A SURVEY ON
HIGH-VALUE RECOVERY MANUFACTURING
IN EUROPEAN SAWMILL INDUSTRIES

by

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Diplom-Holzwirt, University of Hamburg, 1996

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(Department of Wood Science)

We accept this thesis as conforming to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA
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Name of Author (please print) Date (dd/mm/yyyy)

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Department of Wood Science
The University of British Columbia
Vancouver, BC Canada
ABSTRACT

Lumber manufacturing technologies in British Columbia’s sawmill industry originally developed for high volumes of commodity products to be produced at high speed nowadays turn out to be inflexible and prevent sawmills from producing custom-tailored, high-value lumber products that would give them a competitive edge on today’s world markets. In European sawmills, on the other hand, value is often added to lumber not only through drying and planing but also, for instance, by strength grading of structural lumber or the manufacture of products such as gluelam, roof trusses, edge-glued panels, and more. The production strategy of many European mills is customer-oriented and product-driven; cutting-to-order is standard rather than an exception.

By means of a qualitative survey, sawmills in Europe were interviewed about their raw material supply, processing technologies, product mix, and marketing techniques. A two-page questionnaire in three languages was mailed to nearly 1,600 companies in Norway, Sweden, Finland, Germany, Austria, and Switzerland selected in a modified simple random sampling procedure.

Approximately 300 companies replied, about 70% of which returned a completed survey. Almost all of these mills began optimising the extraction of high-value wood products already on their log yards where they sorted logs by diameter, species, and according to the intended purpose. Many mills were specialised for certain lines of products and processing technologies were well tuned to the mix. The majority of the interviewed mills were cutting between 60% and 100% of their production to specific customer orders, and besides standard dimension lumber many of them also produced gluelam, laminated window stock, and other secondary products.

Based on the survey, recommendations are made to softwood lumber producers in British Columbia and throughout Canada on how they can change their manufacturing strategies to achieve a value-uplift of their production output and how more jobs per tree felled can be generated.
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1. INTRODUCTION

1.1 BACKGROUND

In British Columbia (BC), Canada’s westernmost province, one of the most important sources of income is the vast and high-quality forest resource. The forest products industry and as part of it the sawnwood industry are major providers of direct and indirect employment and, thus, income for the BC economy. Any slowdown in the forestry and forest products sector has immediate effects on the overall economic situation of the province.

During the last decade, the reliance of BC’s lumber industry on only a few export markets began to show its negative side effects. The United States, BC’s most important market, erected over the years a number of barriers for Canadian lumber exports designed to limit the market share of commodity lumber products sold to the U.S. Without counting two lumber trade disputes with the U.S. that happened already in the late 19th and the early 20th century, the latest softwood lumber disputes have been going on now for over 20 years. Rulings by both the World Trade Organization (WTO) and a panel within the North American Free Trade Agreement (NAFTA) are expected to lead to a final settlement in February 2004. (RandomLengths 2004)

The Asian Economic Crisis also contributed to an economic slowdown in BC’s lumber industry. Exports of softwood lumber to Japan dropped from 2.25 billion Can$ in 1997 to 1.55 billion Can$ in 1999 (COFI 1998, COFI 2000a). Moreover, phytosanitary measures introduced in the early 1990s by the European Union (Cohen et.al. 2003) and growing environmental concerns of European consumers regarding the management of BC’s temperate rainforests caused sales to drop heavily, especially in the UK and Germany.

BC’s lumber industry also has to deal with some home-made problems: a report by PricewaterhouseCoopers (2000a) found that much of the decrease in profitability in BC’s lumber industry was caused by an increase in raw material (wood fibre) costs due to heavy governmental
regulation of the forest resource. In 1995, an extensive Forest Practices Code had been passed, regulating forest management and harvesting practices. The forest area under protection was increased in an attempt by the provincial government to address concerns of environmentalists inside and outside the province. The code is currently under replacement by a new Forest and Range Practices Act, which will be fully implemented by the end of 2005. The new act is designed to reduce the administrative load on BC’s forest industries and allow for greater flexibility to address third-party certification and local interests (BC Market Outreach Network 2004). Moreover, BC’s Ministry of Forests recently initiated a Forestry Revitalization Plan, among others designed to promote a freer flow of raw material to the secondary wood manufacturing sector (BC Ministry of Forests 2004).

In summary, BC’s softwood lumber industry faces numerous challenges:

- Increasing global competition: softwood lumber commodity products are increasingly being produced in countries like Chile and Brazil where wages are much lower.
- Increasing competition by engineered wood products (EWP)s, such as parallel strand lumber (PSL), laminated veneer lumber (LVL), and glued-laminated timber (gluelam).
- Competition by non-wooden building products such as steel, aluminium, and plastics.
- Increased raw material procurement costs.
- A more restricted access to the forest resource in the future due to environmental considerations.

Some of these issues require policy changes, governmental efforts and international negotiations between governments. Others, however, are completely within the power of individual companies who might want to consider changes to their production and marketing strategies.
1.2 HIGH-VALUE RECOVERY MANUFACTURING

Much of the lumber production capacity in BC has been built around rather inflexible manufacturing of commodity products. As long as optimisation in lumber production meant increasing volume recovery and the production of large quantities of a few products at high production speeds, BC's lumber industry was the undefeated world leader. Significant progress in development and implementation of optimisation techniques and specialised computer software were made in BC. Producing a narrow range of products aimed at a broad customer base, however, was only competitive as long as low prices were sustained by uncomplicated and inexpensive production technology together with high output volumes.

A lack of flexibility and the reliance on high-speed production rendered BC's lumber manufacturers unable to take advantage of higher-value niche markets and shorter-term opportunities. In Japan, for example, market shares for lumber products were lost to European suppliers. Swedish and Austrian companies were able to offer kiln-dried lumber and high-end, custom-tailored glued-laminated timber (gluelam) superior to the rough-sawn, green hemlock timbers coming from BC. Because of a lacking drying capacities in Japan and the even appearance and defined characteristics of gluelam, these products were able to gain considerable shares on the Japanese market (UN-ECE/FAO 2001).

The lumber industries in both Finland and Sweden are comparable to the one in BC in terms of economic importance for forest-dominated regions. According to a 1995 survey, however, large Finnish sawmills increasingly focused on a few well-defined end-use segments and end-users. Instead of producing only commodity products, they emphasised specialty and custom-made products (Niemela and Smith 1995). Swedish sawmills are also increasing their application of value-added processes such as the production of edge-glued panels or furniture blanks, and strive for
competitive advantages by orienting themselves towards niche and upgrade markets (Roos et al. 2002).

BC’s sawmilling industry is still the world leader in terms of exported volumes of softwood lumber (COFI 2000a, UN-ECE/FAO 2001), but today companies are struggling to maintain their share of many of the world’s markets. To re-gain their competitiveness, BC’s lumber producers should consider changing their strategy of producing almost exclusively large volumes of commodity products. A more balanced approach should focus on High-value Recovery Manufacturing (HVRM) techniques that recover an increased value from the high-quality raw material available to them.

Products more desirable to their potential customers are easier to sell and earn higher prices. Producing intermediate and final products custom-tailored to the needs of both, secondary wood manufacturers and end-consumers of lumber is a possibility to increase value recovery in lumber manufacturing in BC. Market pull generated by customer demand should replace the push strategies common nowadays in the marketing of BC’s lumber products.

More advanced wood products will not only have a higher value but will also employ a higher labour input. This effect on employment is cumulative, as a product going through different stages of manufacturing will have helped to generate jobs at all of these stages. Such an employment effect might even be more important for BC’s economy than generating higher product values. Outside the Greater Vancouver Regional District (GVRD), 31 economic regions with more than 270 communities depend on the forest industry (COFI 2000b).

HVRM comprises the entire range of techniques aimed at increasing the value that is extracted from each unit of wood fibre put into the conversion process. HVRM addresses raw material procurement techniques, processing techniques and equipment being employed, products and services being offered, marketing techniques, and levels of worker skills.
2. LITERATURE REVIEW

2.1 FORESTRY AND WOOD PRODUCTS INDUSTRY IN CANADA

2.11 Canada in General

Comprising almost one billion hectares, Canada is in charge of the second largest landmass in the world managed by a single country. More than 40% of this area (nearly 420 million ha) are covered with forest and other wooded land according to the definition\(^1\) of the United Nation's Food and Agriculture Organization (FAO) (UN-ECE 2000). One tenth of the world's forests are located in Canada, equipping the country with the world's third largest forest resource after the Russian Federation and Brazil.

Canada's economy is based on natural resources. Having a population of just over 30 million people, Canada is a net-exporter of many natural resource based products such as oil, gas, metals, minerals, and farm products. Canada also exports more forest products than any other country in the world (Figure 2-1), including wood pulp, newsprint and paper, paperboard, plywood and veneers, as well as softwood lumber. In 1999, Canada's share in value of total world exports of forest products was 21%, more than that from Sweden and Finland combined (COFI 2000a).

As part of the forest products industry, lumber producers play an important role in Canada's economy. With the major share of Canada's lumber production going into exports, Canada is the largest exporter of softwood lumber in the world (Figure 2-2). In 1999, Canada's softwood lumber exports accounted for nearly 50% of the world's total export volume of 101 billion m\(^3\) (COFI 2000a).

---

\(^1\) Forest is classified as land with a tree crown cover of more than 10% and area of more than 0.5 hectares. Other wooded land is land either with a tree crown cover of 5-10% of trees able to reach a height of 5m or a crown cover of more than 10% of trees not able to reach a height of 5m. For a more detailed description see UN-ECE (2000).
Figure 2-1: Value (current USD) of Canadian imports and exports of forest products 1975 to 1999. The chart also indicates Canada’s (value) share of total world exports of forest products. (Source: FAOSTAT database)

Figure 2-2: Volume of production (incl. exports) and trade of softwood lumber in Canada 1975 to 1999. The chart presents the development of Canada’s softwood lumber production between 1975 and 1999. It demonstrates the large proportion that is exported. Imports are almost negligible, causing the positive trade balance characteristic for all Canadian forest products. (Source: FAO 2001)
Table 2-1 shows Canada’s 1999 production and trade of sawnwood in relation to corresponding data for the six European countries investigated in this study.

Table 2-1: 1999 production and trade of lumber together with number of sawmills for Canada and six European countries.  
(Source of sawnwood data: FAOSTAT database)

<table>
<thead>
<tr>
<th>Country</th>
<th>Sawmills (estimated)</th>
<th>Production ('000 m$^3$)</th>
<th>Imports ('000 m$^3$)</th>
<th>Exports ('000 m$^3$)</th>
<th>Exports / Imports</th>
<th>Exports / Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>837</td>
<td>69,300</td>
<td>1,800</td>
<td>49,700</td>
<td>2,720 %</td>
<td>72 %</td>
</tr>
<tr>
<td>Norway</td>
<td>275</td>
<td>2,600</td>
<td>800</td>
<td>800</td>
<td>90 %</td>
<td>30 %</td>
</tr>
<tr>
<td>Sweden</td>
<td>2,435</td>
<td>14,900</td>
<td>300</td>
<td>11,100</td>
<td>3,570 %</td>
<td>74 %</td>
</tr>
<tr>
<td>Finland</td>
<td>1,007</td>
<td>12,800</td>
<td>300</td>
<td>8,300</td>
<td>2,870 %</td>
<td>65 %</td>
</tr>
<tr>
<td>Germany</td>
<td>2,300</td>
<td>16,300</td>
<td>6,200</td>
<td>2,500</td>
<td>40 %</td>
<td>15 %</td>
</tr>
<tr>
<td>Austria</td>
<td>1,700</td>
<td>9,800</td>
<td>1,300</td>
<td>5,800</td>
<td>460 %</td>
<td>59 %</td>
</tr>
<tr>
<td>Switzerland</td>
<td>600</td>
<td>1,500</td>
<td>500</td>
<td>200</td>
<td>30 %</td>
<td>12 %</td>
</tr>
</tbody>
</table>

Quebec and BC together account for about 80% of Canada’s entire lumber production (Figure 2-3).

Figure 2-3: Lumber production in Canada by province 1975 to 1995.  
The chart presents softwood and hardwood production volumes for each province (or group thereof) as well as relative shares for BC’s and Quebec’s sawmill industries. However, hardwood species account for only 2% of the total lumber production in Canada. Data for Ontario and the Prairie Provinces (Manitoba, Saskatchewan, Alberta) also contain production data from the Yukon and North West Territories. (Source: CFS 1997)
Accounting for more than 50% of the entire Canadian production, BC's lumber industry contributes the largest volume share. In 1999, lumber exports from BC worth 7.5 billion Can$ made up 49% of the value of all of BC's forest product exports or 55% of the value of all sawnwood exports from Canada (COFI 2000a).

### 2.12 British Columbia

**Forest resource**

Comprising almost 95 million ha, BC holds nearly 10% of Canada's land base. Predominantly coniferous forests cover about 60 million ha or two-thirds of the province. Total growing stock volume is about 9 billion m$^3$ (COFI 2000a). Almost half of BC's forestland is stocked with trees that are more than 120 years old (BC Ministry of Forests 1994). The overwhelming proportion of forestland in BC is publicly owned, mainly by the province, and to a small part by the state. Private ownership accounts for only 4%.

More than 10 million ha of the western mountain slopes of coastal BC are covered with temperate rainforest, a type of forest that is extremely rare worldwide. Predominant tree species are western hemlock and western redcedar. Red alder is the common broad-leaved species in the coastal region. (BC Ministry of Forests 1994)

The western part of the Interior receives comparatively little precipitation. Forests here contain more aridity-resistant tree species such as Ponderosa pine, lodgepole pine, with Douglas-fir in the South and white spruce and hybrid white spruce in the North. Aspen, the most abundant non-coniferous tree species in BC, is also common in the Interior. (BC Ministry of Forests 1994)

The very east of the Interior receives much more rainfall than the western and Central Interior regions. Forests in the eastern Interior are predominantly stocked with hydrophilic species quite similar to the coastal forests. (BC Ministry of Forests 1994)
With its Temperate Coastal Rainforest, its diverse biogeoclimatical zones, and a large number of unique tree species all over the province, BC’s wood products industry has a forest resource at its disposal that is hard to match by other places in the world. Table 2-2 presents some important softwood species used in BC’s wood products industries and explains current and potential applications.

