paper machine rebuilding. The following technical items should be clarified within a short time:

- The quality level of the new product , produced by other suppliers
- The quality demands from the customers
- Results of testing paper from competitors
- Which pulp quality to be applied in the paper machine during technical trials at the enterprise in Moss
- Which process conditions to be applied during the technical trials at the enterprise in Moss

Visits to Scandinavian suppliers of the new product quality to discuss technical parameters on the new product quality. Technical trials were carried out at NTH in Trondheim

As a result of the preliminary study a detailed specification was established for the first full scale technical trial on the rebuilt paper machine. The administration or the marketing department were not much involved in the preliminary study described above.

10.1.4.5 Full Scale Technical Trials

Four technical trials were planned to be carried out on the rebuilt paper machine. The first trial should start approx. two years after up-start of the work to introduce the new product quality.

A chemical supplier was involved in one of the technical trials. The company got very little information about the technical trials that should be done at the enterprise in Moss. It seemed just like an ordinary technical trial at a pulp & paper company. The enterprise in Moss did not seem to be interested in applying the know-how and experience of the chemical supplier.

A associated company of the enterprise in Moss was involved to do printing tests, taking the role as a demanding customers. The product quality achieved at the enterprise in Moss was all the time compared with the best qualities in the market. The associated company did not take

part in any positive dialogue with the aim of sharing knowledge on how to make progress in Moss.

After the first technical trial, which was unsuccessful, the trend was clear. It was a need for more bleached pulp on the top wire of the paper machine than the design value of 60 g/m². This situation got worse as gram weights of paper decreased. In these situations there were small amounts of fibre on the bottom wire and large amounts on the top wire.

The four technical trials were accomplished as planned. All of them were unsuccessful. The main technical conclusions were:

- More bleached pulp on the top wire of the paper machine was necessary to obtain the required brightness
- Filler material had to be applied to manage the required opacity
- Mottling could be seen on the top layer
- The speed of the paper machine had to be greatly reduced
- Printing trials were unsuccessful

The technical department was negative to the introduction of the new product quality from the time it realised what was required to produce the quality, and the department limited its efforts to producing the existing products on the rebuilt paper machine, and nothing more. The empirical material does not say from what time the technical department got this attitude and started to signal to the rest of the organisation that the paper machine was not designed to produce this quality. It seems that the problems came as a surprise to most of the involved actors. According to the empirical material some of the reasons could be:

- A preliminary study had not been performed upstream the rebuilding of the paper machine to examine what was required to produce the new quality
- The preparation for production of the new quality was done as a part of the operating work in the technical department, without enough resources to do R&D work
- The organisation did not possess enough competence about the product, the market and the required technology.

10.1.4.6 Seminar to introduce the new Quality

As a part of a large marketing campaign the new quality product was introduced to the most important customers of the company in a seminar in the southern part of Norway. Two of the large scale technical trials had then been fulfilled with poor results. In spite of this, the enterprise in Moss and the parent company stated in the seminar that the company would become a stable supplier of the new quality within half a year, with a quality acceptable to the customers.

The enterprise in Moss did not manage to produce a market quality of the new product on the rebuilt paper machine. The product did not come on the market as promised to the customers, which was very embarrassing to the enterprise in Moss.

In the seminar the technical department tried to enrol the customers in its vision that if everybody accepted a lower brightness of the top layer of the new product than the present requirements in the market, they would be happy. These statements were based on the existing capability of the rebuilt paper machine to produce the new product quality. It seems that the technical department did not succeed in persuading the customers to go for a lower quality than the market quality.

10.1.4.7 Termination of the first Phase of the Work of Introducing the new Product Quality in the Market

There was a change in the administration at the enterprise in Moss approximately half a year after the introduction seminar described above. According to the empirical material this suited the technical department well, because it then got someone to talk with that understood and shared the ideas of the technical department.

A meeting was arranged, in which only representatives from the technical department took part. A simplified profitability analysis was presented together with the contribution rate of the new product quality versus an existing quality. The calculations were done by the technical department and were based on chosen single values of cost factors and product

prices. The calculations showed that production of the existing product quality was most profitable at that moment of time.

Further, the administration doubted that the enterprise in Moss would have the capacity to produce a new quality product, as no large changes in the existing product mass balances were expected. The administration was not interested to reduce the production capacity of the existing products on the paper machine to the benefit of some thousand tons of the new product quality. These were new thoughts that were in sharp contrast to the intentions stated in the existing strategy document, established shortly after the rebuilding of the paper machine. The conclusions of the meeting were as stated by the administration:

“We are able to produce the new product quality. We have no plans to produce the new product quality in the nearest future”.

The work to introduce the new quality product in the market was in reality abandoned. The technical department had succeeded in terminating this work. According to the empirical material, the mechanisms behind are unclear. However, strong informal communication structures were achieved in the organisation at that time.

The final insurmountable obligatory passage point was introduced by the technical department shortly afterwards. A letter was forwarded to the administration. In this it was argued that extra investments on the paper machine of approx NOK 1.5 million had to be done in order to produce the new quality product. Further it was argued, due to delivering time, that the earliest time of production of the new product quality would be approximately two years later. Finally, the technical department argued that in spite of these investments, the enterprise in Moss could not expect to compete with the existing market qualities of the new product quality, due to the dark bottom layer of the product.

According to the empirical material are the arguments about the long delivery time, the earliest time of production approximately two years later and the inability to compete because of a dark bottom layer, all very questionable.

The official reason for stopping the activities of introducing the new quality product in the market the costs of purchased bleached pulp and low prices on the new product quality. However, the empirical material shows that another reason was technical motivated, that the rebuilt paper machine was not designed for producing a market quality of the new product, resulting in low productivity and high production costs.

10.1.4.8 A Pause in the Activities of Introducing the new Product Quality in the Market

The activities of introducing the new quality product in the market were shelved for two years, before they were started up again. According to the empirical material this seems to have taken place in a more or less accidental way. The second phase of the introduction activities can be characterised as an ad-hock project, motivated in low prices and a shrinking market for some of the existing products. It was, according to the empirical material, the marketing department that wanted the product. It seems that the management more or less just embraced any possible opportunity, based to some extent on short term thinking and not full order books.

Interview objects have argued that the customers outside the main markets Germany, England and Scandinavia were not given preference when the order books were full. When the order situation changed, the marketing department would search for customers in all markets.

10.1.4.9 Change of Strategy at the Enterprise in Moss

The work to make a complete strategy plan at the enterprise in Moss was started shortly after the change of administration in Moss. The reason was a need for long-term strategic goals and actions plans. The new strategy plan, which was a typical one, was kept secret to the organisation. It was thus not a live document rooted in the organisation.

The new strategy was in line with the ideas of the technical department, and represented a break with the former strategy. The new business idea was that the enterprise in Moss should be a main supplier of the company's existing products to the non-integrated corrugated paperboard mills in Europe.

The focus in the strategy was on increased production of liner, and of virgin pulp, and on termination of the production of another paper product. Development and production of the new quality product and similar qualities were not mentioned in the new strategy plan.

10.1.5 Phase two of the Activities to introduce the new Quality Product in the Market

10.1.5.1 Organising the Activities

In spite of the fact that the new product quality was not included in the existing strategy plan, the second phase of the activities to introduce the new quality product in the market were initiated two years after they had been stopped the first time.

The enterprise in Moss had, between the two phases of activities, created a product development function within the organisation, and employed a manager of development responsible for this function.

Product development procedures were established in line with the NS – EN ISO 9001 quality management and quality assurance standards.

A common permanent executive group was established for all product development activities, made up of members from the top management team at the enterprise in Moss and the director of technical development at the parent company. This created a better basis for a more reasonable organising of the innovation activities than was the case during the first phase.

The activities to introduce the new quality product in the market were organised as a project according to an integrated model of product, which was implemented in product development procedure at the enterprise in Moss. Members from the operating, the marketing and the development functions participated in the project group. The progress was evaluated in milestones, where knowledge from all involved actors was included. According to the empirical material, the cooperation in the project group functioned fairly well.

10.1.5.2 Preliminary Study

There was not executed any preliminary study at the start of the second phase of the innovation activities, to evaluate of a systems perspective:

- The realism in the project
- To check out what would be possible to achieve in the project with which kinds of resources
- To calculate the profitability of the project

According to the empirical material some of the reasons for the lack of a preliminary study could be that the enterprise in Moss, with its relatively small organisation, did not possess enough competence regarding the product, market and technology to successfully perform that kinds of discussions. Strong managers with the highest competence in certain fields could without much problems force their opinion through. There were at that time only a few persons with relevant competence in the organisation.

10.1.5.3 Goal Formulation

In an initial meeting in the executive group, the project goal was formulated. The desired paper properties to be achieved were decided. It was decided upon that the product should have good runability on the paper machine and result in a good profitability. These statements signalled an initial desire from the executive groups for a high quality product.

10.1.5.4 Resources to be applied in the Project

The executive group decided upon that the product should be ready for production one year after up-start of the second phase of the project, and implied that no heavy investments should be done on the paper machine. Further, the market survey should be short. It seems that this decision had its background in the previous experience from the first phase of the activities to introduce the product, where the management already thought that it was known which level of quality it was possible to achieve on the rebuilt paper machine.

10.1.5.5 Accomplishment of Market Survey

A comprehensive market survey was done by the sales office at the enterprise in Moss in cooperation with the sales offices in England and Germany. The conclusion of the survey was that the new product quality, with regard to appearance, had to be among the best in the market. Further, the new product quality ought to have an improved environmental image than similar qualities from the competitors. A specification was established that was a compromise between what the market wanted and what the project group meant was possible to achieve on the paper machine. This compromised specification was never checked out in the market.

10.1.5.6 Final Decisions on what the Quality Level of the new Product should be.

The compromised product specification was presented in the executive group, where it was rejected. It was decided that the enterprise in Moss should produce a Peterson quality of the new product. This quality should not compete with the best in the market. The product quality could be lower than the market quality. The executive group meant it was possible to sell a lower quality in the market to a lower price.

The marketing department doubted that this was possible to achieve, and that the market would accept to buy a lower quality if the product price was lower. A market survey to check out these conditions was never carried out.

The empirical material shows that the background for the decision to produce a Peterson quality, was violent discussions between the administration and the technical and marketing departments. It seemed to have been a large disagreement between these actor groups as to what the quality should be. The technical department managed to base on the organisation that it was talking about a Peterson quality and not a market quality, forcing its view through.

