New products and production systems for increased profitability within the mechanical hardwood industry

— Dick Sandberg and Jimmy Johansson

This research project focuses on the identification and development of profitable products of Swedish hardwood that can make the Swedish mechanical hardwood industry become more competitive.

The starting point is that the structure of the Swedish mechanical hardwood industry is characterised by a small scale and the fact that it is located primarily in southern Sweden. The development of new production systems for the products identified within the project has been judged to be essential if the results are to become industrially applicable.

The general question propounded is how the degree of refinement and the profitability in the Swedish mechanical hardwood industry can be improved through the development of products and production systems.

In the description below of this field of research, a number of ideas for products and production systems are also presented. These constitute the basis for the ongoing work of finding solutions to the problem of increasing the profitability of the Swedish mechanical hardwood industry.

The Swedish hardwood forest and the mechanical hardwood industry

Today, about 16% of the Swedish forest is hardwood forest. The annual growth of this stand is about 14 million m³fub¹ while the felling amounts to about 6.3 million m³fub. Of this quantity, only about 300 000 m³fub is used for wood-mechanical refinement (the National Board of Forestry 2003). Within this project, the wood-mechanical industry is defined as in figure 1.

Mechanical wood industry

The Sawing industry The Building industry The Wood manufacturing Industry

The carpentry industry The packaging industry The wooden house industry The furniture industry

Figure 1. Within the project, the mechanical wood industry comprises the sawing industry, the building industry and the wood manufacturing industry.

The wood distribution in the Swedish forest is indicated in table 1. The most common tree species are spruce and pine. Birch, which constitutes 10.5% of the volume m³sk², is the most common broad-leaved tree followed by aspen, alder, oak and beech in that order. The other broad-leaved trees consist mostly of sallow, rowan and ash.

¹ m³fub - cubic metre, under-bark volume
² m³sk - Forest cubic metres, the volume of a whole trunk above the stump including top and bark.
Table 1. The distribution of species in Sweden (the Swedish National Forest Inventory 2003).

<table>
<thead>
<tr>
<th>Species of tree</th>
<th>Percentage of the volume m³sk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spruce</td>
<td>43.4</td>
</tr>
<tr>
<td>Pine</td>
<td>38.7</td>
</tr>
<tr>
<td>Birch</td>
<td>10.6</td>
</tr>
<tr>
<td>Aspen</td>
<td>1.4</td>
</tr>
<tr>
<td>Alder</td>
<td>1.2</td>
</tr>
<tr>
<td>Oak</td>
<td>0.9</td>
</tr>
<tr>
<td>Beech</td>
<td>0.6</td>
</tr>
<tr>
<td>Other broad-leaved trees</td>
<td>0.9</td>
</tr>
<tr>
<td>Dead trees</td>
<td>2.3</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

In order to obtain as high a value as possible from the hardwood forest, straight timber with a large diameter and as free from knots as possible should be produced. This timber is used as saw timber and has the highest economic value. In today's forests, however, the broad-leaved trees are usually found in poorly husbanded mixed stands of conifers and broad-leaved trees. The broad-leaved trees are normally cleared away in the first thinning. This means that the quality of the cut hardwood timber is low and it is consumed primarily by the pulp industry or is used as fuel, which has a considerably lower refinement value than sawn timber. The reasons for this include the historic conception that the cultivation of hardwood forest is unprofitable (Rytter et al 2000). One of the problems associated with small quantities of hardwood is that transport to the industry is today a problem.

In Sweden and in many other countries, the wood-mechanical industry concerned with the production of hardwood timber usually consists of small companies with poor profitability. Because of this poor profitability, new investments are rare and the companies' products are developed very little (see e.g. Bowe 2001).

During the 1990s, only 5 % of the felled volume of hardwood timber within the sawmill industry was refined in Sweden. For softwood, the corresponding figure was 50 % (Rytter et al 1999). According to Rytter et al (1999), there are three primary reasons for the low refinement volume:

- The quality of the standing hardwood forest is judged to be poor.
- The growth in poorly managed hardwood forests is slow, and the dimensions of the felled timber are small. Today, hardwood timber is not judged to be sawable until a top diameter of 17-18 cm below the bark is attained.
- All the sawable timber does not reach the sawmills; a large part is used as pulpwood instead.
With a production of over 1 000 m³, there were 13 sawmills in Sweden in 2000 which sawed only hardwood and 20 which sawed both hardwood and softwood. The hardwood sawing is most common in southern Sweden. There is a tendency for the number of sawmills to decrease. Table 2 shows how the number of sawmills, which saw only hardwood, has dropped from 1979 to 2000.