Many of BC’s native tree species are well suited not only for two-by-fours and other standard dimension lumber, but also for a great variety of other applications such as engineered wood products (EWPs), panelling, flooring, doors and windows, architectural millwork, furniture, and specialty products. This opens opportunities not only to the secondary wood industry, but also, and foremost, to BC’s sawmill industry. Sawmills in BC can easily widen their product range through the application of new species in existing products as well as the development of new products making best possible use of the vast variety of properties inherent to BC’s many wood species.
<table>
<thead>
<tr>
<th>Common name</th>
<th>Scientific name</th>
<th>Habitat</th>
<th>Heavy construction</th>
<th>General construction</th>
<th>Slabs</th>
<th>Paneling</th>
<th>Architectural millwork</th>
<th>Doors &amp; windows</th>
<th>Furniture &amp; parts</th>
<th>Railway ties</th>
<th>Plywood &amp; veneers</th>
<th>Specialty wood products</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>amabilis fir or</td>
<td>Abies amabilis</td>
<td>Coast: N</td>
<td>good</td>
<td>excellent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>light &amp; clean appearance</td>
</tr>
<tr>
<td>Pacific silver fir</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Douglas</td>
<td>Pseudotsuga</td>
<td>Coast: S Interior: SI, SP, SM</td>
<td>excellent</td>
<td>good</td>
<td></td>
<td></td>
<td>good</td>
<td>excellent</td>
<td>good</td>
<td></td>
<td></td>
<td></td>
<td>very hard, stiff, strong, durable</td>
</tr>
<tr>
<td>Engelmann spruce</td>
<td>Picea Engelmannii</td>
<td>Interior: SM</td>
<td>good</td>
<td></td>
<td></td>
<td></td>
<td>good</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>grand fir</td>
<td>Abies grandis</td>
<td>Interior: SM</td>
<td>good</td>
<td></td>
<td></td>
<td></td>
<td>good</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>hybrid white spruce</td>
<td>P. engelmannii x</td>
<td>Interior: NP, SM</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>lodgepole pine</td>
<td>Picea contorta var.</td>
<td>Interior: SP, NP, NI</td>
<td>good</td>
<td>excellent</td>
<td></td>
<td></td>
<td>good</td>
<td>good</td>
<td>good</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>latifolia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>good</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ponderosa pine</td>
<td>Picea ponderosa</td>
<td>Interior: SI</td>
<td>good</td>
<td></td>
<td></td>
<td></td>
<td>good</td>
<td>good</td>
<td>good</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sitka spruce</td>
<td>Picea sitchensia</td>
<td>Coast: N</td>
<td>excellent</td>
<td></td>
<td></td>
<td></td>
<td>good</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>subalpine fir</td>
<td>Abies lasiocarpa</td>
<td>Interior: NP, SM, NI</td>
<td>good</td>
<td></td>
<td></td>
<td></td>
<td>good</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>western hemlock</td>
<td>Tsuga heterophylla</td>
<td>Coast: S, C, N Interior: SM</td>
<td>excellent</td>
<td></td>
<td></td>
<td></td>
<td>good</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>even grain; easy to machine</td>
<td></td>
</tr>
<tr>
<td>western larch</td>
<td>Larix occidentalis</td>
<td>Interior: SE, SM</td>
<td>excellent</td>
<td></td>
<td></td>
<td></td>
<td>good</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>very strong; durable</td>
</tr>
<tr>
<td>western redcedar</td>
<td>Thuja plicata</td>
<td>Coast: S, C, N Interior: SM</td>
<td>good</td>
<td>excellent</td>
<td></td>
<td></td>
<td>good</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>extremely durable; light</td>
</tr>
<tr>
<td>western white pine</td>
<td>Pinus monticola</td>
<td>Interior: SM</td>
<td>good</td>
<td></td>
<td></td>
<td></td>
<td>good</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>uniform texture; fine grain</td>
</tr>
<tr>
<td>white spruce</td>
<td>Picea glauca</td>
<td>Interior: NP, NI</td>
<td>excellent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Explanations:
1) Coast: S=South, C=Central, N=North; Interior: SI=southern I., SP=southern Plateau, SM=southern Mountains (Columbia & Rockies), SE=Southeastern, NP=northern Plateau, NI=northern I.
2) incl. dimension lumber
3) incl. outdoor furniture, boat building, food containers, musical instruments and parts thereof.

Table 2-2: Commercially used tree species in BC, their habitat, and main applications. Sources: BC Ministry of Forests 1994, BC Ministry of Forests 2001b.
Production and trade of forest products

BC's forests play an important role for the province, not the least in terms of employment and income. In 1999, the forest and wood products industries in BC generated 90,600 direct jobs and accounted for 16% of the province's gross domestic product (GDP) (PricewaterhouseCoopers 2000b). The consumption of forest products, however, within the province is very limited because of the small population. The forest products industry is therefore highly oriented towards production of primary commodity products. In 1999, BC's exports of almost exclusively primary forest products accounted for 7% of the total value of all world exports (COFI 2000a).

Burda and Gale (1998) investigated the degree to which BC's forest industry depends on production and export of only four commodity products: softwood lumber, pulp, newsprint, and paper. They concluded that this low-value-added, high-volume commodity production is socio-economically and environmentally no longer sustainable and that a low-volume, high-value-added strategy for the province's forest products industry is urgently needed.

Structure of the sawmill industry

The sawmill industry is a key sector of BC's forest products industry. Direct employment in 1999 in BC's sawmills industry was 20,300 jobs, equivalent to 22% of the direct employment provided by the entire BC forest products industry (COFI 2000b).

The industry is strongly oriented towards supplying export markets with lumber products. In 1999, the total volume of softwood lumber exports from BC accounted for 26% of the world exports (COFI 2000a). These exports were worth 7.6 billion Can$, nearly three-quarters of which were generated from U.S. markets and one-fifth from the Japanese market (Figure 2-4) (COFI 2000a).
BC's sawmill industry consists of two geographically very distinct segments: a Coastal and an Interior industry. The Coastal industry produces a wide range of lumber products, including standard dimension lumber, boards, timbers, and specialty products. This diversification is the result, on one hand, of a wood resource of western hemlock, western redcedar, and Douglas-fir, available in a wide range of log diameters, and, on the other hand, easy access to overseas markets with a broad range of customers. In 1999, BC's coastal sawmills provided direct jobs for 7,000 employees and produced 2.8 billion board feet (6.6 million m$^3$), equivalent to 21% of BC's total lumber production (PricewaterhouseCoopers 2000b; COFI 2000a).

Sawmills in the BC Interior concentrate on converting a raw material mix of spruces, lodgepole pine, balsam fir, and Douglas-fir in smaller and more consistent log diameters mostly into structural dimension lumber products. The Interior industry is strongly oriented towards supplying the U.S. American market. Owing to the closeness to the U.S. (building and home-renovation) market and the characteristics of the available forest resource, the share of dimension lumber versus...
the share of specialty and advanced wood products is much higher for the Interior sawmill industry than for the Coastal mills.

Direct employment in the Interior sawmills in 1999 was 13,300 and lumber production was 10.7 billion board feet (25.2 million m$^3$), equivalent to 79% of the total sawnwood production in BC (PricewaterhouseCoopers 2000b, COFI 2000a).

**Secondary Wood Manufacturing in BC**

Wilson *et al.* (2001a) identified 774 companies in BC involved in secondary manufacturing of solid wood products. These were distributed over nine business types, namely remanufacturing, engineered wood products, millwork, cabinets, furniture, pallets and containers, panelboards, shakes and shingles, and other wood products with remanufacturing and engineered wood products together accounting for 45% of the companies (Wilson *et al.* 2001a).

Total employment, measured in full-time equivalents, for above nine business types was 19,490 persons, with a median company size of 11-15 employees and 53% of the companies employing 15 people or fewer. On average, secondary wood manufactures in BC provided 1.14 jobs (full-time equivalents) for every 1,000 m$^3$ roundwood processed. At nearly 20 jobs per 1,000 m$^3$, cabinet manufacturers provided far more jobs than the average, together with furniture manufacturers (7 jobs/1,000 m$^3$). (Wilson *et al.* 2001a)

Different from the primary wood industry, secondary manufacturers are more common in the Coast region. Wilson *et al.* (2001b) reported about 1.5 times as many establishments in the Coast region as in the Interior. The majority (90%) of secondary manufacturers in BC reported at least some sales within the province, and 47% even indicated BC to be their major market. Especially final products such as cabinets, furniture, and pallets and containers were sold inside the province. Remanufacturing and panelboards together accounted for 62% of the estimated total sales revenues and for 78% of the raw material usage. (Wilson *et al.* 2001a)
Raw material procurement is a major concern for the secondary solid wood manufacturing companies in BC (Kozak et.al. 2003). It appears that despite an abundant supply of high-quality roundwood to lumber manufacturers both in the Interior and Coastal regions, neither the necessary quantities nor the required quality of material can be made available to secondary wood manufacturers (Janssen 2001, Kozak et.al. 2003).

BC's secondary wood industry constitutes a considerable domestic market for advanced and specialty wood products from HVRM processes in the lumber industry (Kozak et.al. 2003). Developing this market, however, requires that BC's volume-focused lumber manufacturers become interested in supplying the province's secondary industry with raw materials and blanks, i.e. pieces of lumber prepared to be turned into secondary products in further processing steps.

2.2 FORESTRY AND WOOD PRODUCTS INDUSTRY IN EUROPE

2.21 Norway

Forest resource

Norway stretches along the western edge of the Scandinavian Peninsula beyond north of the Arctic Circle. Forest and other wooded land¹ cover about 12 million ha, or nearly 40% of Norway's mostly mountainous land area. Rugged and inaccessible terrain, however, makes a quarter of the forest uneconomical to use as timber resource. Seventy-nine percent of Norway's forests are privately owned, 9% are owned by industries, and the state and other institutions own the remaining 12%. (FAO 2001)

The total growing stock volume is almost 750 million cubic metres (around 8% of BC's growing stock volume) and consists mainly (75%) of Norway spruce² and Scots pine. The most

¹ See definition on page 5.
² For scientific names of common European tree species please refer to APPENDIX C.
abundant non-coniferous species is European birch, although European aspen and common alder appear also quite frequently.

**Production and trade of forest products**

The forestry and forest products industry in Norway contribute considerably to local economies. While hunting, recreation and collection of non-wood forest products are major forest functions, roundwood production remains the most important function of Norway's forests. (FAO 2001)

About half the wood production is consumed by Norway's pulp and paper industry, which belongs to the most important in Europe. Nearly 25% of the pulp production and almost 90% of the paper and paperboard production are exported. (FAO 2001)

**Structure of the sawmill industry**

In 1998, Norway's sawmill industry consisted of 207 establishments (units with more than 5 employees) (Trelast 2000). Sawmills are located all over Norway close to the raw material resource and play important roles for local economies and employment. Main products are structural and non-structural sawnwood products for the building industry as well as components for joinery and furniture manufacturing (FAO 2001). Main exports markets are Sweden, the UK, and Continental Europe, i.e. Germany and the Netherlands. However, most of Norway's lumber production is utilised domestically, making Norway a net importer of lumber and wood products, unlike its fellow Nordic countries Sweden and Finland (see Table 2-1 in section 2.11 above).

The degree of computer-utilisation and technological development in all aspects of the sawnwood production process in Norway is high, as is the degree of value recovery. In 1995, the wood products industry employed around 16 000 people (Levende Skog, n.d.). Exports of high-value secondary wood products contributed with 500 million Norwegian Kroner (around 80 million US$) to Norway's economy (Levende Skog, n.d.). Two examples illustrating the high
degree of advanced wood processing technology in Norway are the roof of the Olympic Viking Ship Hall, a gluelam construction with a non-supported span of up to 120 m, and the terminal building at Gardamoen, the new international airport outside of Norway's capital Oslo.

2.22 Sweden

Forest resource

Sweden stretches over almost 1,600 km in South-to-North direction, causing climatic conditions to range from temperate in the South to boreal and almost arctic in the North. Forest and other wooded land cover more than 30 million ha and account for 75% of the land area. More than 75% of the forests are available for wood supply. The remainder is not available mainly for reasons of conservation and protection.

Private individuals own 51% of the Swedish forests, companies with limited liability own 39%, public institutions other than the state own 7%, while the state itself owns 3%. However, as it is the sole stockholder of a limited liability company owning almost 3.5 million ha of forests, the state is in fact the largest forest owner in Sweden. (Skogsstyrelsen 2003)

Total growing stock volume amounts to nearly 3 billion m³, one third of BC's. Softwood species account for more than 80% of the growing stock (FAO 2001). The most important tree species are Scots pine and Norway spruce, while European birch is the main non-coniferous species.

Production and trade of forest products

Hunting and nature conservation are major forest functions, as is collection of non-wood forest products like berries and mushrooms. Supplying the large wood processing sector with wood, however, remains the most important function of Sweden's forests.

The forest industry is one of the driving forces of the Swedish economy and Sweden is one of the leading exporters of pulp, paper, and sawnwood in the world. With 12% of the total, forest products are the second most important source of export income for Sweden's economy after

**Structure of the sawmill industry**

Lumber production in Sweden has a history of well over 500 years. The year 2000 sawmill census counted about 1,900 establishments. Two hundred and forty-one of them produced more than 5,000 m³ annually and accounted for 96% of Sweden’s entire production of sawnwood (Staland 2002). Total production of softwood lumber in 1998 was nearly 15 million m³ (FAO 2001). Main export markets are the UK and Germany.

In order to recover higher values, the Swedish sawnwood industry also produces and exports some secondary sawnwood products. These are mainly planed and moulded goods, furniture blanks, gluelam, and building components. Moreover, the Swedish sawnwood industry frequently adds value to their products through strength grading, trimming to order, and drying to order. (Warensjö and Jäppinen 1997)

### 2.23 Finland

**Forest resource**

Finland stretches from the eastern shores of the Baltic Sea to far north of the Arctic Circle. It has a mostly flat topography covered by forests and lakes. Forest and other wooded land cover nearly 23 million ha or about 75% of the land area (FAO 2001). Apart from some areas set aside for conservation and protection, most of the forests are available for wood supply. Private individuals and some forest industries own roughly 70% of the forest resource; the Finnish State owns most of the remainder.

Finland’s forests are almost exclusively boreal. Total growing stock volume is about 2 billion m³ (less than one quarter of BC’s) with over 80% of it being coniferous, predominantly
Scots pine and Norway spruce. The major non-coniferous species is European birch, although common alder is also widely spread.