10.1.5.7 Cooperation with a Customer

The enterprise in Moss involved a customer in the project. During the project he was reasonable satisfied with the Peterson quality and executed printing trials on the new quality product in his mill. The customer recognised the potential to create a niche market for corrugated boxes.

Later, when the enterprise in Moss started to sell the new quality product, he changed his mind and wanted a market quality. The empirical data shows that this was not strange. At that time several suppliers changed to be total suppliers of liner. Therefore it would be easier for the corrugated box plants to predict about the future. Further, it was known that the box plants wanted at least two similar qualities to make the same product.

10.1.5.8 Normal Production of the new Product Quality

Due to a pressure from the market, the enterprise had to improve the quality of the new product up to a level close to the market quality shortly after up-start of normal production. The quality was never completely accepted in Great Britain. In Germany a considerable tonnage was lost due to a well known problem of trim of the rebuilt paper machine.

10.1.5.9 Necessary Organisational Consequences in the Paper Mill for running the new Quality Product

The new product made stronger requirements for a high and stable quality than any of the other products that were produced at the enterprise in Moss. The data material shows that they were not in control of many technical things as regards the operation of the paper machine. The project organisation had not realised that this product required an other way of running the machine and a higher competence of the operators. Instead they got frustrated and angry because they did not manage the quality, and wanted to stop the production. Every production run could be regarded as a full scale technical trial. It was difficult to keep a stable production as long as the operators had to run the paper machine at operating conditions outside the specifications for it.

10.1.5.10 Termination of the Project

After one year of normal production the discussions about termination of this project were initiated. The arguments applied by the technical department against further production were:

- Too small production volumes
- A long time to stabilise the production according to the specifications
- High percentage of breakage , delaminating of the paper, poor profiles and other quality variations

It was discussed if it was right to produce the product with such tough requirement in so small series as the enterprise in Moss did, and where the price on bleached pulp totally dominated the cost side of the product. This was a good excuse for terminating the project, when the costs of bleached pulp increased strongly, and the new product quality became unprofitable to produce any longer.

When the production of the new quality product was terminated, there was a broad agreement within the top management group to do that. It was also stated that when the production of this quality was stopped, this was forever.

PROJECT NO 2

10.2 Project no 2

10.2.1 Introduction

A process section in the pulp mill should be optimised in this project. The process control tools that should be developed existed in the market, but were new to the enterprise in Moss. The main background for initiating this project was the need to reduce the effluents of organic material at one of the associated companies of the enterprise in Moss.

The project started at the end of the 1980s, and was terminated after a project duration of three years. The project was partly financed by NTNf.

My story about this project involves both a description of activities that took place upstream the project and a description of the main project. The upstream activities are included due to their decisive signification for the final project result.

During the project there was a change of the project manager after a project duration of approx one year.

10.2.2 Empirical Material

In the project 14 central actors participated. Among these the manager director, the manager of development and two of the suppliers were not interviewed. The following table 23 shows the list of involved human actors according to their function.

Project no 2
Managing director at the enterprise in Moss
Director of technical development at the parent company
Technical director at the enterprise in Moss
Development manager at the enterprise in Moss
Manager of automation department at the enterprise in Moss
Maintenance engineer at the enterprise in Moss

Project no 2
Project engineer at the enterprise in Moss
Operating engineer at the enterprise in Moss
Process operator in the pulp mill at the enterprise in Moss
Department manager at NTNf
Department manager at an external private consulting company
Consultant from company outsourced from PFI
Supplier of a process control equipment
Supplier of an online process analyser

Table 23: Actors involved in project no two according to their positions

Among the technical artefacts involved as actors in the project were the continuous pulp digester and the actual process section in the pulp that should be optimised in this project.

10.2.3 Description of Activities upstream the main Project

A private consulting company was involved in an EU project called ESPRITE. The goal of this large project was to strengthen Europe's competitive forces against USA and Japan, and to motivate for an increased exchange of technology between the European countries. According to the empirical material it was important for Norway to participate in this project.

The financing of EU project within the EU system was done through fund toward involved actors. In Norway the Norwegian government had to give financial support to Norwegian actors that were involved in EU projects. In the actual case the private consulting company should be financially supported by NTNf, in order to enable the consulting company to participate in the EU project .

To make it politically possible for NTNf to support the private consulting company, it was necessary to involve a Norwegian process industry and to test the application, which was a part of the ESPRIT project, through this industry.

The empirical material diverges as to what further happened. It seems however, that the private consulting company contacted PFI and asked if the research institute knew about a demonstration project to test a new ESPRIT technology. PFI took contact with the technical department at the parent company of the enterprise in Moss that opened up for a demonstration project at the actual process plant in Moss, in which project no two took place.

It seems that an open discussion took place between NTNF and PFI about the contents of the project at the enterprise in Moss. PFI confirmed that the new ESPRIT could be tested. However, in order to do that, the research institution argued, was NTNF financing needed to do an optimisation project at the enterprise in Moss. Without this optimisation project, it was argued, the implementation of the ESPRIT technology would have no purpose.

NTNF accepted the above conditions. It was agreed that the enterprise in Moss should be financial supported to do its optimisation project through the research program called Automation in the Process Industry, (AIP). A condition for participating in this program, was that all technology should be Norwegian. The implementation of the ESPRIT technology did not fulfil this requirement. The project was split into two parts, one working with optimisation of the actual process plant, and the other concerned with the testing of the ESPRIT technology.

It seems that testing of the ESPRIT technology was NTNF's real goal for the project in Moss. The optimisation project was regarded to be a secondary and necessary project to accomplish the testing of the other technology.

It seems that the actual supplier of process control equipment was involved through the private consulting company due to its interest in selling new technology within the pulp and paper market on a global basis. Besides that, this technology was Norwegian, and thus fitted into the AIP program.

The supplier of the online process analyser was involved with the parent company of the enterprise in Moss. The supplier was Swedish, but had a Norwegian agent. There was no other alternatives in the market to this technology.

It seems that the upstream activities described above, were known by very few actors at the enterprise in Moss. The enterprise was not involved in the choice of the external actors, but the decisions were made above the heads of most of the members in the organisation in Moss.

10.2.4 The Actor Network upstream the main Project

As described above, PFI took a strong position during the negotiations about testing of the ESPRIT technology and the creation of an optimisation project at the enterprise in Moss. It seems that PFI took the position as an obligatory passage point during the activities upstream the project. This is illustrated in the following figure.

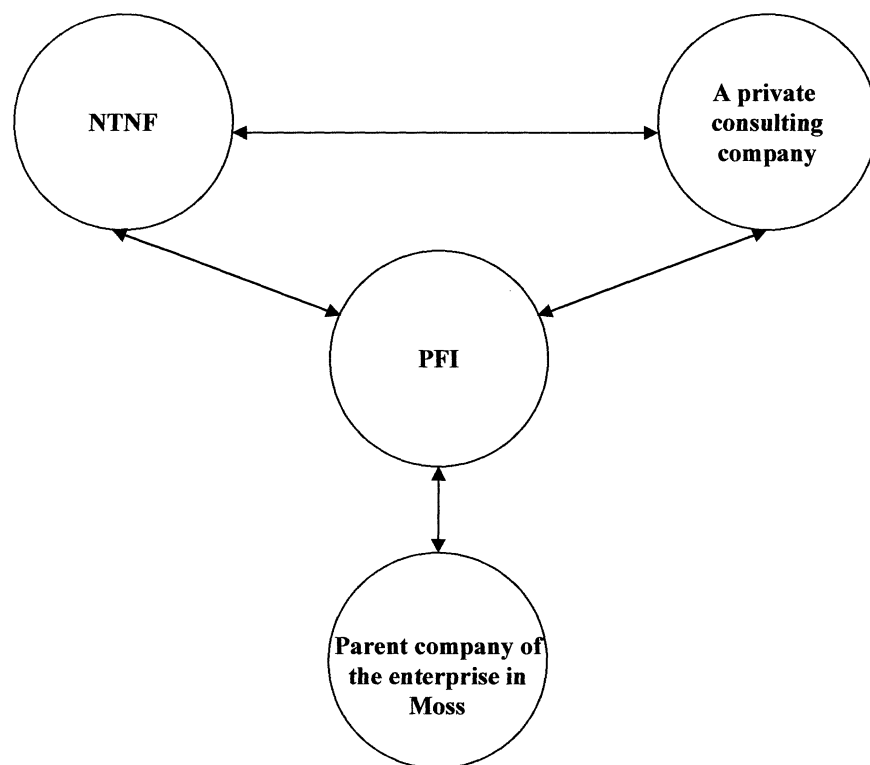


Figure 61: The actor network upstream the project

The figure above shows that PFI was controlling the communication, due to its key role in establishing the two projects described above.

According to the empirical material, the external suppliers were not very interested in whether the optimisation project should be a success or. They were looking after their own strategic interests as gaining competitive advantage in the market through successful implementation of their equipment.

10.2.5 The strategic Background for the Project

The strategic document covering the project period of this project included the export of pulp treated in the process unit that should be optimised to a associated company of the enterprise in Moss. However, the same yearly tonnage was included for the whole strategic period. It was stated in the strategic document that this had to be co-ordinated with the associated company. It seems that this never took place. Consequently no strategic guidelines seem to have been made regarding the business between the two companies. The strategic plans of both the enterprise in Moss and its associated company were in principle kept secret to the organisations.

The background for the production of a special treated pulp to the associated company of the enterprise in Moss goes back to the middle of the 1970s, when the parent company bought the associated company. The takeover was seen in connection with delivery of pulp from Moss. In the middle of the 1980s new equipment was installed in the pulp at the enterprise in Moss, enabling the production of pulp with a low content of lignin.

According to the empirical material both the enterprise in Moss and its associated company earned good money on this business until 1990, when the Russian market for paper from the associated company collapsed. Approx 90 percent of the production was delivered to Russia.

