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COMPETITIVE ADVANTAGE OF THE FINNISH FIBER PROCESSING MACHINERY INDUSTRY

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Kansallinen kilpailukyky ja teollinen tulevaisuus -projektissa tutkitaan, millaista teollista toimintaa voidaan harjoittaa Suomessa menestyksekkäimmin. Siinä tutkitaan menestyneitä vientiyrityksiämme ja pohditaan, miten niiden toimintaympäristöä tulisi kehittää, jotta ne pystyisivät saavuttamaan kilpailuetuja kansainvälisiin kilpailijoihin verrattuna.

Projektin päärahoittajina ovat Suomen itsenäisyyden juhlarahasto (SITRA), Elinkeinoelämän Tutkimuslaitos (ETLA), kauppa- ja teollisuusministeriö (KTM) sekä eri alojen tärkeimmät yritykset.

"The Competitive Advantage of Finland" research project evaluates the competitiveness of Finnish export industries and crucial elements behind their performance. The project focuses on what kind of industrial activities have the best possibilities for success in Finland.

The project is organised by Etlatieto Ltd and financed mainly by the Finnish national Fund for Research and Development (SITRA), The Research Institute of the Finnish Economy (ETLA), Ministry of Trade and Industry (KTM) as well as major companies in various fields.

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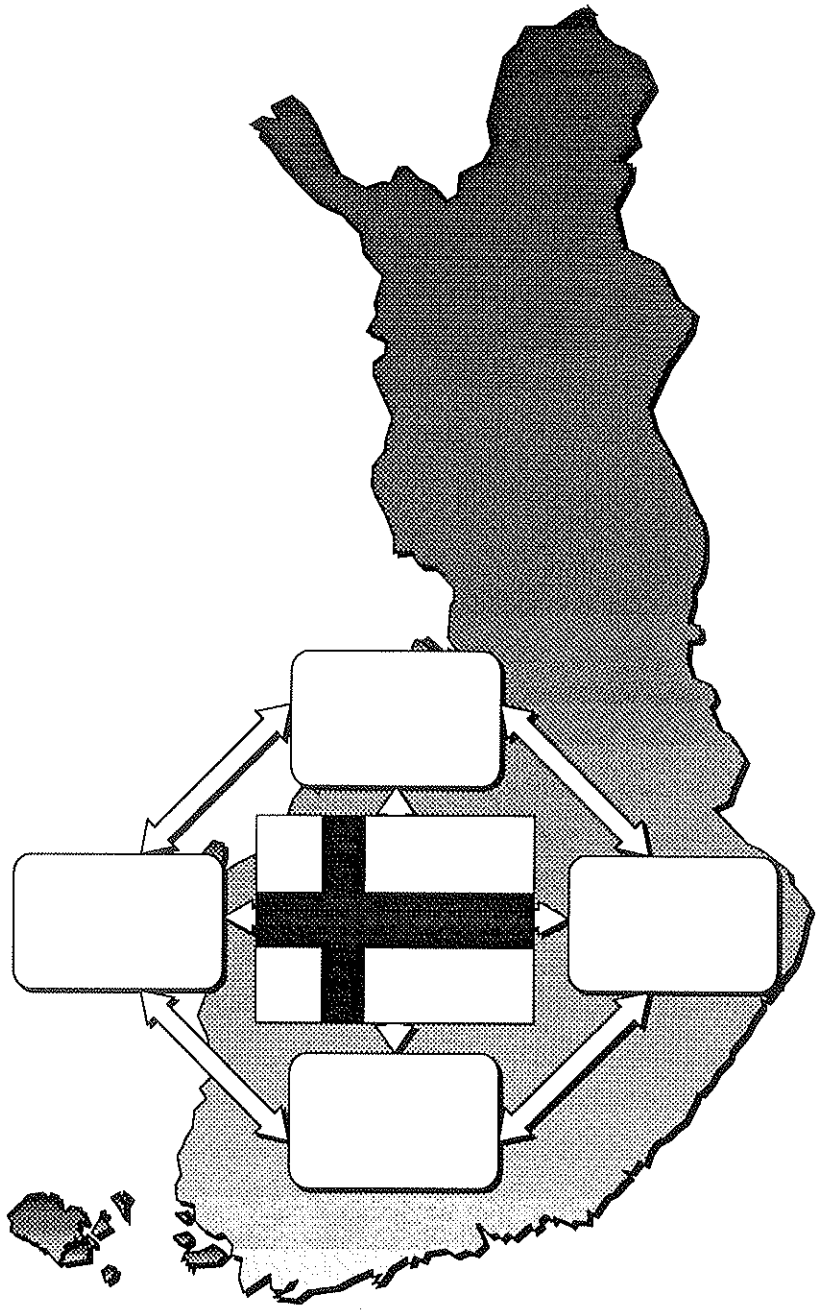
Kansallinen kilpailukyky ja teollinen tulevaisuus

The Competitive Advantage of Finland

COMPETITIVE ADVANTAGE OF THE FINNISH FIBER PROCESSING MACHINERY INDUSTRY



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ABSTRACT: The objective of the study is to analyze the international competitive advantage of the Finnish fiber processing machinery industry. The theoretical framework is based to a great extent on Michael E. Porter's diamond model of national advantage which lays the preconditions for the advantage creation. The top management of the leading Finnish fiber processing machinery suppliers is the most valuable source of information. As a result, both company specific advantages as well as the nation wide advantages are presented.

The Finnish fiber processing machinery industry is highly competitive in world terms due to the impact of the national advantage determinants. The steering force for the development of this industry has been the Finnish pulp and paper industry and its demand for production machinery. The user-producer relations play a significant role in sustaining and upgrading the advantage.

KEY WORDS: the fiber processing machinery industry, mechanical pulping, chemical pulping, stock preparation, technological development, competitive advantage

Kontulainen, Nina J., **SUOMALAISEN MASSANVALMISTUS- JA -KÄSITTELY-KONETEOLLISUUDEN KILPAILUKYKY.** Helsinki: Elinkeinoelämän Tutkimuslaitos, The Research Institute of the Finnish Economy, 1994, 60 s. (Keskusteluaiheita, Discussion Papers, ISSN 0781-6847; No. 511).

TIIVISTELMÄ: Tutkimuksen tavoitteena on arvioida Suomen massanvalmistus- ja massankäsittelykoneteollisuuden kansainvälistä kilpailukykyä. Pääasiallisena viitekehikkona on Michael E. Porterin kansallisen kilpailukyvyn timanttimalli, joka asettaa edellytykset etujen luomiselle. Merkittävimpänä informaatiolähteenä ovat suomalaisten korkeatasoisten massanvalmistus- ja massankäsittelykonevalmistajien johtajat. Työpaperissa esitellään sekä yrityskohtaiset että kansalliset edut.

Kansallisen kilpailykyvyn osatekijöiden tuloksena suomalainen massanvalmistus- ja massankäsittelykoneteollisuus on kansainvälisesti erittäin kilpailukykyinen. Tämän teollisuuden kehitystä ohjaava voima on ollut suomalainen sellu- ja paperiteollisuus ja sen tuotantokoneiston kysyntä. Tuottaja-käyttäjäsuhteet ovat merkittäviä kilpailukyvyn ylläpitämiselle ja jalostamiselle.

AVAINSANAT: massanvalmistus- ja massankäsittelykoneteollisuus, mekaaninen massanvalmistus, kemiallinen massanvalmistus, massankäsittely, teknologian kehittyminen, kilpailuetu

EXECUTIVE SUMMARY

This study is a part of a large project called Competitive Advantage Finland conducted by the Research Institute of the Finnish Economy (Elinkeinoelämän Tutkimuslaitos). The aim of the project is to define and analyze the competitive industry clusters in Finland, and to provide guidelines for the national industrial policy. The target of this study is the Finnish fiber processing machinery industry consisting of companies producing machines for mechanical and chemical pulping and stock preparation.

The theoretical framework is based to a large extent on Michael E. Porter's diamond model for national competitive advantage. Determinants in the model are domestic factor conditions, demand conditions, related and supporting industries, and firm strategy, structure and rivalry. These components are evaluated by interviewing the top management of the leading Finnish fiber processing machinery manufacturers. The companies include Ahlstrom Machinery, Sunds Defibrator Jylhä, Sunds Defibrator Pori, and Valmet-Tampella. Also secondary data such as company histories and other written material is used.

The Finnish fiber processing machinery industry is highly competitive. All the case companies are among the world leaders in their field. Advantageous conditions in various parts of the national diamond provide a solid base for creating and sustaining competitiveness. The most important of these are sophisticated and demanding domestic buyers. It can be claimed that the Finnish pulp and paper industry is the steering force for the development of the Finnish fiber processing machinery industry. Domestic buyers are among the pioneers in the world setting extremely high technological requirements on the suppliers. This has forced companies to innovate and upgrade products and processes. The buyer needs abroad are anticipatory enabling the technology transfer. Another significant factor are the human resources. The education level in Finland is high providing talented, innovative people for the industry. In addition, there is a complete range of internationally competitive related and supporting industries. Referring to the chemical pulping, the government has taken the environmental issues into account by setting high regulations for the mill effluent. This in turn has forced the suppliers to innovate new technologies which are also welcomed in other market areas. No selective factor disadvantages were found even though the other diamond determinants do not upgrade the competitive advantage.

Besides these diamond based advantages there are other factors behind the success. The most important of these are user-producer relations. The fiber processing machinery manufacturers and their domestic customers, the pulp and paper industry, have grown together and have established strong links inbetween. In some cases there are suppliers and

buyers, that is mills and engineering works, within the same corporation providing a natural base for co-operation. Technological breakthroughs are often a result of this kind of close relations. In addition, the entire Finnish forest cluster is particularly strong. Network relations and co-operation in various forms dates far back reinforcing advantages of each party involved. Especially joint R&D is significant.

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1.1 Introduction

Finland is among the world's richest countries as regard to forests. The forest industry constitutes about 40 % of the exports as pulp and paper being the nuclear export products. These industries have given the impulse for other related industries to emerge and to develop, resulting in world leading positions in the manufacture of paper and pulp machinery among others. In fact, in the forest machinery business Finnish corporations show similar or even larger market shares on the international scale. For example, the world market share of Finnish companies in harvesters is over 40 % and in fiber processing machinery and paper machinery over 30 % .

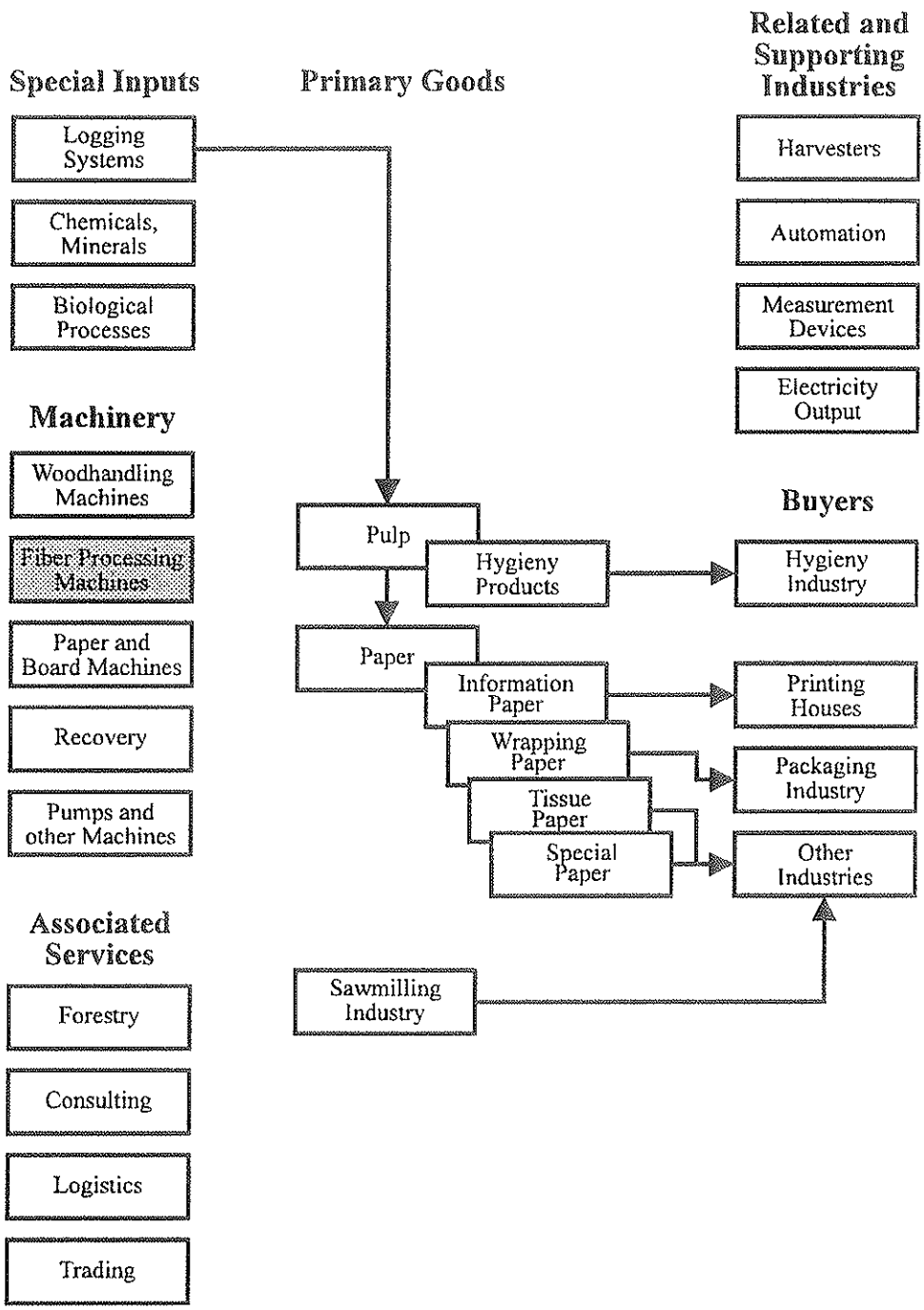
In Finland, the dominance of the forest cluster is based on economic, social and political mechanisms. The economic significance is reproduced by the demand for domestic raw materials, exports incomes and the multiplier effects on the Finnish economy. Its social base lies in the local communities, forest owners, professional networks and ethnic homogeneity of the Finnish people.