**Production and trade of forest products**

The forest sector is one of the driving forces of the Finnish national economy. Hunting, reindeer husbandry, and gathering of non-wood forest products are important forest functions for local populations. Roundwood production, however, is the most important forest function and the forest products industry contributes significantly to the GDP.

Although Finland owns only 1% of the global coniferous forest resource, it produces 5% of the global production of forest products. Exports of forest products account for a quarter of all exports from Finland and represent 10% of the total world exports. In terms of printing and writing paper, Finland has a share of 25% of the total world exports (FFIF n.d.).

**Structure of the sawmill industry**

In terms of production volume, Finland's sawmill industry is the seventh largest in the world and the third largest in Europe (FFIF n.d.). Its output of 11.4 million m³ is only slightly below that of the Swedish sawnwood industry.

Finnish sawnwood production clearly exceeds domestic consumption (Table 2-1 in section 2.11). Around 65% of the production volume is exported, making Finland the third largest exporter of sawnwood in the world after Canada and Sweden. Large companies and production units dominate the sawnwood industry.

Finland mainly produces and exports primary wood products. The degree of value-recovery within the country is relatively low. The secondary wood products industry as a consumer of primary wood products is small and focused on a limited domestic market. However, the sawnwood industry itself or direct subsidiaries produce and export some secondary wood products.
such as planed goods, building products, gluelam, wooden house components, and packaging products.

2.24 Germany

Forest resource

The Federal Republic of Germany is located between Denmark to the North and Switzerland and Austria to the South. Forests cover roughly 30% (11 million ha) of the land area, foremost in the South, centre, and East of the country. Except for a negligible share, all forest is available for wood supply.

The federal states own about 30% of the forestland in Germany, while the German State (federation) itself owns only 4%. Municipalities and other public institutions own about 20%. The remaining 46% of forestland is privately owned with two-thirds of it allocated to small and very small forest ownerships. (Holzabsatzfonds n.d.)

The total growing stock volume lies at nearly 3 billion m$^3$, one third of BC’s. Two-thirds of the growing stock volume consist of softwood species, mainly Scots pine, European larch, and Norway spruce. Oak species account for roughly 10% of the growing stock, while European beech and other broadleaved species account for the remaining 25% (Holzabsatzfonds n.d.).

Production and trade of forest products

The forest and wood industries in Germany are rather well developed, although their contribution to the country’s total GDP is only marginal. Germany is one of the leading producers of paper and wood-based panels in the world. Germany’s production of sawnwood is of nearly the same order as Sweden’s. Roundwood production is therefore the most important function of Germany’s forests. Further functions include recreation for the public and hunting as well as harvesting of non-wood forest products such as Christmas trees, berries, and mushrooms.
Besides some large-size companies in the pulp and paper, wood-based panel, and sawnwood industries, Germany's wood products industry is dominated by medium sized enterprises. In 1999, the entire forest products industry (incl. pulp and paper) turned over about 85 billion US$ (Holzabsatzfonds n.d.).

Germany is an important producer and trading partner in forest products despite the industry's low importance for the country's GDP. Main markets for the German forest products industries are its neighbouring countries within the European Union (EU).

**Structure of the sawmill industry**

The German sawmill industry produces about 15 million m³ sawnwood products annually in around 2,300 plants with a total of almost 30,000 employees (Holzabsatzfonds n.d.). Two-thirds of all German sawmills lie in the two southernmost federal states. The production volume is comparable to that of Sweden despite a forest base only one third the size. The level of technological development varies widely. Often only larger and financially better equipped companies can afford to invest into new technologies.

Many German sawmills have turned away from producing only rough-sawn lumber and extended their depth of production. Kiln-drying, planing, moulding, finger-jointing, and chemical treatment with preservatives are frequently applied techniques to recover higher values in the lumber production process. A number of German sawmills include secondary processing units in order to recover the best possible value from the comparatively expensive raw material.

German consumption of sawnwood exceeds domestic production by far, causing a dependency on imports. This is partly due to the strongly developed secondary wood processing sector. Germany has the largest engineered wood products industry in Europe. The furniture industry together with a huge number of carpentry and joinery shops contribute more than half of the annual turnover of the entire forest products industry (Holzabsatzfonds n.d.).
2.25 Austria

**Forest resource**

Surrounded by Germany and the Czech Republic to the North, Hungary to the East, Italy to the South, and Switzerland to the West, Austria is a landlocked country in central Europe. Its western two-thirds are alpine. Nearly half of the land area (3.9 million ha) are covered with forest and other wooded land, almost all of which is available for wood supply.

More than 80% of Austria's forest resource are owned privately, mostly by individuals. The total growing stock volume is just over one billion m$^3$, 11% of BC's. Over 80% of it are coniferous. The main softwood species are Norway spruce, Scots pine, European larch and silver fir, while the main broadleaved species is European beech.

**Production and trade of forest products**

Producing large quantities of paper, wood-based panels, and sawnwood, Austria is one of the major suppliers of forest products both in Europe and the world. In 1998, Austria exported forest products for a total of 2.35 billion US$. Production of industrial roundwood is therefore the most important function of Austria's forests. In some mountainous areas, forests also serve an important function as protection against avalanches.

Sixty percent of the annual production of forest products is exported, mainly to countries of the EU. After tourism, forest product exports are the second-most important source of income for Austria's economy (proHolz, n.d.). The most important markets are Italy and Germany. Exports to Asia and the U.S. have been increasing strongly over the last years.

**Structure of the sawmill industry**

The Austrian sawmill industry comprises about 1,500 establishments. More than 85% are small and medium-sized enterprises. Austria's total annual output of sawnwood products in 1998

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21
was 8.7 million $m^3$, over 95% of it coniferous. Exporting around 60% of its production, Austria ranges fifth among the big sawnwood exporting countries of the world.

Aiming for an increased value recovery, many Austrian sawmills have extended their production into solid wood wall panels, glued-laminated timber, or pallets and crates. Moreover, Austria produces a wide variety of secondary wood products such as doors and windows, wooden floorings, furniture, and especially skis. Accordingly, the level of technological development in the Austrian wood processing industry is high and the workforce is highly skilled. The largest employer is the joinery industry, with its numerous small and medium-sized companies employing more than 40,000 employees or about one-third percent of the total workforce in the wood products industry (including pulp and paper).

### 2.26 Switzerland

**Forest resource**

Switzerland is a landlocked, alpine country in central Europe surrounded by Germany to the North, Austria to the East, Italy to the South, and France to the West. Forests and other wooded land cover around 1.2 million hectares or 30% of the land area. Ninety percent of the forest resource is available for wood supply.

Nearly 75% of the forest resource is publicly owned, mostly by municipalities. The remaining 25% are in the possession of more than 250,000 private forest owners. Total growing stock volume is around 430 million $m^3$ (5% of BC's) and nearly 75% of it is made up of coniferous species.

The two dominant tree species are Norway spruce, with a share of almost 50%, and European beech, with 16% of the growing stock volume. Further common conifers are silver fir and Scots pine, while maples, oaks, and European ash are common deciduous species in the Swiss forests. (Waldwirtschaft Schweiz 2003)
Production and trade of forest products

Employing less than 3% of the total workforce, the Swiss forest and forest products industries are only of minor economic importance. Besides wood production, Switzerland's forests serve very important functions in avalanche protection and as soil retainers in the mountainous terrain.

Switzerland is a net exporter of logs and a net importer of sawnwood. In 1996, almost 20% of the harvested volume of nearly 4.5 billion m$^3$ was used as fuel wood, around 15% went into the pulp, paper and panel industries and about 65% were consumed by the sawmill and veneer industries (Statistik Schweiz, n.d.). Switzerland’s primary non-wood forest products are Christmas trees.

Structure of the sawmill industry

The Swiss Federal Statistical Office (Statistik Schweiz, n.d.) counted a total of 958 sawmills employing together around 3,000 employees in 1991. The vast majority of these mills had annual capacities of less than 5,000 m$^3$ roundwood. Most of them are located at the northern edge of the Swiss Alps and in the interior plateau.

The main sawnwood products are structural lumber from softwoods and live-sawn joinery timber from hardwoods. In 1991, the Swiss wood products industry consisted of around 12,000 establishments employing about 90,000 people (Statistik Schweiz, n.d.). Around 7,500 of these were small and medium sized carpentry and joinery shops with 48,000 employees altogether.

Moreover, there are great numbers of furniture manufacturers as well as door, window, and wooden floor producers. Accordingly, the level of value-added in the Swiss wood products industry is very high as is the proportion of skilled labour force. Most of the industry’s production goes into the domestic market or to the neighbouring parts of France, Italy, or Germany.
2.3 THE COUNTRIES IN COMPARISON

The following section briefly compares the six European countries in this study to BC and Canada. Table 2-3 presents some key figures on production and trade of forest products and employment in the forest sector.

Table 2-3: Some key figures on forest products industries in Canada and Europe.

<table>
<thead>
<tr>
<th>Country</th>
<th>Forest products imports over exports (value)</th>
<th>Value share of sawnwood of all 1998 forest products exports</th>
<th>Total 1998 sawnwood production (1000 m$^2$)</th>
<th>Sawnwood consumption over production</th>
<th>Employees in forest products industries per 1,000 m$^2$ roundwood consumed</th>
</tr>
</thead>
<tbody>
<tr>
<td>British Columbia</td>
<td>0.0</td>
<td>49%</td>
<td>30,237</td>
<td>0.2</td>
<td>1.39</td>
</tr>
<tr>
<td>Canada</td>
<td>0.1</td>
<td>33%</td>
<td>65,109</td>
<td>0.3</td>
<td>1.40</td>
</tr>
<tr>
<td>Norway</td>
<td>0.6</td>
<td>7%</td>
<td>2,525</td>
<td>1.1</td>
<td>2.68</td>
</tr>
<tr>
<td>Sweden</td>
<td>0.2</td>
<td>22%</td>
<td>15,124</td>
<td>0.3</td>
<td>1.43</td>
</tr>
<tr>
<td>Finland</td>
<td>0.1</td>
<td>14%</td>
<td>12,300</td>
<td>0.4</td>
<td>1.54</td>
</tr>
<tr>
<td>Germany</td>
<td>1.1</td>
<td>6%</td>
<td>14,972</td>
<td>1.2</td>
<td>19.89</td>
</tr>
<tr>
<td>Austria</td>
<td>0.5</td>
<td>24%</td>
<td>8,737</td>
<td>0.6</td>
<td>15.70</td>
</tr>
<tr>
<td>Switzerland</td>
<td>1.6</td>
<td>3%</td>
<td>1,400</td>
<td>1.3</td>
<td>27.82</td>
</tr>
<tr>
<td>Europe</td>
<td>1.0</td>
<td>13%</td>
<td>117,122</td>
<td>1.0</td>
<td>...</td>
</tr>
<tr>
<td>World</td>
<td>1.0</td>
<td>17%</td>
<td>410,612</td>
<td>1.0</td>
<td>...</td>
</tr>
</tbody>
</table>

1) Cons = Prod + Imp - Exp


Germany and Switzerland were the only two countries that imported more forest products than they exported. The other countries had forest product export surpluses of varying magnitudes. Lumber exports as (value) share of total forest exports also varied strongly between different countries. BC's lumber exports represented 49% of all forest product exports while for all of Canada it was 33%. For both Sweden and Austria, lumber exports represented over 20% of their total forest product exports, while for Finland it was just 14%. With lumber consumption exceeding production, Norway, Germany, and Switzerland were net-consumers of lumber, while the other countries were net-producers.
Most striking are the differences between countries when employment figures per volume unit roundwood consumed were compared. In BC and Canada, as well as Sweden and Finland, consumption of 1,000 m$^3$ roundwood sustained close to 1.5 jobs from logging to the final processing step. In Norway, it was almost twice as many. The three German-speaking countries showed the biggest difference with more than ten times as many jobs sustained per 1,000 m$^3$ roundwood consumption.

These large discrepancies are partly explained by BC and Canada as well as the three Nordic countries having forest industries almost exclusively oriented towards production of primary commodity products such as softwood lumber and especially pulp and paper. These industries are extremely resource but not labour intensive. The German-speaking countries, on the other hand, also have strongly developed secondary wood processing industries consisting of small and medium sized units supplying local and domestic markets. These companies are less volume and more value-oriented and require much higher labour input.

Above findings point in the same direction as similar figures provided by Wilson et.al. (2001) and Kozak et.al. (2003) for BC’s secondary wood industry. Part of the discrepancies, however, could also be caused by differences in collecting employment data on wood manufacturing industries in different countries.
3. OBJECTIVES AND SCOPE

3.1 RESEARCH OBJECTIVE

The main objective of this study was to initiate a learning process leading to BC's lumber industry re-gaining its competitive edge. Specifically, the extent to which sawmills in different European countries, where HVRM techniques were in use, applied these techniques is investigated. A further aim of the study was to determine the kinds of HVRM techniques employed and what made them successful.

Finally, ways of introducing HVRM techniques in the BC sawmill industry were of interest. Employment of HVRM techniques in BC was expected to promote more efficient manufacturing, enhanced harvesting methods, more jobs involved in high-end manufacturing, and intermediate products better aimed at the secondary manufacturing industry.

The following particular research questions were to be answered:

(1) To which extent do sawmills in Europe employ HVRM techniques?

(2) What distinguishes HVRM mills from other mills in terms of production equipment, products, and marketing strategies?

(3) Which effect on employment does a higher degree of value recovery in the wood processing chain have?
3.2 SCOPE OF THE STUDY

For reasons of financial and time constraints, and because background information was more readily available, the study was limited to sawmill industries in the six different European countries described earlier in section 2.2. These countries were selected according to the following criteria:

- The sawnwood industry is of economic importance.
- The sawnwood industry is based on a timber resource similar to the one in BC (primarily coniferous species).
- The degree of technical development within the industry is relatively high.
- It is possible to obtain information on the size of the target population and company addresses with a reasonable amount of effort.
- A mail questionnaire could reach the target group within an appropriate timeframe.
- Respondents are able to communicate in a language known to the researcher, i.e. English, German, or Swedish.
4. RESEARCH METHODOLOGY

4.1 SURVEY

Questionnaire

Survey participants were interviewed by means of a mail survey on a range of HVRM production-related issues. A two-page questionnaire was developed that contained a total of 22 questions in five different sections: (1) structural company information, (2) raw material supply and handling, (3) processing technologies, (4) products and services, and (5) customers and markets. A copy of this questionnaire is presented in APPENDIX A.