10.2.6 The Anchoring of the Project

This project was not deeply rooted at the management level of the enterprise in Moss. It seems that the company was negative to the project due to different reasons:

- After the collapse of the Russian market there was a strong belief in Moss that the enterprise was losing money on its business selling special treated pulp to its associated company.
- Tough discussions about the prices on the pulp of the enterprise in Moss contributed to a poor atmosphere between the two companies
- It was a belief in Moss that a strong reduction in the lignin content of the pulp to the associated company of the enterprise in Moss, which was one of the goals of the project, would hinder an increase in the pulp yield from the continuous digester, and would thus negatively influence the total profitability at the mill.
- This project was regarded at the enterprise in Moss as “a group project”.
- The enterprise in Moss and its associated company were at that time mostly concerned with optimising of their own businesses, and not so much of utilising synergetic effects between them.

10.2.7 Running of the Main Project

10.2.7.1 The Title and Goal of the Project

After closure of the controversies during the upstream activities, the title of the project and the project goal were decided. The project should be coordinated with the activities within the testing of the new ESPRIT technology.

10.2.7.2 The Project Size

The project was planned to include the following activities as shown in the following table

Optimisation Project	Testing of ESPRIT technology
Installation of a new process control system	Design and test of an application of an ESPRIT technology
Installation of an online process analyser	

Development of model- based optimisation tools	
Implementation of optimisation tools on the new process control system	

Table 24: The activities involved in project no two

At the start of the project it was not decided that the optimised control system from an outsourced company from PFI, if successful, should be implemented as a part of the operating control system in the pulp mill. Resources needed for implementation were not, however, included in the project budget upstream the project.

It seems that the development of optimisation tools by the company outsourced from PFI was a result of a deal between PFI and NTNF, and not based on any initiative from the enterprise in Moss.

10.2.7.3 Project Organising

The project organisation at project start is shown in the figure below.

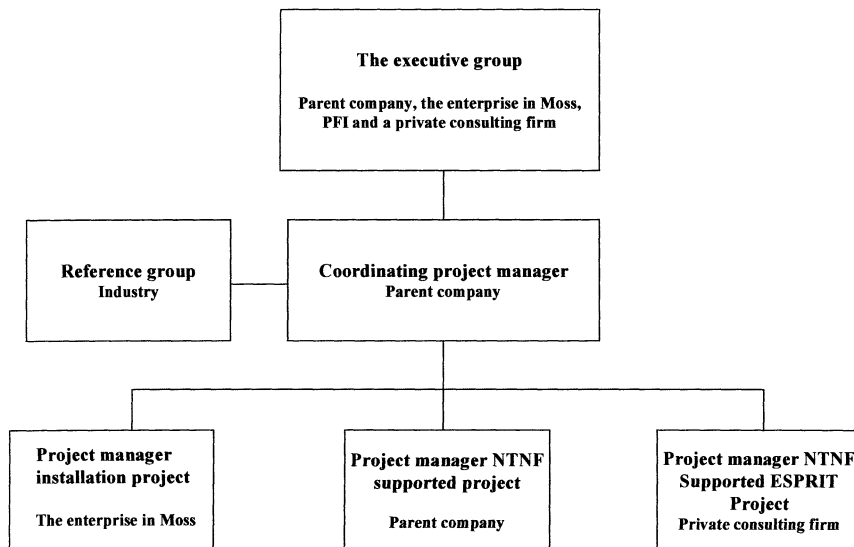


Figure 62: The project organisation of project no two

The figure above shows the formal project organisation. A executive group should take the position as an overall management of the project, controlling the progress of the project at predefined milestones.

The executive group should consist of representatives from the main actor groups: The parent company, the enterprise in Moss, PFI and the private consultant that was working with the ESPRIT technology.

However, a very important actor group was not invited to participate in the executive group, and that was the administration at the enterprise in Moss. It was the administration in Moss that signed the contract with NTNf and was thus formally project responsible towards the authorities. The management, as the project owner, was not given any role in the executive group, to make it possible to influence the project. According to the data material, the explanation of this may be found in the way the project was planned and initiated, as a result of the upstream activities described above.

It was the coordinating project manager from the parent company who presented the project idea to the enterprise in Moss. He had a professional interest in the development of the new technology, and took the leading role in the creation of a project organisation and in writing the project application to NTNf about financing.

During the project duration of three years the data material indicates that there was no meeting in the executive group, and that could be due to disagreements between central actors that should have been involved in the group.

The data material further shows that the two levels of project managers could result in unclear situations as to responsibility, and this was not the best solution.

As described earlier, the project was not well anchored at the management level of the enterprise in Moss, and it was felt that this was "a group project". The coordinating project manager from the parent company had little influence in coordinating the resources of the different projects groups. The most important roles he had were to be a resource person in the project group for developing the model- based control system, due to his high competence in

the field. There was not much communication between this group and the management at the enterprise in Moss. The coordinating project manager had taken the position as an obligatory passage point for the project group that was working with models. He created more or less the image of reality that the project group had regarding the project.

In this project the R&D part was integrated with an installation project belonging to the operating department. The trials and errors during the R&D work part were done more or less on-line on the equipment, which the operators were aiming in keeping the bleaching process in control. This created frustrating situations among the operators when the equipment did not work. However, no arena was made to discuss about other possibilities of running the project. These kinds of decisions were taken up-stream the main project without the involvement of the enterprise in Moss.

The figure above shows that the NTNF supported the PFI project and the ESPRIT project as an integrated whole. In reality they were running as separate projects with a low degree of communication and cooperation. The original idea of the private consulting company to make a process application was based on making correct estimations of various process conditions, which could not be measured directly, for instance the degree of delignification. This activity was included in the early project planning before the up-start of the optimising project at the enterprise in Moss.

According to the empirical material, it seems that the enterprise in Moss was not very interested in this project, it felt that it was asked by NTNF to involve the private consulting company in its project. Further, experts from the supplier of process control equipment did not believe very much in the Artificial Intelligence approach of this consulting company. No Peterson application of the actual technology was made by the consulting company. It seems that this was partly due to lack of human and financial resources. The private consulting company left the project at an early stage.

In a historical perspective it could be discussed if the controversies described above should have been solved at a much earlier stage, to clarify that the private consulting company either should not be involved at all or should rather have participated with its knowledge in another

way in the project. On the other hand if these discussions had been taken, it is not certain that the optimising project at the enterprise in Moss had been started at all.

Below follows a description of the different project tasks implemented in Moss.

10.2.8 The Installation Project

10.2.8.1 Installation of a new Process Control System

The first part of the project was to move the process control from a panel-mounted system to a computer - based process - control system from the supplier. These installations were finished within one year.

To the supplier of process control equipment this was a commercial project. The company got a certain amount of money to be involved in the project. The supplier wanted to install more or less the established technology. The main interest of the supplier was to achieve new technological knowledge about bleaching processes and how to control these kinds of processes, in order to improve its position globally within this area.

The change to the new process control system did not initially make it easier for the operators to control the process. The empirical material shows for instance that the number of operations to move a valve could be much higher than with the old control panel. During the installation of the control system, an open controversy broke out.

A SUN working station to do the configuration work in a remote location was not purchased or borrowed in the project, which is normally done in installation projects like this. Instead the configuration work had to be done in the control room, close to the operators running the process, sometimes making a hopeless situation for both for operators and engineers. Because of this, it seems that many actors got the wrong picture that the system was difficult to work with. Further it turned out that the project leader from the supplier had limited process knowledge about the actual processes. According to the empirical material it seems that many arising problems, especially during up-start of the system, could have been solved more easily if the supplier had possessed this kind of knowledge.

The operators got involved in the design of screen displays of the first version of control system from the supplier of process- control equipment.. However, they were not involved, when the final up-dated version was installed with quite different functions than the operators were used to operate. What characterised the up-dated version, was a large number of redundant functions, slowing down the computer speed and contributing to a more negative attitude against the system.

After some time actors within the supplier of process- control equipment organisation were moved to other more profitable projects and replaced with others, resulting in reduced progress in the project and tensions in the co-operation between the supplier and the enterprise in Moss. It seems that this project was not properly rooted in the supplier's organisation.

According to the empirical material, the maintenance department felt that the supplier's technology was more or less forced upon the organisation, and was struck by the "Not invented here" syndrome. There was no feeling of ownership, because others had chosen the system up-stream the project. Consequently the motivation within the automation department was low as to keeping it in operating condition. After some time, the maintenance of the system was connected to one single actor in the automation department. It was considered to be his equipment, and he was the only man to be contacted if anything went wrong with the equipment.

10.2.8.2 Installation of an online Process Analyser

The process analyser to be installed was a technological prototype. It was not fully developed when the enterprise in Moss got it. However, the supplier followed up in a good way, wanting the instrument to become a good commercial product as fast as possible. At the enterprise in Moss the instrument was planned to be an important part of the new model- based control system, which should be developed later in the project. It required a close follow-up, with cleaning and calibration nearly every day. This was a job the maintenance department was not willing to spend the necessary time and resources on, partly due the fairly low interest in the project at the technical department. The installation thus became extraordinary expensive, due to too little experience in the project group of handling the arising problems. The

responsibility for the online analyser was given to one person, who got his name connected to it.

The empirical material indicates that problems with the online analyser contributed to a gradually less motivation for working with the system, including the new control - system, which was developed later in the project.

10.2.8.3 Developing an optimal, Model- based Control System.

An optimal, model based-control system was developed of the outsourced company from PFI. The system was developed around an existing Odin Monitoring diagnosis system on a PDP-11 MicroVAX computer. This control system was closely linked to the process - control system, receiving signals from the online process analyser through the process- control system , delivering process control set points back to the process- control system system.

According to the empirical material, the co-operation between the company outsourced from PFI and the enterprise in Moss functioned well during most of the R&D work. The operators were involved in the design of a new trend system. They communicated well in problem-solving discussions with the external company, that was periodically staying very much in the control room at the pulp mill.

However, when anything went wrong with the control system, there was no knowledge at the enterprise in Moss to do anything but starting/stopping the computer. The enterprise was extremely dependent on the external competence from the company outsourced from PFI, because of lack of proper technological transfer from the company. The empirical material shows that this may be due to too small amounts of resources put into the project by the enterprise in Moss, together with a weak understanding of the importance of creating conditions for learning in projects.

10.2.8.4 The Situation after Configuration and Up-start

Very little work was done on the system after configuration and up-start. People got the system on some distance, and it was gradually more and more difficult to fix something when break-downs took place. When the project was finished, the resources working on it were taken away. The interest in the system was not kept alive.