1.2 Definitions of the Study

The target of this study is the Finnish fiber processing machinery industry. It consists of machines used by pulp and paper producers in fiber processing and can further be divided in three different branches: chemical pulping machines, mechanical pulping machines and stock preparation machines. Also the word pulping machinery can be used when meaning any of these machines, but not to get mixed up I use here the term fiber processing machinery when generalizing them. However, in order to give a more precise picture these three branches are introduced separately in the next sub-chapter. Companies involved in these businesses have separate units for the mechanical and the chemical pulping, as these have entirely different characteristics. Stock preparation is normally either under one of the former two branches because it comes after handling pulp, was it mechanical or chemical handling (see appendix 2). Concluding, the focus of the study is on the manufacturers of these machines, not the users of them i.e. the paper and the pulp industry.

The fiber processing machinery industry is a part of the chemical forest industry and is positioned in the following way:

Figure 1: Basic Structure of Forest Cluster



See also appendix 1 and 2 for more detailed information about the fiber processing machinery, and the environment where it is positioned. Appendix 3 is an example of the chemical pulping process and corresponding machines by Sunds Defibrator which is one of the case companies.

1.2.1 Pulping [1]

Pulping, in which wood is broken into wood fibers, can be considered as the first stage of paper manufacturing. The choice of the pulping process depends on the wood species used as well as the desired characteristics of the final pulp. The two pulping methods are mechanical pulping and chemical pulping. Also the recycled fiber can be used and has lately taken markets from these two other pulping methods. In each method there are several different stages in which the wood is handled. Each method as well as each stage requires its own machinery.

In the next pages the pulping process is described in general in order to give an idea of what pulping is about. This is necessary to understand because it is the pulping process and the pulp producers that set the conditions for the machinery and its manufacturers. Comprehending the pulping process gives background information and helps to concretize the machines which will come up in the case company presentations in chapter 2. However, the evaluating point of view is business oriented, and therefore the purpose of this study is not to provide technical information of the procedures and developments. Thus the pulping process presentation does not go, and is not meant to go, deep into details. In the next sub-chapter the stock preparation is handled accordingly.

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[1] See for example: FAO 1981s, FINNPAP 1993, METLAS KY 1991, METLAS KY 1984, Metsäteollisuuden Työnantajaliitto 1979, Laurila et al. 1968. Also information for this sub-chapter is obtained from the interviews.

Mechanical Pulp

In mechanical pulping, wood is broken up into fibers mechanically. First the pulpwood logs are debarked and washed. It is followed by different competing methods to be used in crushing the wood logs or wood chips. For example, the logs can be pressed against a rotating grindstone to produce groundwood pulp (GW), or alternatively wood chips can be defibrated and refined between grooved steel plates at high consistency resulting in so called refiner pulp. Thus, the mechanical pulps are usually named after their own special features: groundwood (GW), pressure groundwood (PGW), refiner pulp (RMP) and thermomechanical pulp (TMP). Today, the mostly used method is thermomechanical pulping.

In the refining method (RMP, TMP) first the pulp is beaten in refiners by forcing it between rotating grooved steel plates. This dissolves the fiber bundles and yields fibers with the desired dimensions. Refining affects largely the paper properties such as strength and opacity.

After refining the pulp is normally bleached. The bleaching is done using chemical bleaching components such as chlorine compounds, dithionite and peroxide in multiple stage processes. The most used methods are the chlorine and the oxygen bleaching. The choice of the bleaching process depends on the type of pulp and brightness desired. Bleaching is followed by dewatering, washing and drying.

One of the advantages of mechanical pulping is the high yield: 92-97 % of the wood can be converted into fibers. Regarding to the raw material use this allows production costs to be kept lower and leads to paper with good opacity and printability characteristics. The disadvantages are lower strength of the pulp and the discoloring of the paper. In addition, mechanical pulping uses more energy than chemical pulping which is energywise self-sufficient.

Mechanical pulp is mainly used in the production of newsprint papers, magazine papers and other printing papers. It is also used in paperboard, tissue paper and kraftliner. Also some chemical and cemichemical pulps must be added to the groundwood pulp due to quality, production technical and economical reasons.

Chemical Pulp

Chemical pulping consists of cooking wood chips with chemicals in a pressurized digester. Impurities, such as lignin, resins gums and other undesirable partials, are removed from the wood. The remaining component is mainly cellulose. Two mostly used chemical pulping processes are sulphate and sulphite processes. The sulphate process is environmentally much friendlier, and the trend has been to move from the sulphite to the sulphate methods. For example, in Finland all the pulp mills in operation use the sulphate process. However, in the Central Europe still the use of sulphite dominates due to legal prohibition of chlorine in the bleaching process. The cooking liquor in the sulphate process is alkaline, and the method is suitable for pulping different species of wood including pine and hardwoods. The sulphite based method uses an acid cooking liquor which is best suitable for spruce.

After cooking the pulp is deknotted, washed and screened, oxygen delignified and bleached. These are followed by secondary screening, pulp thickening and drying. Many of these are namewise same as in the mechanical pulping process, but the machines used differ in their technological structures. Along this so called actual pulping process there is a recovery side which takes care of the residual chemicals. Recovery processes make up about the other half of the entire chemical pulping, whereas the actual pulping makes the other half. However, in this study recovery is classified as a separate industry branch, and therefore it is excluded.

The advantages of chemical pulping are good strength characteristics and resistance to discoloration of the paper, as well as high brightness which can be achieved by bleaching the pulp. On the other hand, there are disadvantages as well, such as low pulping yield (from 30-60%) and high production costs. In addition, traditionally the environmental load of the process effluent has been high. Now the technological achievements enable environmentally friendlier production, and the trend is towards chlorine free delignification and closed water circulation which means less effluent.

Because of its characteristics the chemical pulp is suitable for various purposes. It is used to produce paper that has to be strong, bright and suitable for archiving. In the manufacturing of the mechanical paper grades the chemical pulp is added to mechanical pulps to improve the strength of the paper. The sulphite pulp fits especially to manufacture of newspaper and fluting whereas the sulphate pulp is common in craft liners, for example.

There are also chemimechanical methods which can be used for pulp production. These methods are a combination of the mechanical pulping and the chemical pulping being closer

to the chemical procedures. The chemimechanical pulp has been developed, because the chemical pulp has an unnecessary good quality for certain use purposes whereas the mechanical pulp does not reach the quality standards.

Recycled Fiber

Recycled fiber is gaining great importance as a raw material for paper making. The used paper is repulped and the ink and other impurities are removed in a process called deinking.

The quality of recycled fiber varies, depending on how well the paper is sorted and cleaned as well as on the deinking process used. Usually recycled fiber can not be the only component in the paper, it must be mixed either with mechanical or chemical pulp. The usability of the recycled paper strongly differs by the end products. It is technically possible to use the recycled fiber in newspapers about 85 %, in paperboard about 75 % and in printing and writing papers 35-40 %. In some packaging papers the recycled fiber can constitute over 90 %.

1.2.2 Stock Preparation

After the actual pulping, regardless whether it is chemical or mechanical pulp or recycled fiber, the pulp has to be handled before it is ready to be used as raw material in the paper machines. This second stage of the manufacture of paper is called stock preparation, and it involves different processes in which the pulp is treated.

The key stock preparation stages are repulping, refining and deflaking. To have a correct approach to the stock preparation requires a complete understanding of different paper grades and furnishes. After repulping, pulps that are hard to defibrate need to be deflaked prior to refining. Refining is the key unit process influencing the final properties of the paper. The entire process includes for example refiners, deflakers, cleaners, screens, pulpers and agitators and recycled fiber treatment when required.

However, finally customers do not care what kind of machines they have in the process. What matters is the end result which is how the fiber binds in the groove of the paper machine. The main target is that the papermakers can produce high quality paper and that

the machine suppliers add to their competitive advantage. In the mechanical, chemical and stock preparation business there are different competing approaches to solve customers' problems.

1.3 Historical Development of the Finnish Fiber Processing Machinery Industry

1.3.1 The Emerge of the Finnish Forest Industry

To understand the evolution of the Finnish fiber processing machinery industry it is first necessary to look at the origin of the Finnish forest industry as a whole. The heavy emphasis on the forest industry in Finland dates back to the founding period of this industry in the 1860's. Around that time inventions were made which enabled the use of wood chips in the paper making. This altered the value of forests completely. In this period Finland was a part of Russia as a Grand Duchy. The Russian markets formed a large home market for Finnish forest firms without having a customs barrier unlike the competing Western European paper companies. The railway links to Russia were excellent for transportation from the South Eastern part of Finland. Thus, besides the abundance of raw material, the major stimulus for the specialization of the Finnish forest industry was the closeness of a large home market. [2]

It probably can be claimed that a rise of an own works industry is an indispensable prerequisite for a stable and extensive industrialization and economic growth. A country should be able to manufacture at least the most valuable machines needed by the most important and expanding industries. The industrialization can not be fully reached if there is a lack of own production of these machines. [3] In Finland among the most important and expanding industries is the paper and pulp industry which has been the pulling force for the development of the forest related works industries.

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[2] Lilja et. al 1992

[3] Alho 1978

Starting from the last decade there has been a trend of consolidation of the Finnish forest sector including paper and pulp companies as well as fiber processing machinery companies and other engineering works. In recent years particularly the machinery sector has undergone extensive restructuring with a series of mergers and acquisitions. A similar trend is also seen globally.

1.3.2 The Evolution of the Fiber Processing Works [4]

The Changing Role of the Finnish Engineering Works

Typically, the first works were developed to fill the maintenance and repair needs of the saw industry. Later either the business scope of these works was expanded into reparations of pulp and paper mills, or paper and pulp mills founded themselves simple works within close location to fulfil their maintenance and reparation needs. Gradually the works started to manufacture own products. The Finnish pulp and paper industry became the driving force for the development of the fiber process engineering works.

As the Second World War started and the Soviet Union attacked Finland the production of the engineering works had to be changed to serve the emerging needs of a war economy, by manufacturing grenades and war material, for example. The war caused a shortage of foreign machines as the international trade collapsed. In order to continue business, those mills without own works were forced to establish them and start machine manufacturing. After the war ended the most factor and works capacities were bound to the reparation strain. Many years the production had to be directed to the manufacture of products going to the Soviet Union. Finally the focus could be shifted back to the original businesses.

Through obligated engagement in the war reparation business many of the companies gained valuable knowledge. For example, as the Soviet Union did not necessarily give any instructions how to produce something companies were forced to be innovative and to find

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[4] This sub-chapter is based on company interviews and for example on following literature: Carpenter 1987, Kaukoranta 1981, Laurila et al. 1968, METLAS 1984. However, the references are not separated because the same facts came up in various contexts.

solutions of their own. Many of these companies lived through wealthy times as money from neighbor country's huge orders floated in.

Connections established during the reparation period yielded also business in the future. The first exports, thus, were directed to the Soviet Union. The Eastern trade was very profitable for the Finnish works and the entire country was quite dependent on this trade system. In the 1970's, then, the Western exports came into the picture. The following decade can be considered as a break-through when Finnish companies really pushed themselves to the Western markets. Today the main business areas are North America, Europe and Asia increasing its importance constantly.

Technological Development

The invention of machines that could form paper continuously occurred as early as in the late 1700's. When looking at the pulping technology, the first method to be used was the stone grinding enabling the production of the first mechanical pulp suitable for making paper. This was in the mid-1800's and at the same time the manufacturing of stone grinder machines begun. The second company in the world to manufacture the grinders was Oy Tampella Ab of Tampere since 1868. It was and still today is (belongs to Valmet Corporation) the only Finnish company in this line of business. Gradually some older technology was replaced by more advanced technology of that time. In the 1920's Tampella undertook the construction of continuous grinders under licences from Warren and Fuellnerwerk followed later by other licences. The first machines were delivered to the domestic paper mills, and after the 2nd World War Tampella started to build the grinders also for the world market. In 1955 a licence agreement with the Great Northern Paper Company terminated, but, however, Tampella continued to build grinders based on the general Great Northern-Waterious design, identified as the two-pocket, Tampella hydraulic grinder.

The first attempts to produce mechanical pulp in another way, by disk refiners, were made in the 1950's. There were no Finnish companies pioneering this technological development. A little later, though, Finnish Enso-Gutzeit Osakeyhtiö (whose works today belong to A. Ahlstrom Corporation) entered into an agreement with Bauer to manufacture Bauer's double-disk, counter-rotating grinder. Jylhävaara Engineering Works of the United Paper Mill (today called Sunds Defibrator Jylhä of Repola Corporation) was established in 1940. The first refiner was manufactured in 1954 based on own design. Thus Jylhävaara engaged

in the stock preparation business. The next step in the refiner technology was the thermomechanical pulping (TMP) introduced in the beginning of the 1970's. Jylhävaara's first TMP-system was taken in use in Kaipola mill in 1975 when Jylhä rebuilt its RMP-refiners according to its latest technological development. In the following year Enso-Gutzeit manufactured its first TMP-system under Bauer's licence for its own paper mill in Summa.

