RELATIONSHIP BETWEEN MARKETS AND TECHNOLOGY IN LARGE WESTERN CANADIAN SAWMILLS

by

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ABSTRACT

The relationship between marketing and technology has been discussed in many articles, but little empirical research has been conducted to examine this subject, especially in wood product industry. Results of this study indicate that markets served by Western Canadian sawmills are closely linked with the technologies used in their production. Forty-eight sawmills with annual production over 50 million board feet on BC coast, in BC interior and Alberta were surveyed by personal interview. Forty-three questions related to marketing, products, quality control activities, and processing technology were presented to each participating mill. Data analysis shows that in 1995 there were two distinct markets served by Western Canadian sawmills: North America (predominantly the US) and overseas (predominantly Japan). Interior BC and Alberta sawmills focused more on the North American market, while coastal BC mills focused more on overseas markets. The two groups of mills with different market orientations also show differences in raw material supply, product, quality control factors, size control software, the age of machines, and optimized work centers. This study shows the current situation for the Western Canadian sawmilling industry, and highlights opportunities for using appropriate technology, marketing strategies, and quality control techniques to improve product quality and maximize value and volume of production from limited timber resources.

Key Words: market orientation, optimization, quality control activity, sawmilling industry, Sawmill technology, size control, Western Canadian sawmills,

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1. INTRODUCTION

This research project was part of a larger project: Establishing Technology Benchmarks in Canadian Sawmills for Processing Quality Control and Training Needs. The main objective of this study was to identify the relationship between technological innovation and marketing in Western Canadian sawmills. This was accomplished by surveying sawmills on the BC coast, and in the BC interior and Alberta. Information was collected through interviewing respondents in each sampling unit (individual sawmills) in an attempt to analyze the current status in terms of technology levels, quality control activities, markets served and products produced. Changes to BC mills concerning technological innovation and marketing orientations were highlighted by comparing the research results of this study to a previous study completed four yeas ago. Research results provide a better understanding of the interrelationship between marketing and technology to the Western Canadian sawmill industry, and establishes benchmarks for marketing orientations, products, processing technology, and quality control activities in these sawmills.

This study was preceded by a previous study, conducted by Robert Smith in 1992 and published by Maness and Cohen in 1993, which indicated that there was a strong link between level of quality activities and marketing direction in British Columbia sawmills (Maness and Cohen, 1993). The results of this study compared the two main segments of British Columbia lumber production, coastal mills and interior mills, on their markets, products, and level of quality control activities. Two distinct markets, onshore (North America) and offshore (mainly Japan), were identified for BC sawmills, with each market served mostly by the different geographical regions. Coastal mills were highly focused on the Japanese market, while interior mills placed more emphasis on the US market. Regional differences were also reflected in the products since the coastal mills produced more diverse and specialized products, while interior mills concentrated on producing commodity dimension lumber.

Market and products determined the location and type of technology applied in lumber processing, and quality control activities. Sawmills serving the overseas market tended to use more sophisticated levels of technology and hire more quality control personnel at the front end of processing (bucking and primary processing) and updated and maintained their technology more frequently. Mills serving the North American market tended to focus on technology at the back end of processing (trimming). Results of previous research highlighted the necessity of extending the research breadth to the sawmill industry national-wide. This study reports on sawmills in Western Canada, which includes the BC coast, the BC interior and Alberta. Results also indicate changes regarding markets, products, technology innovation and quality control activity within the British Columbia sawmill industry for the past four years (1991-1995). In addition, data were collected using personnel interviews instead of a mail survey which should improve the accuracy of the results (Tull and Hawkins, 1993).

After introducing this research, the objectives are stated in chapter two. This is followed by a comprehensive literature review in chapter three. Research methods then are discussed in the chapter four. The main body, results and a detailed data analysis are in chapter five. Discussions about study results and theory applications are in chapter six. Finally, a summary and concluding remarks complete this report.

2. OBJECTIVES

There have been many theoretical discussions concerning the relationship between marketing and technology in the literature. However, little empirical research has examined this subject, especially in the wood products industry. The overall objective of this project is to better understand the technology-market relationship indicated by the pilot survey in BC sawmills by Maness *et al* (1994), and to identify the opportunities for using appropriate technology, marketing strategies, and quality control techniques to maximize the quality and value of products from our limited timber resources. These objectives will be accomplished by the following:

1. identifying the markets served by sawmills in the three regions in Western Canada;
2. examining quality control activities along with manufacturing processes and observe what differences exist based on markets served;
3. obtaining first hand information about the current state of processing technological innovation in BC sawmills, and observing the differences based on markets served;
4. comparing the information obtained in previous study in 1991 and observing the changes on markets, products, quality control activities, and processing technology.