At the project start there were no plans to implement the model-based control system. It was originally a pure R&D project, financed by NTNF. Consequently, human and financial resources needed to implement, up-date and follow-up the system were not included in the budget at project up-start. Neither was there any finance given at the end of the project to implement the system.

There was a resistance against the systems, coming from outside trying to control the process, where only a few persons at the enterprise in Moss had knowledge about them, and where external help was necessary to make any changes.

The enterprise in Moss got three unknown and very different systems to learn and get knowledge from, which were not integrated into one system with a single window towards the operators. This was a problem, especially for the maintenance department with scarce resources, and when problems arose in the control room, involving these technical systems.

Part of the organisation argued that wrong technology was chosen, partly because the technology had been forced upon central actors without their involvement.

10.2.9 User Involvement in the Project

According to the empirical material, there was not much resistance against the project from the operators. The general attitude among them was that they would make the best out of the system, as they after some time saw clear advantages with it.

A representative from the user group was, in co-operation with the labour union, selected to participate both in the installation phase and the R&D phase of the project.

Some of the actors that were interviewed focused on aspects, which are important in a learning and implementation context related to communication, when operators were involved in the project:

1. When the process control was moved from the panel-mounted system to the computer-based process-control system, a lot of frustration was experienced among the operators. The subject and premises of communication were chosen by the supplier.
2. To be an adequate member of a project group, the actor needed to be in close communication within the project group and with the operators he/she was representing, in order to communicate back to the project group the operators' arguments about the functionality of the equipment. It seems that an unsatisfactory communication in both directions was a problem when operators were involved in the project. This was reported to be a common problem.
3. The operator representative did not manage to mobilise the large interest of his colleagues in the new technology, before it was ready to use, and was instead more or less rejected.
4. A common language of communication was not created in the project, sometimes resulting in the operative representative having problems in fully understanding the contents in all technical discussions.

10.2.10 Results obtained in the Project

The project managed to show that it was possible to produce bleached pulp with a lignin content corresponding to the project goal. However, it was only in shorter periods possible to run the system in a closed loop mode, with important control parameters calculated by the new model-based control system. According to the empirical material it seems that this was due to many factors. Among them were technical problems with the online process analyser itself and large quality variations in the pulp from the digester to the bleaching process, resulting in kappa numbers which were outside the area of calibration of the process analyser.

It seems that the variations in the pulp quality from the digester, upstream the oxygen bleaching process should have been reduced first, taken a system approach, if the model-based control system developed in this project should have been a success.

In a large part of the time the operators had to run the process in a manual mode, as they did before the project started, resulting in larger quality variations of the bleached pulp, but without any serious reductions in productivity. However, the data material shows that the operators had gained a lot of knowledge through participation in the project, enabling them to run the process in a better way.

10.2.11 Final Comments

The enterprise in Moss had at that time strong requirements for high productivity. According to the empirical material it was wrong to install prototype process technology at the company.

No project evaluation for learning purposes was done.

Project no 3

10.3 Project no 3

10.3.1 Introduction

An associated company of the enterprise in Moss was in the early 1990s a producer of a special quality paper for wrapping materials containing fat and for baking purposes. The production included both bleached and unbleached paper qualities, where special treated pulp from the enterprise in Moss was applied as fibre raw material. The production resulted in a certain waste emissions of organic halogen (AOX), chemical oxygen demand (COD) and suspended solids (SUSP). Limits of waste emissions into water of the above waste categories were drawn up by the environmental authorities in Norway.

The most important challenge was to find solutions to reduce outlet of AOX. The authorities had permitted a maximum emission of AOX/ton pulp after 1. January 1992. Implementing a new process in 1990 solved this. A condition for succeeding in this process seemed to be supply of pulp from the enterprise in Moss with a low lignin content. The involved actors in this project were the associated company of the enterprise in Moss and suppliers of oxygen and hydrogen peroxide. The main actors and the interests in participating are shown in the figure below.

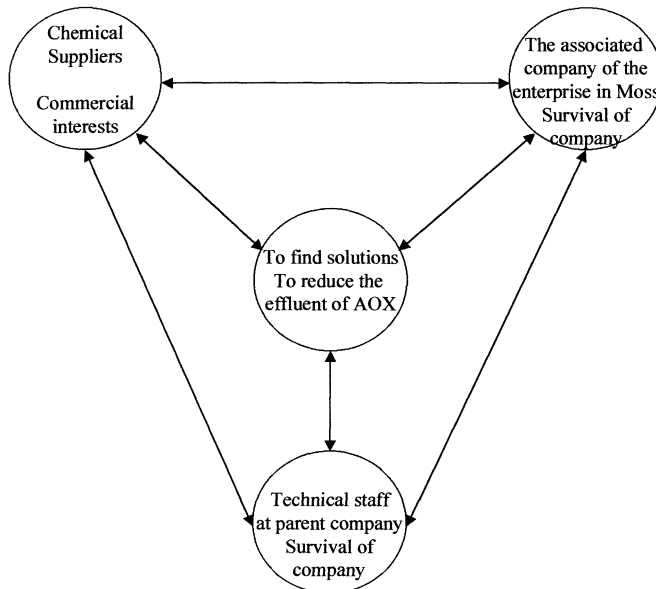


Figure 63: The main actors involved in the problem-solving upstream project no three

At that time the associated company of the enterprise in Moss did not have any other formal demands from the authorities for further reduction in the waste emission with a time schedule to keep within certain limits. There was more a trend to reduce the use of chlorine in the bleaching process. It was however, quite clear that the demands would become more severe. Discussions had been started up in Paris to achieve a common agreement between European countries on emission limits.

A NTNF- financed research project was started up early in 1992, with a project period of three years. Until then the improvement activities in the bleaching process had been run as an internal project.

10.3.2 The Roots of the Project

Heavy discussions were going on between the management at the associated company of the enterprise in Moss about the prices of the special treated pulp from the pulp mill in Moss. There were different opinions at the enterprise in Moss about the profitability of the bleaching. The price discussions resulted in a very poor climate of cooperation between the two companies.

According to the empirical material the technical department in Moss argued that the special treated pulp to its Associated company to a low lignin content hindered the further development at the enterprise. Instances like the upward limits of kappa number of own pulp and the priority given to the associated company above compared to pulp to their own paper machines were mentioned in interviews.

The basis at the start of the project was a capacity of a bleaching process to be implemented of 35-40.000 tons/year of pulp, 20.000 tons for use at the associated company of the enterprise in Moss and 20.000 tons of bleached pulp to be used in Moss. However, the enterprise in Moss had never guaranteed for more than 20.000 tons/year of pulp to its associated company. This turned out to be a key when profitability calculations were made.

The management at the enterprise in Moss looked at the bleaching project as a project rooted in its associated company. They did not see that this project would create any added value to

the company and was consequently not interested in either covering any expenses in the project or in installing a new process plant.

10.3.3 The empirical Material

The basis for this analysis has been the empirical material from the available documentation, together with the knowledge achieved from several in- depth interviews. Fourteen central actors participated in the project. Of these 11 actors were interviewed. In the table below is a presentation of the interviewed actors together with their formal positions during the implementation of the project.

Project 3 – Actors participating in the Project	
Managing director	The enterprise in Moss
Project engineer	Associated company of the enterprise in Moss
Manager laboratory	Associated company of the enterprise in Moss
Technical director	Associated company of the enterprise in Moss
Technical director	The enterprise in Moss until 1993
Manager of development	The enterprise in moss
Chief engineer technical department	The enterprise in Moss
Project engineer	The enterprise in Moss
Technical director	The enterprise in Moss from 1993
Technical manager	Associated company of the enterprise in Moss
Director technology	Parent company
Project engineer	Chemical Supplier X
Sales manager	Chemical Supplier Y
Factory engineer	The enterprise in Moss

Table 25: Actors involved in project no three according to their positions

The non-human actors involved in the project were the oxygen bleaching process and the digester at the enterprise in Moss, and the bleaching process at the associated company of the enterprise in Moss.

10.3.4 Running of the Project

10.3.4.1. Introduction

A project was started up early in 1992 and had a duration of 3 years, was called:

Bleaching of sulphate cellulose with nothing or little use of chlorine chemicals

During the project a chlorine- free bleaching sequence for high - yield sulphate pulp was developed, including use of ozone and peroxide bleaching chemicals. At the end of the project detailed engineering calculations were done together with machine suppliers, in order to determine the total costs of a bleaching process plant based on oxygen, ozone and peroxide.

The project was partly financed by NTNf.

10.3.4.2 Project Application to NTNf

The project application to NTNf was established by the project manager from the parent company. In this application this project was defined as a main project, with project number two included in these thesis as a sub project. The last project should be completed at the end of 1992. These two projects were closely connected to each other. An important condition for succeeding in this project, was the achieving of a stable reduction of the lignin content to a low value at the enterprise in Moss was The empirical material does not say anything about the strategy behind the connecting of these two projects.

The data material shows that it was not wise to integrate an already running project into a new project, due to potential problems in following up the project progress and costs. An increased uncertainty and risk of not achieving the project results was the practical consequence of this strategy. This became clear after some time of running this project that it was not possible to achieve the project goals in project no two. As soon as this was realised, they actually knew that it was not possible any more to achieve the project goals in project no three.

The above strategy of connecting two projects also opened up for a prolonging of the optimising project with three years, and flexible use of resources between the two projects. However, nothing in the empirical material indicates that that took place in the actual project.

The application was co-ordinated with a joint application to a NTNF supported research programme, where most of the Norwegian Pulp and Paper industry in Norway participated with their own project applications. PFI was a contract partner and figured as the management of this program. It seems that this was not a good solution. The management and organisation of each individual projects were kept invisible to NTNF when evaluations on financial support to projects were done. It was thus impossible for the research institution in a good way to judge the quality of each individual project application.

10.3.4.3 Project Goals

According to the empirical material several objectives were presented in the project application to NTNF. These were:

1. The associated company of the enterprise in Moss should make a bleached pulp without use of chlorine within the end of 1995. This would be a condition for the mill to survive in the future, due to stronger requirements on emission of AOX
2. The bleached pulp should be suitable to production of a special paper quality at the associated company of the enterprise in Moss.
3. The bleached pulp should be suitable raw material to special linerboard products.