Another coming of the grinders happened in the 1980's when Tampella Papertech (bought by Valmet Corporation in 1992) developed a new technology called pressurized grinding system (PGW). Thus, the Finnish technical skills have had a significant contribution to bringing the grinding process to its present standard. However, again in the late 80's and in the beginning of the 90's the pulping process based on modified refiner technology has to a large extent set PGW aside.

The invention of the first methods for chemical lignification of wood dates back to the 1860's (the chemical soda method) and 1870's (the sulphite method). The first engineering works were established in Sweden and in the United States. The first Finnish sulphite plants were built in 1885. The global pulping technology development continued rather steadily through decades. In the past few decades the sulphite method has been superseded by a new, environmentally friendlier sulphate cooking. The first cooking system was based on batches. Then in the 1950's the continuous cooking set aside the batch cooking due to its energy economy. First everyone aimed to the continuity in the process industry, but later it was understood that continuous cooking is not qualitywise as good as cooking done in batches. The quality of same material can vary from time to time, and in batch cooking the cooking conditions can be adjusted to the changes in the raw material faster do to the shorter run-through time of the process. In the development of cooking technology Sunds Defibrator Pori has been in the front with some other companies. This development work is based on the work started already by Rauma-Repola Pori Works, the predecessor of the present Sunds Defibrator Pori Oy.

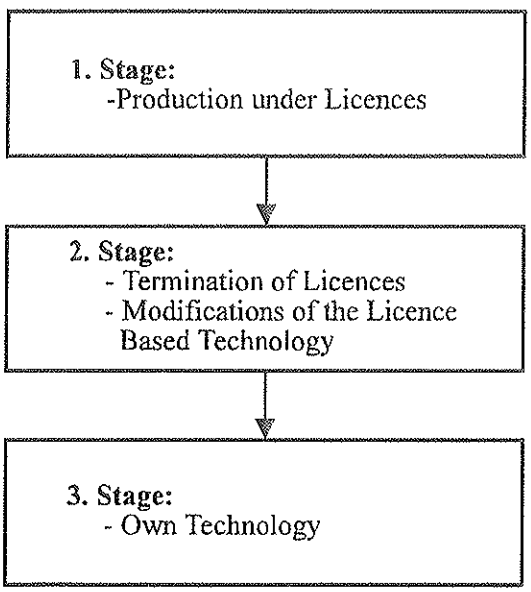
There are also two remarkable technical changes in the chemical pulping in which the engineering works have played a comprehensive role. The first was the development of Medium Consistency (MC) technology which allowed a switch to pulp displacement lines of medium consistency in the 1980's. This technology was developed in some kind of co-operation between Ahlstrom Machinery and Kamyr. Ahlstrom Machinery had a great input in the development, but now both companies consider it as its own. Another change related to the environment is taking place presently. The customer of the 1990's wants chlorine free paper. This process is changing the bleaching technique from the traditional chlorine

bleaching to oxygen bleaching. The solution provided by Ahlstrom is using ozone in the process. As the environmental issues steer the development direction, the trend in the chemical pulping is towards mills with closed circulation systems by which the environmental impacts can be minimized.

When comparing the fiber processing industry to some other industries, for example to the information or the communication industries, historically no real jumping steps from stages to stages has taken place. Even though there are break-throughs the technological development has been rather increment. Same production machinery capacity in mills can be under operation at least 20 years. The paper and pulp industry is a form of production that changes very slowly. As new investments are huge the customer is not willing to take any big risks.

The Tampella case presented in the beginning of this sub-chapter is a typical example of how Finnish fiber processing machinery companies have first diffused technology from abroad via licences. Then after terminating the agreement they have continued to modify the machine based technology on the acquired one. Gradually own technological innovations and break-throughs have overcome the licences. This kind of path has begun at different times in companies reflecting to a large extent the emerge of the divergent pulping processes. Also the speed in which the companies have moved along the path is company specific. It must be noted, though, that there are some exceptions to this stages of development.

Figure 2: A Typical Development Path of the Finnish Fiber Processing Machinery Industry



In the 1960's as a result of co-operation with its clients the Finnish paper and pulp machine manufacturing industry as a whole was capable of manufacturing almost all the equipment required in this field by using both licences, own licence based technology and truly own technology. Today own technology play the most important role, and licences are becoming rare. Only one of the interviewed companies still today uses some licences, even though the technology is own to a great extent.

1.3.3 Factors Affecting the Geographical Location

Paper and pulp mills have built works near the production facilities. Thus the works were located according to the mill location. Geographically, there are three visible trends affecting the choice of a mill location. In the last century the water power was the most influencing factor. Mills were built by the rapids regardless of the production related transport costs which could be high. On the other hand, transporting wood through water ways was advantageous. From these times there are mills for example in Kuusankoski, Äänekoski, Mänttä and Tampere. Later the transport conditions have played an important part when choosing the mill location. The coastal towns provided chances for a good place for an export harbor where at the same time was sweet water available. Examples of these are Pori, where today is located one of the leading suppliers of the chemical pulping machines, Rauma which is only 50 km from Pori as well as Kemi, Oulu and Pietarsaari. Later, a third factor having a decisive role in the mill location is the wood raw material and its transport distance. As a result of this trend there are Kemijärvi, Uimaharju, Kuopio and Kaskinen mills. Because in different periods different factors have determined the location of a paper or pulp mill, there are paper and pulp industry all over the country. [5] All the fiber processing machine manufacturers are located near its main customers in Southern Finland.

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[5] METLAS 1984

2. CASE STUDIES OF MAIN FINNISH COMPANIES IN THE INDUSTRY

2.1 Ahlstrom Machinery

A. Ahlstrom Corporation is a global, diversified, privately-owned Group with net sales of FIM 10.8 billion for 1993. The personnel strength is 11,000 of which approximately one-half is working outside of Finland. The company is founded in 1851, and today operates on the leading edge of the pulp, paper and power technologies. The four sectors are: Ahlstrom Machinery, Ahlstrom Pyropower, Ahlstrom Paper and Ahlstrom General Products. Ahlstrom Machinery delivers machinery, equipment and systems for the pulp and paper industry as one of the leading suppliers in the industry. Ahlstrom Pyropower's product range covers industrial and utility boilers including the sector's leading product Pyroflow Circulating Fluitilized Bed Boiler. Ahlstrom Paper's core products are filter papers, release base papers, wallpaper base and other speciality grades. There are paper production in Finland, Germany, Italy, the USA and South Korea. Ahlstrom General Products include packaging materials, glass and plastic containers, cores and board, insulation materials, and electrical accessories and glass fiber. Its position is strong in the Nordic countries.

Ahlstrom Machinery supplies fiberline and chemical recovery expertise for pulp mills, recycled fiber pulp mill systems, and machinery for fiber treatment and transfer in paper mills (stock preparation machines). The environmental aspects of the products and processes are carefully considered in designing systems. Solutions for the treatment of mill effluents, sludges and flue gases are an important part of the product scope. In addition, the sector offers project financing capabilities that span the entire scope of supply.

Main Products

The scope of supply is wide. It ranges from a single process machine to a large turnkey plant, and also the process equipment such as pumps, mixers and agitators, and cleaners are produced. The main business is fiber processing in which the entire process is important.

Pulp Washing. A new washing concept developed by Ahlstrom offers considerable advantages to pulp mills. The concept is based on a multistage washer - the Drum Displacer - which carries out several washing stages in a single drum. Mill experience with DD-washing has demonstrated that high efficiency is achieved with submerged washing under air-free conditions. The rapid response control system and the compact liquor system guarantee easy, reliable operation. Finally, the single unit process with proven drum design reduces the maintenance requirement to a minimum.

Pulp Screening. Ahlstrom provides machines used in knot separation, screening of unbleached pulp and screening of bleached pulp. The company has been solving screening problems for 100 years. Attention has always been paid to the systems themselves. This gives a good background for meeting and solving new screening problems.

Pulp Cooking. By acquiring an American company, Kamyr Inc., in 1990 Ahlstrom progressed further in high cooking technology. Kamyr Inc. is one of the leading suppliers in this field with the continuos Kamyr cooking system.

Pulp Bleaching. Ahlstrom has created a unique approach to the bleaching of chemical pulp: all unit operations take place under Medium Consistency (MC) conditions. A new washer - the MCDD - plays a central role in this approach. The installation of sophisticated MC process components throughout bleaching plants for example ensures good washing between bleaching stages, and guarantees low chemical consumption. Both economic and environmental objectives, reducing operating costs and effluent discharges, can be achieved with the MC technology and the MCDD washer.

Stock Preparation and Secondary Fiber Systems. These comprise processes such as stock screening and cleaning, fiber recovery and dewatering, bleaching of mechanical pulp, broke handling and recycled fiber treatment. Medium consistency and hydraulic pressurized technologies create great opportunities for improved efficiency in several stock preparation unit operations. Ahlstrom is a pioneer in these technologies.

Technological Developments

Ahlstrom Machinery has a long history. The first business was the manufacture of pumps, and gradually other equipment for fiber processing was added to the production line. During the 20th century there has been two specific features of advancing in technology. In 1930's-

1950's new technology was mainly acquired by licence agreements with some foreign companies. The company's target has been to obtain a full process line covering the entire process. A dominating feature for 1980's-1990's are company acquisitions, through which Ahlstrom Machinery has obtained new technology and fulfilled technological gaps in the process. Another reason for these acquisitions was the penetration into new market areas. The latest noteworthy acquisition was Kamyr Inc. in 1990. That made Ahlstrom Machinery one of the leading suppliers of cooking systems for pulp mills and gave the company more strength in North America.

Today there are only a few products manufactured under licences. However, Ahlstrom Machinery's case is another good example of how Finland has diffused technology and then very skilfully applied it to the own production.

Besides licences and acquisitions Ahlstrom Machinery has focused on own technological development with good results. Examples of these are Punched and Slotted Screen Plates developed for screening the in 40's, and Medium Consistency (MC) technology, a significant invention from the 1980's. One of the latest focus has been on washing technology resulting in Track Displacer system. Even though own input in research and development is most valuable, there is co-operation with Finnish buyers, research institutes and universities. The company has had quite significant joint projects particularly with the buyers.

At the moment R&D on the fiber technology is divided between Ahlstrom Machinery in Finland and Kamyr Inc. in the United States so that the Finnish responsibility is on fiber processing, physical characteristics, mechanical handling, screening and pumping among others whereas the American counterpart takes care of cooking chemistry and bleaching technology. Essential steps towards developing an environmentally benign pulp mill of the future have been taken. Recycling of fibers, chemicals and recovery of energy will all be areas of future expansion.

Appendix 4 summarizes Ahlstrom's product and company acquisition milestones during its 100 years of history.

Competitive Advantage

As a corporation, Ahlstrom's purposeful and increasing commitment to research, product and corporate development as well as operations in global markets ensure the company's continuos advancement. Own related and supporting industries create synergy in between and boost an advantage that draws from the wide range of supply. Ahlstrom Machinery benefits from Ahlstrom's global presence in the pulp, paper and power industries, links to the Paper Sector, a global speciality paper manufacturer, and to Pyropower as a leading force in developing environmentally safe combustion technology. Ahlstrom is also one of the leading suppliers of pumps to the pulp and paper industry. These offer opportunities for the sector to better serve customers. In addition, the company's scope of supply is very complete and flexible adjusting to the customer needs.

Ahlstrom Machinery's main strengths are the high technological level and the quality of products. According to the customer feedback the company is valued as a supplier of high technology and has a wide product scope with a high quality level. Developing next to the pulp and paper industry, and having an own mill in the corporation have benefited the company. As the result, the company has a deep understanding and knowhow of an entire process and the communication skills with customers.

The legal win over the Kamyr selling rights debate with the Norwegian Kvaerner strengthens the company's position. Ahlstrom Machinery and Kvaerner had earlier divided markets for the special Kamyr cooking system so that the Finnish company had rights to sell and market these products in North America, Mexico and South Africa. Later the parties came to a disagreement. This win opens broad new avenues for the company as it and Kvaerner are the only ones in the world having the advantage of being capable of supplying the entire pulp mill including also recovery systems.

An advantage compared to the competitors is that Ahlstrom Machinery is extremely international since long ago. The paper and pulp industry used to be quite local but is now internationalizing at an increasing speed. Ahlstrom Machinery is already there, and the match is believed to be good.

The corporate identity is the sum of all efforts, the attitudes and the actions of everyone who works for Ahlstrom. Machinery people are taken as a particular strength. The company values them as most talented and dedicated in the industry, whose innovative concepts and solutions help the sector meet customer needs. This statement is backed with the fact that in 1992, while the global recession impacted customers, orders booked with the company

were at a high record. Thus, inputs in strengthening the corporate identity have begun to yield some results, not only externally but also internally. Ahlstrom claims that the values and principles by which it operates make it unique, strong and competitive. Its Corporate Identity is the essential element of continuity and future success.

2.2 Sunds Defibrator

Sunds Defibrator is one of the world leaders supplying fiber processing technologies and offering a comprehensive product range in the industry. The annual sales amounted to FIM 2.0 billion with 2,650 employees in 1993. The company can deliver complete fiber lines from the woodhandling to the end product. Sunds Defibrator is a Swedish Corporation headquartered in Sundsvall, Sweden. It has total eight Finnish subsidiaries two of which are in the interest of this study: Sunds Defibrator Jylhä (former Jylhävaara Engineering Works) producing mechanical pulping machines as well as stock preparation equipment and Sunds Defibrator Pori (former Porin Tehtaat of Rauma-Repola) being a supplier of chemical pulping processes. However, after a series of acquisitions in 1991 the Finnish Repola Concern owns now the Finnish Rauma Group which in turn owns the whole Swedish Sunds Defibrator Corporation.