The objectives of the study can be also expressed by the following hypotheses:

HO 1: Sawmills in coastal BC, interior BC, and Alberta have no differences in marketing focuses

The initial study from 1991 indicated that two distinct markets, North America and overseas, were served by the sawmills in different locations in BC. Coastal sawmills placed more focus on the overseas market (mainly Japan), while sawmills in the interior focused on the North

American market. Is the result of the pilot study still true today? By including Alberta in the survey coverage, this study will investigate the current market orientation of large lumber manufacturers in the three areas.

HO 2: There are no differences in products based on the markets served by the sawmills

It was shown in the pilot study that interior sawmills concentrated on producing commodity dimension lumber, while coastal mills produce more diversified and specialized products. This result will be examined in this study again by testing the products produced by the mills with different marketing focuses, and then comparing results from this study and with the previous one.

HO 3: There is no difference in the level of quality control (QC) activities based on markets served

The level of QC activities, which include QC techniques, QC factors at different working centers, and QC staff levels, were also different between coastal BC sawmills and interior BC sawmills based on the results of the pilot survey. It is well known that the overseas market requires higher quality lumber products than the North America market. Mills that produce specialty products directed toward offshore markets have higher QC staffing level and QC techniques. Those results will also be verified by this study.

HO 4: There is no difference in process technology among the Western Canadian sawmills based on markets served

It was also found in the pilot survey that the sophistication of technology, the type and frequency of technological maintenance, and the location of automated process control in BC sawmills were different based on the markets that the sawmills served. Mills serving offshore markets tended to focus on sophisticated controls at the bucking and primary breakdown work centers, while mills serving the North American market tended to focus on technology sophisticated process control at primary breakdown and edging centers. By adding age of equipment and a history of facility updating, this study will examine and test whether the process technology and facility innovation differ between mills with different marketing orientations.

Testing the above hypotheses (statistical tests for significance and descriptive statistics) will help to reveal the interrelationship between marketing and technology in Western Canadian sawmills. However, this study will place more emphasis on how the marketing strategy influence technology used in sawmills, which means that all of the technology attributes will be measured based on the different marketing orientations. No reverse test will be applied. A more comprehensive study on the mutual relationship between marketing and technology with a focus on how technology affects marketing strategies is still needed (see discussion of marketing pull and technology push in the Literature Review).

3. LITERATURE REVIEW

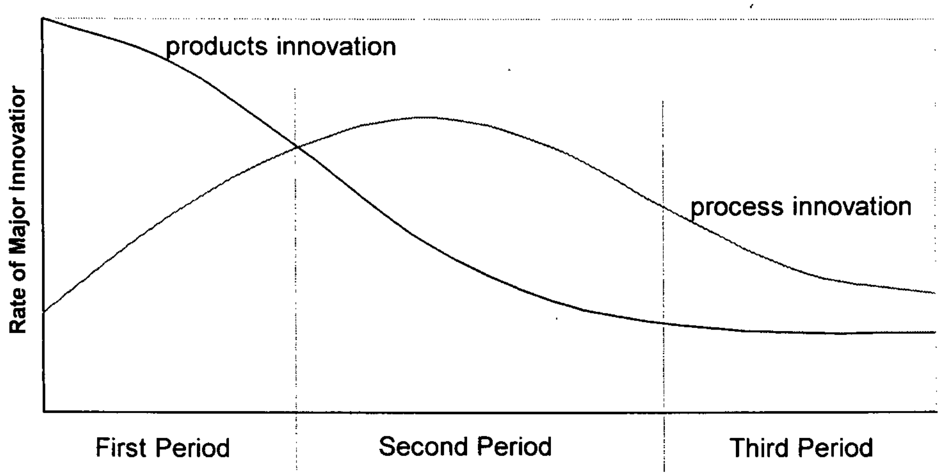
The adoption of technology innovation in processing can be continuous or discontinuous. Continuous technology innovation can be described as incremental improvement on technology adoption rather than dramatic change. Discontinuous technology innovation mainly refers to radical, new and/or different technology for manufacturing a product in a substantially different manner (Sinclair and Cohen, 1992). Technology innovation is usually a continuous process and therefore, discussion about technology innovation in this study mainly refers to continuous technology innovation.

Products, process, and management are the three major aspects of technology innovation in a manufacturing industry (Sinclair and Cohen, 1992). As a result of manufacturing, products are directly provided by the manufacturers to the market, while the process, or the operation of manufacturing, indirectly connects the manufacturers with the market through the products. What management tries to do in setting the proper business strategy is to organize an efficient process to supply high quality products to consumers. Management technology is usually considered a type of business strategy. It is most frequently studied separately from product and process technologies because of its complexity and different functions (e.g. Brownile, 1987, Cowling, 1994, Maisseu, 1995, and Prabhaker, and Golehar, 1994).