An Unofficial Goal

On the background of research experience from PFI, the chemical suppliers and know-how at the technical staff at the parent company of the enterprise in Moss there was a scientific interest in a new bleaching process. The technical concepts involved were thus given. These concepts should be proved in the project

The different project goals are commented below.

Goal no 1 – to make a bleached pulp without use of chlorine

This was the main goal stated in the application to NTNF. The empirical material indicates that this was the real goal to the parent company.

Goal no two – the pulp shall be suitable for production of a special quality paper at the associated company of the enterprise in Moss

Fulfilment of goal three was a condition for approving the bleaching sequence that should be developed.

Goal no three – the pulp shall be suitable for producing special linerboard products

To improve the economy of the project, it was stated in the project application that the pulp should also be suitable as a raw material of special linerboard products. The associated company of the enterprise in Moss had for some years before the project up-start delivered bleached pulp to the enterprise in Moss.

The data material indicates that this goal was not widely known among the involved from the enterprise in Moss, and resulted later in tough arguments.

Goal no four – A given process concept should be proved in the project

According to the empirical material this was an important goal to some of the central actors. The external suppliers had for market reasons a strategic interest of being in the frontline of the development. A bleaching concept involving ozone and peroxide was presented in the project application to NTNf. The idea of some of the central actors was to prove in the project that this concept was right.

10.3.4.4 The Organising of the Project

The project was run as a parent company project, with a representative from the technical staff as the project leader.

According to the project plan the focus was on developing a bleaching sequence, suitable to the production of a special paper quality at the associated company of the enterprise in Moss. A technical phase, to calculate the costs of a process plant, was only implemented during the last part of the project.

The organising of the whole project is shown in the figure below.

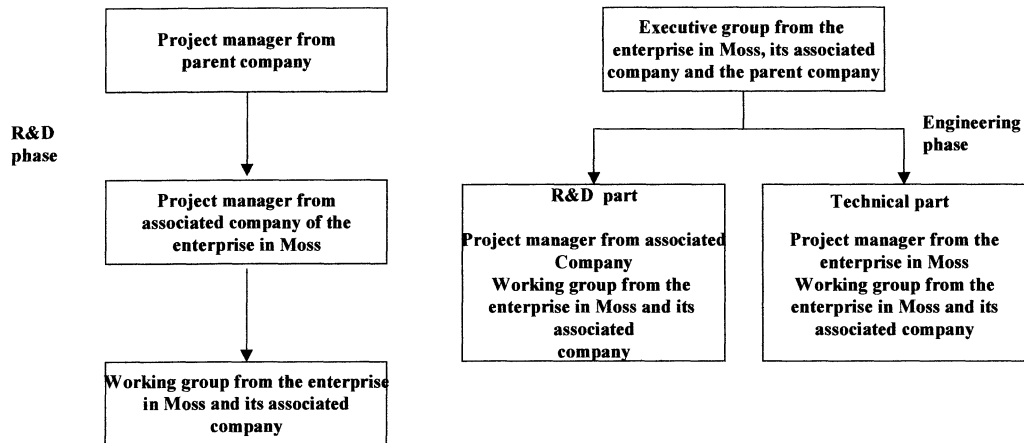


Figure 64: The organisation of the R&D and the engineering phases of project no three

The co-ordinating project leader did not consider necessary to have a executive group in the R&D part of the project. In fact he functioned himself both as a project leader and a executive group. He was thus in full control, reporting to NTNf and the administration of the parent company.

According to empirical material most of the actors involved in the project thought there was a executive group in the R&D part of the project.

As can be seen from figure , the project organisation in the R&D phase consisted both of one co-ordinating project manager and one secondary project manager, and no executive group. In the engineering phase the project was organised with a executive group and two project managers.

Basing on the data material it can be discussed if it is wise to have more than one project manager in any project, due to potential problems with pulverizing of responsibility, or to combine the roles and functions of a project leader and of a executive group in the same person.

10.3.4.5 Description of the Project

According to the empirical material, the R&D part of the project was run professionally. The project group with both internal and external actors succeeded in developing a bleaching sequence based on ozone and peroxide, which gave a bleached pulp, suitable for the production of a special paper quality. The bleaching sequence included an ozone stage and a peroxide stage, as originally planned.

An engineering study was done, when the development of a process sequence was completed, in order to establish a basis to calculate the total costs of a complete bleaching plant. Peterson did this work in co-operation with four main machine suppliers. An almost detailed engineering was done of the external suppliers.

The calculated price of equipment was thus fairly accurate. The calculations were based on 20.000 tons of pulp. The profitability to the enterprise in Moss of selling oxygen-bleached pulp to its associated company was not included in the calculations. The management at the enterprise in Moss defined all conditions for the economic calculations.

The result of the engineering study showed a too high cost of building a new bleaching plant.

The project had to be run for three years to draw this conclusion. As discussed earlier in this case description, this project could have been stopped earlier due to the failure of achieving its goal in project no three included in this thesis.

The knowledge gained from this project could later effectively be used to quickly install a similar process plant at another associated company of the enterprise in Moss.

10.3.4.6 Lack of preliminary Study

No preliminary study was done at beginning of the project. In line with the empirical material, implementation of the R&D results in a new bleaching plant was not in focus at that time. A rough preliminary study could have given an indication if this would be a good business for Peterson or not, what the price per ton of the special quality paper had to be, in order to defend the costs. There was a lack of system thinking in the planning of the project.

A new plant for bleaching of pulp, according to the developed bleaching concept, would require new knowledge in the areas of the product, the market and the production. According to the bleaching concept, the bleaching process would be very modern with extensive use of IT. The product would have a high added value with increased requirements to quality, requiring new ways of running the process. The project was regarded to be pure technical. The empirical material indicates that the involved actors did not deal with the above important factors. It seems that the associated company of the enterprise in Moss did not have the necessary knowledge in the enterprise to make such a project a success.

An important element was the financial situation of the associated company of the enterprise in Moss, which had not been very good since the Russian market collapsed in 1990, with stop of production for some weeks both in 1992 and 1993. A profitability analysis at an early stage would have unveiled if an investment in a new bleaching plant at the associated company had been realistic. During the R&D phase of the project, equipment calculations were done by the external actors and discussed in the project group, which should have opened up the eyes of the actors participating in the group.

The data material shows that questions were raised in the R&D group at the associated company of the enterprise in Moss in September 1992 if the company was working under realistic conditions, if the enterprise in Moss would keep its obligations as a supplier of pulp with an acceptable lignin content. A decision was taken to evaluate alternative suppliers of pulp, in order to save money. However, the company could max use approx. 10% of ordinary Kraft pulp without getting problems of meeting the specs.

These kinds of activities were regarded as background noise to the project group, which did not disturb its work.

The empirical material indicates that the reason why nobody seems to have asked some critical questions about the further progress of the project, to a large degree was the constructions of reality among different actor groups. With basis in the empirical material this will be discussed in the following.

10.3.4.7 Different Construction of Reality

According to the empirical material it seems that different realities were constructed both within the enterprise in Moss, and its associated company.

It seems that the management of the enterprise in Moss, the project manager from the parent company and elements of informal communication resulted in the constructing of different realities in the project. This is shown in the following figure.

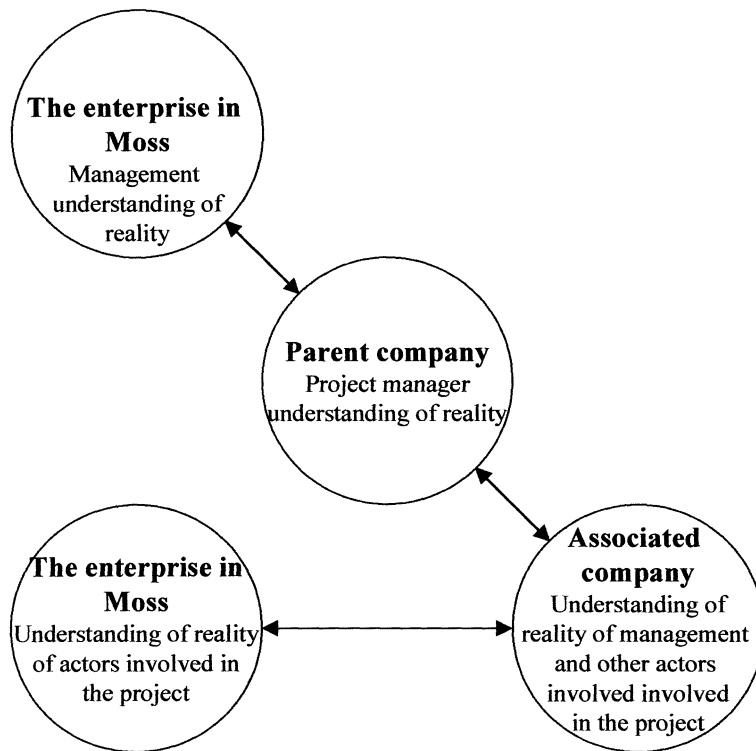


Figure 65: The construction of realities

The figure above illustrates that there was no formal communication between the management of the enterprise in Moss and its associated company, and between involved

actors and the management at the enterprise in Moss. The project leader at the parent company took a central position regarding control of communication lines.

The Project Manager's Image of Reality

The project manager regarded this project to be a project of the parent company, which had to find a solution on the environmental problems at the associated company of the enterprise in Moss. According to the project leader's view there was no other alternative than development of a chlorine free bleaching process, needed for the future existence of the associated company. In line with this thinking important decisions had to be taken by the parent company. One question was regarding the physical location of the ozone stage. The project leader argued that it was natural to place this in Moss, due to utilisation of excess oxygen from the ozone generator and possibilities to recycle the discharge from the ozone stage. It seems that there was a belief that the parent company could force through a solution.

The Image of Reality of the Management at the Enterprise in Moss

The management at the enterprise in Moss also considered this to be a project of the parent company, and was negative to finance any of the project costs. It seems that the management built up its own image of reality through the company's strategy.

Part of the management in Moss seemed to believe that the company was losing money on the oxygen bleaching of pulp to its associated company.

The enterprise in Moss wanted to increase the yield of pulp from the digester. According to the existing strategy the enterprise in Moss should be an efficient producer of brown liner and mottled liner. There were plans to extend the capacity of one of the paper machines during the project period. The enterprise in Moss would therefore not guarantee for more than a certain volume of pulp to its associated company. According to the empirical material the company took early adopted a negative position to the project. Their attitude was that this project would not result in any added value. Consequently the management did not show much interest or enthusiasm.