Completed questionnaires were to be returned by fax. This not only ensured a reasonable return time, but it also was expected to boost response frequency in this international survey.

Sampling

Two different sampling schemes were applied for the Nordic countries (Norway, Sweden, and Finland) and for the German-speaking ones (Germany, Austria, and Switzerland). Owing to time and money constraints, only a relatively small number of addresses, mainly from one source, could be obtained for the Nordic countries. These working populations \( N_w \) corresponded to about 40% of the estimated population size for Norway and around 15% of the estimated population sizes for Sweden and Finland, respectively. It was therefore decided to perform a total sampling of the working population for the Nordic countries.

Addresses for the German-speaking countries were sampled in a modified simple random sampling procedure. The available address data \( N_w \) for the German-speaking countries comprised altogether over 4,000 addresses corresponding to over 90% of the combined estimated population sizes. The sample was designed to consist of roughly 25% or 1,000 of these addresses. In order to ensure a return of at least 10 questionnaires from each country at an estimated response rate of 10%, 100 addresses per country were randomly drawn in a first sampling step. In a second step, a further
700 addresses were randomly sampled from the remaining addresses. Roughly 30 of the addresses later had to be discarded for a variety of reasons. The breakdown by population and sample sizes is presented in Table 4-1.

Table 4-1: Sizes of estimated and working populations together with sample sizes.

<table>
<thead>
<tr>
<th>Country</th>
<th>Estimated Population</th>
<th>Working Population</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Year</td>
<td>Source</td>
</tr>
<tr>
<td>Finland</td>
<td>1,000</td>
<td>1997</td>
<td>Finish Wood Industry Assoc.</td>
</tr>
<tr>
<td>Subtotal</td>
<td>3,710</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>2,300</td>
<td>1999</td>
<td>German Sawmill Association</td>
</tr>
<tr>
<td>Austria</td>
<td>1,700</td>
<td>1998</td>
<td>Austrian Sawmill Association</td>
</tr>
<tr>
<td>Switzerland</td>
<td>600</td>
<td>1999</td>
<td>Swiss Sawmill Association</td>
</tr>
<tr>
<td>Subtotal</td>
<td>4,600</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>8,310</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) The source contained 73 addresses of sawmills in Norway and 285 addresses in Sweden. These were completed by directory listings from the countries’ different sawmill and timber associations found on the Internet.
2) The source contained 105 addresses of sawmills in Finland. These were completed by company directory listings on the Internet, and references from a manufacturer of sawmill equipment with contact to the Finnish sawnwood industry.
3) Equals number of recipients contacted in the respective countries.

Time frame

Questionnaires in three languages, English, German, and Swedish, accompanied by a cover letter were sent out to all approximately 1,600 recipients in mid August 1999. Six weeks after the initial mail-out or about four weeks after the estimated date of receiving the first questionnaire, follow-up letters containing a further copy of the questionnaire were mailed to those recipients who had not responded by this date. The final cut-off date was set as November 15, 1999. After this date, no more surveys were accepted and the coded data from the completed surveys were transferred into a spreadsheet database and a statistical software package for evaluation.
5. RESULTS AND DISCUSSION

5.1 RESPONSE ANALYSIS

Recipients who chose not to complete the survey were asked to check all of the following six statements that were applicable contained in the follow-up letter and return this information:

a) Company is not a sawmill
b) Company does further processing only
c) Sawmill was closed down
d) I don't have the time
e) I am not interested in participating in this study
f) Other reason (please explain)

Because letters returned with "address unknown" could not be expected in such an international survey, responses to some of these statements enabled an educated guess on unreachable recipients. Adjusted response rates could then be calculated for each country. The results are presented in Table 5-1.

Table 5-1: Breakdown of responses.

<table>
<thead>
<tr>
<th>Country</th>
<th>Recipients</th>
<th>Responses</th>
<th>No (operating) sawmills</th>
<th>Completed surveys</th>
<th>Response rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initial</td>
<td>Follow-up</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norway</td>
<td>107</td>
<td>10</td>
<td>13</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>Sweden</td>
<td>343</td>
<td>44</td>
<td>37</td>
<td>14</td>
<td>63</td>
</tr>
<tr>
<td>Finland</td>
<td>158</td>
<td>18</td>
<td>13</td>
<td>3</td>
<td>24</td>
</tr>
<tr>
<td>Subtotal</td>
<td>608</td>
<td>72</td>
<td>63</td>
<td>28</td>
<td>99</td>
</tr>
<tr>
<td>Germany</td>
<td>448</td>
<td>40</td>
<td>40</td>
<td>25</td>
<td>52</td>
</tr>
<tr>
<td>Austria</td>
<td>344</td>
<td>23</td>
<td>27</td>
<td>12</td>
<td>32</td>
</tr>
<tr>
<td>Switzerland</td>
<td>180</td>
<td>19</td>
<td>22</td>
<td>9</td>
<td>28</td>
</tr>
<tr>
<td>Subtotal</td>
<td>972</td>
<td>82</td>
<td>89</td>
<td>46</td>
<td>112</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1580</td>
<td>154</td>
<td>152</td>
<td>74</td>
<td>211</td>
</tr>
</tbody>
</table>

The adjusted overall response rate was 14.0%. In view of the international nature of this survey and at a targeted minimum response rate of 10% (Marshall 1999), the outcome can be regarded as satisfactory.
Evaluation of the answers to the above six questions also enabled a rough estimate of the number of mill closures in the respective countries. The rate of closures was 2-3% for most countries. For Germany, it was 4.7%, while for Finland it was only 0.6%. These results have to be regarded with care as certainly not all mill closures were accounted for. Moreover, smaller sawmills, which are usually more susceptible to closures, were more common in samples from the German-speaking countries, as will become clear further down.

For three of the six countries, it was possible to compare proportions of respondents in different categories to results in other literature. Staland (2002) reported on the numbers of sawmills in operation in Sweden in 2000, broken down by capacity categories. The figures were compared to the distribution of all respondents from Sweden over the same categories. Results are presented in Figure 5-1.

![Figure 5-1: Swedish sawmills according to the 2000 sawmill census compared to responses to this survey.](image)

The comparison made clear that large sawmills with production capacities of 25,000 m$^3$ and above were over-represented among the Swedish respondents, while smaller sawmills were underrepresented. The observed bias was suspected to be inherent to the address source, a directory of Nordic lumber producers, which was more likely to list large sawmills that focus on exports rather than small mills producing for local customers. Since working populations for both the
Norwegian and the Finnish sawmill industry originated from the same source, there is reason to assume that a similar bias existed for respondents from these countries as well.

The distribution of sawmills over different capacity classes according to a year-2000 census on the German sawmill industry (Mantau 2003) was compared to the distribution of German respondents in this study over the same size classes. Results are presented in Figure 5-2.

![Figure 5-2: German sawmills by capacity class according to a year 2000 census and in this study.](image)

Larger sawmills with annual production capacities of 10,000 m$^3$ and higher were overrepresented among the German respondents, while smaller sawmills were underrepresented. The present study, however, agreed with the year-2000 census of the German sawmill industry insofar as 75% of the German respondents were found to be softwood mills with at least 90% of their raw material supply consisting of softwood species.

The source used to obtain the working population of Austrian sawmills also contained information on their classification into different size classes. The proportions of sawmills in the working population in these three classes were compared to the distribution of Austrian respondents to this survey. The results are presented in Figure 5-3.
The result for Austrian respondents was similar to that of Swedish and German respondents. Large sawmills with production capacities of 10,000 m³ and above were over-represented and smaller sawmills were underrepresented.

![Bar chart showing Austrian sawmills by capacity class](image)

**Figure 5-3:** Austrian sawmills by capacity class in the working population (Altrichter 1998) and in this study.

The observed bias might best be explained by the attitude of respondents from smaller sawmills. They might have felt their participation was of little consequence for the outcome of the study or they simply might not have had the time to complete a questionnaire. This was further confirmed by the fact that a number of sawmills from the German-speaking countries, which did not submit a completed survey, indicated they considered themselves "too small" to participate.

The above results indicate that data collected in this study are not suited to make inferences on the totality of sawmills in the six countries under investigation. It should be remembered, however, that making such inferences was not the primary aim of this study. The explorative and descriptive nature of this survey was to be emphasised.

Finally, numbers of non-respondents were determined for each question and corresponding response rates were calculated. The results are presented in Table 5-2. The question regarding the length of a typical production run (Question 12) was only answered by 47% of the respondents. Moreover, many of the given answers were ambiguous. The question was therefore excluded from further evaluation.
Table 5-2: Response rates per question based on the 211 completed surveys.

<table>
<thead>
<tr>
<th>Question</th>
<th>Number of non-respondents</th>
<th>Response rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. a) Respondent's address</td>
<td>0</td>
<td>100.0</td>
</tr>
<tr>
<td>b) Annual production capacity</td>
<td>2</td>
<td>99.1</td>
</tr>
<tr>
<td>c) Number of employees</td>
<td>4</td>
<td>98.1</td>
</tr>
<tr>
<td>2. Ownership structure</td>
<td>3</td>
<td>98.6</td>
</tr>
<tr>
<td>3. a) &amp; 3. b) Size &amp; type of own forests</td>
<td>7</td>
<td>96.7</td>
</tr>
<tr>
<td>4. Raw material consumption (volume)</td>
<td>17</td>
<td>91.9</td>
</tr>
<tr>
<td>5. Specification of raw material:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Softwoods vs. hardwoods</td>
<td>16</td>
<td>92.4</td>
</tr>
<tr>
<td>Logs vs. cants &amp; lumber</td>
<td>29</td>
<td>86.3</td>
</tr>
<tr>
<td>Domestically purchased vs. imported</td>
<td>13</td>
<td>93.8</td>
</tr>
<tr>
<td>6. Wood species processed</td>
<td>24</td>
<td>88.6</td>
</tr>
<tr>
<td>7. a) Log sorting activities; location</td>
<td>2</td>
<td>99.1</td>
</tr>
<tr>
<td>b) Log sorting criteria</td>
<td>16</td>
<td>92.4</td>
</tr>
<tr>
<td>8. a) Quality control of logs</td>
<td>6</td>
<td>97.2</td>
</tr>
<tr>
<td>b) Log grading</td>
<td>5</td>
<td>97.6</td>
</tr>
<tr>
<td>c) Use of log scanning systems</td>
<td>8</td>
<td>96.2</td>
</tr>
<tr>
<td>9. Equipment employed</td>
<td>0</td>
<td>100.0</td>
</tr>
<tr>
<td>10. a) Number of drying kilns</td>
<td>15</td>
<td>92.9</td>
</tr>
<tr>
<td>b) Average kiln size</td>
<td>29</td>
<td>86.3</td>
</tr>
<tr>
<td>c) Kiln drying capacity</td>
<td>12</td>
<td>94.3</td>
</tr>
<tr>
<td>11. Scanning systems</td>
<td>20</td>
<td>90.5</td>
</tr>
<tr>
<td>12. Length of typical production run</td>
<td><strong>111</strong></td>
<td><strong>47.4</strong></td>
</tr>
<tr>
<td>13. a) &amp; 13. b) Production line upgrades &amp; reasons</td>
<td>5</td>
<td>97.6</td>
</tr>
<tr>
<td>14. Production volume 1998</td>
<td>11</td>
<td>94.8</td>
</tr>
<tr>
<td>15. a) Processing of lumber</td>
<td>11</td>
<td>94.8</td>
</tr>
<tr>
<td>b) Grading methods</td>
<td>11</td>
<td>94.8</td>
</tr>
<tr>
<td>16. Specific primary products</td>
<td>15</td>
<td>92.9</td>
</tr>
<tr>
<td>17. Secondary products</td>
<td>18</td>
<td>91.5</td>
</tr>
<tr>
<td>18. Services</td>
<td>n/a¹)</td>
<td>n/a¹)</td>
</tr>
<tr>
<td>19. Domestic sales vs. exports</td>
<td>3</td>
<td>98.6</td>
</tr>
<tr>
<td>20. Distance of domestic customers</td>
<td>3</td>
<td>98.6</td>
</tr>
<tr>
<td>21. a) &amp; 21. b) Export markets &amp; trends</td>
<td>26</td>
<td>87.7</td>
</tr>
<tr>
<td>22. Self assessment:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(A) Customer research</td>
<td>17</td>
<td>91.9</td>
</tr>
<tr>
<td>(B) Realisation of customer demands</td>
<td>15</td>
<td>92.9</td>
</tr>
<tr>
<td>(C) Introduction of new products</td>
<td>17</td>
<td>91.9</td>
</tr>
<tr>
<td>(D) Service improvements</td>
<td>9</td>
<td>95.7</td>
</tr>
<tr>
<td>(E) Flexibility in production</td>
<td>10</td>
<td>95.3</td>
</tr>
</tbody>
</table>

¹) Since the question did not contain an option to check "no services provided", it was difficult to determine whether no check mark meant the respondent provided no service or had neglected to answer the question.
5.2 RESULTS BY QUESTION

5.21 Respondent Profile

Basic information on company structure was collected in the first section of the survey. Table 5-3 shows the respondents by country, annual production capacity, and sawmill type according to wood species processed.

Table 5-3: Number of respondents by country, level of HVRM output, mill type, and size.

Softwood mills had a raw material supply of at least 90% softwoods and hardwood mills had at least 90% hardwoods. Level of HVRM output was defined as share of HVRM products according to the definition on pages 45 f in the total 1998 production volume.