Table 2. The number of sawmills which only saw hardwood, with a production greater than 1 000 m³ (Andersson et al 1991, Staland et al 2002).

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of sawmills</th>
</tr>
</thead>
<tbody>
<tr>
<td>1979</td>
<td>22</td>
</tr>
<tr>
<td>1984</td>
<td>26</td>
</tr>
<tr>
<td>1990</td>
<td>19</td>
</tr>
<tr>
<td>2000</td>
<td>13</td>
</tr>
</tbody>
</table>

The production of sawn hardwood has decreased throughout the 90s. A total of 217 000 m³ of hardwood were sawn in 2000. Of these, 30 000 m³ were produced in sawmills with a production less than 1 000 m³. In 2000, the consumption of hardwood timber was 410 000 m³fub in the sawmills, which means that the import of hardwood timber was more than 100 000 m³fub. On average, the sawing yield in the hardwood sawmills was 53 %, which is higher than that that achieved in the sawing of both spruce (48 %) and pine (46 %). The sawing yield tends to decrease with increasing size of the sawmills (Staland et al 2002). Table 3 shows the total production of the hardwood sawmills divided into size classes for different parts of Sweden.

Table 3. The total production of the hardwood sawmills (1000 m³) in three size classes for different regions in Sweden (Staland et al 2002).

<table>
<thead>
<tr>
<th>Region</th>
<th>1-5</th>
<th>5-25</th>
<th>&gt; 25</th>
<th>Total production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Norrland</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Southern Norrland</td>
<td>5</td>
<td>13</td>
<td>-</td>
<td>18</td>
</tr>
<tr>
<td>Svealand</td>
<td>12</td>
<td>-</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>Götaland</td>
<td>34</td>
<td>39</td>
<td>84</td>
<td>157</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>52</td>
<td>84</td>
<td>188</td>
</tr>
</tbody>
</table>

Sweden's production of sawn hardwood represents approximately 12 % of Europe's combined production, which is 17.4 million m³. This can be compared with the situation with regard to sawn softwood, where Sweden's volume share is about 15 % (the National Swedish Board of Forestry 2003).

The market for sawn hardwood is today primarily in the furniture, floor and carpentry industries, and to a certain extent in the building sector (interior fitting carpentry). Important customer groups for the hardwood sawmills are thus manufacturers within these particular product areas. In the introduction of new products, the prescribing stage, i.e. designers and architects, is an important channel to the market. A customer segment that has become increasingly important on the market during recent years is the so-called do-it-yourself (DIY) sector, i.e. private persons who want to make or prepare products themselves in their own homes. Characteristic for the hardwood users
is that their demands on the properties of the hardwood are very high. This is particularly true of appearance requirements such as colour and texture.

With the increasing development of new products and production systems, the wood-mechanical industry should be able to use the existing hardwood more efficiently. This would reduce the need for imports and mean that the Swedish forest owners would receive a better yield on the timber from their forests, at the same time as new attractive products would be added to the market.

*Problem formulation and questions*

One of the most important refinement stages from forest to final product (consumer product) is the division of the log into boards and planks, and the drying of the sawn timber so that it can be used in the subsequent refinement stage and function in the final product. Traditionally, this refinement is carried out in sawmills.

Compared with the softwood sawmills, the Swedish hardwood sawmills are few in number, and they are characterised by producing either a small volume of low-refined products or large volumes of hardwood specialised towards a particular final product, such as floors. The profitability is in general low.

The hardwood, which the sawmills produce, comes from a raw material with a variation in properties, which influences the properties and appearance of the sawn wood. The market, on the other hand, makes very exact demands, which the wood must meet. The result is that the hardwood sawmills in the present situation cannot create a profitable market for all their products since the customers' requirements are not being met.