Sunds Defibrator's business areas include: woodhandling, chemical pulping, high-yield and mechanical pulping, dewatering, drying and baling, stock preparation, recycled fiber, panel board, and refiner segments as well as customer service and support. All basic engineering, manufacture of equipment and installation, as well as personnel training and supervision of plant start-up are included in the contract. Thus, the company can deliver all main process equipment to the mill. The only component missing in the chemical pulping processes is the recovery system which constitutes about the half of the entire pulp plant. However, this does not weaken Sunds' position because of the nature of the pulp mill construction. The recovery and other parts of the pulp mill are bought separately. Thus, being without the recovery system does not exclude Sunds from any possible contract.

The R&D activities focus on cost-efficient technologies that meet the demand for environmentally friendly, energy-efficient fiber production solutions with an optimal raw material yield. The Group comprises engineering, sales and service companies and offices in all major forest products countries. The main markets are Scandinavia, Europe, North America, South America and Asia.

As the general trend today, Sunds Defibrator's technological focus is on the environment, and among others on the chlorine-free pulping. The company consolidated its position in this field with a market introduction of the Sunds Defibrator Totally Chlorine-Free (TCF) Fiber Line in 1992. The company has established itself as a technology leader in responding to the industry's increasing demand for TCF production capacity. The TCF fiber line eliminates chlorine chemicals and reduces the overall effluent load, while improving total operating economy.

2.2.1 Sunds Defibrator Jylhä Oy

Main Products

Mechanical Pulping. The product range in the mechanical pulping is also covering. Some examples of these are filters, mixers, pulpers, and thickeners. However, these are not introduced more deeply, because the superiority of the refiner segments was strongly emphasized in the interview.

Refiner Segments. The company supplies segments and fillings for all types of refiners. Keeping in mind that the customer is mainly interested in the end quality of his product, what in the process matters in the last resort is the refiner segment. It gives the final qualities to the pulp before it enters into papermaking. In addition, the proper choice of segments increases capacity and cuts operating and maintenance costs. Thus, the components of the refiners, refiner segments, are the outmost important products for Sunds Defibrator Jylhä.

Stock Preparation. The company supplies a complete range of equipment and modern product lines for stock preparation of chemical, mechanical and recycled fiber including slushing, deflaking, refining and broke handling. The main products are repulpers, refiners and deflakers.

Technological Developments

Research and development are divided so that Sunds Defibrator Jylhä concentrates on fiber processes and recycled fiber, whereas Swedish have the responsibility of TMP-technology. However, the company does not distinguish itself from the Swedish counterpart when speaking about today's research, new innovations and technical knowhow. The approach is rather Nordic.

Technical advancements have been obtained to a great extent through own innovations and close co-operation with Finnish paper mills, especially with Kaipola which is within the same corporation. In the beginning of the 1960's the building of two big paper machines in the parent company's mill impulsed Jylhävaara to broaden its product scope. As a result of own development the company started to manufacture many new products.

As a result of company's own technological development, the manufacture of conical refiner was started in 1976. With some modifications it became a distinctive break-through product in the beginning of the 1980's. Around that time also Conflo-segments begun to capture markets. Within the mechanical pulping United Paper Mill's PM 6 represents a major advancement utilizing TMP for ultra high quality SC-paper.

Stock preparation technology has been under constant development since the 1950's. Focus has been traditionally on refining. The Valkeakoski pilot plant has enforced the R&D efforts. Conflo refiners were introduced in the early 1980's featuring a unique design in the market. Preflo-repulping and Deflo-deflaking judicate promising potential for defiberizing optimization and energy savings in the stock preparation process.

Competitive Advantage

There are various corporate wide advantages of which each company benefits. For example, Sunds Defibrator has a strong emphasis on the customer service. Sunds has invested in customer relations by having a Customer Service division and by opening up new local service units. Sunds Defibrator's Services is leading the way in the development of new business partnerships with customers.

A strength is also having an own process machinery manufacturing which improves the operations of the other units. For example, a new production planning system was

introduced in the Pori unit in 1992. This system is designed to achieve shorter lead times, distributed decision-making, accurate response to changes and more efficient utilization of resources. Also the Finnish and Swedish companies complement each other's production lines. Savings in expenses take place when joining the resources together. One of the central features in the competitive advantage is the control of an entire chain: the company has plant deliveries, maintenance of the production capacity, refiner fillings and customer service. The customer is hold on tightly.

After the acquisition by Swedish Sunds Defibrator the both Finnish companies, Jylhä and Pori which will be presented in the next sub-chapter, gained an advantage of the worldwide network that the parent company had developed. This gave a straight, fast and inexpensive access to the global markets through the infrastructure such as market channels, for example, and certain customer contacts that already existed.

One of keys to the success along the years have been the Jylhä people. There have been especially innovative and talented persons dedicated to the company. In addition, having a paper mill within the same company and growing together with it has given a solid background for being in the fiber process business. The United Paper Mills has been one of the impulsers. It has been setting requirements, and for example TMP-approaches have been developed in co-operation.

An advantage is gained also through R&D and a differentiated technology which is based on improved understanding of customer needs. No one else has the same kind of refiners in the stock preparation.

2.2.2 Sunds Defibrator Pori Oy

Main Products

Sunds Defibrator and its counterpart in Sweden have divided chemical pulping processes so that the Finnish company has technological responsibility for cooking equipment and drying machines. The development of other parts of the process is taken care of in Sweden. Adding the product ranges of the two companies results in a comprehensive process from woodhandling to baling, the only missing component is recovery. The marketing

responsibility is divided accordingly with the logical exception that Pori handles the entire Finnish market as well as Russia, and the Swedes take care of all marketing in Sweden. In addition, on case-by-case basis this geographical division of the market area has been different in some projects; for example often the Finnish export credits favor the delivery from Finland rather than from Sweden.

Cooking. As a result of extensive research and development work Sunds Defibrator Pori can today offer the SuperBatch cooking process utilizing modified cooking chemistry. This makes extending of delignification to kappa number[6] 10 possible without losing pulp strength. The new batch cooking system has proven its superiority compared to other cooking methods as to energy consumption, pulp quality and flexibility.

Drying. To save energy and to improve sheet quality in the pulp drying process, the company has developed a twin wire concept called PressFormer. Because the pulp is dewatered between two travelling wires and the water is mechanically removed from the web, no vacuum pumps are needed. This in turn means substantial energy savings as the PressFormer energy consumption is less than half that is required for a conventional Fourdrinier-type machine.

Technological Developments

The company emphasizes four elements in the technological development: economy, flexibility, environment and quality.

There are at least three break-through technologies. Firstly, in the 1950's the pressure washing, invented by the former mother company Rauma-Repola, started to capture the world. Secondly, an American company, Beloit Corporation, can be considered as one of the forefathers of the new modified batch cooking technology which has led to the present SuperBatch cooking process. Rauma-Repola had a licence from Beloit during the 1980's until 1988 when the co-operation was ended by the merger of the pulping technologies of Rauma-Repola and Swedish Sunds Defibrator AB. The cooking technology was developed further. As a result, the emerged new, more advanced batch cooking process technology,

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[6] Kappa number represents the final pulp hardness impacted by the cooking time and temperature; the lower the number, the better

SuperBatch cooking, is Pori's most remarkable technological break-through. Thirdly, the development of the PressFormer dates back to the 1980's when Rauma-Repola owned the company and started this project in co-operation with a local engineer. Though this drying machine the company was finally able to penetrate the Swedish market.

After merging with Sunds Defibrator in 1988, a wide product rationalization took place. SuperBatch cooking and PressFormer drying technology were kept in the product range. Swedish Sunds Defibrator had also developed a modified batch cooking process, but Pori's batch version was selected as the basis for the SuperBatch due to technological advantages. Therefore, the technological and marketing responsibility were left in Finland.

1992 was a milestone year for Sunds Defibrator in the chemical pulping. One of the two events that highlighted activities was the start-up of the SuperBatch cooking plant at the Enocell Uimaharju mill in Finland. The proprietary SuperBatch cooking process is the most recent in series of technologies that are making it possible for pulp and paper manufacturers to eliminate virtually all chlorine-based bleaching chemicals. It also allows low kappa numbers in cooking which drastically reduces the use of bleach chemicals. SuperBatch cooking is recognized as the most selective and energy-efficient cooking process.

Competitive Advantage

Same corporate wide advantages that were discussed above in Sunds Defibrator Jylhä's case apply also here. In addition, a wide and covering product range provided by Sunds Defibrator Pori and its counterpart in Sweden certainly add to each units' competence. The entire concept presented in slogan - From Wood to Bales - is an advantage. No one else can supply a complete fiber line. To connect these processes demands a particular knowhow which creates advantage. Having good woodhandling and cooking sets the starting point to a higher level. In that sense the company can deliver the best pulp to the end line.

Some other advantages are the quality of pulp and its even level. Flexibility based on cooking in batches adds to that as different pulps can be run at the same time. With the automation also the continuity advantage of the continuos cooking has diminished as the batch systems have employed with automatic systems. The advantage of PressFormer is that it saves over the half of the energy what a typical drying machine requires.

Having parent company owned mills (Rauma mill and Joutseno-Pulp) within the corporation has again become an advantage. Through joint development work with them the works has gained understanding and knowledge. The mills have also served as trial plants for new prototypes.

2.3.Valmet-Tampella - Stock Preparation

Valmet Corporation, a leading international industrial group with the headquarters in Finland totalled to net sales of FIM 10.7 billion in 1993. Exports from Finland and income from operations outside Finland accounted for 83 % of this figure. Valmet's operations employing some 16,000 persons encompass the globe. They focus on serving the pulp and paper industry and meeting the needs for advanced transportation technology. During the 1980's the Corporation went through a true internationalization process by acquiring companies outside Finland. Today Valmet has its own production in all continents, and sales and service outlets in all of the main markets.

Valmet Corporation consists of five divisions three of which are under pulp and paper industry. These include Valmet Paper Machinery, Valmet-Tampella and Valmet Automation, as the remaining two are Saab-Valmet and Valmet Aviation Industries. Valmet-Tampella includes eight companies: Tampere producing board machines and related equipment, Stock Preparation including process systems and other machinery for fiber treatment, Valmet-Karhula Inc. being responsible for paper machines and related equipment, and four other companies outside of Finland concentrating mainly on the paper machinery. Some structural changes have recently been taking place. For example, Groundwood Systems was included under Stock Preparation in the beginning of the 1994. Both these units were acquired from Tampella Papertech of Tampella Corporation in the spring of 1992.

Main Products

Stock Preparation. Valmet-Tampella supplies almost all equipment for the stock preparation including machine screens, broke and bale pulpers, agitators, cleaners and defiberizers. The missing ones, deinking and refiners, are acquired from subcontractors. The

company presents itself as a process supplier rather than a supplier of certain products. However, strategically the most important product is Tap Screen. This new pressure screen has been developed for optimum screening of mechanical pulp, recycled fibers and virgin pulp. Its strengths are better efficiency, lower power consumption and easier access to the screen cylinder and rotor for cleaning and inspection.

Groundwood Systems. The main product is grinder. Different grinder types are produced for wood of different length.

Technological Developments

The emphasis of R&D is on screening equipment which is used in stock preparation, in short circulation and in broke handling. At the moment there is no production under licences, all technology is own.

Internationally speaking, in the end of the 1980's some problems with the screening came up. The conventional technology was complicated and a lot of calculations and simulations were made, but no one concentrated on the machine itself. Tampella Papertech's stock preparation business was initially started by producing screens and pulpers with a licence from Black-Clowson which provided the initial technological base for the development of TapScreen. Later the co-operation ended and the two companies became competitors. In 1987 Tampella Papertech started to develop the screening technology. The result was a completely new technology as the concept of screening was thought differently in a revolutionary way. In addition to better runnability some new characteristics were added so that Tampella Papertech could eliminate some other machines which previously were necessary in the process. The first TapScreen was launched into the market in 1989. It is suitable for both the mechanical pulp and the recycled fiber. In 1993 two new twinwire machines were developed.

Valmet-Tampella is the only supplier of pressure groundwood (PGW) machines in the world. Some other companies supply grinders of different types. The development of the grinder technology follows the typical Finnish path from technology diffusion via licences through terminating the agreement to modifying the technology obtained from licences. The competitiveness of the traditional grinding process started to weaken in the 1970's as the thermomechanical pulping (TMP) entered strongly to the market. It gave more strength and used less energy. Around that time Tampella started to develop the traditional grinder

method further. The development of the new technology called pressure groundwood (PGW) is an exception of the typical development path. It begun as a Swedish engineer contacted the company and presented his ideas. The development was done in co-operation, but Tampella was the manufacturer. The first trials were made in 1977, and two years later the machine was taken into operation. The success time of the PGW-technology was from the beginning of the 1980's to the mid 1980's. Since the end of the 1980's the PWG-unit has encountered some difficulties, and there are a few technological unsolved problems even today.

Competitive Advantage

Valmet Corporation is committed in achieving customer satisfaction through quality and creativity. Each of the products is designed to meet the highest standards in quality, runnability and maintainability. Valmet is known as a company with first-rate quality, reliability, flexibility and after sales service.