3.1 *HILL AND UTTERBACK*'S TECHNOLOGY INNOVATION MODEL

Studying the relationship between marketing and manufacturing technology, product innovation is often considered first since the product is the direct physical link between market and technology. Thus, the importance of process technology is usually shaded by the importance of the product's technology. Hill and Utterback (1979) thought that market competition required the development and improvement of both products and process. Technology innovation of products and processes are closely interdependent with business development. This was clearly described by Hill and Utterback (1979) through a model of the dynamics of processes innovation in industry (Figure 3.1), in which technology innovation was divided into three periods and each innovation attribute had its special characteristics within each period.

Figure 3.1 A Model for the Dynamics of Process Innovation in Industry



Source: Hill and Utterback, 1979

Five aspects are presented for each period. They are: predominant type of innovation, stimulation for innovation, marketing competition emphasis, production process, and equipment. Table 3.1.1 summarizes the function of the model by illustrating the specific features on each of five attributes in the three different periods.

Table 3.1.1 - Functions of Model of the Dynamic of Process Innovation in Industry

	First Period	Second Period	Third Period
Predominate type of innovation	frequent major change in products	major process change required by increasing production	incremental for both products and process, with cumulative improvement in productivity and quality
Innovation stimulated by	information on customer's need and user's technical requirement	opportunities created by expending of internal technical capacity	market pressure of cost reduction and quality improvement
Marketing competition emphasis on	functional products performance	products variation	cost reduction
Production process	flexible and inefficient; major changes easily accommodated	becoming more rigid, with major changes occurring in major steps	efficient, capital intensive, and rigid; high cost of changes
Equipment	general-purpose, requiring highly skilled labor	subprocesses automated, creating "island of automation"	special-purpose, mostly automotive with labor tasks mainly monitoring and control

Table adopted from Hill and Utterback, 1979

This model shows that technological innovation is primarily stimulated by the market demand on products. Thus, product innovation is the first step in the innovation of process technology. As the product innovation continues, process innovation become more important for increasing the product's variety and volume. With markets and products maturing, competition on production cost and product quality have to be emphasized. At this stage, process innovation has to not only increase productivity, but to improve product quality. Therefore, process technology becomes much more important to satisfy market demand. Viewing the whole innovation course, the influence of markets on process technology innovation is critical in terms of a manufacturer's ability to compete, survive, and grow in the market place, although this linkage is not obvious at first glance.

Examples of the development of different forest products illustrate the model of process innovation much more clearly. Lumber products, as well developed products, are manufactured with more mature technology. The process technology would be categorized at the third stage according to Utterback's model, where innovation is mainly to improve product's quality and process productivity. Innovation is usually initiated by the requirement on price and quality from markets. Manufacturing process emphasizes efficiency. However, engineered wood products are in the introduction period. The process technology is obviously at the first stage where major innovation is caused by frequent product changes, such as OSB (oriented strandboard), or LVL (laminated veneer lumber). Innovative initiation often comes from the customer needs (e.g. water proof requirement) and market demand (level of acceptance).

3.2 *WEST*'S "ACTIVE" PROCESSING TECHNOLOGY THEORY

In contrast to the argument of process technology innovation as a 'passive' way for changing the company's position in the market, West (1992) listed four reasons why an institution actively seeks potential opportunities for gaining advantages over the competition by improving manufacturing process technology. These are:

1) Companies can gain an advantage by increasing the speed of manufacturing process, and therefore increase productivity.

2) Investment in process technology can substantially improve the flexibility of production to enable moving from manufacturing one product to another.

3) Process innovation could dramatically decrease the time taken in moving from the initial concept to the final finished product, using technologies such as computer-aided design (CAD), computer-aided manufacturing (CAM), and flexible manufacturing systems (FMS). These can become very important market forces and significantly influence the development of other types of innovation.

4) Process innovation can improve the ability of production processes to deliver products with specified quality, and lower the production cost.

3.3 INTEGRATION OF TECHNOLOGY INNOVATION

As process technology is emphasized, it doesn't mean that process innovation is isolated from other types of technology innovations. Technology innovation requires changes in many facets of the firm (Hill and Utterback, 1979). As information technology develops with one generation and then, is quickly stepped over by another generation, marketing information and customer demand can be quickly obtained by the manufacturers. Communication technology and information systems are leading manufacturing technology to new concepts that are smarter, faster, better integrated, and far more flexible than previous ones. Firms are moving from product-driven to technology-driven and market-driven (Prabhaker and Golehar, 1994). An apparent trend in the wood products industry is a move away from producing one or a few commodity products that favor certain markets to producing diversified products for a variety of markets. Enhancing production flexibility in the sawmills to produce small orders of specialty products requires new process technologies characterized by computer integrated manufacturing and flexible manufacturing systems (Schuler and Meil, 1990). Quality no longer only refers to products, but to services, packaging, and delivery, as well as the whole manufacturing process.