This project is studying how new products, more rational production systems and new technology can be developed and adapted to the requirements of the mechanical hardwood industry, so that the volume and quality of the hardwood forests in Sweden are properly exploited. A knowledge of the customers' requirements, i.e. how the products must be designed to satisfy the customers' needs, is one of the parameters to which special attention will be given in the project. To investigate what demands the customers make on the products and what they perceive to be quality is thus an important aspect.

More specifically, the project starts with the following questions:

- How can new products of hardwood be created with properties that are attractive to the customers?
- How can the quantity of Swedish raw material available for the hardwood sawmills be increased, e.g. with other grades and other dimensions?
- How can the Swedish hardwood timber be used more efficiently in the division process through new production systems?
**Aim and goal**

The aim of the project is to refine and evaluate products and production systems for the sawing and further refinement of Swedish hardwood raw material. This will take place through an evaluation of the total economy, the technical conditions and the degree of acceptance of the products by the customer.

The objective is to demonstrate attractive products to the customer, which can be manufactured with efficient production systems for the sawing and further refinement of the Swedish hardwood raw material and which thereby leads to a total concept, which has a higher total economic profitability than today's system.

**Market introduction and the market's requirements with regard to new wood products**

The following section describes the background to the customer-centred development model, which is used within the project. The demands which customers and other interested parties can make on a product, with a focus on the material in the product, are described in general and thereafter specifically for furniture, floors and houses. This section describes the general ideas that precede the choice of material, and the demands, which can be made specifically on the wood material.

A failure to understand the customers' needs and demands has been shown to be a decisive reason why the introduction of new products onto the market has failed (Bergman et al 1994). Patrick (1997) showed, for example, that more than 90% of all launchings of technical products onto the market are considered to have failed. Ljungberg et al (2003) claim that this occurs even though the product itself exhibits technically good properties with regard to e.g. function and material. In these cases, the products have not been fully accepted by the customers who need to understand and accept both the technical and non-technical functions of the product.

With respect to wood usage, Baudin (1999) suggests that an insight into the market is required and an understanding of what the customers want, if an income-generating production is to be created. The needs and demands of the final consumers should govern the development process.

However, Ashby et al (2003) emphasise that revolutionary products often surprise the market, i.e. the demand for a product is not created until it is launched onto the market, where the digital clock or the laser pointer are typical examples. In these cases, a need has not been expressed by the final customer but has instead been envisaged by e.g. the designer. Designers and architects can thus be regarded as important customers of a sawmill since it is they who influence the choice of material in a product. Helin (2002) also points out that trends are often created when, for example, an interior decoration magazine writes about a designer's ideas and spreads the message to a broader public.

Ljungberg et al (2003) suggest that the most common way of choosing a material for a product is to systematically determine the technical specification, which is required. Such a method is theoretically interesting for the choice of material, but in practice it is also necessary to give consideration to the metaphysical values that a product will express. The metaphysical values are those feelings that the customer develops for a product on the basis of understanding, experience, imagination and preconceived ideas. For each product there is a specific balance between the physical and the metaphysical
values. The problem is that, for any given product, this balance differs among different customers.

A problem with wood as a material is that designers nowadays often use other materials than wood as a basis for new products (Sundberg 1999). This is because wood is not regarded as a technical material but is primarily used to give a product a certain aesthetic value. According to Ljungberg et al (2003), natural materials such as wood or wool are often appreciated because they create a history around the product, which can for example be used in the marketing in expressions such as "This product is manufactured from a tree which grew in the Alps" or "This coat has been produced with wool from Scottish sheep".

Wiklund (1991, 1992) says that many architects know too little about the wood material. Representatives for other materials are much more active in marketing their materials and in presenting technical solutions for the use of the materials in different applications. Better information is therefore required about how the wood is to be used. This also applies to the interaction between different materials and for how wood is to function together with a material such as glass. Baudin (1999) thinks that the wood industry suffers from too great a fixation on the wood as a raw material, which is necessary but not sufficient. Contacts with the market must be improved.