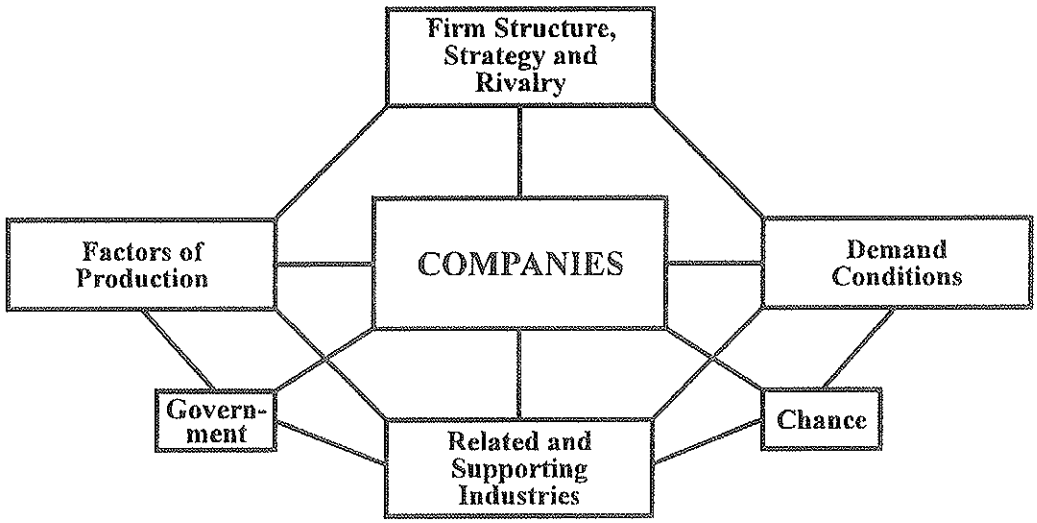
The competitive advantage comes through the entire fiber processing chain and through the key machine, TapScreen. Valmet-Tampella also offers the customers the "try and see" possibility to test their screens by providing a possibility to run a trial in the company's pilot mill or leasing a screen from the company. This is possible because the screens are relatively easy to move around and place in the customer's mill next to their present screens with a double coupling. Thus the customer can try and compare the results. At the same time the supplier gets fast feedback. This creates a positive attitude as customers can test the equipment without any bounding commitment to buy it. Having good user-producer relations is an advantageous way to operate.

Pressure groundwood does not have a competitive advantage in the fiber processing machinery market at the moment due to technological deficiencies. However, it has success factors that earlier enabled the company to win contracts. These include the best printability in paper, lowest electric energy in mechanical pulping, and lowest biological and chemical oxygen demand. But without solving the technological problems the demand for PGW machines will not increase.

3. TOWARDS COMPETITIVE ADVANTAGE THROUGH PORTER'S DIAMOND MODEL

In this chapter the competitive advantage of the Finnish fiber processing machinery industry is evaluated via Porter's diamond model. This is a widely used approach when the sources of the national advantage are being analyzed from the company point of view. According to the model the competitive advantage of companies is affected by factor conditions, demand conditions, related and supporting industries and firm strategy, structure and rivalry. There are also two environmental factors, government and chance, which can influence the conditions for the advantage.

Figure 3: Basic Factors of National Advantage



Source: Porter 1990

The purpose of this model is to examine the competitive advantage factors forming the concept of the real competitive advantage. In the long-run it is more important than a competitive price advantage that is measurable in individual factors of production such as wage level, for example. One can draw from the model at least four central observations:

(1) The self-created resources are more important than natural resources - the lack of the relative advantages can be substituted by innovations.

(2) Domestic market, particularly a sophisticated demand, has a central role in creating and sustaining the international competitive advantage.

(3) Companies in the related and supporting industries are needed for the creation of the competitive advantage - companies having abundantly goods or information flow based links with other companies and other industries are the ones succeeding.

(4) Rivalry among domestic companies producing supplementary products forces the companies to be efficient.

3.1 Factor Conditions

Physical Resources. Geographical location of Finland is often stereotypically considered as a hinder, but as the infrastructure has reached a high standard, for example far progressed telecommunication systems, this claim is no more valid. Conversely, the geographical location can be seen as an advantage for the Finnish fiber process suppliers. The market closeness, i.e. Finnish paper and pulp mills in Finland, has greatly influenced the formation of this industry. In addition, the location of Finland can be seen more like an image factor. Finland as a forest industrial country has a good reputation wordwide.

Raw Materials and Machinery Tools. Iron is the main raw material. The basic iron is obtainable in Finland. Outokumpu, a Finnish mining company, is today also capable of producing almost all the special irons fiber processing manufacturers need. However, due to lower costs and shorter delivery times they often are acquired from abroad. Machinery tools come from various different sources. Few of them are selfmade in own works, some come from other Finnish metal works, but most often they are imported.

Human Resources. One of the international advantages of the Finnish fiber processing machinery industry are highly skilled people. The driving force behind the technical advancements are the company people. During the historical development there have been strong characters innovating and steering companies towards success. The education level

in Finland is at a top filling the industry's needs. The supply of talented university graduates, most of which come from technical universities, as well as craftsmen is sufficient securing the continuity of the industry.

Infrastructure. The infrastructure in Finland is well established, but does not provide any special advantage because the infrastructures in competitors' countries are on the same level. Thus the present level of the Finnish infrastructure is more like a must than a competitive edge. It should be noted, though, that the high standard of the infrastructure and the far progressed telecommunication systems, which can be used for example in marketing and transportation, have also diminished the disadvantages of the geographical location far up in the north.

Concluding, the most important advanced and specialized factors of production which create, sustain and upgrade the competitive advantage for the Finnish fiber processing machinery industry are the human resources. Also the geographical location as an image factor boosts the advantage. On the other hand, basic and generalized factors which are vital for operations, but do not upgrade the advantage, include raw materials, machinery tools and infrastructure. At the present there are no selective factor disadvantages.

3.2 Demand Conditions

Home Demand Composition. Even though there are sophisticated and demanding buyers also elsewhere, it can be claimed that the Finnish customers of the fiber processing machinery are among the most sophisticated and demanding in the world. This has two reasons. Firstly, Finnish mills are geographically far from the important customers located in other countries. To overcome the higher transportation cost disadvantage compared for example to other European countries, the Finnish mills have had to lower their unit costs by expanding to the economies of scale and scope. As a result, the production capacity has been increased, mills have integrated their processes and product ranges have become wider. In addition, there has emerged a need for machines that can use all kinds of raw material. These have placed new needs on the machine suppliers. Secondly, in order to remain the reached top position in the world markets the paper and pulp manufacturers demand the highest possible technology available and a constant technological improvement. This in turn has acted as an adhock for the forest machinery suppliers to

upgrade and improve their product and process technologies by removing bottlenecks and experimenting with new ideas.

In addition, the buyer needs in the main markets, Europe, Japan and United States, are anticipatory meaning that in these areas buyers demand same kinds of machines and processes. However, in less developed markets such as South America or Asia these high-technology products are often difficult to sell without any modifications and simplifications.

Demand Size and Pattern of Growth. The demand of fiber processing machinery reflects the demand pattern of the end product, paper, to some extent. The use of paper follows the development of the gross national product. Demand for pulp, in turn, goes along the paper demand trend with a delay.

Taking into account that Finland is a small country, the size of the domestic demand has been relatively large. Finland has about one fourth of the global market share in printing papers of which basic raw material is the mechanical pulp. Also the Swedish market share is high. Therefore, the Scandinavian countries constitute one third or even more of the world's demand for mechanical pulping machines.

Due to the exceptionally strong recession in Finland the investments are close to zero at the moment and the demand for new machinery is almost non-existent. Today's business is mainly in modernizing and rebuilding old equipment. This applies also to the main paper and pulp producing countries. This has naturally had a negative impact on the machinery suppliers. On the other hand, there is some light in the future as it seems that the paper and pulp have reached the deepest bottom of the down-turn. Still the revitalizing of investments is not expected to happen until in 1995. In addition, Finland is among the few countries that at the moment is investing in new capacity as Metsä-Botnia is building one of the world's most modern pulp mills in Rauma.

Internationalization of Domestic Demand. Earlier the paper and pulp industry was to a large extent local, but recently the trend has been towards expansion abroad. The Finnish buyers have been internationalizing themselves fast by acquiring or establishing mills in other countries. They have often used Finnish suppliers for production machines and processes, thus pulling the domestic fiber processing machinery producers to the international markets.

Interplay with Demand Conditions. Domestic demand conditions are one of the most significant factors influencing the competitive advantage creation of the Finnish fiber

processing machinery manufacturers. Firstly, Finnish buyers are extremely sophisticated and demanding thus forcing the equipment suppliers to upgrade and innovate continuously. Secondly, Finnish buyers have drawn Finnish suppliers to the international markets with them. Thirdly, the buyer needs in the main markets are anticipatory. All these factors have a reinforcing effect on each other.

3.3 Related and Supporting Industries

Research and Development. The growing concern over our environment has shifted the focus of the research in the forest industry. Instead of concentrating efforts on increasing efficiency and improving quality, the main emphasis is on the environment. Particularly this is a concern of the chemical pulping industry. A Finnish scientific contribution to new bleaching technologies is enzymatic bio-bleaching. It boosts efficiently other bleaching processes resulting in lesser chemical need. Finnish industries consisting of enzyme producers, hardware manufacturers and pulp companies, for instance Metsä-Serla Group which is a pioneer of adopting environmentally friendly technologies, joined forces in the 1980's to conduct a five-year research programme with the Finnish Pulp and Paper Research Institute, and Biotechnical Laboratory of the Technical Research Center of Finland. The latest innovation that has reached the commercial stage is ozone bleaching developed jointly by A. Ahlstrom Corporation and Oy AGA Ab, with backing from the Technology Development Center TEKES. [7]

Overall it can be claimed that in Finland the R&D is of a high standard. There are research institutes, paper and pulp mills and machinery suppliers having joint and individual research projects. In addition, consulting companies providing associated services take a part also in R&D. A significant amount of Finnish R&D in the pulp and paper machine branch is carried out by the Finnish Pulp and Paper Research Institute in collaboration with the industry and its central organizations. Universities' input is mainly on the basic research.

Associated Services. An important provider of associated services have been the internationally successful engineering companies with a wide process knowhow. At the moment there is one particularly important Finnish consulting company, Jaakko Pöyry

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[7] Joensuu 1993

Consulting Group, providing services for both the paper and pulp producers and for the machine and process suppliers. Engineering and consulting companies often work closely with the paper and pulp mills when choosing from the potential fiber line manufacturers. The Finnish forest industry consulting companies having global connections and networks often are sources for technical innovations and providers of valuable data. The engineering companies have been creating a good image of overall Finnish knowhow in the forest sector. Their global connections have also been boosting the competitive position of the Finnish forest machinery manufacturers including the fiber processing machines as well as the Finnish paper and pulp producers.

Instrumentation and Automation. There are several Finnish, top ranking small and medium sized companies providing analytic instrumentation for the pulp and paper industry. Among others these include robotized on-line laboratories for quality control of chemically and mechanically produced wood pulp, robotized automatic analysis of liquid solutions and pulp bleachability, and analyzers capable of measuring the paper web very accurately both in machine and cross direction. [8] According to a competitive study conducted by Fadum Enterprises Inc. in summer 1992 Valmet Automation is the world leader in the automation systems for the paper and the pulp industry [9]. Another strong Finnish company in this field used to be Ahlstrom, but in 1992 it sold its automation to an American company, Honeywell.

Also in almost all related and supporting industries there are at least one Finnish world class competitor. In addition to the presentation above these areas include air systems, electrification, maintenance, valves and pumps without forgetting all other forest engineering works such as for example harvesters with over 40 % market share, transportation, reforestation, woodhandling machines, recovery systems, paper and paperboard machines, coating machines, calanders and paper cutters. This is a long list covering the entire process from wood to final product, paper. There are four major Finnish corporations involved in these businesses, three of which also supply fiber processing machinery: Ahlstrom, Kone, Rauma including Sunds Defibrator and three other subsidiaries, and Valmet.

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[8] Farrand et. al 1993

[9] Kujala 1992

The wide presence, probably the widest of all Finnish industry clusters, of related and supporting industries has a reinforcing effect on the competitive advantage of the entire cluster.

3.4 Strategy, Structure and Rivalry

According to Porter[10], it is very significant for the export success of an industry's products that there are various domestic firms competing with each other in the industry. The most important results of the competition among these firms are the creation of innovations and upgrading of the operations. Strong local competitors create and sustain the international competitive ability. The domestic competition can be tougher than the international competition because the competition personalizes in characters knowing each other. However, in Finland there are not very many domestic rivals in internationally successful industries. This applies also to the fiber processing machinery suppliers. Even though domestic rivalry exists to some extent, an adequate prerequisite for sustaining the competitive advantage seems to be that these companies are exposed to the global competition, and the government does not interrupt their ways of doing business by supports or protection.