Due to different business interests, there was a poor atmosphere for communication between the two companies. The above mentioned thoughts of the management at Moss were never discussed with the management at its associated company, and the strategies of the two companies were not coordinated.

The image of Reality among Employees at the Enterprise in Moss

Actors from the middle management that participated in the project did not know the above thoughts among the management at the enterprise in Moss. The strategy was not widely known within the organisation. As seen by the empirical material local members of the project group were never told directly that the enterprise in Moss would not share the costs in the project. The involved people at the enterprise in Moss did not get any back - up from the management. Nobody seemed to ask about the progress of the project. The project leader from the parent company was the only person who was talking about the project. However, it seems that the involved people at the enterprise in Moss were told that the company was losing money on the bleaching process to its associated company, and that the company did not have any extra capacity for continuing with this in the future.

Discussions in the project group together with observation of practice in the project contributed to establish the image of reality among the involved people from Moss.

The Image of Reality at the Associated Company

The associated company of the enterprise in Moss was interested in getting the bleached pulp from Moss. The company argued that a new bleachery was necessary for further survival. The associated company believed that a high tonnage of pulp should be available from Moss. The project leader from the Parent company did not check this out with the different partners. Calculations of costs during the project were based on this high amount of pulp. The empirical material indicates that these figures were based on the project leader's own judgement of a potential digester capacity in Moss. The enterprise in Moss did not agree that the capacity could be that high. The project group in the R&D phase of the project looked at the work of developing a new bleaching sequence as a given task. There was not the responsibility of the project group to stop the project

There were long discussions between the enterprise in Moss and its associated company, without the involvement of the management in Moss. There seems to have been a belief at the associated company that the parent company could force through a decision, which would be positive.

10.3.4.8 Final Comments

In line with the empirical material there were several agendas in the project, little openness, and strategies which developed in different directions. Both the enterprise in Moss and its associated company were working to optimise their own businesses, and were not much interested in utilising any synergetic effect between the two companies.

No project evaluation to initiate organisational learning purposes was done.

PROJECT NO 4

10.4 Project no 4

10.4.1 Introduction

A pre – project was done to evaluate the design and calculate the costs of a new process, in-line with one of the paper machines.. Upstream and parallel to this work, technical trials were carried out to develop a working process to make the new product reach a desired level of quality.

The idea of creating a new product quality at the enterprise in Moss came out at an internal creative seminar. In this seminar it was stated that a simple and cheap process should be developed.

During the R&D and pre-engineering work the enterprise in Moss cooperated with external chemical and machine suppliers.

10.4.2 Empirical Material

In this project 12 central actors were involved. All of them were interviewed except for the financial director, the marketing director and the manager of development. The table below presents the actors involved according position during the project.

Project no four	
Managing director	The enterprise in Moss
Technical director	The enterprise in Moss
Director of technical development	Parent company
Marketing director	The enterprise in Moss
Technical service manager	The enterprise in Moss
Mill manager	The enterprise in Moss
Financial director	The enterprise in Moss
Manager of development	The enterprise in Moss
Project engineer	The enterprise in Moss
Department manager	Chemical supplier X

Department manager	Chemical supplier Y
Project no four	
Managing director	Consulting company

Table 26: Actors involved according the positions

The following technical artefacts were involved in the project: Two pilot coaters, one paper machine, one corrugated board machine, one post- print machine and one pre-print machine.

10.4.3 Activities upstream the Project

10.4.3.1 Creative Seminar

In the existing strategy it was stated that the enterprise in Moss should go in for niche products. The product development goal for in the strategy plan of the parent company was to apply an average of 1.5 percent of the turnover in each Peterson company on product development.

With the above background a two days creative seminar with an external facilitator was arranged early in the 1990s. The ambition was to find new applications and increase the value of the produced paper in Moss.

The actors participating in the seminar came from the top management and from the level below. The data material shows that the discussions took place in an open and friendly atmosphere.

As one of the R&D ideas a new product idea emerged. It was stated by the management that the company should try to find a simple and cheap process to make the product. Costs of NOK 40 – 50 millions were mentioned. The actual product was already produced in Europe and USA, but it was new to the enterprise in Moss. A new market should not be created.

It was decided that the creative process and the product ideas should be kept confidential , something that had never happened before to the external facilitator at the seminar. The idea

was, if the company succeeded, to prevent companies by a much larger capital base from implementing the results of the project before the enterprise in Moss, and to take the competitors with surprise.

10.4.3.2 Technical Trials at an external Producer of the new Product Quality

The first thought was to do some short runs to evaluate what kinds of results that could potentially be achieved. The enterprise in Moss came into contact with an integrated pulp and paper mill that had some free capacity to do the extra technical trials for the company. An agreement was signed. It was understood that if the trials were successful, it could be actual for the external company to make a proportion of the liner from Moss according to the new process at the external company on a commercial basis

A small project group was created and approved by the executive group, shortly before the technical trials should take place. A preliminary technical specification was established, which was noted by the executive group. The fundament for making this was very weak. No marketing survey had been done. The organisation at the enterprise in Moss had little knowledge about the required market quality of the actual product. In the same meeting it was decided that no other external companies should be involved at that stage.

Two full- scale technical trials were carried out at the external pulp & paper mill. It appeared that the machine was not technically suitable to run paper from the mill in Moss. The company also did not possess any experience with the actual paper quality. The results of the trials were not good. The external mill asked for a fairly high price for the trial runs.

There was a consensus in the executive group to terminate the cooperation with the external pulp & paper company. One reason behind the high costs of the trials could be due to the fact that that during the trials the company discovered that the new product from the enterprise in Moss could be a potential competitor to the company's own products.

10.4.3.3 Project Planning

In a top management meeting in Moss two months before the coating trials at the external pulp & paper mill took place, it was decided that coating of liner should have top priority

among different R&D product development projects. A project plan for one year had been developed by the development department, and was presented in the meeting.

In spite of many uncertainties in the plan, the empirical material shows no discussions or comments to it apart from one point. The project plan suggested that the project group should cooperate with external partners, as suppliers and customers that were ahead of the development, and to invest resources and competence in these.

The above suggestion of external cooperation was rejected by the executive group. It was emphasised that contact with our customers on a general basis must not be taken. Concrete discussions between participants in product development projects and our customers had to be co-ordinated by the marketing department.

A market survey was planned, in order to uncover needs in the market for this product and interesting product types, however, it was carried out. One of the central actors who was interviewed argued that it was not necessary. It was stated in the executive group that the enterprise in Moss knew the size of the actual market, which the company potentially should penetrate. On the condition that we could develop a quality which was profitable to the enterprise in Moss, it was expected to be no problems in selling the product if the price was right.

After the technical trials at the external pulp & paper mill were completed, the project group was asked by the executive group to work on a survey regarding other companies which possessed the process technology for producing the new product quality, in order to evaluate if a commercial co-operation on coating might be established with any of them. It was only possible to get a limited amount of information, however, due to the secrecy of the project and the prohibition of taking directly contact with customers or competitors in the market.

It gradually turned out that it was difficult to keep the project secret to suppliers of chemicals to the actual process. It got known that both that two major chemical suppliers knew about the technical trials at the external pulp & paper mill. The executive group asked the project group to take contact with these companies.

The empirical material shows that it always will be like that. It is not possible to keep a development project secret to either external or internal sources for a long time. According to the empirical material it is usually useless to try to keep this kind of secrecy. You will create a lead because of competence, rooted in the organisation and involvement of the people that are going to accomplish it.

10.4.4 The Project Accomplishment

10.4.4.1 Signing of Secrecy Agreements

In a meeting in Moss the chemical suppliers and the enterprise in Moss agreed to initiate a co-operation on development of the new product quality at the enterprise in Moss. A secrecy agreement was signed between the two parties. This was also done at a later stage between another major chemical supplier and the enterprise in Moss.

The empirical material shows that the chemical suppliers looked at the secrecy agreement with the enterprise in Moss, as a sign of commitment to go in for the project, demonstrating a real interest in the project. The suppliers decided to allocate time and resources on the project. At the company's research centre there were located two very modern pilot machines, which could be run at high speeds. The most modern product technologies could be configured in the pilot machines. At the end of the project it became clear that the chemical suppliers had used large sums of money on two large pilot trials, one pilot printing trial and training of actors from the enterprise in Moss in Germany. The possibility was realised of being the future suppliers of chemicals to the new process at the enterprise in Moss.

To sign a secrecy agreement was according to the empirical material very usual for the large chemical companies as the chemical suppliers. It did not restrict the work very much due to the large internal network and knowledge base within these large companies.

However, to the enterprise in Moss it was different. The data material shows that the secrecy around the project changed the focus more or less on gaining as much relevant knowledge as possible to which kind of actions which had to be taken in order to keep the secrecy. The project group was restricted in the use of the internal and external network of the group. The final users of the technology were not involved.

According to the empirical material a strong involvement of the practitioners would have been important in order to succeed. It would have been a large challenge to change the attitude of the whole mill, even if we had succeeded in installing the necessary equipment. We would have met stronger requirements and limits, for instance to good paper profiles, paper formation and construction of rolls. These requirements would decide the degree of added value to the product. It was argued that the necessary adaptations are usually very demanding, may be these important questions should not have been evaluated during the pre-project.

As I interviewed central actors, they experienced that the secrecy around the project did not influence the actions of the operating department very much. The department was only involved in the production of test rolls and in doing some testing of paper properties. Because of a fairly low enthusiasm, this project was not a subject discussed. There was no pressure to prioritise the project because of its importance. Therefore it was not a problem to keep the project confidential either. Nobody was talking about it. With the low number of actors involved, the project could easily be interpreted as an activity with a weak focus, an activity with no purpose.

10.4.4.2 Organising of the Project

From the start there were five members in the project group. The group was reporting to a set executive group, called the product development group, which was headed by the managing director. Representatives from the top management constituted the other members of the product development group.

The project was not run with an integrated approach, but rather in a more linear, or even accidental. The secrecy around the project and restrictions in communication were some of the causes of this. No innovation model was applied.

According to the empirical material it seems that the management gradually showed a reduced interest in the R&D project. One signal of this, was the fact that the product development group chose the technical director to function as a executive group on behalf of

the group. The running communication between the product development group and the project group was done through him. However, status and milestone reports were distributed to all the members of the product development group.