For architects, Lindblad (2002) suggests that the following factors may be important regarding the choice of material:

- price and supply
- appearance
- properties, e.g. with respect to quality, maintenance and permanence.
- environmental influence
- knowledge, e.g. the designer's knowledge about the existence and plasticity of the material

Grönlund (1992) suggests that the following factors provide the basis for what can be regarded as the technical quality of the products that the sawmills deliver:

- measurement accuracy
- shape accuracy
- moisture ratio deviations
- surface characteristics

Sandberg (1998) suggests that the properties, which are most important for future wood products and for which customers will be prepared to pay, are:

- aesthetic and tactile properties
- accuracy in measurements and geometry
- freedom from cracks in usage
- controlled movements in the wood material with changing humidity
- strength, hardness and durability

How well the requirements with respect to such properties is an important factor governing the choice of material for a given application. The argument above emphasises, however, that this is not the only controlling factor. The choice of material
in a product is based not only on what seems technically to be the best solution but also on soft factors such as knowledge and feelings. To make demands on a material for a product thus becomes complex. The following sections describe frequently mentioned demands on the materials in products for which the sawmills generate the raw material.

Requirements on wood for furniture and interior fittings

The furniture and interior fittings industry gives the highest income per volume timber (SEK/m³sk) of all the sectors in which wood is used. According to Sundberg (1999) this industry makes demands on the following factors with respect to deliveries from the sawmills:

- amount of knots
- knot size
- the proportion of black knots
- dimensions
- freedom from cracks
- moisture ratio
- price
- delivery precision

It is not, however, relevant to discuss these requirements unless the furniture industry or interior decoration industry has chosen wood as the material for its product. Pakarinen et al (2001) have investigated the factors that influence the customers' choice of furniture and they have established that quality, design, material, price and service are controlling factors.

At the same time, customers put a low value on the environmental aspect and on the importance of the trademark. Nevertheless, many companies use environmental arguments and trademarks in their marketing of furniture (Pakarinen et al 2001). Baudin (1999) agrees completely with the fact that the customers' concern for environmental arguments is small but he suggests that the environmental question is becoming more urgent, and that wood should therefore be advertised more clearly as being an environment-friendly alternative. Sundberg (1999) also points out that customers are often driven by fashion and trends. Rydell (1992) observes that current tastes often control the quality conception of wood for e.g. furniture. This can apply to wood in relation to other materials, whether the wood shall be knot-free or knotty, whether the wood surface shall be dark or light, covered with paint or visible. A further aesthetic property to which Sandberg (1999) draws attention is that vertical annual rings are considered to increase the appreciation of the appearance of the wood surface. A problem with regard to taste is, however, that preferences can vary among countries, among population groups, among different age groups etc (see e.g. Rydell 1992, Ljungberg et al 2003).

According to Pakarinen (1999), many furniture consumers say that a wood material possesses properties that can make it superior to other materials, depending amongst other things on its reliability, its environment-friendliness and its aesthetic texture and appearance.

SNIRI (2002) lists factors which should be taken into consideration when planning an interior decoration and, in addition to the already described requirements with regard to
furniture and furnishings, factors such as wear, climate, life-span, maintenance and care are also listed.

In summary, to fulfil the customers' demands, a piece of furniture or an interior fitting must maintain a certain quality, and this is probably closely linked to the demands which the furniture industry makes on the sawmill products today. The product shall further have a certain design which, considering the properties of the wood material, ought to be determined by factors such as knot characteristics and species of wood, and also by surface properties such as colour nuance, texture and annual ring orientation. However, the design factors can be mysterious and varying. The environment is not something to which the customers currently attach great importance, but it is expected to become more important in the future, and this speaks in favour of wood as a material. The material used in furniture and furnishings must also meet demands related to wear, climate, life-span, maintenance and care.

Requirements on wood for floors

Floors are a product which makes special demands on the material. Jonsson (2004) suggests that the choice of material is to a great extent made directly by the end-user because of the aesthetic character and value of the floor surface. For the actual floor construction, i.e. all the properties other than the appearance of the floor surface and the floor's tactile values, it is the manufacturer who decides on the choice of material. For floors, design factors are thus important.

In his investigation, Jonsson (2004) has shown that the choice of floor material is controlled by both aesthetics and function. The important functional factors are the floor's thermal radiation, hygiene, water permanence and naturalness. These requirements apply in general for floors and are not specific to wooden floors. The reason why the customer chooses a wooden floor are primarily aesthetic and naturalness, and the functional factors are then less important (Jonsson 2004).