The concept of Quality Control (QC) has been accepted by manufacturers as improving product design, shortening production time, reducing cost, increasing productivity, enhancing product quality, and finally gaining profit, market share, product and company reputation. In sawmills, a QC program can be applied at any step of the lumber production process to achieve the goals of improving recovery in terms of value and/or volume of lumber from logs, ensuring lumber uniformity, and increasing productivity (Maness and Cohen, 1993). Technological innovation also requires personnel with higher education and skills to manage and operate more sophisticated manufacturing processes and facilities, such as the CAM process and statistic quality control activities in sawmills.

Another influence on process technology is the growth of manufacturing value-added products which often requires technology innovation in the manufacturing process to add value to products and process (Goldsmith, 1969). In sawmills, value-added products and processes become more important than ever because of increased supply of lower quality raw material, the high cost of logs, and increasing challenges due to the development of engineered wood composites and non-wood alternatives (Maness and Cohen, 1993).

Technological innovation, even continuous process technology, cannot be entirely free from research and development (Goldsmith, 1969). Technology innovation in manufacturing process can build a bridge that transfers scientific research into fulfilling consumers' needs. At present, there is not enough evidence showing active research and development (R & D) in sawmills. The reasons for a lack of R & D may result from the special characteristics of the industry, i.e. standardized products - lumber, and mature markets - residential construction (Sinclair and Cohen, 1992). However, with rapid market changes and the development of R & D in competing products, both wood and non-wood, the importance of R & D in sawmills may become more recognized by industry management.

Technology innovation is not a simple, clear-cut process. The type of innovation in a particular industry or company depends on its market competition and the specific environment (West, 1992). The wood industry, specifically sawmills, has been undergoing substantial technology innovation with its special industrial environment of marketing, manufacturing, and resources.

The competitive global market, increased public concern for the environment, and shortages of supply of wood fiber require manufacturing facilities in sawmills to meet the demand of quantity, quality, and variety of the products.

Process technology innovation can also help to solve the crisis of supply and demand in the market (Maness and Cohen, 1993). This previous study showed that technology focus and activity in firms differed based on market orientations. Alternatively, sawmills with different levels of technology innovation have chosen to operate in different markets. Other evidence showed that firms who increase the adoption of process technology have superior performance in profitability and market share (Sinclair and Cohen, 1992).

3.4 MARKET PULL AND TECHNOLOGY PUSH

Market pull and technology push have been regarded as the two distinct forces leading business to succeed in today's competitive marketing environment. These two forces are not mutually exclusive, but are connected together with a special link (Kiel 1984). Finding the link in these forces, understanding the link's interface, and combining them toward the same direction are keys to long term success for business institutions.

Marketing Pull can be defined as the development, application and transfer of technology initiated by consumer demand on products. This can often require innovation on process and product technology. The process of Marketing Pull could be expressed as:

Consumer requirement → Product specification → Applied research and development → Manufacturing and sales (Cohen, *et al*, 1994).

Technology push, on the other hand, is the development of new products or the improvement of existing products initiated by the research and development of new technologies. The process of Technology Push could be expressed as:

Scientific research and development → Financing and prototypes → Manufacturing → Marketing and Sales (Cohen, *et al*, 1994).

Generally speaking, there are three major sections in the manufacturing stream: resource procurement, manufacturing, and marketing. Technology and technological innovation are applied to the whole manufacturing stream. To a manufacturer, the type of products, the amount of production, and the producing technology depend on both resources and markets. Therefore, technological innovation in manufacturing could be initiated by limited natural resources (e.g. decreasing log supply), social resources (e.g. shortage of labor), and even political resources (e.g. alteration of government policies). Technological innovation could also be initiated by competition within the market, such as, the price of the product, the quality of the products and services, the number of competitors, and even the differences in packaging format. West (1992) called innovation caused by resources "the demand led innovation" and innovation resulting from marketing requirements "the competitive led innovation". He also pointed out that the key factor determining most innovation, based on several survey results, is the effect of competition. Here, we can interpret "the competitive led innovation" as the "marketing pull".

Like other industries, the wood products industry has been experiencing tremendous technological changes. However, the wood products industry has its own special characteristic -

it relies heavily on a limited supply of natural resources. It is reasonable to believe that technological innovation in the wood products industry can also be stimulated by the limitation of natural resources. Because of changing fiber supply, sawmills have to adopt high performance manufacturing technology for some of the following reasons:

1) to offset expensive log costs
2) to maximize lumber yield
3) to keep lumber prices competitive, and,
4) to place high quality products in the marketplace.