The major Finnish companies involved in the fiber processing machinery business are the case companies presented in chapter 2: Ahlstrom Machinery, Sunds Defibrator Jylhä, Sunds Defibrator Pori and Valmet-Tampella. They all are among world's leading suppliers. Ahlstrom Machinery and Sunds Defibrator Pori compete against each other in the chemical pulping. In the mechanical pulping are involved Sunds Defibrator Jylhä and Valmet-Tampella. They have different approaches to the pulping so that the companies are not necessarily fighting for same projects. Sunds Defibrator Jylhä is in the thermomechanical pulping business whereas Valmet-Tampella's concept is pressure groundwood. In the field of stock preparation there are three Finnish players: Ahlstrom Machinery, Sunds Defibrator Jylhä and Valmet-Tampella. The latter two do not always compete directly with each other, their product ranges are more complementary as Valmet-Tampella has a rather complete product scope, and missing refiners are sometimes ordered from Sunds Defibrator Jylhä. (see figure 4 on next page)

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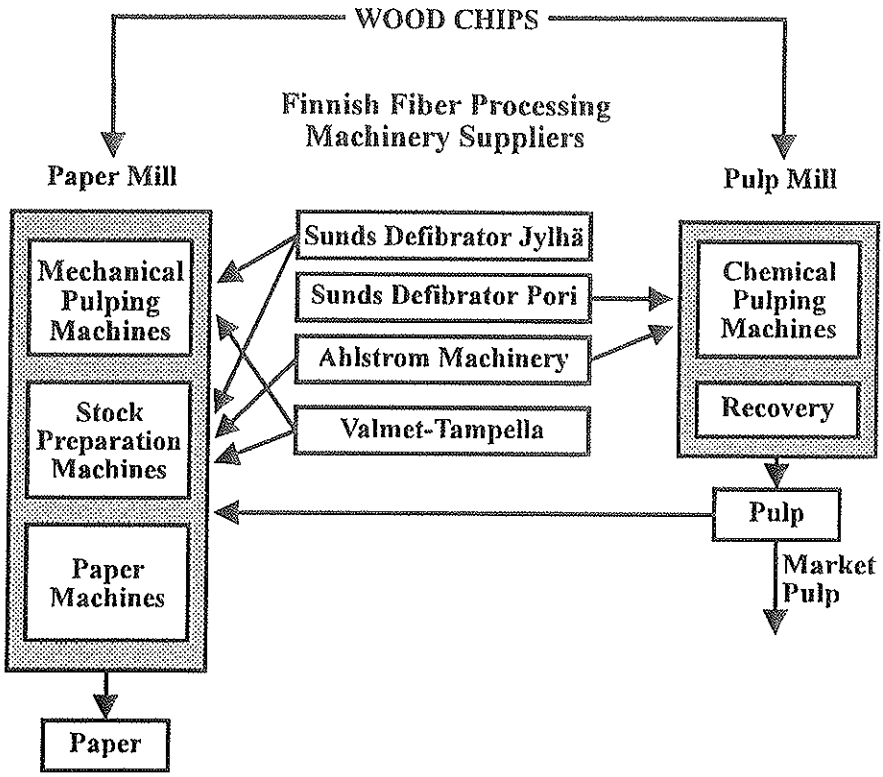
[10] Porter 1990

The competition arena of the Finnish fiber processing machinery producers is the globe. Same competitors are encountered wherever a project is taking place. The rivalry is tough pushing the companies to innovate and upgrade continuously. There is a risk of others trying to copy new technological improvements invented by someone. Therefore, giving a licence is considered a risky business. In recent years there have been quite many consolidations, acquisitions and mergers in the industry as the weaker companies have been undertaken by stronger ones. Another trend has been that companies have rationalized their product ranges by eliminating unrelated operations and moving more resources to the core business.

At the moment both in the chemical and mechanical fiber processing machinery industries there are only a few major competitors forming an oligopolistic market. In stock preparation the number of main companies is larger, and the competitive situation is more monopolistic. All the Finnish companies presented earlier are among the leaders in the industry with the exception of Valmet-Tampella's PGW unit.

Figure 4: Companies' Positions in the Fiber Processing Environment



In the chemical pulping processes there are no Central European suppliers that could be considered as suppliers of machines for the entire process. The competitors for Ahlstrom Machinery and Sunds Defibrator in that area come from the United States. Austrian company, Andritz Sprout-Bauer, produces some parts of the process, though. However, German speaking pulp and paper producers favor suppliers of their origin making it hard for other foreign companies to get a project there. The United States reminds German speaking countries in that respect. Due to the strong national feelings it is quite hard for foreign companies to establish themselves in these markets. As regard to cooking, there are two competing methods. Ahlstrom and Norwegian Kvaerner both have continuous cooking technology, Kamyr, which has been and still is the market leader. The most advanced competitor of the other method, batch cooking, is Sunds Defibrator followed by American Beloit Corporation and Austrian Voest Alpine.

A typical feature of the competition in the chemical side is that pulp mill investments are done in parts: the screening, delignification, washing, cooking equipment and other actual pulping machines as well as different parts of the recovery are bought separately from different suppliers. A good example is Finland's latest new pulp mill, Enocell, taken into operation in 1992. Fiberlines start with Ahlstrom's knot separators followed by drives from Hagglunds-Dennison, screening from Ahlstrom, oxygen delignification, and washing and cooking from Sunds Defibrator. [11] This makes the competition tougher, because companies often aim to be considered as process manufacturers, not just a single machine manufacturers. When the mill machinery is bought in parts, it is not enough to be able to deliver the entire process, but each single part must be the most competitive in order to get the whole project.

In the mechanical pulping the world markets are dominated by two other companies besides Sunds Defibrator: Austrian Andritz Sprout-Bauer and Norwegian Kvaerner's Canadian subsidiary Hymac Ltd. Even in Japan there are no other main competitors in this branch. Again, all three are there where the project is. In the 1980's Sunds Defibrator had about 40 % of the world TMP market share. Another 40 % belonged to Andritz and Hymac had the remaining 10-20 %. The competing method in the mechanical pulping, PGW, is clearly less used than TMP. The pulp for newspapers is regularly made out of TMP, whereas PGW is used only in some magazine papers. The grinding markets are mainly divided between Valmet-Tampella and German Voith. Tampella's projects were probably about 30 % of Sunds Defibrator's corresponding ones in the 1980's.

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[11] Hospod et al. 1993

In the stock preparation business the main global competitors besides Ahlstrom Machinery and Valmet-Tampella are: American Black-Clawson, French Lamort, and German Sulzer Papertech and Voith. However, the market shares of the foreign competitors are quite much higher than the market shares of the Finnish companies. It must be noted though, that the competitors are mainly paper machine suppliers. In addition, there are some smaller companies, or companies with a narrow product range in the international markets. Escher Wyss is the leader in the recycled fiber treatment, and bases almost all its operations on it.

3.5 Government

Environment. The environment has been taken into consideration by tight norms set by the government. Due to this companies have had to develop better methods and equipment. As a result, the Finnish companies are considered as producers of products that fully meet the ever increasing environmental demands. This has boosted the upgrading and improving of the competitive advantage, and has thus given an edge to the Finnish forest sector including the fiber processing industry.

Energy. The recent decision made by the Finnish parliament not to build a new nuclear power plant is a misfortune to the forest industry. When turning down the building of a new nuclear power plant the parliament took no position on how Finland's energy needs will be met in the future. The mechanical pulping is especially energy intensive. If an energy gap evolves increasing the price of energy substantially the investments in the mechanical pulp production will have to be reviewed.

Financing. The fiber processing machinery manufacturers are mainly satisfied with the Finnish financing system. There has been money available when needed. The government has directly supported the innovation promoting, and the aid has come through different governmental institutes and joint projects.

Politicians. Often the Finnish political elite has risen from the forest sector institutions, for example this is the case with various prime ministers and presidents. Thus, the Finnish political institutions have traditionally had an intimate understanding of the interests of the forest owners and the forest sector. Good personal links have convinced the government to

look after the viability of the forest sector. Strong interest organizations and a political representation have secured state support for the forest cluster development. [12]

3.6 Chance Events

There are two so called chance events that have given a substantial stimulus for the development of the Finnish fiber processing industry. These are the 2nd World War followed directly by the reparations to the former Soviet Union [13]. Lack of exports forced companies to start own manufacturing, and thus adapt the existing technologies and also be self innovative. After the war, to pay the bill to the Soviet Union gave a strong stimulus to the industrialization of the country.

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[12] Lilja 1992

[13] See sub-chapter 1.3.2 for more detailed explanation

4. COMPETITIVE ADVANTAGE OF THE FINNISH FIBER PROCESSING MACHINERY INDUSTRY

4.1 The Modified "Diamond" - Factors Affecting the Creation of Competitive Advantage

4.1.1 Network Relations

Perhaps in no other country are there so many forms of co-operation and pooling of resources as in the case of the Finnish forest cluster, particularly in the paper and pulp industry. They have had co-operation and joint ventures in all kinds of business modes. The most significant collaboration comes in forms of the joint sales associations for the various forest industry products. This co-operation dates back to the 1880's when it was started for the Russian markets and it still continues today. Due to this the Finnish paper and pulp producers have secured good visibility in the markets providing an advantage also for the fiber processing machinery suppliers. The Finnish forest sector as a whole has a very good image and is highly valued.

However, from the machinery suppliers' point of view, this kind of intensive domestic co-operation can have an disadvantage, too. Especially Central European paper and pulp mills may fear the Finnish machinery suppliers as a part of "the Finnish Mafia". They recognize the close Finnish network systems and intensive co-operation between the Finnish paper and pulp producers and the machinery suppliers. Some of them do not want to use Finnish suppliers because of being afraid that their technologies and innovations will leak to the Finnish competitors via the Finnish machinery suppliers.

The specialization of the Finnish forest cluster has resulted in a high concentration of globally competent corporations which have production facilities and production communities geographically close one another. This has boosted the competition for improved and upgraded products and production processes. There are various mechanisms allowing the rapid diffusion of innovations across the company borders. These mechanisms consist of the closeness of the various paper and pulp mills to each other, networks derived from the educational institutions, a joint R&D institute, suppliers of machines which also

often are located near the mills as well as suppliers of miscellaneous components, consulting companies, professional societies, and career paths from one corporation to another. Also close, long-lasting relations with subcontractors are emphasized.

A good example of network relations is the joint research and development discussed in sub-chapter 3.3. That sub-chapter discussed about the relating and supporting industries thus omitting the fiber processing machinery suppliers. However, they do have joint research and development projects with various instances. Especially the co-operation and research with buyers is of great importance. These kinds of user-producer relations certainly offer advantages by pooling resources together. The importance of the user-producer relations is discussed in the next sub-chapter.

4.1.2 User-Producer Relations

As mentioned earlier, innovations are a vital element in obtaining a competitive advantage. New innovations are often based on co-operation between the raw material suppliers, investment goods manufacturers, and their customer companies. The longer the relationships last, the more fruitful they become. These user-producer relations have been realized to be the central source for innovations and thus essential for creating, sustaining and upgrading the competitive advantage of all parties involved.

The user-producer relations were emphasized in all the case companies. They all have close co-operation with paper or pulp mills. The mill machinery is so expensive that the partners involved must know and be able to trust each other, particularly from the buyer's point of view. The close co-operation has various positive impacts. The user-producer relations as well as the technological co-operation are often a prerequisite for the development of a dynamic cluster.

One of the most fruitful user-producer relations exists between a mill and a machinery producer which both are within the same corporation. Own mills may let the machinery suppliers to test new equipment in their production facilities. An example of this is former Rauma-Repola pulp mill in Rauma and Sunds Defibrator Pori. Earlier Rauma-Repola owned Sunds Defibrator Pori which at that time was called Porin Tehtaat. In addition, technological developments have been obtained through close co-operation with machinery suppliers and mills of a same corporation. Examples of these are Sunds Defibrator Jylhä and United Paper Mills (UPM) which is the closest, longest and most important partner for

Jylhä. The partnership has produced synergy for both companies. In the beginning of the 1960's Kaipola built two big paper machines impulsing Sunds Defibrator Jylhä (at that time Jylhävaara) to broaden its product scope. This kind of a co-operation does not mean, however, that mills belonging to the same corporation would automatically purchase machinery from own suppliers. They use the most competitive supplier whoever it is. This in turn pushes own machinery producers to innovate and develop technology further because projects with own mills can not be taken as granted.

After sales service is gaining more and more emphasis in user-producer relations. Former the mills used to have their own maintenance units which took care of the repair and the annual checking of the machines. Now the trend is towards closing down these units due to their heavy structure and high costs. Often the machines and processes are so complicated that the technical knowledge of the mills is not enough. The natural supplement are the equipment suppliers, then. This opens a great future potential area also for the fiber processing machinery manufacturers, and some of them have already established own after sales service units.

4.1.3 International Operations

All the case companies are highly global with operations all over the world. It was earlier mentioned that domestic rivalry is one of the most significant factors providing a good base for advantage creation. Since Finland is so small, there can not be extremely intensive domestic competition, at least not to the extent of what Porter means in his model. Therefore, Finnish companies must be global and encounter the competition in international arena. Gaining knowledge and experience about the international market makes companies stronger. The longer a Finnish company has been exposed to the international rivalry, the more capable it is to be innovative and encounter new challenges.

The case companies have internationalized through various modes which have been used together or separately. Firstly, own internationalization efforts play an important role among the companies. Secondly, a significant force for the internationalization of the fiber processing machinery suppliers has been the Finnish pulp and paper industry. As mills have being building their production plants abroad they have pulled the engineering works with them. Finnish pulp and paper mills favor often domestic suppliers due to strong, already existing relations. Particularly the relations between suppliers and buyers within the same corporation can serve as an avenue to the global markets. Ahlstrom Machinery's stock

preparation equipment spread out into foreign markets as company's paper sector internationalized and used own suppliers. United Paper Mill has acquired the equipment for their mills in England and France from Sunds Defibrator Jylhä. It also has supplied machines for Kymmene's mills in France and Germany. At the moment Enso-Gutzeit is constructing a mill in former Eastern Germany using Finnish suppliers among others.

Sunds Defibrator Jylhä and Sunds Defibrator Pori represent a third kind of an example. Even though they had had own international operations before the merger, joining the Swedish company finally pulled them to global markets. The Swedish counterpart had progressed a lot further in internationalization and had developed a wide network of which the Finnish subsidiaries could exploit with modest adjustment.