Requirements on wood for construction work

With respect to building timber, Johansson et al (1990) state that there are requirements regarding:

- dimensions - regarding width, thickness and length
- deformations in the wood
- strength
- stiffness
- movement after installation
- moisture content
- knottiness
- rot
- blueing
- mould

These factors can primarily be derived from the technical wood quality. In addition, those factors which the architects regard as important when making their choice of material should be considered, as has been emphasised earlier.
Summary of the customers' requirements

To be able to use the information relating to all the requirements described above, a reduction in these is required. Table 4 lists the requirement factors which can be influenced in the production system, grouped into four groups: marketing, material technical and process technical, aesthetic and tactile, and environment-related factors. In this list, self-evident factors that a sawmills main products must fulfil have been excluded, e.g. freedom from rot.

For the production systems developed within the project, the marketing and environment-technical parameters will be treated the same for all production aiming at satisfying different customers or segments of customers.

Table 4. Material requirement matrix for wooden products.

<table>
<thead>
<tr>
<th>Main groups</th>
<th>Requirement factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marketing factors</td>
<td>Economy</td>
</tr>
<tr>
<td></td>
<td>Information</td>
</tr>
<tr>
<td>Materials and process engineering factors</td>
<td>Strength</td>
</tr>
<tr>
<td></td>
<td>Stiffness</td>
</tr>
<tr>
<td></td>
<td>Creep effects</td>
</tr>
<tr>
<td></td>
<td>Hardness</td>
</tr>
<tr>
<td></td>
<td>Wear</td>
</tr>
<tr>
<td></td>
<td>Climate variation effects</td>
</tr>
<tr>
<td></td>
<td>Permanence</td>
</tr>
<tr>
<td></td>
<td>Dimensions and shape accuracy</td>
</tr>
<tr>
<td></td>
<td>Moisture ratio</td>
</tr>
<tr>
<td></td>
<td>Surface roughness</td>
</tr>
<tr>
<td></td>
<td>Flexible product selection</td>
</tr>
<tr>
<td></td>
<td>Delivery precision</td>
</tr>
<tr>
<td></td>
<td>Dimensions</td>
</tr>
<tr>
<td></td>
<td>Freedom from cracks</td>
</tr>
<tr>
<td>Aesthetic and tactile factors</td>
<td>Knots</td>
</tr>
<tr>
<td></td>
<td>Colour nuance</td>
</tr>
<tr>
<td></td>
<td>Annual ring orientation</td>
</tr>
<tr>
<td></td>
<td>Surface treatment</td>
</tr>
<tr>
<td></td>
<td>Tactile feeling</td>
</tr>
<tr>
<td>Environment-related factors</td>
<td>Environmental influence</td>
</tr>
</tbody>
</table>
Work model for new products and production systems

The list below presents a very compressed picture of how the product development process is carried out within the project. The different parts of the project are carried out to a greater or lesser extent in cooperation production companies. In general, it can be said that the development of new products follows the model which Cooper et al (1986) described in the following stages:

1) idea generation
2) general survey of the surrounding world
3) market analysis
4) preliminary technical analysis
5) detailed market study
6) economic analysis
7) product development
8) own tests of the products
9) testing of the products at the customer site
10) sales trial
11) test production
12) business analysis before mass production
13) production start
14) market launching

It will be possible to carry out stages 1 - 8 within the framework of the project, while stages 9 - 14 will be carried out in close cooperation with the project, but nevertheless by the production companies. A slightly simplified model for production is described by, for example, Ashby et al (2004), Olhager (2000) and Ulrich (2000), as shown in figure 2. The two different models pass through the same development stages, but Cooper (1986) emphasises more clearly the importance of market orientation in the product development process.

Figure 2. The different stages of the product development process from idea to product launching.
Within the project, the products and their related production systems will be developed in such a way that the customers’ demands will be met. This is illustrated in figure 3. The customer requirements are specified as measurable requirements which the products shall fulfil. These specified requirements then control the different production stages backwards through the whole production system. The forest is regarded as a constant, however, i.e. the availability and properties of the raw material can be influenced to only a minor extent.

The customers

- furniture
- floor
- interiors
- building....

Product requirements

Blanks

Components

Sawn wood

The sawing process

Forest

Wood for....