Compared to marketing directed technology innovation, resources led innovation could be understood as "technology push".

As previously mentioned, there are three groups that are generally classified within technological innovation: product technology, process technology, and management technology (Sinclair and Cohen, 1992). This study will focus mainly on process innovation in sawmills and its connection with market orientation. Other innovations (here referring to product innovation and management innovation) will be also discussed since the three types of technological innovation are highly related and influence each other. Products, functioning as a bridge, always transfers technology information to the market place, as well as bringing market requirements back to the manufacturing facility. Quality Control, as an activity of management innovation, runs through the whole manufacturing process, and directly involves process technology and influences marketing. Therefore, these two factors, Products and Quality Control, will be examined and discussed in this study.

4. RESEARCH METHODS

This chapter is composed of four major parts: Sample Frame, Questionnaire Design, Data Collection, and Restrictions. Sample Frame discusses the survey population and the sample frame. Questionnaire Design describes the contents of the questionnaire and the design steps. Data Collection includes two parts: Sample Selection, where a special sampling method, size sampling, was introduced, and Personal Interview which explains the reasons for this technique. Restrictions discusses two major limitations of the sampling method used in this study, non-random sampling error and nonresponse bias. This study was conducted in five steps:

1) secondary data collection;
2) questionnaire design;
3) data collection;
4) data analysis; and
5) report writing.

4.1 SAMPLE FRAME

The sample frame consisted of 127 sawmills which was 43% of the total sawmills and planing mills industry (Standard Industry Code 2512) in BC and Alberta. It represented the survey population defined as, sawmills that produced more than 50 MMBF (million board feet) softwood lumber in 1994 in these two western Canadian provinces. Information about the mills in the sample frame was collected concerning major products, types of manufacturing facilities, main destination of shipments, and each mill's location, address, and contact persons. Some lumber associations were also contacted to make the population list as complete as possible. Mill information was taken from the Madison Canadian Lumber Directory (1996), North American

Factbook (1995-1996), Forestry Directory of British Columbia (1996), and Forestry Directory of Alberta (1995-1996), as well as the directories of several industry associations.

4.2 QUESTIONNAIRE DESIGN

Questionnaire design is a crucial step in marketing research. Questionnaire design for this study was mainly based on a previous questionnaire used to survey sawmills in the Maritime in 1994. However, question consistency with the survey in 1991 for BC sawmills was also considered to compare results between this study and the one in 1991. The two previous surveys in 1991 and 1994 were considered the pre-tests for this study. Changes and modifications to the current survey were completed based on the results of these pre-tests. Other advice and suggestions on questionnaire design were obtained from professionals and experts both at UBC and from within industry.

The major parts of the questionnaire collected information on:

1) company profiles,
2) technology focusing on quality control activities,
3) product/market orientations of the sawmills, and
4) technology innovation in manufacturing process and facilities

4.3 DATA COLLECTION

Two sections are presented in Data Collection: Sample Selection and Personal Interview. In Sample Selection a special sampling method - size sampling, is introduced, and Personal Interview explains the reasons for this specific interviewing technique.

4.3.1 SAMPLE SELECTION

Due to budget restrictions, time constraints, and transportation difficulties resulting from the regional location of mills, a geographically stratified purposive selection (discussed below) of the large manufacturing facilities was used as the sample selection method. Sample mills were selected from the sample frame based on the convenience of traveling between mills. Between 35 - 45% of the sawmills in each of the three areas were sampled resulting in 48 selected mills with the following breakdown for each regional strata: BC coast (13 mills), interior BC (27 mills), and Alberta (8 mills). Survey results showed that all 48 mills had kept their production level over 50 MMBF in 1995.

Sampling only the larger mills (size sampling) is well accepted in industrial marketing research (Karmel and Jain, 1987) because of its higher efficiency. Using size sampling in this study was based on two major reasons. Firstly, this study was not designed to represent the entire population of Western Canadian sawmills in terms of technology and marketing, instead the objective was to provide more accurate results of the relationship between technology level (advanced technology vs. appropriate technology) and marketing orientations (North American market vs. overseas market). Based on the experience of pre-tests, large sawmills tended to be more active in overseas markets and have capabilities and resources to apply advanced technology. Therefore, it is more efficient to survey only large sawmills to obtain sufficient information to analyze the interaction between technology and marketing with a restricted budget and limited time. Secondly, mills in the list of the sample frame encompass 94% of the production of the entire industry (based on information collected for sample frame, see chapter 4.1, Sample Frame), it is reasonable to assume that the samples selected for this study represent a substantial proportion of the Western Canadian sawmilling industry.