<table>
<thead>
<tr>
<th>Country</th>
<th>HVRM Output</th>
<th>Softwood Mills</th>
<th>Hardwood Mills</th>
<th>Mixed Mills</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Size ('000 m³)</td>
<td>Sub-Size</td>
<td>Size ('000 m³)</td>
<td>Sub-Size</td>
</tr>
<tr>
<td></td>
<td>&gt; 25</td>
<td>&lt; 25</td>
<td>N/A</td>
<td>&gt; 25</td>
</tr>
<tr>
<td>Norway</td>
<td>None</td>
<td>6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt; 50%</td>
<td>5</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>&gt; 50%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-</td>
<td>Totals</td>
<td>11</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>Sweden</td>
<td>None</td>
<td>39</td>
<td>6</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>&lt; 50%</td>
<td>10</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>&gt; 50%</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Sub-</td>
<td>Totals</td>
<td>50</td>
<td>8</td>
<td>58</td>
</tr>
<tr>
<td>Finland</td>
<td>None</td>
<td>15</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>&lt; 50%</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 50%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-</td>
<td>Totals</td>
<td>20</td>
<td>3</td>
<td>23</td>
</tr>
<tr>
<td>Germany</td>
<td>None</td>
<td>12</td>
<td>14</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>&lt; 50%</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 50%</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Sub-</td>
<td>Totals</td>
<td>17</td>
<td>22</td>
<td>1</td>
</tr>
<tr>
<td>Austria</td>
<td>None</td>
<td>8</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt; 50%</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 50%</td>
<td>2</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Sub-</td>
<td>Totals</td>
<td>13</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Switzerland</td>
<td>None</td>
<td>7</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Land</td>
<td>&lt; 50%</td>
<td>7</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>&gt; 50%</td>
<td>1</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Sub-</td>
<td>Totals</td>
<td>1</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>None</td>
<td>80</td>
<td>40</td>
<td>2</td>
</tr>
<tr>
<td>C'tries</td>
<td>&lt; 50%</td>
<td>29</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 50%</td>
<td>3</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>TOTALS</td>
<td></td>
<td>112</td>
<td>70</td>
<td>2</td>
</tr>
</tbody>
</table>
The large majority of respondents (87%) were softwood mills; of these, 62% had production capacities over 25,000 m$^3$ while the remainder consisted of smaller mills.

Figure 5-4 shows the respondents according to their ownership structure, i.e. whether they were independent, part of a wood products manufacturing group, or an integrated company whose business also included forestry and/or secondary manufacturing.

In the German-speaking countries Germany, Austria, and Switzerland, 75% or more of the respondents were independent companies. In the Nordic countries Norway, Sweden, and Finland, independent companies accounted for less than or just about 50% of the total number of respondents.

Integrated companies, on the other hand, were more frequent among respondents from the Nordic countries and otherwise only found among the Austrian respondents. Sawmills belonging to manufacturing groups were represented among respondents from all countries although more frequent among those from Norway and especially Sweden.

The distribution over different ownership and size categories reflected different structures of the sawmill industries in the Nordic and the German-speaking countries. In the German-speaking countries' sawmill industry, independent, small and medium-sized companies with production capacities below 25,000 m$^3$ are strongly represented both in terms of production volumes and
especially in terms of numbers. Although, historically, the sawmill industries in the Nordic countries had similar structures, larger sawmills and sawnwood production groups nowadays make for considerable and increasing shares of the total production volume.

5.22 Raw Material

Forest ownership

Figure 5-5 presents proportions and, inside the bars, actual numbers of respondents by country and forest ownership category. The majority of respondents in all countries did not own any forests. However, around 20% of each of the Swedish and Finnish respondents and just over 40% of the Norwegian respondents owned forests that covered their raw material needs at least partly. Some of the Nordic respondents owned forestland of considerable extension, which they probably had acquired at the time when the large wood products companies went North and started exploiting the vast, boreal forest resource.

![Figure 5-5: Forest ownership: proportions and numbers of respondents (inside bars) for each country.](image)

Twenty-five percent of the Austrian and 10% of the Swiss respondents also owned forests, although these tended to be of smaller sizes than those owned by respondents in the Nordic countries. Only one of the 52 German respondents owned forestland. This reflects the typical ownership structure in Germany, where most of the forests and wood products manufacturers are owned privately but by different parties.
Raw material specifications

Figure 5-6 below presents average shares of the raw material being logs and timbers, respectively. All respondents processed mainly logs. Timbers usually accounted only for shares smaller than 5%, with the exception of respondents from Norway and Sweden, where these shares were about 15%.

![Figure 5-6: Average shares of raw material being logs and timbers, respectively.]

Figure 5-7 below presents average shares of the raw material purchased domestically and imported, respectively. All responding sawmills had obtained most of their raw material domestically. Respondents from Norway and Austria reported the largest import shares, each with an average of around 15%. Respondents from the other four countries reported average import shares of 8% or less.

![Figure 5-7: Average shares of raw material purchased domestically and imported, respectively.]

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Figure 5-8 below presents average shares of the raw material being softwoods and hardwoods, respectively. As mentioned previously, most respondent mills were softwood mills that processed at least 90% softwoods. These results were reflected when average shares of softwoods versus hardwoods in the respondents' raw material supply were compared. Only in Germany and Switzerland were average shares of softwood less than 90%.

![Fig 5-8: Average shares of softwoods versus hardwoods in the respondents' raw material supply.](image)

A detailed breakdown by country of commonly processed wood species is given in APPENDIX B, Figure B-1 and Figure B-2. It was found that 80% or more of the respondents in each country indicated Norway spruce to be one of their commonly processed species, thus making it the dominant species in the European sawmill industry. Moreover, 50% of the Norwegian and nearly 66% of the Swedish and Finnish respondents also processed Scots pine, reflecting a mix of "whitewood" (spruce) and "redwood" (pine) as it is typically processed in the Nordic countries.

Sawmills in the German-speaking countries frequently processed European silver fir together with Norway spruce. This confirmed a practice common in these countries to process the two species as a combined assortment. Further softwood species processed by German, Austrian, and Swiss respondents were Scots pine and European larch.

Hardwoods played an important role mainly in Germany and Switzerland, in terms of volumes as well as numbers of species processed. Predominately processed hardwood species were
European beech and European oak. None of the Norwegian respondents processed any hardwoods. Only few of the Swedish and Finnish respondents processed hardwoods, mainly European birch.

The above results illustrate that the number of species processed in sawmills in the European countries investigated was limited to two softwood species of commercial significance, namely Norway spruce and Scots pine. In contrast, sawmills in BC deal with a much more diverse forest resource containing at least five softwood species of commercial interest in the Coastal region and a further nine important softwood species in the Interior.

5.23 Products and Services

Output volumes

Table B-4 in APPENDIX B presents detailed results on the respondents’ output volumes. Total 1998 production volumes were then compared to the respondents’ production capacities and presented in Figure B-9. The following paragraph summarizes the results of this comparison.

A large number of responding companies in all countries had been producing at their full capacity, in some cases even above that. Moreover, Swedish, Finnish and Austrian respondents all displayed rather small variations, mainly between 85% and 100% of their respective production capacities, while corresponding results for the Norwegian and German respondents varied between about 66% and 100% of their capacity. Although variations were similarly large, respondents from Switzerland had been producing at a lower level, between 60% and 90% of their capacities.

Specific lumber products

When questioned about specific lumber products, respondents indicated they produced a number of different primary lumber products, such as dimension lumber, lumber cut to customer specifications, live-sawn joinery lumber, and others. Most respondents produced structural lumber
in standard dimensions, which accounted for shares between 24% and 37% of the total production volume in all countries, except Switzerland.

Respondents from all countries produced, on average, 3.3 different primary lumber products. Broken down by country, Swiss respondents displayed the greatest diversification with an average of 4.7 different products per respondent while Norwegian, German, and Austrian respondents each produced an average of 3.5 different lumber products. Corresponding numbers for Sweden and Finland were notably lower with averages of 2.5 and 2.9 different lumber products, respectively.

Lumber cut to customer specifications amounted to 34% of the total production volumes in Norway and Sweden, while in Germany and Austria it was 64% and 45%, respectively. About 80% of the respondents in Norway, Germany, and Switzerland sawed lumber to customer specifications, while corresponding numbers for the other three countries were around 65%.

Specific lumber products for joinery applications were more commonly sawn in the German-speaking countries. Between 46% and 68% of these respondents produced live-sawn, unedged planks, and between 50% and 75% of them produced joinery lumber as dressed boards. In terms of volumes, however, the Nordic countries had somewhat higher shares of live-sawn, unedged planks. This might be explained by the fact that Swedish producers used to supply the German joinery industry with live-sawn Scots pine. In the German-speaking countries, on the other hand, live-sawing is mainly applied by hardwood mills which were not very strongly represented among the respondents.

Between 30% and 50% of the responding sawmills produced stock for glued-laminated timber (gluelam) and laminated window squares, although actual product volumes amounted only to 2-10% of the total 1998 production volumes. Twenty percent of the responding sawmills in both
Germany and Switzerland produced stock for other value-added and secondary wood products, mainly for packaging, pallets, and crates.

Numbers, types, and volumes of different products in their output suggested that at least some of the surveyed sawmills aimed at diversified markets and supplied a wider customer base. Manufacturers of secondary wood products were probably some of their most important customers.

**Adding value to lumber products**

Figure 5-9 below shows the value-added to rough-sawn, green lumber products. Clear differences were found between respondents from the Nordic and the German-speaking countries with respect to proportions of kiln-dried\(^1\) and planed lumber. Respondents in the Nordic countries kiln-dried on average around 90% of their production, while corresponding proportions in the German-speaking countries were between 37% and 54% only. Planing was also more common among respondents from the Nordic countries, although differences were not as pronounced.

![Figure 5-9: Average proportions of 1998 production kiln-dried, graded, planed, or treated with preservatives.](image)

Respondents from Germany and Switzerland graded on average 51% and 69% of their respective production volumes, while in the Nordic countries and Austria, corresponding

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\(^1\) For more results on drying and their discussion please refer to pages 49 through 53.
proportions were about 25% to 30% higher. Appearance grading was by far the most commonly applied grading method among all respondents, both in terms of graded volumes and numbers of respondents.

Visual strength grading clearly outweighed machine strength grading, although on a much lower level than appearance grading. Respondents from Norway and those from Austria applied strength grading most often, in terms of graded volumes as well as numbers of respondents. Both countries have high levels of gluelam production, which may explain the situation.

Accounting for around 25% of the respective production volumes in both countries, chemical treatment with preservatives was most common among German and Austrian respondents.

**Secondary wood products**

As can be seen from Figure 5-10, a large number of interviewed sawmills had incorporated the production of one or more secondary wood products. These secondary wood products included gluelam, roof trusses, finger-jointed lumber, laminated window squares, and edge-glued panels. Such products made for considerable shares of the production output at some respondent mills, especially in the German-speaking countries.

Eight percent of the Norwegian respondents produced glue-laminated timber, amounting to an average of 15% of their 1998 output volume. Furthermore, Norwegian respondents produced finger-jointed lumber, roof trusses as well as mouldings and millwork, although average volume shares were rather small.

Thirteen percent of the Swedish respondents had processed on average 62% of their 1998 output mainly into packaging components, pallets, and crates, thus making packaging the most important secondary wood product. Further secondary products were gluelam, finger-jointed lumber, roof trusses, edge-glued panels, as well as mouldings and millwork.
Eight percent of the Finnish respondents had processed on average 18% of the 1998 production into roof trusses. However, results of this survey made manufacturing of secondary
wood products seem to be less common among Finnish respondents than those from other countries. This might be because only few Finnish sawmills with higher outputs of secondary wood products were among the respondents or they were restrictive with such information as was observed in some of the completed surveys from Finland.

Volume shares of secondary products were generally higher among respondents from the German-speaking countries than those from the Nordic countries. Packaging, pallets, and crates played an important role among German-speaking respondents. Roughly 20% of the respondents in each of the three countries produced such packaging products in average amounts of 20-40% of the respective output volumes.

Surveyed German sawmills also produced wooden garden products, mouldings and millwork, some finger-jointed lumber, and edge-glued panels. In 13% of the Austrian sawmills, gluelam amounted to an average of 29% of the total output volume. Moreover, Austrian sawmills produced wooden garden products, roof trusses, and, with a rather small volume share, mouldings and millwork.

Thirty-six percent of the responding Swiss sawmills produced mouldings and millwork, with an average output share of 12%. Further important secondary products were gluelam, wooden garden products, and laminated window squares.

**High-value Recovery Manufacturing**

Results in the previous section demonstrated that a number of European sawmills produced a variety of specialty products aimed at secondary manufacturers. They also produced remarkable amounts of secondary products aimed directly at end-consumers, thus recovering a higher value from their raw material. Such high-value wood products included gluelam, roof trusses, finger-jointed timber, edge-glued panels, laminated window squares, mouldings and millwork, as well as packaging components, pallets, and crates and, finally, construction components. The level of true
high-value recovery in lumber that had been kiln-dried, graded, planed, or treated with preservatives, or in wooden garden or planer mill products, on the other hand, is disputable. Such products basically constitute primary lumber products treated to either fulfil the basic requirements in their application or simply to enhance their attractiveness to customers.

Based on their output volumes of aforementioned products, each sawmill was assigned to one of three HVRM categories:

(a) No HVRM output: 122 (66%) of responding softwood mills.

(b) Moderate HVRM output (0.5-50% of output volume HVRM products): 49 (27%) of responding softwood mills.

(c) High HVRM output (50-100% of output volume HVRM products): 13 (7%) of responding softwood mills.

It was also decided to concentrate evaluation henceforth on softwood mills as it facilitated comparison between different categories as well as with sawmills in BC. Figure 5-11 shows the results.

![Figure 5-11: Numbers and proportions of softwood mills in three HVRM categories.](image)

Sixty-six percent of the 184 responding softwood mills did not produce any HVRM output. Nevertheless, these sawmills produced, on average, 0.6 different secondary products, often with a low degree of value recovery, such as planer mill or chemically treated wooden garden products.
About 50% offered at least one service as a way of adding value through closer customer orientation. Thirty-nine percent offered direct retail to end-consumers, sometimes even Do-it-yourself (DIY) outlets, and 22% offered carpentry and wood construction services. These mills had an average annual production capacity of around 80,000 m³.

Respondents with moderate HVRM output accounted for 27% of all responding softwood mills. Each of these sawmills produced, on average, 2.6 different secondary, high-value products. Seventy-six percent of them offered at least one value-added service. Sixty-three percent had retail outlets while 43% offered carpentry services, and 10% offered wood engineering and design to their customers. The average annual production capacity of these mills was around 180,000 m³ and they were distributed over all capacity categories.

Respondents with high HVRM output accounted for 7% of the responding softwood mills and were, with one exception, located in the German-speaking countries. These sawmills produced, on average, 3.5 different HVRM products each and 92% of them offered at least one value-added service. Similar to the previous group, 62% had retail outlets while 39% offered carpentry and wood construction. Twenty-three percent offered wood engineering, construction planning, and design services to their customers. As two of these mills produced between 100,000 and 500,000 m³, the average annual production capacity was around 40,000 m³ although most sawmills in this category had capacities below 25,000 m³.
5.24 Wood Processing Technologies

Log sorting and quality control

Nearly all the responding softwood mills performed log sorting for manufacturing. Most of them sorted directly at their mills. Nearly 30% of mills with no or moderate HVRM output performed log sorting also in the forest. There was, however, a clear tendency with increasing HVRM output to perform log sorting directly at the mill rather than in the forest.