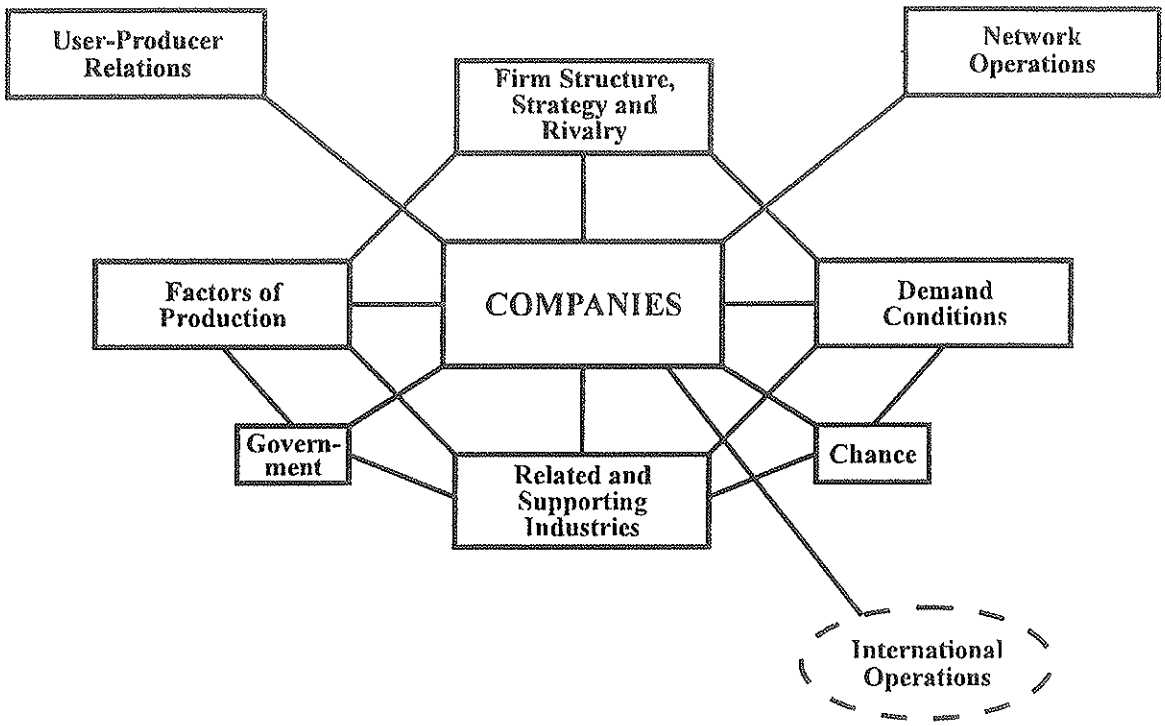
A fourth example is provided by Ahlstrom Machinery. Before Ahlstrom Machinery acquired American Kamyr Inc. they used to have co-operation. In fact, Machinery was Kamyr's subcontractor for pulp digesters. Thus, the actual export efforts were made by Kamyr as Machinery followed behind. Even though Machinery's equipment was been built or delivered around the world in the 1960's and 1970's, Kamyr was the main supplier in those projects.

4.2 Model for Competitive Advantage of the Finnish Fiber Processing Machinery Industry

As a result of studying the Finnish fiber processing machinery industry, its competitiveness and forces behind the success, I must conclude that the diamond model which was guiding the direction first is not completely sufficient in explaining the success of the case companies. It provided a good starting point from which to expand. Three factors came constantly up when searching for the success elements. These are:

1. User-Producer Relations
2. Network Relations
3. International Operations

Figure 5: Modified Diamond as a Model for Competitive Advantage for the Finnish Fiber Processing Machinery Industry



5. FUTURE PROSPECTS

5.1 Environmental Issues

As tomorrow's pulp mill is not allowed to pollute the chemical pulping machine suppliers are encountering great environmental challenges. The main emphasis in research and development is on new cooking and bleaching processes. The ultimate goal of the future pulp mill is zero effluent, and the trend is towards using less water in increasingly closed circulation systems. In order to attain such ideal solutions several major problems must be overcome by co-operative development work between mills, process suppliers and consultants. However, solving the problems is vital for the involved industries' long-term survival. A major constraint to upgrading facilities is the staggering expenditure of pulp and paper making equipment. To overcome this, for example serious investigation is under way in Scandinavia and North America to determine the feasibility of building energy centers capable of recovering pulp mill chemicals and of producing energy.

In Finland the environmental requirements are to a great extent along the line with the EC countries. More and more often the EC directives and other international agreements determine the Finnish norms. In order to be competitive, it is necessary that our environmental requirements will correspond the ones in the competing countries and will continue to be in the top.

Recycled fiber is becoming more and more important as raw material for new paper production capacity. In EC the proportion of the recycled fiber is already now approximately 40 %, and in Finland 4-5 %. It has been estimated that in the 1990's about 60 % of the European new capacity will be build for handling the recycled fiber. Thus, in the beginning of the 21th century its ratio would be increased to the half of the entire raw material used for the European paper production. [14]

On the other hand, one future estimation is that the boom of recycled fiber is expected to level out in the long run. The more demanding paper qualities require more from the fiber. Using recycled fiber in these papers means that the number of circulation rounds will

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[14] Kauppa- ja teollisuusministeriö 1993

decrease due to weaker quality. Thus the virgin pulp will have more demand in the future even though the secondary fiber is now capturing markets mainly from the mechanical pulp and later from the chemical pulp.

Due to advancements in process technologies the need of the chemical pulp can more commonly be limited to products which must be of excellent strength, for example the sack paper, or must have permanent characteristics, for example some fine papers. In the long run, this might be a threat for chemical pulp machine manufacturers if the mills start to favor more mechanical pulp in their production processes.

Substantial increases in energy prices would affect in the opposite way. The mechanical pulping requires high amounts of energy whereas the chemical pulping is energy self-sufficient. Presently there are discussions about laying an energy tax. A high tax might cause mills gradually to favor the chemical pulping process.

5.2 Markets

Production overcapacity, brought on-stream during the boom period in the 1980's, is expected to continue as a problem for customers of fiber processing machinery industry. Investments in new capacity are sharply declining in the biggest markets. However, North America sees some initial signs of an upswing. There are still huge markets in North America for fiber processing machines, but the problem is that funds for new investments are rare at the moment. In Europe there are investments in modernizing the old production capacity, but no new capacity is expected to be built with one exception: Metsä-Botnia is carrying out a green-field investment of a new pulp mill in Rauma, Finland.

Southeast Asia - China, Indonesia and Thailand - is still growing and offers good opportunities particularly for chemical pulping and stock preparation. Also South Africa might have something to offer to the paper and pulp industry and via that also to the fiber processing machinery industry. The local infrastructure is good and the climate favors the wood growth. Sunds Defibrator Pori Oy, for example, has there some projects under way.

One future vision of Finland is that as the new paper mills and the new capacity will be placed in Central Europe close to the consumers and recycled paper, the role left to Finland is the producer of low value added chemical pulp. This would mean that in the long run the

investments in the fiber processing machinery here in Finland would be on the chemical side. Hopefully this does not cause a remarkable disadvantage for the mechanical process machinery producers in terms of gradually losing close connections to local customers which have been a vital source of the competitive advantage.

5.3 EU

Traditionally the integration is assumed to affect each countries' production structure by strengthening the position of those industries in which the country has a relative advantage due to the natural resources and other factors of conditions. It is not clear, whether participating in the European division of labor would be based on the relative advantage. However, the Finnish fiber processing machinery manufacturers are already so global and they already have a foothold in the EC that they do not see that joining or not joining the Community would affect their operations or competitive position much. A negative EC solution would have attitudial effect, though, because Finland could not influence the decision making in the Community, and the Finns would be considered as outsiders.

5.4 Suggestions for Finnish Government

Export quarantees are an essential component in trade between Finnish fiber processing manufacturers and their foreign customers. However, these quarantees pose often a problem for the machinery manufacturers. To overcome this they wish that governmental institutes providing quarantees would take more risks, would grant the quarantees also for smaller projects, and would shift towards more flexible procedures.

6. SUMMARY AND CONCLUSIONS

The goal of the study was to evaluate the international competitive advantage of the Finnish fiber processing machinery manufacturers. The theoretical framework was based to a large extent on Michael E. Porters diamond model which determines the preconditions for the creation of national advantage. The components in the diamond include domestic factor conditions, demand conditions, related and supporting industries, and firm strategy, structure and rivalry. These all have a reinforcing effect on each other. However, for competitive advantage creation all these do not have to be advantageous.

The empirical part was conducted by company interviews. All the main Finnish fiber processing machinery manufacturers were the target group. The managers of Ahlstrom Machinery, Sunds Defibrator Jylhä, Sunds Defibrator Pori and Valmet-Tampella were interviewed. This resulted in three kinds of information. Firstly, the company specific advantages were discussed. Secondly, the national advantage determinants were evaluated. Thirdly, some other competitive advantage factors besides the diamond based were discovered.

All the case companies are among the leading fiber processing machinery suppliers in the world. Thus it is relatively easy to point out competitive advantage determinants. Common features of these companies are global presence, image of process suppliers and problem solvers, as well as close links with the customers. Nuclear elements in the company competitiveness are high technology and excellent quality as well as customer service and satisfaction. Besides these Ahlstrom Machinery's main strengths are as well talented and dedicated people. In addition, an advantage compared to the competitors is that Ahlstrom Machinery is extremely international since long ago. Both Sunds Defibrator Jylhä and Sunds Defibrator Pori enjoy various corporate wide advantages, for example well established marketing networks. Also the control of the entire chain was emphasized as a central feature of the competitive advantage. This was also an important feature for Valmet-Tampella.

Firstly, as regard to the national advantage determinants, demand conditions are one of the most influencial diamond component in the advantage creation. In order to earn their existence, the machinery suppliers have to be able to increase the competitiveness of the customer. Finnish buyers are extremely sophisticated and demanding. As the domestic customers have had high requirements, the fiber processing machinery works have been forced to be innovative and creative.

Secondly, some components in factor conditions are also advantageous. An important component creating, sustaining and upgrading the competitive advantage for the Finnish fiber processing machinery industry are the human resources. Finnish people are highly skilled, and they are often the driving force behind the technical advancements. In addition, the geographical location as an image factor boosts the advantage in most of the markets. There are no selective factor disadvantages. On the other hand, basic and generalized factors such as raw materials, machinery tools and infrastructure do not upgrade the advantage.

Thirdly, domestic relating and supporting industries are very competitive in a global scale. The whole forest cluster in Finland is extremely strong. Especially R&D is of high standard. The wide presence, probably the widest of all Finnish clusters, of related and supporting industries has a reinforcing effect on the competitive advantage of the entire cluster.

Besides these diamond based conditions three other factors influencing the competitive advantage were discovered. These include user-producer relations, network relations and international operations. Due to small size of Finland there are production facilities and production communities geographically close one another. Within the forest cluster there are various kinds of co-operation forms. Resources are often pooled together. This has boosted the advancement towards improved and upgraded products and production processes. Particularly user-producer relations play an essential role in the advantage creation. New innovations are often based on co-operation between fiber processing machinery manufacturers and their domestic customers.

However, even though the Finnish fiber processing machinery companies are highly competitive there is one visible threat for the future success. This is the increasing trend of using recycled fiber in the paper production. Leaders in this field are the Central European and American producers. All the Finnish fiber processing machinery manufacturers have some machines for recycled fiber treatment, and at the present they are investing in R&D in this field. But in no interview the machines for recycled fiber were emphasized or presented as the leading stars regardless that half of the new investments for example in LWC and SC paper production capacity in the 1990's is expected to come for equipment handling recycled fiber. One can conclude that the Finnish companies are following the trend, but are far behind their competitors. Technology here is not as advanced, companies do not have many references, and their product lines are not complete.

Concluding, it can be claimed that the advantageous conditions in the national diamond have provided a strong development base for the Finnish fiber processing machinery

industry. Particularly the domestic pulp and paper industry has acted as a driving power for the development of this industry. Through the forces in the national diamond the companies have the chance to innovate and reach a strong competitive position globally. Since these prerequisites for success are there it is up to the companies, their commitment and desire, to benefit from the existing advantages and further develop own, company specific advantages.