Statistical research has showed that, for any given data, a stratified sample consisting of units with the largest value of the auxiliary variable in each stratum is the most efficient strategy (Karmel and Jain, 1987). This study compared simple random sampling and techniques such as stratification, systematic selection, and probability proportional to size selection with purposive sampling that use auxiliary and survey variables in terms of a model to measure error for distribution. Evidence from over 12,000 industrial business samples, showed that purposive design sampling performed much better than simple random design on estimating Mean Square Error (MSE) and sample error. The study suggested that, if no information about a population is available, a sensible procedure is to use simple random sampling. However, if auxiliary information is available, there is a great deal be gained by using other sampling schemes to produce more accurate estimates. In the case of this study, auxiliary information (mill size) is available, therefore, selecting samples with higher annual production is believed to be an appropriate sampling method. Using size-based sampling, which has been well applied in industrial marketing research, is a well established alternative (e.g. Sinclair and Cohen, 1992).

4.3.2 PERSONAL INTERVIEW

Four survey methods can be applied in marketing research: personal interviews, telephone interviews, mail interviews, and computer interviews (Tull and Hawlins, 1993). Each of the four surveys has its own advantages and problems. Personal interview is regarded as a survey method with a higher response rate and the least bias caused by a misunderstanding of the questions, so it is widely accepted as a survey technique in industrial marketing research (Morris, 1988). However, it is relatively expensive, it can have a higher bias on sensitive questions, and it could have a higher sampling error since it restricts the application of simple random sampling. Comparing the different bias that exist among the different interview processes, a lower response rate has the most influence on the accuracy of the final analysis (Tull and Hawlins, 1993). Based on the result of a similar mail survey tested in the Maritimes in 1994, response rates were insufficient for acceptable analysis and results. Therefore, personal interview was considered as the most suitable survey method for this study because it could increase the response rate, and it is capable of handling the complex technological questions which comprise the major part of this study,

To ensure a high rate of response, several steps were taken:

1) the most suitable respondent in each company was contacted by telephone;
2) the questionnaire was sent to the respondent by fax for interview preparation;
3) an interview appointment was made by telephone;
4) the actual personal interview was conducted at the sawmill.

The interviews were conducted by two interviewers and therefore a training program with an interview rehearsal was completed before the actual field survey. This ensured that both interviewers had a thorough understanding of the objectives of the questionnaire design and the interview technique. The main purpose of the interviewer training was to reduce the possible bias created by the interviewers. Care was taken to avoid asking leading questions, or not properly explaining the questionnaire. This ensured that consistent data were collected for accurate analysis.

The 48 responding mills represents 38% of the sample frame, which consists of 127 sawmills with annual production over 50 MMBF in 1994 in British Columbia and Alberta.

4.4 RESTRICTIONS

Industrial marketing research is different from the consumer marketing research and the research in social science. Sample size of industrial marketing research is smaller, but survey time tends to be longer and cost is higher. Respondents are more difficult to access and personal interviews with managers in targeted companies are typical for industrial marketing research. Understanding the special technology involved in the industry is required and interviewer training is necessary (Morris, 1988). Special characteristics of the industrial market lead to some restrictions in marketing research particularly in terms of sample selection and interview technique. Two major limitations to this study were non-random sampling error and non-response bias.

In survey research, there are two components of total survey error, sampling error and non-sampling error. Sampling error is caused by the sample selection which is unable to represent the test population often due to non-random sampling, while non-sampling errors are caused by nonresponse error that occurs when sample members do not respond, and response error that occurs when sample members respond inaccurately (Assael and Keon, 1982). In this study, sampling error could be introduced by non-random sampling, and nonsampling error could be caused by nonresponse.

Random sampling error is easy to control by careful sample selection and by increasing the sample size. However, time and budget constrains prohibited using a strict random sampling method or increasing the sample size in this study. By using non-random sampling (geographical stratification with convenience along the travel routes), sampling error could be introduced into the survey results. Therefore one must assume that mills close to the travel route were not different from mills that were not close to the route in terms of all variables of interests (productions, products, marketing orientations, quality control activities, and process facilities and technology). This assumption is needed to be able to infer results from the sample to the population and to accept the hypothesis tests.

Study results of Assael and Keon (1982) indicate that nonsampling error is, on average about 95% of total survey error. Although personal interview prohibits using complete random sampling in the survey, its capability of dealing with more complicated technology questions to ensure the quality of survey data was the major reason for choosing personal interviews as the survey technique in this study.