Figure 3. Model for the development of new products and production systems for the Swedish mechanical hardwood industry. The customers make demands which the products must fulfil. These are translated into requirement profiles in the production systems developed for sawing, drying and quality sorting, and also blank and component manufacture.

The intention is that products and production systems developed within the project will show better properties than today's products and production systems. An evaluation model is used which is based on the product demands established within the research field as follows:

- The total economy for developed products and production systems shall be better than it is in the current situation.
- The production systems developed shall build on available technology in order to reduce investment costs. Modifications to the technology may however become necessary.
- The products which are generated shall be those for which there is a demand on the market.
- The raw materials used shall be currently available in the Swedish forest.

A clear picture of the bases for the evaluation is given in figure 4.
Ideas for new products and production concepts

The following section presents ideas for products and production systems which it is planned to analyse and evaluate within the project. These ideas have been developed to fulfil those demands which the customers are expected to make on products of hardwood, and these will be verified within the project.

The PrimWood-method

The customers' requirements with regard to the wood which is to be used in high-quality products such as furniture, interior fittings and carpentry are essentially requirements which can be characterised by e.g. accuracy in dimensions and geometry, an absence of cracks, and controlled movements with changing moisture content. These requirements can be fulfilled if the wood material is sawn so that it exhibits vertical annual rings.

Traditional sawing methods for producing wood with vertical annual rings have been shown to have a poor degree of material utilisation and to give high production costs (Desch et al 1996), but Sandberg (2005) has developed a new system for the production of wood and components with vertical annual rings, as shown in figure 5.

This production system, which is called the PrimWood-method, is primarily intended for timber from softwood and it has thus not been optimally adapted for the conditions which apply for hardwood. The conditions for applying the PrimWood-method in the sawing of Swedish hardwood will therefore be fully investigated to fulfil the aim of the project.

Figure 5. Star-sawing, the sawing pattern which constitutes the basis for the PrimWood-method (Sandberg 2005).
Alternative grades of hardwood

The aesthetic and tactile properties of hardwood may mean that new grades can be marketed, if only they are exposed in the right way to the final consumer.

In hardwood, changes may occur as a result of e.g. sickness, vermin and insects or genetic conditions, which markedly change the appearance of the wood. Certain changes, e.g. rind gall or tree warts on birch are already today much sought after by the market and command very high prices (Nylander et al 2001), whereas false heartwood, for example, is not accepted by the market (Hardwood Institute 2004).

The idea of having alternative grades for hardwood aims to investigate how one can take advantage of deviations in texture and colour in products and how the manufacturing process can be designed to produce wood in a manner that makes it attractive for the customer.

Glued wood products

By using hardwood in glued constructions, customer requirements such as shape-stability and purpose-adapted dimensions can be satisfied, at the same time as different wood grades can be used in the best way.

A large proportion of sawn hardwood is destined to be used in various glued constructions, e.g. in floors or sheet materials. These products may exhibit problems with e.g. shape stability after the products have been put into use. This sub-project aims at studying how such products can be improved through better designs and better production processes.

Building carpentry

The final result of all timber sawing is a product that exhibits variations in quality. The grades which are usually desired on the market are characterised by being free from knots and having an even texture. Such wood commands a high price and is used primarily for furniture and for visible furnishing details. Wood which does not meet these quality requirements is difficult to sell, especially at a price level which is profitable for the sawmill.

Building carpentry in general has a requirement profile different from that of furniture and visible furnishings. Technical properties such as straightness, permanence, and paintability have a higher priority in timber for building purposes than aesthetic and tactile properties. This is because it is used in a manner which ensures that the wood will either receive a finishing coat or be concealed inside a construction. Hardwood with a lower grade can here be an excellent alternative to other wood types or materials.

Small and crooked birches

The traditional way of sawing hardwood means that mainly straight, and relatively thick and long dimensions are sawn. This has meant that the sawing systems used today are adapted according to this raw material. The supply of straight and thick hardwood in Sweden is limited and the hardwood sawmills are now experiencing a shortage situation.

The demand from the consumer for products made from birch has however increased considerably during recent years, and this has meant that IKEA and many other furniture producers are experiencing a strong competitive situation with regard to sawn birch wood. Their interest has thus turned towards being able to use other grades of
birch than those which have traditionally been used for sawing. Birch pulpwood is here an alternative. A characteristic of this raw material is that it is often crooked and has small dimensions, and that it has a quality which will influence the appearance and technical performance of the final product. On the other hand, there is a plentiful supply.