The technical director functioned as an obligatory passage point in the project. There was no creative environment connected to this way of organising. The project organisation is shown in the figure below.

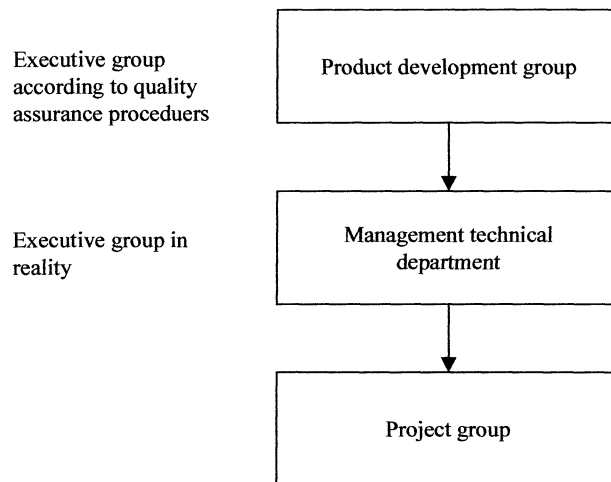


Figure 66: The project organisation

The first pilot coating trials of one of the chemical suppliers had been accomplished in Germany. It was concluded that the preliminary results were promising, and it was decided that the product development group should go further with the project. A new project group was established, with the first milestone being calculate lay-out and costs for an in-line coating installation. The project group was now reduced to three members. It was stated that only the actors working with the project should be informed about the progress.

From the moment the equipment calculations started, the project turned to become a technical project, with more focus on equipment investments than on product development. The machine supplier was contacted, and a secrecy agreement written with the supplier. An illustration of the project organisation is given in the figure below.

The communication network in the project is shown in the following figure.

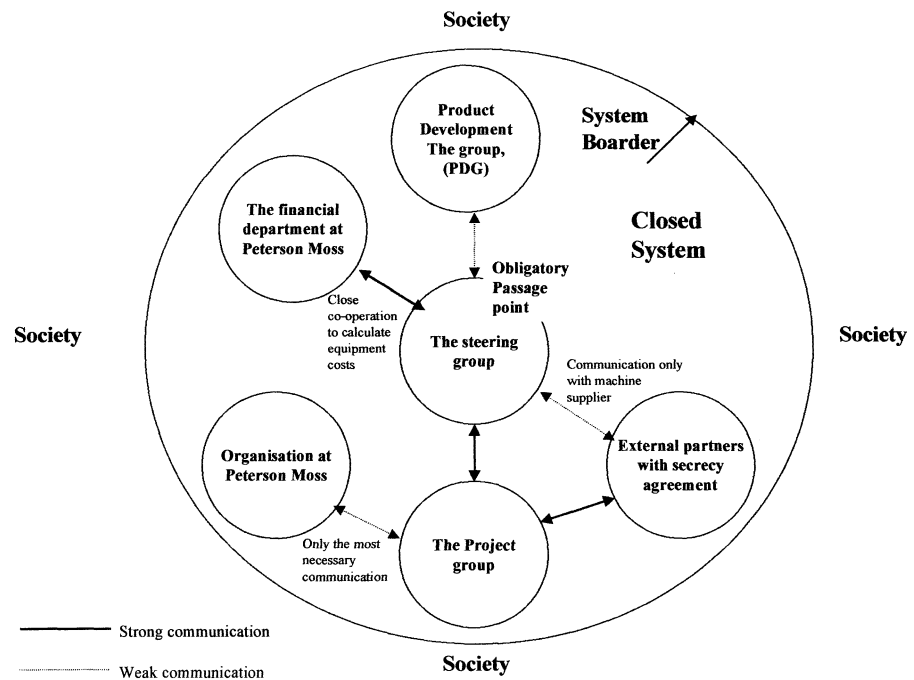


Figure 67: The main communication network

As shown in the figure above the project group's main communication links were:

- To the executive group, i.e. the technical director
- Status and milestone reports were distributed directly to the members of the product development group.
- To the chemical suppliers. The contact with the machine supplier was mostly taken care of by the technical director
- The most necessary communication to the rest of the organisation

The executive group's main communication links were:

- To the project group
- To the machine supplier
- To the financial director doing the profitability calculations in a close co-operation with the technical director.

- A weak communication with members of the product development group.

The figure above illustrates the communication system within the framework of a closed system.

According to the involved actors the co-operation was very good between the project group at the enterprise in Moss and the approved external co-operating parties, forming an open network. There was an open and direct communication, actively transferring knowledge to each other. Firm alliances were made between the chemical suppliers and the machine supplier. The project was well documented according to the quality system ISO 9001.

10.4.4.3 Technical Trials

The trials accomplished during the R&D part of the project included both several pilot trials at the suppliers' industry, along with research at universities and research institutes, and full- scale tests at one associated company of the enterprise in Moss. Many technical problems had been solved..

Both chemical suppliers argued in interviews that most of the technical problems had been solved in the project, and the companies were certain that acceptable technical solutions would have been developed, that would have given a coated liner of proper quality.

One important element came up during my research. All along there was in the project a focus on a very high speed of the potentially new product technology at the enterprise in Moss. The company was asking for product technology to be run in-line on a paper machine at a speed of 800 m/min. The data material shows that this was a mistake. The company was focusing on much higher speeds than what could be expected. A consequence was that the project group was working with a wrong type of technology, both during the pilot trials and the equipment design.

The challenges together with the equipment costs could have been reduced, if one had chosen to install an off-line product technology. In fact such a message was never given by the executive group and was consequently not evaluated, either technically or economically.

10.4.4.4 Termination of the Project

Four months ahead of the termination of the project a milestone report was made, including thorough financial calculations of the equipment costs, done by the financial director in close cooperation with the technical director of the equipment costs. A sensitivity analysis was included in the analysis. The report was presented by the project manager in a strategy meeting. The presentation was well received. It was stated that the project was still very interesting, and that it should continue. A marketing survey of approximately half a year's duration should be started up.

After the strategy meeting, the last coating trials in the project were done at the last part of April. Pilot printing trials and full-scale converting trials were done. Both trials were done in a positive and optimistic atmosphere. The technical results were promising.

The project manager then went to USA, to participate in a seminar about the actual product technology.

Shortly after he came back to Norway, he was invited by the marketing manager to a meeting in order to discuss how the enterprise in Moss should eventually make further progress in the project. Representatives from one associated company of the enterprise in Moss were also invited.

In the meeting the administration decided to terminate the coating project. This was a big surprise both to the project manager and to the technical department, who were accused that the project was not presented in a proper way at an earlier stage.

It has not been possible to document the events taking place the last few months of the project, which caused the attitude to the project to change dramatically.

PROJECT NO 5

10.5 Project no 5

10.5.1 Introduction

In the late 1980s the environmental policy in Norway was still very traditional, and mostly based on end-of-pipe solutions, involving external cleaning of the polluted water streams. The Norwegian Pollution Control Authority mostly took a police role, and had a clear control function with regard to the companies' compliance with the effluent permits issued.

In the late 1980s cleaner production came up in international environmental policy discussions, fronted especially by the Environmental Pollution Agency (EPA) in USA and the Netherlands. The background was an understanding that this strategy could be both a cheaper and more efficient method of effluent reduction. Gradually, when the Norwegian Pollution Control Authority got more knowledge about cleaner production, the Authority adapted a more flexible approach with regard to the industry's choice of solutions for reducing the pollution.

In 1989 The Norwegian Pollution Control Authority performed a comprehensive environmental audit at the enterprise in Moss. The effluent level was pretty high, but was within the effluent limits. The company was instructed to elucidate technical solutions and costs for reducing the level of dissolved organic material with 50 percent compared to 1989. The enterprise in Moss believed that this would soon become a requirement.

A larger engineering company, which was approved by the Norwegian Pollution Control Authority on inquiry by the enterprise in Moss, was chosen to do the elucidation. The solutions were very traditional and based on large buffer volumes external cleaning by means of chemical treatment of the effluent streams. The costs of reducing the effluents by 50 percent were calculated to NOK 85 – 115 millions. According to the managing director this was totally unacceptable.

The enterprise in Moss came into contact with Oestfold Research Foundation, (STØ), situated in the same region as the enterprise in Moss, which was given the task to do a cleaner production project at the company. The emphasis was both on a search for internal efforts to

reduce the effluents of dissolved organic material by 50 percent, and implementation of an environmental protection system to secure permanent learning and continuous improvements in the company.

The research foundation, which was in an up-start phase in 1989-90, had made a link to a cleaner production project in Sweden to utilize resources from the University at Lund in the first phases of a cleaner production project in the Oestfold region run by STØ. A connection was made to United Nations' environmental program, (UNEP), in Paris.

At about the same time the Ministry of Environment in Norway had initiated the work with the creation of a new strategy in the environmental policy regarding the industry in Norway. In this work the Ministry strongly focused on cleaner technology and cleaner production, how to implement this approach when issuing effluent concessions, and on allocating financial resources and other means for pushing in the same direction.

The project at the enterprise in Moss fitted well into the work of the Ministry of Environment, which was interested in initiating some Norwegian case studies for the purpose of learning from practice. Thus the Ministry accepted to finance 40 percent of the project costs at the enterprise in Moss

This cleaner production project in Moss was one of the first pilot projects before a broad cleaner technology program was established in Norway.

10.5.2 Empirical Material

The basis of the project description has been available written material together with in-depth knowledge from interviews. Out of seven actors that were involved in the project, 5 actors were interviewed.

In the table below presents the actors interviewed, together with the formal position they had during the project.

Project no 5	
Vice President Technology	Parent company
Managing director	The enterprise in Moss
Technical director	The enterprise in Moss
Department manager	Oestfold Research Foundation
Bureau manager	The Ministry of the Environment
Department manager	The Norwegian Pollution Control Authority
Group leader in the paper mill	The enterprise in Moss
Factory engineer	The enterprise in Moss

Table 27: Actors involved in project no five according to their positions

10.5.3 Short Description of Principles for Cleaner Production.

A principle for cleaner production according to EPA includes solutions of environmental problems according to the following priorities, EPA 1988*:

1. Minimise the amount of waste and pollution generated during the production process
2. Recirculate internally as much as possible of the generated waste and pollution
3. Recirculate externally the amount of waste and pollution, which cannot be treated internally
4. Utilize the amount that cannot be recycled to energy production
5. Treat externally the amount of waste and pollution, which cannot be handled within the points 1-4.