The most important criteria in log sorting were sorting by log diameter and species. These criteria were used by around 75% of the respondents, whereas log quality was used by 24%. Some respondents, mainly from Sweden and Finland, also mentioned log length as sorting criterion. Thirty-eight percent of respondents with high HVRM output, twice as many as in the other categories, used log quality as sorting criterion. Further results are presented in APPENDIX B, Figure B-3 and Figure B-4.

Seventy-nine percent of all responding softwood mills performed quality control of incoming logs. A similar proportion also performed log grading for manufacturing, this means they actually used the log quality information to make decisions in the production process. Thirty-eight percent of the responding softwood mills used log-scanning systems.

Regarding log quality control and the use of scanning equipment, proportions of mills with high HVRM output were by about 10% lower than the average. They were by about 20% lower with respect to log grading for manufacturing. These differences were best explained by different log handling customs in different countries rather than by level of HVRM processing. In Sweden, for example, logs are bucked in the forest and forest owners are paid dependent on log quality determined at the sawmills’ log yards. This would explain high levels of log quality control at Swedish sawmills. In Germany, tree-length logs are often bucked at the sawmills, which could be a reason for higher levels of log-scanning equipment used in the process.
Further to the above information, sawmills with high levels of HVRM output were often smaller and therefore might not want to invest into expensive scanning equipment. They also might not feel the need for such equipment since their production process might be slower and allow for more human judgement. It could also be that these mills preferred continuous decision making during the sawing process rather than grading entire logs and then cutting them with a single-instance cutting solution.

Production equipment

Figure 5-12 below presents primary log breakdown equipment used by responding softwood mills grouped by HVRM level. Fifty-seven percent of the respondents with no HVRM output used chipper reducers in primary log breakdown. In comparison, only 43% of the respondents with moderate HVRM output and only 23% of those with high HVRM output used chipper reducers.

On the other hand, 62% of the respondents with high HVRM output used frame saws, but only around 45% of the respondents with no or moderate HVRM output used them.

![Figure 5-12: Primary log breakdown equipment in softwood mills grouped by HVRM level.](image)

In general, chipper reducers and circular saws, often in combination, were more common with respondents with moderate HVRM output, while bandsaws and frame saws were more often used at respondents with high HVRM output. This indicated, on average, smaller log diameters and
higher production speeds together with a stronger focus on high output volumes at mills with lower levels of HVRM production.

Figure 5-13 below presents equipment used by responding softwood mills in lumber processing subsequent to primary breakdown. Seventy-seven percent of the respondents with no HVRM output and 94% of the respondents with moderate HVRM output operated drying-kilns while only 54% the respondents with high HVRM output used them. Moreover, proportions of respondents with no and moderate HVRM output who operated grading lines were more than twice as high as those with a high HVRM output.

On the other hand, proportions of respondents with moderate and high HVRM output that operated planers were twice as high as those with no HVRM output. It seemed that respondents with low levels of HVRM production restricted their operation more to kiln-drying and grading of lumber while respondents with higher levels of HVRM production operated more planers probably mainly in the secondary manufacturing part of their production line.

![Figure 5-13: Lumber-processing equipment in softwood mills grouped by HVRM level.]

Drying kilns

Figure B-5 in APPENDIX B presents medians and ranges of the numbers of drying kilns operated by respondents with different levels of HVRM output. The median values of numbers of kilns operated by respondents with no and with moderate HVRM output were seven and five,
respectively, while 75\textsuperscript{th} percentiles were around twelve. Respondents with high HVRM output generally operated fewer kilns. The median for this latter group was only two and numbers of kilns operated varied less between respondents. Forty-five percent of the respondents with no HVRM output, 51\% of those with moderate HVRM output and 31\% of those with high HVRM output operated kilns of different sizes.

Figure B-6 in APPENDIX B presents medians and ranges of average capacities of drying kilns operated by respondents with different levels of HVRM output. Average kiln capacities for respondents with no and with moderate HVRM output were roughly in the same range between ten and 300 m\textsuperscript{3} with a median of 75 m\textsuperscript{3}. For respondents with high HVRM output, the median of average kiln capacity was lower at around 40 m\textsuperscript{3}. This means that 50\% of these respondents were operating small kilns with capacities of 20-40 m\textsuperscript{3} while the other 50\% were operating kilns with average capacities up to 200 m\textsuperscript{3}.

Smaller kiln sizes, on one hand, might indicate a stronger customer-orientation at respondent mills with high HVRM output as they enabled these mills to dry smaller batches and, thus, become more flexible in the drying process. On the other hand, as average production capacity for respondents with high HVRM output was only about 50\% of those with no HVRM output and less than 25\% of those with moderate HVRM output, fewer kilns and smaller kiln sizes might simply reflect these smaller production capacities.

Figure 5-14 presents relative annual drying capacities by level of HVRM output and including standard deviations and numbers of respondents in each group. Relative drying capacities, i.e. annual drying capacities in relation to annual production capacities, apparently were subject to a size-effect as well as an (inverse) value-effect. While respondents with no and with moderate HVRM output with production capacities over 25,000 m\textsuperscript{3} had average relative drying capacities of
around 80% of their annual output, corresponding capacities at smaller respondents were 30-40% lower.

The average relative drying capacities of respondents below 25,000 m³ production capacity with high HVRM output corresponded to only 27% of their production capacity, while similar-sized respondents with moderate HVRM output had average capacities of 36% of their output. For those with no HVRM output, relative drying capacities were even higher at 50%.

The size-effect was not completely unexpected because drying kilns constitute a considerable investment that smaller mills might not be able to afford or willing to pay. The inverse value-effect, however, was somewhat surprising as it was expected that higher levels of HVRM output would require larger proportions of the production to be kiln-dried before processing them further. When drying capacities were set in relation to actual 1998 production volumes, the picture was very much the same.

A possible explanation could be that the relatively small sawmills with high HVRM output either air-dried their sawn green lumber or they contracted other plants to do the drying for them.

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Figure 5-14: Relative annual drying capacities by level of HVRM output and mill size.
The figure includes standard deviations (error bars) and numbers of respondents (n) in each group.
Both explanations, however, seem rather unlikely and the question remains unanswered until it can be investigated in more depth.

### Scanning equipment

Figure 5-15 presents proportions of respondents and where in their production process they employed scanning equipment. Respondents with no and those with moderate HVRM output most frequently mentioned edging, followed by primary breakdown and stem bucking. Around 35% of the respondents with no HVRM employed scanning equipment in edging and slightly over 30% of the respondents with moderate HVRM output used scanning equipment in primary breakdown as well as in edging.

![Proportions of respondents using scanning equipment at different stations in production.](image)

Around 30% of the respondents with high HVRM output employed scanning equipment in stem bucking. This was a higher proportion than in the two other groups. Moreover, nearly 25% of the respondents with high HVRM output used scanning equipment in trimming, which was more than double the proportions in the two other groups.

The average numbers of different stations where scanning equipment was employed were then calculated. Forty-eight percent of the respondents with no HVRM output used scanning equipment, on average, at 1.9 different stations in their production process. Sixty-one percent of the
respondents with moderate HVRM output used scanning equipment, on average, at 1.7 different stations in their production process, and 38% of those with high HVRM output employed scanning equipment, on average, at 2.0 different stations in their production process.

The proportion of respondents with moderate HVRM output that employed scanning equipment was slightly larger than those with no HVRM output, and might indicate a trend towards more scanning equipment in more advanced production. In general, however, no differences between groups of respondents with different levels of HVRM output could be observed. An additional answer option, where respondents could have indicated “other” locations where they might operate scanners, might have been able to shed a better light on this question.

Larger proportions of respondents with high HVRM output seemed to employ scanning equipment in cross cutting operations (bucking and trimming). The actual number of respondents with high HVRM output, however, was too small to make conclusive statements. Moreover, the relatively large proportion of respondents in this group using scanning in stem bucking could be result of a country-effect as most of these respondents were located in one of the German-speaking countries. In these countries, it is a common practice to transport tree-length logs to the sawmill and then perform bucking at the mill. In the Nordic countries, on the other hand, stems are usually bucked in the forest by equipment that was not included in this survey.

**Technical upgrades and improvements**

Sixty-eight percent of all responding softwood mills had upgraded their production lines in some way during the last five years. Detailed results broken down by level of HVRM output are presented in Figure 5-16.

Mentioned by around 50% of the respondents at all levels of HVRM output, “Reduce Costs” was the most frequently mentioned reason for upgrading. All three groups also ranked it as the most important one.
Almost as many respondents gave “Increase Production” as another reason for technical upgrades and among those with no and with moderate HVRM output, it was ranked as the second most important. Remarkably, more respondents with no HVRM output mentioned increasing production compared to reducing costs as a reason for technical upgrades, while among respondents with moderate HVRM output it was vice versa. A possible explanation is that respondents with no HVRM output tried to reduce their unit costs in order to be more competitive, while the production processes for respondents with moderate HVRM production were already too complicated to simply expand and they were looking at other ways to reduce costs.

Figure 5-16: Frequencies (bars, left axis) and importance of reasons (data points, right axis) for upgrades in softwood mills.

Nearly 40% of the respondents with high HVRM output mentioned “Increase Recovery” while of those with moderate HVRM output it were 27% and of those with no HVRM output only 21%. “Improve Quality” showed a similar trend being mentioned by 31% of the respondents with high HVRM output and only 16% of the respondents with moderate HVRM output. However, 30% of the respondents with no HVRM output also mentioned “Improve Quality”, although at
much lower level of importance. To respondents with high HVRM output, improving quality had been of an equally high importance as had been reducing costs as reason for technical upgrades.

Respondents with no HVRM production apparently put a strong emphasis on volume output, as technical upgrades that reduce costs and increase production are an indicator for high-speed volume-oriented processes. While reducing costs was naturally also very important to respondents with high levels of HVRM production, they had put equal emphasis on improved quality and also increased recovery in their production processes, which points at a higher degree of customer-orientation in production. Moreover, an increased production output might not be as easily achieved in an industry branch that produces a wider range of diversified products. Changing raw material and the introduction of new products seemingly played only a rather minor role for all respondents, which points at a generally very conservative industry used to working along established tracks.
5.25 Customers and Markets

Domestic and export sales

Figure 5-17 below presents the average production shares shipped to domestic and export markets broken down by level of HVRM output and mill size. Two trends emerged: first, respondents with production capacities above 25,000 m³ on average exported about 60% of their production. These shares were much larger than those of smaller mills at the same level of HVRM production were. Secondly, with increasing levels of HVRM production, not only did export shares decrease visibly, but so did sales to domestic customers located further than 100 km from the mill.

![Figure 5-17: Average production shares shipped to domestic and export markets by level of HVRM output and mill size.](image)

Figure 5-17: Average production shares shipped to domestic and export markets by level of HVRM output and mill size.

Apparently, respondents with higher levels of HVRM production were more strongly focused on customers located closely to their mill. This not only helped keeping transportation costs for more advanced wood products down but also was assumed to lead to closer business contacts and better person-to-person information exchange, both of which are critical in more specialised and customer-oriented productions. Large mills, on the other hand, and those with low or no HVRM output were focused on producing large volumes of little advanced lumber products intended for export.
Specification of export markets

Table 5-4 presents the proportions of respondents that exported to different markets together with the proportions of exports that went to these markets. The table also presents the respondents’ outlook on growth of these markets in the three years following the survey.

Continental Europe, i.e. mostly countries of the European Union, was the most important export market for all respondents. Further important export markets were the United Kingdom (UK) as well as countries of the Middle East and Japan.

Table 5-4: Proportions of respondents and exported volumes as well as expected growth of various markets.

<table>
<thead>
<tr>
<th>Markets</th>
<th>No HVRM Output</th>
<th></th>
<th>Moderate HVRM Output</th>
<th></th>
<th>High HVRM Output</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Respond. (%)</td>
<td>Exports (%)</td>
<td>Expect. Growth</td>
<td>Respond. (%)</td>
<td>Exports (%)</td>
<td>Expect. Growth</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>44</td>
<td>19</td>
<td>+</td>
<td>43</td>
<td>19</td>
<td>++</td>
</tr>
<tr>
<td>Continental Europe</td>
<td>63</td>
<td>69</td>
<td>+</td>
<td>63</td>
<td>70</td>
<td>+</td>
</tr>
<tr>
<td>Middle East</td>
<td>27</td>
<td>10</td>
<td>-</td>
<td>27</td>
<td>12</td>
<td>+</td>
</tr>
<tr>
<td>North America</td>
<td>5</td>
<td>7</td>
<td>0</td>
<td>12</td>
<td>9</td>
<td>+++</td>
</tr>
<tr>
<td>Australia &amp; New Zealand</td>
<td>2</td>
<td>1</td>
<td>+++</td>
<td>4</td>
<td>1</td>
<td>+++</td>
</tr>
<tr>
<td>Japan</td>
<td>25</td>
<td>10</td>
<td>+++</td>
<td>29</td>
<td>10</td>
<td>+++</td>
</tr>
<tr>
<td>Other Asian Countries</td>
<td>7</td>
<td>7</td>
<td>++</td>
<td>20</td>
<td>4</td>
<td>+++</td>
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<tr>
<td>Other Countries</td>
<td>21</td>
<td>24</td>
<td>+</td>
<td>14</td>
<td>8</td>
<td>++</td>
</tr>
</tbody>
</table>

Sixty-three percent of the respondents with no and with moderate HVRM output shipped on average 70% of their lumber exports to Continental European countries. The second highest share of exports went to “Other countries”, probably Norway, as many of these respondents were located in Sweden and Finland, both of which export lumber to Norway. The UK and the Middle East are traditionally strong importers especially of Nordic lumber, which was clearly reflected in the results. Interestingly, lumber exports to Japan had reached an even level with those to the Middle East and this was also the only market that respondents in all three groups expected to grow.
strongly over the following three years. A similarly strong growth was only expected for exports to Australia and New Zealand although the amounts exported were negligible.