Non-response error is caused by the difference between those who respond to the survey and those who do not respond. Generally, the lower the response rate, the higher the probability of non-response error (Tull and Hawkins, 1993). In this study, the non-response rate was only 10%, that is over 90% of the mills approached for an interview agreed to participate. It is believed that such lower nonresponse rate could not create influential nonresponding error for the interpretation of the results. Therefore, nonresponse error was not considered as a major factor in the total survey error. Furthermore, non-response error is a problem only when a difference between the respondents and non-respondents results in an incorrect conclusion or decision. Since this research did not measure the difference between the respondents and non-respondents, it is assumed that there is no difference between the mills who responded and those refused to participate or those were not asked to participate, in terms of all variables of interests (productions, products, marketing orientations, quality control activities, and process facilities and technology).

5. DATA ANALYSIS

There are four sections in this chapter: Data Analysis Based on Market Orientation, Data Analysis based on Geographical Location, Data Analysis based on Comparison of Results for surveys in 1991 and 1995, and Hypothesis Tests. Data analysis was completed from three perspectives: grouping respondent mills by market orientation, grouping them by geographical location, and comparing current results with the previous survey.

In grouping respondents by market, mills were classified based on their geographical market focus: North America and overseas (predominantly Japan and other Asian markets). Mills with overseas shipments exceeding 50% of their total production were counted as having an overseas market orientation, while mills with more than 50% of shipments to Canada and US were classified as having a North American market orientation. Of the 48 respondent mills, there were only nine mills considered as having an overseas market orientation, with the remaining 39 mills having a North American market focus.

The second method classified mills based on the three different geographical locations of the processing facility: Coastal BC, Interior BC, and Alberta. This classification method facilitated comparing results from this survey with one completed four years ago in BC concerning technology, products and markets (Maness and Cohen, 1993). Although the questions asked in the two surveys were not exactly the same, many questions regarding technology and markets were designed to ensure comparability. Comparison of the two survey results highlight the changes in the BC sawmilling industry regarding technology application and marketing orientation over time. Further analysis explored what has changed and why there were changes.

For the analysis which compares BC sawmills over time, Alberta mills are omitted since no prior information was available.

Not all survey respondents answered all questions and some answers could not be coded for statistical analysis. For this reason, the average number of acceptable responses for each question has been included in this report. Averages were used for each group to compensate for the uneven numbers of mills in each group. The statistical methodology used in this analysis was primarily descriptive, as is typical with benchmarking studies.

Interviews were completed with management personnel. Titles of interviewees ranged from general manger to production manager to division manger, and so on. The reason for choosing managers for the interviews is because they are the people with the broadest knowledge of the mill and therefore, they could answer the questions most accurately. Mill mangers at two thirds of the mills were available to be interviewed, while another 23% of those interviewed were quality control personnel. The remaining 10% were supervisors and superintendents.

5.1 DATA ANALYSIS BASED ON MARKET ORIENTATION

Respondent mills were grouped into two classes: mills who focused on North America markets and mills whose focused on overseas markets. There were nine mills with overseas shipments that accounted for over 50% of their total production and there were 39 mills with more than half of their production sold into the North American market in 1995. The following data analysis describes the differences between these two groups of mills for markets and products, quality control activities, and production technology.

5.1.1 MARKET AND PRODUCTS

This section presents results of the analysis on Respondents Description and Production, Markets, Products, Species Distribution, and Distribution Channels.

5.1.1.1 Respondents Description and Production

The total 1995 production of the 48 surveyed mills was 6,847 MMBF. The 40 responding BC sawmills produced 5,668 MMBF which represented 41% of all BC lumber production in 1995 (total production was 13,820 MMBF according to BC Forest Industry Statistical Tables - COFI April 1996). The eight responding Alberta mills produced 1,179 MMBF that represented 59% of softwood lumber production in Alberta (total production was 2,000 MMBF according to Canada & US Softwood Lumber Production Outlook - Wood Market 96').

Production for the sawmills predominantly serving overseas markets was 1,406 MMBF representing 21% of all respondents' production, while those predominantly serving the North American market produced 5,441 MMBF which represented 79% of all respondent production. Eight of the nine mills making up the overseas group (89%) were coastal BC mills, while in the NA group (39 mills) the majority were from the interior of BC (69%), and the remainder from Alberta (18%) and the BC coast (13%). For details on production and mill location see Tables 5.1.1 and 5.1.2.