The above principles are summarised in the figure below.

* The EPA procedure of 1988 was revised in 1992. Per Kirkebak was giving major contributions in this work

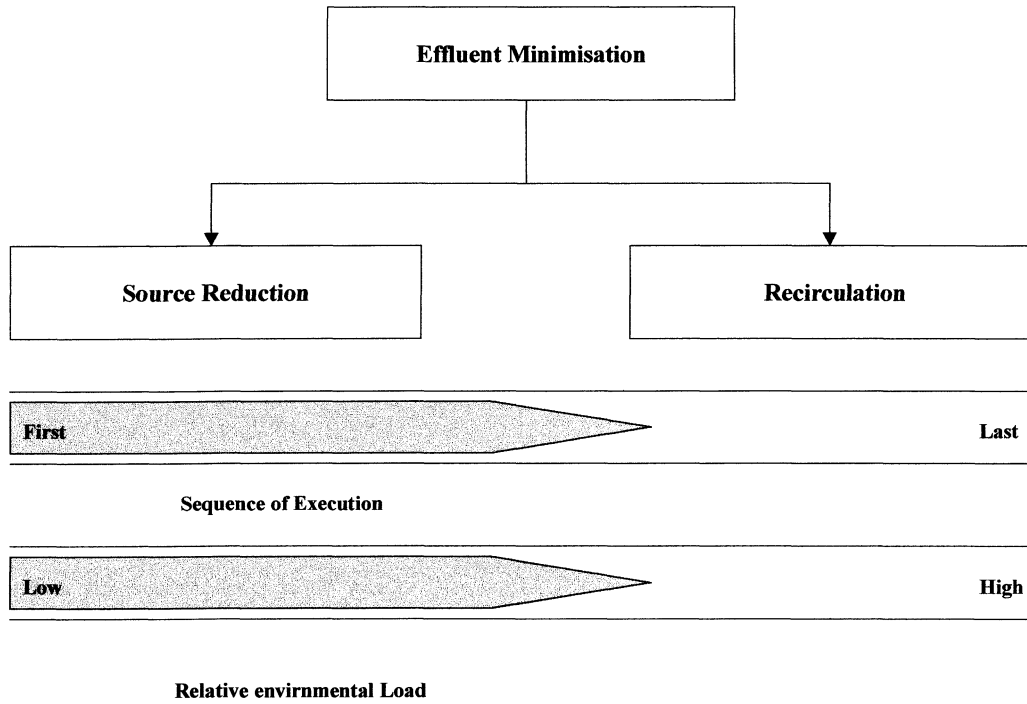


Figure 68: Environmental priorities according to EPA's methodology

When organising a cleaner technology project EPA focused on:

- Management responsibility and involvement
- Definition of clear overall goals for the project
- Establishing working groups, involving the employees that own the problem
- Use of external competence.

EPA's recommendation as for organising a cleaner production project, was really a description of the principles of organising and running an action research project.

10.5.4 Project implementation in Moss

Project Organising

A executive group was established, which was headed by the managing director. It included the following three external actors: one department manager from the Norwegian Pollution Control Authority, one bureau manager from the Ministry of the Environment and one department manager from Oestfold Research Foundation. The data material shows that the participation of the authorities was regarded as positive. It signalled to the enterprise in Moss a new way of working as a team with the authorities, and was a valuable learning process for both parties. The Norwegian Pollution Control Authority got knowledge about a large process enterprise, how it's organised, its culture and its production equipment. However it was very clear that the authorities did not want to have a function that would commit them to any special solution, which could result in a situation of joint responsibility. It seems that the close co-operation with the authorities in the project resulted in a more open and improved relationship to the State Pollution Agency.

A small project group with four members was established. The project leader was an outsider, and had the position as a senior researcher at Oestfold Research Foundation.

A working group was established, including practitioners from the paper mill. It was planned that much of the work should be done in a dialogue between this group and the project team.

Up-start Meeting

An up-start meeting was arranged with participation of the Moss Municipal Manager of the Environment, media, the project group, the executive group and other key persons in the organisation at the enterprise in Moss. This was an important meeting. The managing director who strongly fronted the project, was heading the meeting. He presented the project goal as 40 percent reduction of the effluents of dissolved organic material to the, and asked the organisation to focus on achieving this. The project and executive groups were presented. The managing director opened up the organisation for the project group, that they were allowed to go anywhere in the organisation in search of knowledge. By his involvement he strongly signalled that this project had a high priority and had commitment from the top management.

It should then be easier to initiate a dialogue with the members of the organisation. The employees felt that it still was possible to come up with solutions to problems, when the managing director strongly urged them to do so.

The empirical material indicates that there were some counter forces within the technical department that openly worked against it, however, since the managing director fronted the project so strongly as he did, this did not create any problems.

The open network of the project group is illustrated in the following figure.

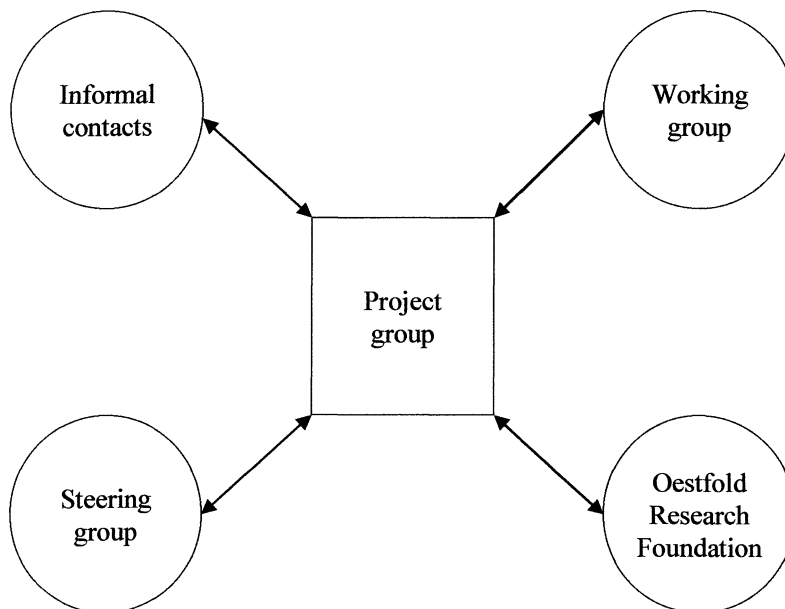


Fig 69: The project group's network

A Systematic Analysis of the Cellulose and Paper Mill

The enterprise in Moss knew that a large part of the total effluents to the sea were irregular and non-continuous. The executive group believed that this kind of effluent could be greatly

reduced , when people who owned the problems were involved in solving them. It was regarded as a management challenge to reduce these kinds of effluents.

The project work started with meetings with practitioners in the established work groups and opened up informal communication with actors working at the mill, in order to learn the process. At the first meeting in one work group the project leader, who was an outsider, presented the project and its background. The workers were then told that the members of the project group wanted to share their knowledge and competence with him, and that the practitioners were regarded as important resources for the project. Through the close communication and the checking out with the workers, the members of the project group gradually achieved more knowledge about the process.

According to the empirical material the workers felt that the outsider, who took a humble position, came to help the enterprise in Moss to solve the environmental problems at the company, and was not trying to force any solution upon them. Confidence was built up between the project group and the practitioners, who sensed that they were taken seriously, had a good influence in the project, and did not possess formal roles as “hostages”.

The project leader had agreed with the management that solutions up to a certain economic limit should be implemented as soon as the project group and the practitioners through discussions had agreed to do so. In this way results of discussions where consensus had been achieved, could be seen to be implemented during the progress of the project. According to the empirical material this was one of the key success factors in the project. As it was said in one interview that the amount of ideas were not a problem at the enterprise in Moss. However, it was argued that good ideas tend to disappear. It was further believed that this way of working was a strong motivation factor for the practitioners for transfer their implicit knowledge to the project group.

During extensive cooperation with the operating department, the technical department and the maintenance department, the project group systematically analysed the cellulose and the paper mill with focus on potential sources of reductions of environmental effluents of dissolved organic material to the sea, including a thoroughly survey of the management practice.

The work started with updating process flow sheets, establishment of mass – and energy balances and reviewing process descriptions and the existing procedures. Potential effluent streams of organic material were mapped. This created the basis for the further work. The project group established a list of prioritised measures, which were recommended to carry out. Among these were:

- Replacement of clean water with recirculated water to achieve an increased process closure
- Improved process control of tanks to avoid overflow
- Alarms on potential effluent sources, as for instance manual valves
- Process optimisation
- Improved management system

10.5.5 Project Results

The project group found solutions giving 40 percent reduction in the effluents to the sea within a cost of NOK 30 millions. The effluent reduction was in line with the goal established at the start of the project. Compared with the NOK 85 – 115 millions, calculated by the “traditional” engineering company, it was no doubt that the new approach of working had extensively saved the company’s costs of achieving the desired result

According to the empirical material, the key success factors in the project can be summed up as:

- Broad involvement of practitioners, participating actively as valuable resource persons
- A humble attitude from the outsider working as a facilitator or a project leader
- A strong commitment from the management.

It was argued that the EMAS certification of the enterprise in Moss would have come much later if we had not done this cleaner technology project. The enterprise in Moss was no one in Norway and no two in the Nordic countries obtaining this certificate. The reason was similar basic ideas behind the EMAS certification and the cleaner production thinking: that it was

possible with proper management systems to reduce the effluents by internal efforts, and further that the companies should be open towards the society.

Within one year of project work the goal of 40 percent reduction in the effluents to the sea was reached. However, the overall project goal of implementing an environmental protection system had not been achieved. The project was terminated too early. According to the empirical material there could be several reasons for this. It seems that more focus could have been put on the goal formulation at the start of the project, with the main goal of implementing a durable environmental protection system, combined with a strong pressure from the management as to not terminating the project too early.

When the 40 percent effluent reduction was reached, central actors of the project team went to other tasks, which were given a higher priority by the management. It was said that this was a general problem at the enterprise in Moss. One reason might be too many projects running at the same time.

No project evaluation report, to initiate organisational learning, was written.

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