Besides the traditional export markets mentioned above, 20% of the respondents with moderate HVRM output supplied wood products to Asian markets other than Japan, although only in small amounts. Further 12% of these respondents shipped almost 10% of their exports to North America and expected a strong growth in this market.

Only few of the respondents with high HVRM output exported any wood products at all, and if, then they shipped their products to neighbouring countries in Continental Europe. Only one respondent of a total of 13 in this group also exported a small share to Japan. This respondent, however, expected the Japanese market to grow strongly in the following three years.

Respondents with no HVRM output, meaning producers of plain lumber, not only had a strongly export-based production, but also they had a rather sober outlook on the development of their (export) markets. They expected none of their traditional markets to develop strongly in the three years following the survey. A possible explanation is that traditional markets for European exports of plain lumber seemed to have reached a steady state and can be expected to yield only slow growth, if any at all. European lumber producers that are strongly volume and export-oriented therefore seemed to face a period of stagnation.

Respondents with moderate HVRM production, on the other hand, had a clearly more enthusiastic view and expected especially non-traditional markets such as North America, Australia and New Zealand as well as Japan and other Asian countries to develop strongly. It was assumed that manufacturing of advanced wood products caused respondents with moderate HVRM production to take a more optimistic stand as they saw opportunities for marketing and sales of such products.
Respondents' self-assessment

Respondents were asked to indicate their level of agreement with five statements on a five-point Likert-scale from strongly disagree to strongly agree. Since it was felt that sawmill size might influence the respondents' level of agreement, results were distinguished by size and then presented in Figure 5-18 and Figure 5-19.

![Figure 5-18: Level of agreement with five statements of small softwood mills (<25,000 m³).](image1)

![Figure 5-19: Level of agreement with five statements of large softwood mills (>25,000 m³).](image2)

Responding softwood mills with production capacities below 25,000 m³ responded neutrally at all three levels of HVRM output with regards to the performance of customer research, having an
extra person for the integration of customer demands, and the frequent introduction of new products. They saw themselves, however, continuously striving to improve their services and as being highly flexible in production scheduling.

Responding softwood mills with production capacities of more than 25,000 m³ generally agreed with the statements given in the survey. Again, respondents with different levels of HVRM output provided similar answers. However, the three larger respondents with high HVRM production strongly agreed that they were performing continuous customer research and were aiming at improving their service levels, as well as being highly flexible in production scheduling. In this way, they characterised themselves as very customer-oriented.

Differences were found not so much with respect to level of HVRM output but with respect to sawmill size. Smaller sawmills seemed to shy away from activities other than production and sales of wood products such as performing customer research or employing extra staff for customer relations. They were customer-oriented in ways that they could realise mostly through their daily, operational behaviour. Larger sawmills appeared to be somewhat more open to or could more easily afford such activities. Again, an image of the sawmill industry in general as rather conservative emerged since for none of the respondents the (frequent) introduction of new products seemed to be an issue of any importance.
5.3 THE EFFECT OF HVRM PRODUCTION ON EMPLOYMENT

Employment generation per volume unit wood consumed

When numbers of employees per 1,000 m³ wood consumed were computed and set in relation to levels of HVRM output, the number of staff was found to increase with increasing levels of HVRM output. Results are presented in Figure 5-20.

![Graph showing employment per 1,000 m³ wood consumed by level of HVRM output.]

Median values per 1,000 m³ wood consumed increased by 200% from 0.4 employees for respondents with no HVRM output to 1.2 employees for respondents high HVRM output. Lower quartiles increased also by 200% from 0.3 employees for respondents with no HVRM output to 1.0 employees for respondents with high HVRM output and upper quartiles rose even more sharply.

Table 5-5 presents average numbers of employees per 1,000 m³ wood consumed for each group of respondents with different levels of HVRM output. On average, respondents with moderate HVRM output employed 1.1 persons per 1,000 m³ wood consumed or almost twice the number of staff as respondents with no HVRM output. For respondents with high HVRM output,
numbers doubled again. The average number of employees for respondents with no HVRM output was lower than averages for respondents with moderate and with high HVRM output.

<table>
<thead>
<tr>
<th>Table 5-5: HVRM-effect on employment.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level of HVRM Output</strong></td>
</tr>
<tr>
<td><strong>Employees per 1,000 m³ wood consumption</strong></td>
</tr>
<tr>
<td><strong>n</strong></td>
</tr>
</tbody>
</table>

Considering that the average number of staff per 1,000 m³ wood consumption nearly quadrupled from no to high HVRM output, a considerable employment-creation effect of High Value Recovery Manufacturing had to be assumed. However, the share of small sawmills below 25,000 m³ production capacity was proportionally larger among respondents with high HVRM output. A hidden size effect could therefore not be ruled out as smaller sawmills usually employ more people per volume unit wood consumed than larger mills.

When only small sawmills were compared, there was still an 80% increase in the average number of staff employed from no to moderate HVRM output. The corresponding increase from none to high HVRM output was 130%.

**Possible implications for the BC Forest Products Industry**

According to the Canadian Council of Forest Ministers (2003), the annual allowable cut (AAC) of softwood from Provincial Crown Land in BC was 70 million m³ in 2001. Assuming this amount would be reduced by 10% or 7 million m³, this would mean a loss of more than 9,000 jobs in BC's forest products sector at an employment rate of 1.4 according to Table 2-3, section 2.3.

Respondents to this survey with moderate HVRM production employed, on average, 120 people each. Assuming this as average employment, 75 new sawmills with moderate HVRM production would theoretically be needed in order to generate employment for 9,000 people.
A more realistic approach might be to increase the level of HVRM production in a number of existing sawmills in order to secure employment in forestry based communities. An increased HVRM output could be achieved, for instance, by increasing shares of products such as gluelam, roof trusses and finger-jointed lumber, advanced exterior wood products, as well as some manufactured and specialty wood products in sawmill production.
6. SUMMARY AND CONCLUSIONS

European sawmill industries were surveyed in an exploratory manner. Limitations inherent in the address material, however, and a bias towards larger mills in the responses made inferences on sawmill industries in the investigated countries unfeasible. The research was therefore restricted to exploratory, qualitative statements for three categories of responding softwood sawmills that were identified with regard to their level of value-oriented manufacturing.

It was found that European sawmills not only produced plain lumber, but also a wider range of advanced wood products. These were partly blanks aimed at secondary wood industries as customers and partly finished products out of HVRM processes such as finger-jointed lumber, roof trusses, gluelam, exterior wood products, edge-glued panels, laminated window squares, as well as packaging and crates. Some sawmills had developed into exclusive producers of one or a small number of such HVRM products instead of selling any plain lumber at all. These mills, however, accounted only for a minor share of 7% of all responding softwood mills.

It was further found that the production equipment of sawmills with higher HVRM output was more oriented towards slower processes that allowed a stronger customer-focus. Somewhat surprising was that sawmills with higher output of HVRM products seemed to have smaller kiln-drying capacities in relation to their production capacities, despite the fact that it was expected that they would kiln-dry their entire output before further processing it. A satisfactory explanation for this result was not found. With regard to scanning equipment used at different stations in the production process, no meaningful differences between groups of mills with different levels of HVRM output were discovered.

Replacing some of the commodity production with HVRM methods is expected to generate higher incomes for BC sawmills through increased incomes from higher value products, increased sales, and increased exports. The one key result, however, from this research is that application of
HVRM methods in sawmills had a significant positive effect on employment. Increasing the level of high-value recovery manufacturing in BC's sawmills is therefore expected to compensate partly for job losses due to declining harvesting volumes and provide long-term prospects for sustaining forestry-based communities in terms of employment and income.

When applying findings from this study to BC's sawmill industry, one has to keep in mind that sawmills with high levels of value recovery were usually smaller and strongly oriented towards domestic markets, which in BC is very limited. Moreover, most of these sawmills operated in countries that had far-reaching traditions in advanced wood products manufacturing and, thus, a pool of skilled workers. Thus, results cannot be transferred directly but have to be adjusted to the particular situation in BC's lumber industry, especially with respect to raw material and markets.

It might be advisable to import some of the needed professional knowledge from (European) countries where it is readily available. Such knowledge is likely to have the positive side effect of creating a network of contacts that will be beneficial for establishing confidence and developing a market base in other countries. BC has a large forest resource of many unique softwood species (Table 2-2), which, when marketed correctly, can provide the province's forest products industry with a leading advantage on a world market for advanced, high-quality wood products.

In summary, the research questions can be answered as follows:

- There were sawmills that realised moderate to high degrees of value recovery in their production, partly even to the extent of secondary wood processing. Particularly, sawmills with very high degrees of value recovery, however, accounted only for less than 10% of the respondents.
• Sawmills with HVRM production tended to employ slower and more flexible production equipment, produced a wider range of products, and focussed more on local customers and markets.

• The employment of HVRM techniques in sawmills had a considerable effect on the number of jobs they were able to provide per volume unit roundwood consumed. Sawmills with moderate degree of HVRM production employed, on average, twice as many people per 1,000 m$^3$ as sawmills with no HVRM production. For sawmills with high degrees of HVRM production, the number double again.

The potential to produce advanced wood products in BC profitably and sell them to far-away markets has to be the subject of further research. In-depth research is also needed to determine why only few mills produced really large shares of HVRM products and others a moderate amount. For 66% of the respondent sawmills, it still seemed to be more advantageous to limit production to plain lumber and in some cases a negligible share of slightly more advanced wood products. HVRM production as a long-term strategic goal seems to be viable only for a smaller number of sawmills and not the entire sawmill industry of a country.
7. LITERATURE CITED


COFI — Council of Forest Industries. (Editor). 2000b. In British Columbia, forestry is everybody’s business. Information brochure


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**APPENDIX A - THE QUESTIONNAIRE**

**International Sawmill Survey**

**Page 1**

**Questionnaire No.**

Please provide your answers based on information from the fiscal year 1998.

---

### Company and Contact Information

1. a) Company Contact Information. (Use the provided space for corrections or additions.)

b) Annual Production Capacity: ____________ m³/year
c) No. of Employees: ____________ full-time ____________ part-time

2. What is your sawmill’s ownership structure? (See explanations on reverse)

- Part of a Wood Products Manufacturing Group
- Integrated Company
- Independent Company
- Other: (please specify)

---

### Raw Material Supply

3. a) Does your company own forest lands? **Yes** **No**

b) If yes, how much? Coniferous: _________ ha Deciduous: _________ ha Mixed Woodlands: _________ ha

4. Please indicate your total raw material consumption in 1998: m³\text{1998}

5. Please indicate the proportions of your entire raw material supply that are

- Softwoods (coniferous): _________ % Logs: _________ % Bought domestically: _________ %
- Hardwoods (deciduous): _________ % Cants / Lumber: _________ % Imported: _________ %

---

6. Indicate your commonly processed wood species:

---

---

7. a) Where are your logs sorted for manufacturing? (Check all that apply)

- At the Mill
- In the Forest
- Other Location: (please specify)

b) Which are your sorting criteria?

- Diameter
- Species
- Other: (specify)

8. a) Is the quality of incoming logs checked by your sawmill? **Yes** **No**

b) Do you perform any kind of log-grading for manufacturing? **Yes** **No**

c) Does your sawmill use log-scanning systems? **Yes** **No**

---

### Processing Technology

9. Which equipment does your mill use? (Check all that apply)

- Frame Saw
- Reducer/Chipper
- Dry Kiln
- Planer
- Grading Line

10. a) Please indicate how many dry kilns you operate and if they are of different sizes.

b) Indicate your average dry-kiln size: ____________ m³

c) Indicate your annual drying capacity: ____________ m³/yr

11. Please indicate where you use scanning systems in your production process. (Check all that apply)

- Stem Bucking
- Primary Breakdown
- Edging
- Trimming
- No Scanning Systems

12. How long is a typical production run at your mill? (Indicate time) Min: _________ Average: _________ Max: _________

13. a) Has your operation upgraded its production line in the last five years? **Yes** **No**

b) If yes, please rank the three most important reasons. (Apply numbers from 1 to 3 with 1 indicating the most important)

- Changing Raw Material
- Reduce Costs
- Increase Recovery
- Increase Production
- Change / add New Products
- Improve Quality
- Other: (specify)

---

**FAX THIS PAGE BACK TO:** H. Chrestin, CAWP, UBC, Vancouver BC, Canada  **FAX:** int+1-604-822-9159

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Please read this information carefully

This page is used for explanations that did not fit onto the actual survey pages. You are, of course, very welcome to use the remaining space for additional comments. After completing the survey, please separate the two pages along the perforation in the middle and then fax pages 1 and 3 back to me at the number mentioned in the footer.

**Company's ownership structure**

**Part of a Wood Products Manufacturing Group**
- mill belongs to company that owns further operations (e.g. other sawmills, plants for further processing, or for manufacturing of architectural wood products)

**Integrated Company**
- company performs variety of forestry and forest products related operations along entire chain (e.g. forest management, harvesting, log transportation, sawmilling)

**Independent Company**
- only business is cutting and selling sawn wood products
- no ownership-ties to any other processing facility anywhere else

**Telephone Interviews**

I would like to conduct follow-up telephone interviews with selected companies. The individual interview will last about 25 minutes and will be held at a time that is the most convenient for you. The language of the interview can be either English or German, whichever you might prefer. In the interview, I will ask questions on the following topics:

- Extent to which your facility cuts to order
- Primary and secondary breakdown equipment and activities
- Degree of optimisation and optimisation software used
- Product sorting and grading systems
- Secondary processing activities (planing, moulding, laminating, etc.)

Again, allow me to express my great appreciation for your co-operation. Your contribution is very valuable to my thesis. Thank you for supporting me in my investigations.

Use this space for any additional comments

The survey is continued on the next page.
International Sawmill Survey

Page 3

Questionnaire No.