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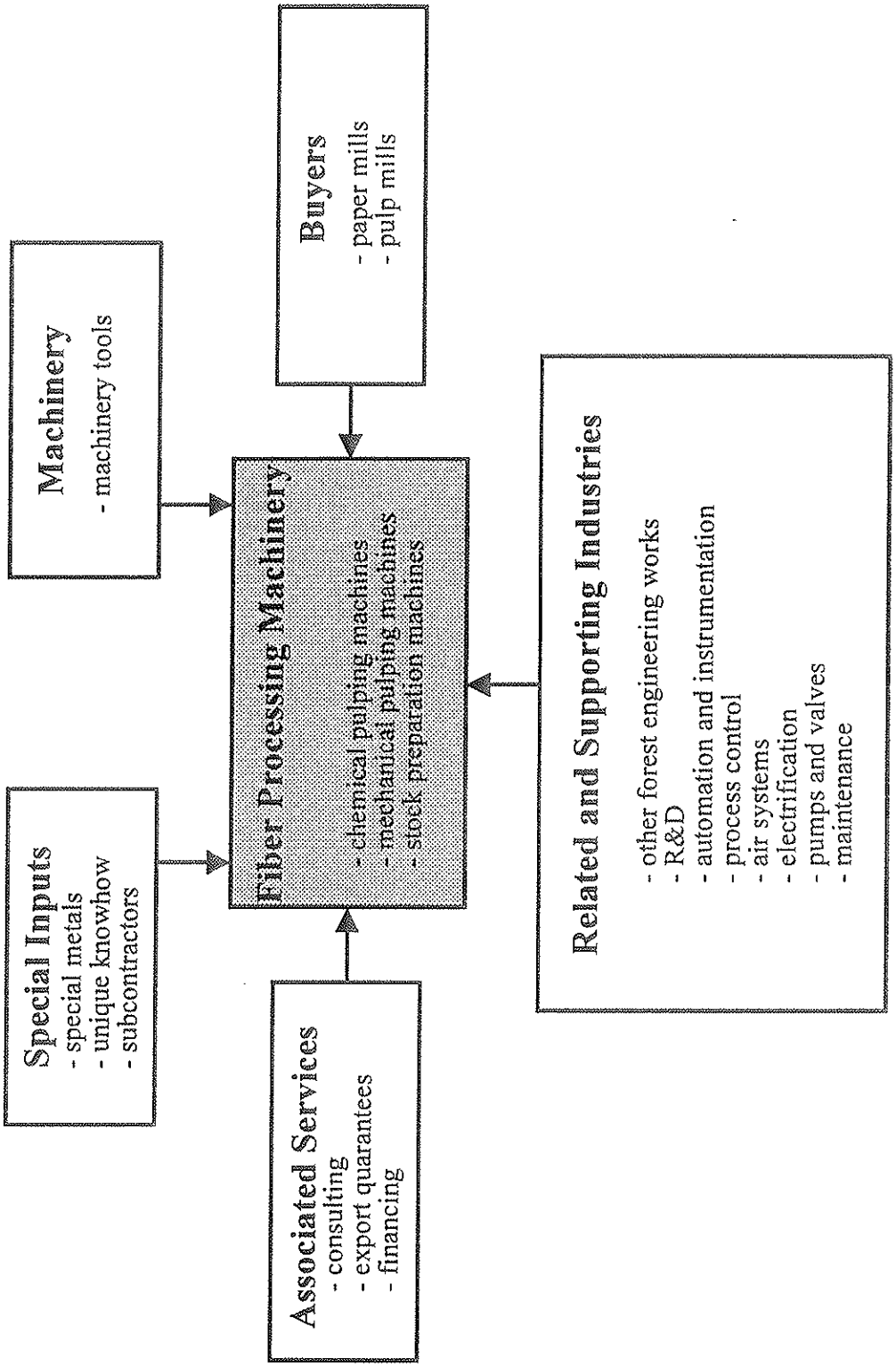
26.61993*	AHLSTROM MACHINERY Fiber Processes Jukka Sainiemi, Managing Director
17.8.1993*	AHLSTROM MACHINERY Tuomo Rönkkö, Director
18.10.1993	SUNDS DEFIBRATOR JYLHÄ OY Mechanical Pulping Systems Arto Aaltonen, President Vesa Suhonen, Marketing and Comm. Manager
19.10.1993	VALMET-TAMPELLA INC. Stock Preparation Ane Ahnger, General Manager, Marketing
26.10.1993	SUNDS DEFIBRATOR PORI OY Chemical Pulping Systems Kari Kovasin, Manager, R&D Alpo Tuomi, Manager, Marketing and Sales
29.10.1993	AHLSTROM MACHINERY Erkki Eiroma, Vice President, Marketing, Europe and Asia-Pasific operations
12.11.1993	VALMET-TAMPELLA INC. Groundwood Systems Hannu Salakari, General Sales Manager Matti Tapio, Vice President

* = These interviews are conducted by Jari Hyvärinen, ETLA

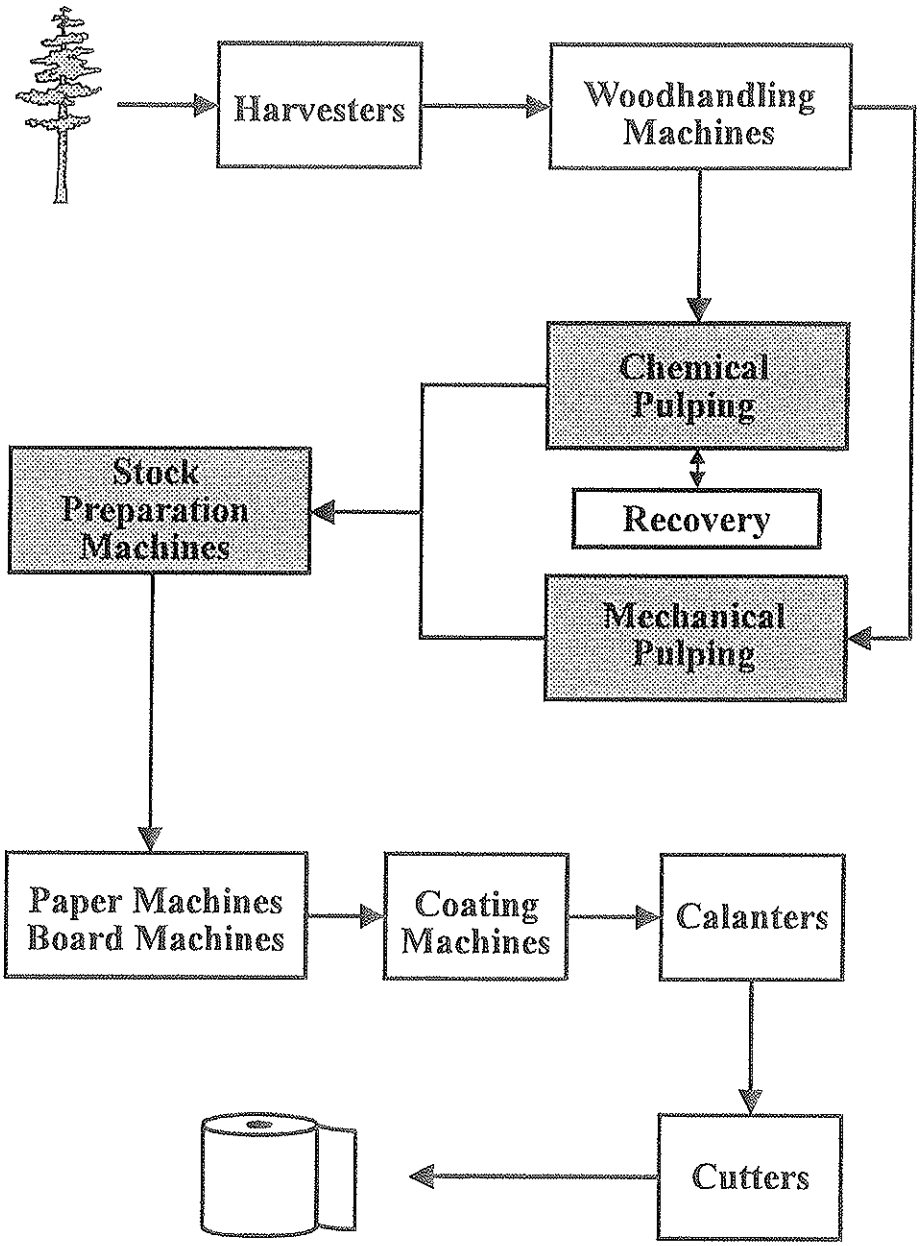
APPENDIX 1

FACTORS CONNECTED TO THE FIBER PROCESSING MACHINERY



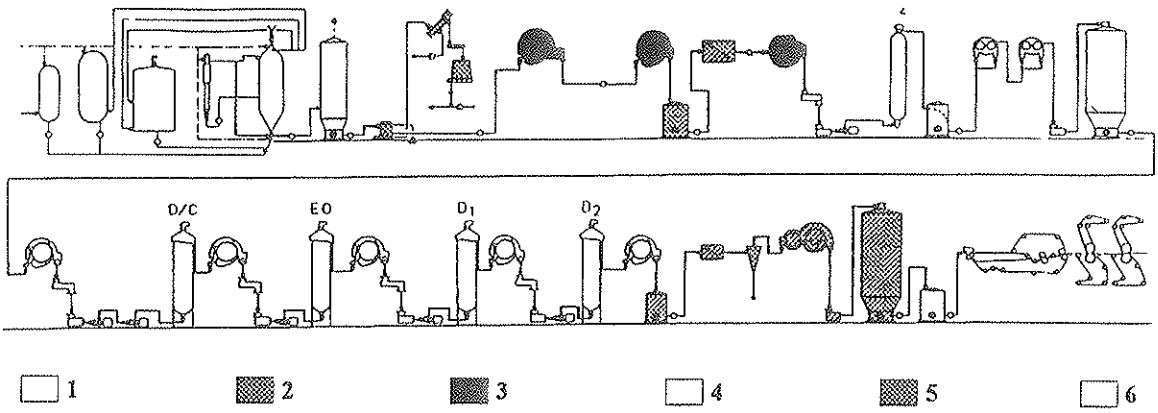
APPENDIX 2

FROM WOOD TO PAPER: FOREST WORKSHOPS



APPENDIX 3

A LAYOUT OF THE CHEMICAL PULPING PROCESS AND CORRESPONDING MACHINES. An Example from Sunds Defibrator



1. COOKING
- Super Batch
- SDC Sulphite Displacement Cooking
- Special Batch Cooking Systems

2. DEKNOTTING & SCREENING
- Knotters
- Knot Separators
- Pressure Screens

3. WASHING
- Ultrawasher
- Pro-Feed Washers
- Pressure Washers
- Vacuum Filters
- Displacement Presses
- Liquor Filters
- Foam Breakers
- Propeller

Source: Sunds Defibrator Pori

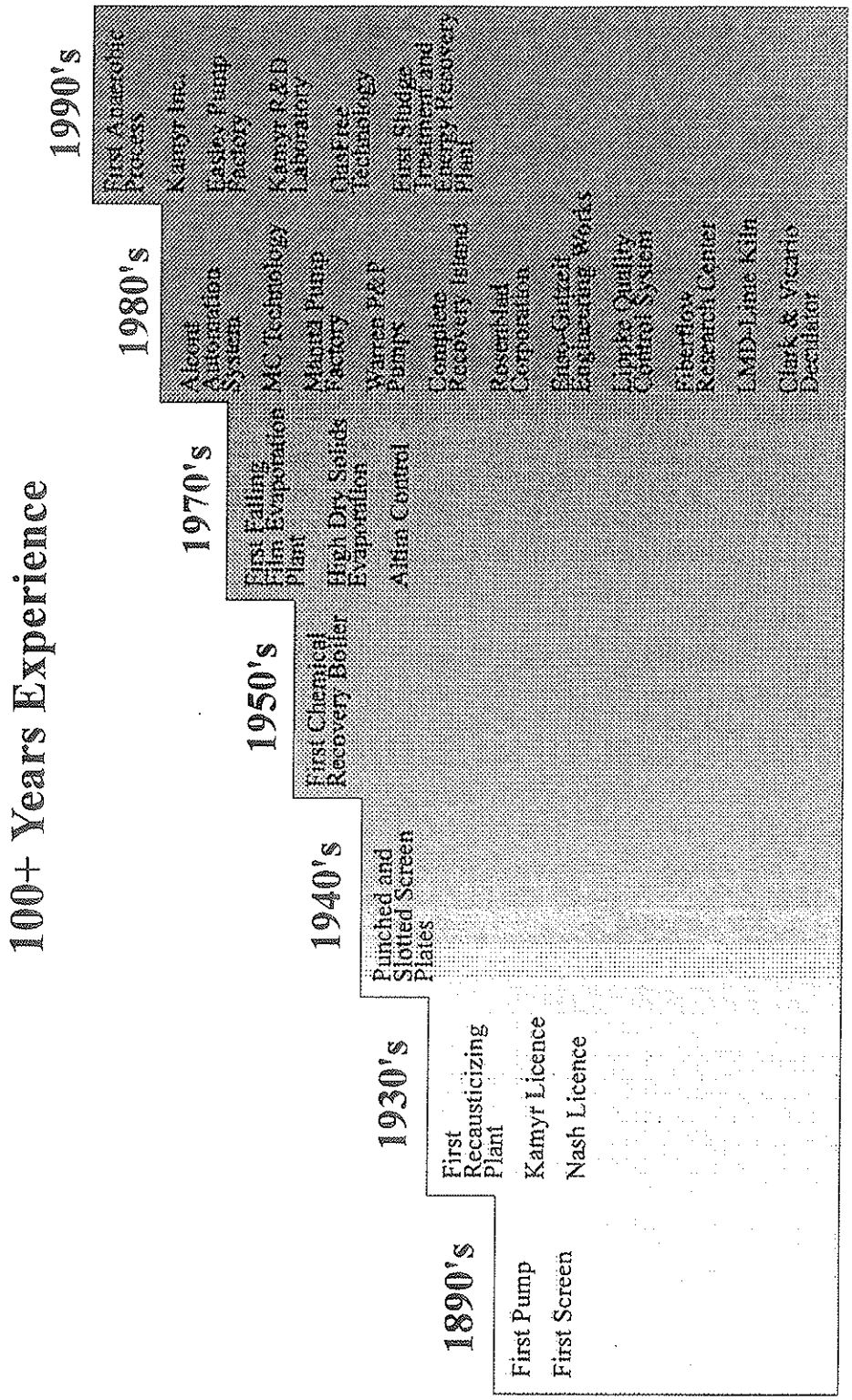
4. OXYGEN DELIGNIFICATION + BLEACHING
- Displacement Presses
- Vacuum Filters
- Pro-Feed Washers
- MC & HD Pumps
- Steam Mixers
- Tower Scrapers & Agitators
- Propeller Agitators
- Chemical Mixers
- Dilution Nozzles
- Reaction Towers & Tanks

5. PULP THICKENING
- Pressure Thickeners
- Open Drum Thickeners
- Vacuum Thickeners Pumps

6. DRYING
- Pressformer
- Baling and Bale Handling Systems

APPENDIX 4

AHLSTROM'S MILESTONES



Source: A. Ahlstrom Corporation - interview with Mr. Eiroma

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