The use of crooked and small logs for sawing makes new demands on the sawing system, if an acceptable economic yield is to be obtained from the plant. This applies particularly with regard to the technology used for the sawing, where considerably shorter lengths must be handled than is normal today.

Within this sector, questions regarding the sawing of crooked and small birch will be considered. The aim is to analyse and describe the marketing and technical conditions for using small and crooked birch for sawing.

**Driving forces for the increased refining of the Swedish hardwood forest**

With a total hardwood stock of circa 400 million m³, there are of course a large number of alternative fields of application for hardwood, where the final product has a higher economic potential than it has today, i.e. where it is used mainly as fuel and cellulose chips. An increased utilisation of hardwood in alternative products will create more jobs, especially in sparsely-populated areas, and increase the motivation for taking care of the hardwood forest in order to achieve an increased value of the timber as a result. This is in accordance with the environmental quality goals which have been established for the forestry industry. There are further clear indications that an investment in hardwood forest and in the use of hardwood follows the Government's aims for the adaptation of the agricultural industry. The hardwood forest as a basis for a rich biological multiplicity, at the same time as it is contributes to a positive landscape picture and an active outdoor life, are also important aspects to be considered in this context.

The price development for forest raw material during the last decade has shown unambiguously that the price level (on a fixed monetary value) for softwood is decreasing slightly, while the price for hardwood, with the exception of beech, is increasing. Nevertheless, large volumes of hardwood are being imported for both pulpwood and sawn timber. It is believed that this is not a temporary development but that, even in the future, the use of hardwood within the industry will lie at a higher level than the felling. The need for hardwood will continue to be "high" and the domestic supply will not increase in the short term. With the present organisation, the structure of industrial forestry does not favour the intensive care of small units, specific assortments etc, and this leads to poor conditions for hardwood forestry and a poor supply of domestic raw material.

Today, there is a great demand for and an ability to pay for thick hardwood timber of high quality, both in Sweden and abroad. Depending on the species, it takes between 40 and 120 years to produce this timber. The economic yield from maintenance measures (thinning) is decisive for motivating the cultivation of hardwood. With the exception of birch, the capacity of the existing industry to pay for pulpwood and grades with a small diameter is very poor. For e.g. oak and alder, the capacity to pay is so poor that this probably has a negative influence on the maintenance of these stands. Alder pulpwood commands only about 40 % of the price of softwood pulpwood, while saw timber of alder commands a price at the level of that of spruce timber. Small dimensions of oak
can in general only be sold as fuel, whereas saw timber of oak is paid for many times higher than the corresponding softwood timber. The price span from pulpwood to veneer logs of birch is from SEK 250 to SEK 2000/m³fub. This shows clearly the need for new fields of application for small hardwood dimensions, which can lead to products with a high value for the final customer, if the cultivation of hardwood is to have a future in Swedish forestry.

The final consumers have in recent years become more numerous and more environmentally conscious and, as a reaction against the gross felling of tropical tree types, the trend in wood usage has during this period been directed towards lighter wood species. At the planning stage, there has been a preference for birch, maple and ash, but more recently even the slightly darker wood species such as oak have become very popular. This demand from the consumer stage means an increased utilisation of hardwood.

Final comments

The project *New products and production systems for increased profitability within the mechanical hardwood industry* aims at developing and evaluating products and production systems for sawing and for the further refining of the Swedish hardwood forest.

The customer requirements are the starting point for the products produced within the project and they thus provide the conditions for the production apparatus required. The production systems must thus be adapted to the requirement of the mechanical hardwood industry, to the volume and quality of the hardwood forest which exists in Sweden, at the same time as the customer requirements with respect to the final product are fulfilled.

This makes great demands on the production development work involved in the project, both to meet the customers' demands and at the same time to be able to utilise those properties which the wood raw material possesses and which cannot be changed in the short term.

Building on the ideas for new products and production systems which are developed within the project, we hope to be able to indicate profitable solutions which will mean that the Swedish mechanical hardwood industry will become more competitive.
References


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