Products and Services
14. Please indicate your total production volume in 1998: (This includes all products that you mill processed) ____________ m³
15. a) Estimate the proportions of your production volume that you plane ______ % grade ______ % treat ______ %
   kill-dry ______ % cut to order ______ % cut to inventory ______ % further process at your mill ______ %
b) If you perform grading, indicate the timber volumes that were appearance-graded in 1998 ______ m³
   visually strength-graded in 1998 ______ m³
   cut to customer specifications ______ m³
   as rough-sawn, dressed boards ______ m³

16. How much of the following specific products did you produce in 1998?
   Structural Timber: in standard dimensions ______ m³ cut to customer specifications ______ m³
   Joinery Timber: as unedged fitches ______ m³ as rough-sawn, dressed boards ______ m³
   Laminating Stock: for glue-laminated timber ______ m³ for window frames ______ m³
   Stock for re-manufacturing ______ m³ Other: (specify) ______ m³

17. Of your total production in 1998 as indicated in Question 14, what proportions did you further process into the following products?
   Glue-laminated Timber: ______ % Finger-Jointed Timber ______ % Laminated Window Stock ______ %
   Roof Trusses ______ % Edge-glued Panels ______ % Wooden Garden Products ______ %
   Mouldings ______ % Planer mill products ______ % Other: ______ %

18. Which of the following services do you provide? (Check all that apply)
   • Retail Sales / Do-it-yourself Market
   • Carpentry & Wood Construction
   • Wood Construction Design
   • Other: (please specify)

Customers and Markets
19. Please indicate the volumes you shipped in 1998 to Domestic Markets: ______ m³ Export Markets: ______ m³
20. Estimate the proportion of your domestic sales in 1998 sold to customers farther than 100 km from your mill ______ %
21. a) Do you expect these markets to grow (↑), decline (↓), or remain the same (□) over the next 3 years? (Circle the appropriate symbol)
   Great Britain & Ireland ______ % Continental Europe ______ % Other Asian Countries ______ %
   Australia & New Zealand ______ % Middle East ______ % North America ______ %
   Japan ______ % Other ______ %

22. Please indicate your level of agreement with the following five statements:
   (For each statement, circle one number indicating your level of agreement)
   Our mill... 1 2 3 4 5
   ...performs ongoing customer research on how to improve our products
   ...has an individual person integrating our customers demands into the production
   ...frequently introduces new products
   ...looks for ways to constantly improve our service
   ...is highly flexible in production scheduling

Thank you very much for your time and cooperation in completing this survey. With selected companies, I am planning telephone interviews* and your participation in one of these would be greatly appreciated!

* For more detailed information please refer to page 2.

23. a) Would you participate in a follow-up telephone interview? Yes ______ No ______
   b) If yes, who would be the appropriate contact person for a telephone interview?
   • Yourself ______ Other Person ______
   First Name, Last Name, Telephone Number: ______
   c) Which would be the most convenient days and times for you to be contacted? (Check all that apply)
   • Mondays ______ Tuesdays ______ Wednesdays ______
   • Thursdays ______ Fridays ______ Saturdays ______
   • Before 8:00 AM ______ Before 12:00 noon ______ After 4:00 PM
   • 8:00 AM to 12:00 noon ______ 12:00 noon to 4:00 PM

FAX THIS PAGE BACK TO: H. Chrestin, CAWP UBC, Vancouver BC, Canada FAX: int+1-604-822-9159
Thank you
very much for your time and co-operation in completing this survey. Your
contribution means an invaluable support of my investigations. Please be
assured that any specific company information will be handled
with absolute confidentiality!

Each company completing the survey will be automatically be added to a list of
mills that will receive a free copy of the summarised results from this
international sawmill comparison.

You do not have to fax this side back.
APPENDIX B - MORE DETAILED RESULTS

Question 1. c) - Numbers of full and part-time employees

Table B-1: Average numbers of full and part-time employees by country and production capacity. 
Behind each figure, the number of evaluated cases (n) is mentioned in parentheses.

<table>
<thead>
<tr>
<th>Sawmill capacity category ('000 m³)</th>
<th>Country</th>
<th>Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>&lt; 2</td>
</tr>
<tr>
<td>Norway</td>
<td>Full-time</td>
<td>27.0 (1)</td>
</tr>
<tr>
<td></td>
<td>Part-time</td>
<td>--</td>
</tr>
<tr>
<td>Sweden</td>
<td>Full-time</td>
<td>4.3 (3)</td>
</tr>
<tr>
<td></td>
<td>Part-time</td>
<td>1.0 (1)</td>
</tr>
<tr>
<td>Finland</td>
<td>Full-time</td>
<td>5.0 (1)</td>
</tr>
<tr>
<td></td>
<td>Part-time</td>
<td>3.0 (1)</td>
</tr>
<tr>
<td>Germany</td>
<td>Full-time</td>
<td>3.7 (3)</td>
</tr>
<tr>
<td></td>
<td>Part-time</td>
<td>--</td>
</tr>
<tr>
<td>Austria</td>
<td>Full-time</td>
<td>2.7 (3)</td>
</tr>
<tr>
<td></td>
<td>Part-time</td>
<td>1.3 (3)</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Full-time</td>
<td>4.3 (4)</td>
</tr>
<tr>
<td></td>
<td>Part-time</td>
<td>1.3 (4)</td>
</tr>
<tr>
<td>All</td>
<td>Full-time</td>
<td>3.6 (10)</td>
</tr>
<tr>
<td></td>
<td>Part-time</td>
<td>1.3 (7)</td>
</tr>
</tbody>
</table>

Question 3. b) - Forest ownership

Table B-2: Ownership of different types of forestland (sizes).

<table>
<thead>
<tr>
<th>Country</th>
<th>Coniferous (ha)</th>
<th>Deciduous (ha)</th>
<th>Mixed (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norway</td>
<td>median (n)</td>
<td>31,000 (4)</td>
<td>-- (1)</td>
</tr>
<tr>
<td></td>
<td>min – max</td>
<td>10,000 – 43,000</td>
<td>6,500</td>
</tr>
<tr>
<td>Sweden</td>
<td>median (n)</td>
<td>700 (8)</td>
<td>20 (2)</td>
</tr>
<tr>
<td></td>
<td>min – max</td>
<td>100 – 12,000</td>
<td>15 – 25</td>
</tr>
<tr>
<td>Finland</td>
<td>median (n)</td>
<td>300,250 (2)</td>
<td>-- (3)</td>
</tr>
<tr>
<td></td>
<td>min – max</td>
<td>500 – 600,000</td>
<td>500 (3)</td>
</tr>
<tr>
<td>Germany</td>
<td>median (n)</td>
<td>-- (1)</td>
<td>-- (1)</td>
</tr>
<tr>
<td></td>
<td>min – max</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Austria</td>
<td>median (n)</td>
<td>140 (7)</td>
<td>418 (2)</td>
</tr>
<tr>
<td></td>
<td>min – max</td>
<td>5 – 9,600</td>
<td>5 – 830</td>
</tr>
<tr>
<td>Switzerland</td>
<td>median (n)</td>
<td>42 (2)</td>
<td>-- (1)</td>
</tr>
<tr>
<td></td>
<td>min – max</td>
<td>4 – 80</td>
<td>1.5</td>
</tr>
</tbody>
</table>
Table B-3: Respondents' raw material consumption ('000 m$^3$) 1998 by country and production capacity.

The table presents mean values in thousand cubic metres together with the number of valid responses in parentheses. In the second row, coefficients of variation (CoV = std. deviation/mean) are presented.

<table>
<thead>
<tr>
<th>Country</th>
<th>Sawmill capacity category ('000 m$^3$)</th>
<th>&lt; 2</th>
<th>2–10</th>
<th>10–25</th>
<th>25–100</th>
<th>100–500</th>
<th>≥ 500</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norway</td>
<td>Avg. (n)</td>
<td>--</td>
<td>--</td>
<td>24.0</td>
<td>66.7</td>
<td>240.0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>CoV</td>
<td>0 %</td>
<td>47 %</td>
<td>20 %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweden</td>
<td>Avg. (n)</td>
<td>3.0</td>
<td>(1)</td>
<td>5.5</td>
<td>(3)</td>
<td>20.2</td>
<td>(8)</td>
<td>103.1</td>
</tr>
<tr>
<td></td>
<td>CoV</td>
<td>0 %</td>
<td>33 %</td>
<td>55 %</td>
<td>37 %</td>
<td>53 %</td>
<td>0 %</td>
<td></td>
</tr>
<tr>
<td>Finland</td>
<td>Avg. (n)</td>
<td>--</td>
<td>--</td>
<td>10.0</td>
<td>(1)</td>
<td>19.5</td>
<td>(10)</td>
<td>83.2</td>
</tr>
<tr>
<td></td>
<td>CoV</td>
<td>0 %</td>
<td>83 %</td>
<td>43 %</td>
<td>48 %</td>
<td>0 %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>Avg. (n)</td>
<td>1.2</td>
<td>(3)</td>
<td>5.7</td>
<td>(15)</td>
<td>15.3</td>
<td>(12)</td>
<td>72.4</td>
</tr>
<tr>
<td></td>
<td>CoV</td>
<td>65 %</td>
<td>50 %</td>
<td>30 %</td>
<td>64 %</td>
<td>60 %</td>
<td>0 %</td>
<td>0 %</td>
</tr>
<tr>
<td>Austria</td>
<td>Avg. (n)</td>
<td>2.2</td>
<td>(3)</td>
<td>4.3</td>
<td>(9)</td>
<td>25.0</td>
<td>(6)</td>
<td>107.0</td>
</tr>
<tr>
<td></td>
<td>CoV</td>
<td>63 %</td>
<td>40 %</td>
<td>50 %</td>
<td>47 %</td>
<td>44 %</td>
<td>94 %</td>
<td></td>
</tr>
<tr>
<td>Switzerland</td>
<td>Avg. (n)</td>
<td>1.3</td>
<td>(4)</td>
<td>4.0</td>
<td>(14)</td>
<td>12.8</td>
<td>(4)</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>CoV</td>
<td>33 %</td>
<td>54 %</td>
<td>50 %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Question 6. - Commonly processed wood species

Figure B-1: Proportions of respondents who indicated to process coniferous species.

Figure B-2: Proportions of respondents who indicated to process deciduous species.
Figure B-3: Proportions of respondents who performed log sorting at different locations.

Figure B-4: Proportions of respondents who performed log sorting after certain criteria.
Question 10. - Drying Kilns

Figure B-5: Medians and ranges of numbers of drying kilns by level of HVRM production. Below the x-axis, proportions of respondents operating kilns of different sizes are shown in parentheses.

Figure B-6: Medians and ranges of average kiln capacities by level of HVRM production.
Figure B-7: Annual drying capacities by level of HVRM production.
Please observe the logarithmic scale on the left axis!

Question 11. - Scanning equipment at different stages of the production process

Figure B-8: Proportions of all respondents that used scanning equipment at different process stages.
Table B-4: Average total production ('000 m³) with numbers of respondents and coefficients of variation (CoV) by country and capacity category.

<table>
<thead>
<tr>
<th>Country</th>
<th>Sawmill capacity category ('000 m³)</th>
<th>&lt; 2</th>
<th>2 - 10</th>
<th>10 - 25</th>
<th>25 - 100</th>
<th>100 - 500</th>
<th>≥ 500</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norway</td>
<td>Avg.(n)</td>
<td>16.0 (1)</td>
<td>36.7 (6)</td>
<td>109.8 (5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CoV</td>
<td>0 %</td>
<td>40 %</td>
<td>38 %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweden</td>
<td>Avg.(n)</td>
<td>1.5 (1)</td>
<td>3.4 (3)</td>
<td>10.9 (7)</td>
<td>52.4 (33)</td>
<td>145.2 (17)</td>
<td>550.0 (1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CoV</td>
<td>0 %</td>
<td>25 %</td>
<td>41 %</td>
<td>48 %</td>
<td>42 %</td>
<td>0 %</td>
<td></td>
</tr>
<tr>
<td>Finland</td>
<td>Avg.(n)</td>
<td>5.0 (1)</td>
<td>9.9 (3)</td>
<td>35.4 (11)</td>
<td>249.5 (8)</td>
<td>2,170.0 (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CoV</td>
<td>0 %</td>
<td>56 %</td>
<td>42 %</td>
<td>41 %</td>
<td>0 %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>Avg.(n)</td>
<td>0.9 (3)</td>
<td>3.8 (16)</td>
<td>11.2 (13)</td>
<td>46.1 (11)</td>
<td>152.5 (4)</td>
<td>470.0 (1)</td>
<td>10.8 (1)</td>
</tr>
<tr>
<td></td>
<td>CoV</td>
<td>42 %</td>
<td>53 %</td>
<td>28 %</td>
<td>55 %</td>
<td>57 %</td>
<td>0 %</td>
<td>0 %</td>
</tr>
<tr>
<td>Austria</td>
<td>Avg.(n)</td>
<td>1.7 (2)</td>
<td>3.4 (8)</td>
<td>15.5 (5)</td>
<td>67.0 (5)</td>
<td>231.0 (4)</td>
<td>785.0 (4)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CoV</td>
<td>13 %</td>
<td>40 %</td>
<td>42 %</td>
<td>56 %</td>
<td>44 %</td>
<td>83 %</td>
<td></td>
</tr>
<tr>
<td>Switzerland</td>
<td>Avg.(n)</td>
<td>1.1 (4)</td>
<td>3.0 (14)</td>
<td>9.5 (5)</td>
<td></td>
<td></td>
<td></td>
<td>35.4 (2)</td>
</tr>
<tr>
<td></td>
<td>CoV</td>
<td>33 %</td>
<td>46 %</td>
<td>68 %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure B-9: 1998 production volumes in relation to indicated production capacity.
APPENDIX C - SOME EUROPEAN WOOD SPECIES

<table>
<thead>
<tr>
<th>Common name</th>
<th>Scientific name</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Softwoods:</strong></td>
<td></td>
</tr>
<tr>
<td>European silver fir</td>
<td><em>Abies alba</em></td>
</tr>
<tr>
<td>European larch</td>
<td><em>Larix decidua</em></td>
</tr>
<tr>
<td>Norway spruce</td>
<td><em>Picea abies</em></td>
</tr>
<tr>
<td>Scots pine</td>
<td><em>Pinus sylvestris</em></td>
</tr>
<tr>
<td><strong>Hardwoods:</strong></td>
<td></td>
</tr>
<tr>
<td>European or common alder</td>
<td><em>Alnus glutinosa</em></td>
</tr>
<tr>
<td>European birch (species)</td>
<td><em>Betula ssp.</em></td>
</tr>
<tr>
<td>European beech</td>
<td><em>Fagus sylvatica</em></td>
</tr>
<tr>
<td>European or trembling aspen</td>
<td><em>Populus tremula</em></td>
</tr>
<tr>
<td>European oak (species)</td>
<td><em>Quercus ssp.</em></td>
</tr>
</tbody>
</table>

Table C-1: Common and scientific names of some European wood species mentioned in the text.