Table 5.1.1 - Production and Employees

	No. of Mills		Production			Employees		
	Total	% of Total	Total	Average	% of Total	Total	Average	% of Total
Overseas Group	9	23.7	1,406	156.2	20.5	2,501	278	25.4
North American Group	39	76.3	5,441	139.5	79.5	7,352	189	74.6
Total Surveyed Mills	48	100.0	6,847	142.7	100.0	9,853	259	100.0

Table 5.1.2 - Mills Location and Markets Orientation

	BC coast	BC Interior	Alberta
Overseas Group	8	0	1
North American Group	5	27	7
Total Surveyed Mills	13	27	8

The average production per sawmill for the overseas group was 156.2 MMBF. This was slightly higher than the NA group which produced on average 139.5 MMBF per mill. The average number of employees working at sawmills in the overseas group was 278 while the average employees per sawmill in the NA group was 189. Given the average production and employees, production for each employee was 0.56 MMBF for the overseas group and 0.74 MMBF for the NA group.

5.1.1.2 Markets

There were seven markets that Western Canadian sawmills targeted in 1995. These were: Canada, USA, Europe, Japan, Other Asia, Middle East, and Oceana (New Zealand and Australia). The 47 mills (one mill didn't answer this question) that estimated the proportion of volume shipped to the different markets in 1995 indicated that the USA was the biggest market for Western Canadian sawmills. Approximately 58% of total lumber shipments went to the US and 23% went to Japan. Local Canadian markets were numbered the third, accounting for 16% of shipments. These three countries alone accounted for 96% of total shipments from the 47 respondent mills in 1995 (Table 5.1.3).

There were nine mills with over 50% of their shipments going overseas. This represented, on average, 84% of their 1995 annual production. Three mills in the overseas group shipped more

Table 5.1.3 - Volume Shipped to Different Market from Each Group

			OS Group	NA Group	Total Mills
No. of Mills			9	38	47
Production (MMBF)			1,406	5,356	6,762
NA Market		Shipment	141.6	3,748.2	3889.7
	US	% of NA	61.6	78.9	78.1
		% of Total	10.1	68.9	57.5
		Shipment	88.2	1,002.6	1090.7
	Canada	% of NA	38.4	21.1	21.9
		% of Total	6.3	18.7	16.1
	NA	**Shipment**	**229.7**	**4,750.7**	**4980.4**
		% of Total	16.3	88.7	73.7
OS Market		Shipment	1,022.2	518.8	1,541.0
	Japan	% of OS	86.9	85.7	86.5
		% of Total	72.7	9.6	22.8
		Shipment	57.9	14.6	72.5
	Other Asian	% of OS	4.9	2.4	4.1
		% of Total	4.1	0.3	1.1
		Shipment	57.5	51.0	108.5
	Europe	% of OS	4.9	8.4	6.1
		% of Total	4.0	1.0	1.6
	Others	Shipment	39.4	20.9	60.3
	(Middle East	% of OS	3.4	3.5	3.4
	& Oceana)	% of Total	2.8	0.4	0.9
	OS	**Shipment**	**1,176.9**	**605.3**	**1,782.2**
		% of Total	83.7	11.3	26.4

than 90% of production volume overseas in 1995. Japan was the major market for this group of mills, with all nine mills selling over 50% of their total production in the Japanese market. On average, the typical mill shipping offshore sent more than 70% of their total production to Japan, and the Japanese market accounted for 87% of the total overseas shipments of the responding firms that focused on offshore markets. Other Asian countries and Europe were the other two exporting destinations for this group accounting for approximately 4% of total production, and representing only 5% of their overseas shipments in each area.

There were 39 surveyed mills that focused mainly on the North American market. The US was the biggest market for this group of mills, accounting for 69% of their total production in 1995 which represented 79% of all North America shipments. The remaining 21% of North American sales were consumed locally in the Canadian market, which represented 18% of the total production in the 47 surveyed mills.

Among the group of mills with overseas market orientation, there was little expected change on volumes shipped to the North American market over the next three years. Thirty-seven point five percent of mills in this group indicated that their sales in the US market would increase in next three years. Another 37.5% of mills expected sales to remain at current levels. Only 25% of them expected a decrease in sales to the US market (Table 5.1.4).

Table 5.1.4 - Expected Markets Changes in Next Three Years

		Overseas n=8	% of OS	North A. n=32	% of NA	Total Mills n=42	% of Total
	Increase	3	38	1	3	4	10
USA	Same	3	38	5	16	8	19
	Decrease	2	25	26	81	28	70
	Increase	3	38	20	63	22	55
Canada	Same	3	38	11	34	14	35
	Decrease	2	25	1	3	4	10
	Increase	3	38	26	81	29	73
Japan	Same	5	63	6	19	11	28
	Decrease	0	0	0	0	0	0
	Increase	5	63	3	9	8	20
Other Asian	Same	3	38	29	91	31	78
	Decrease	0	0	0	0	0	0
	Increase	2	25	4	13	6	15
Europe	Same	4	50	28	88	32	80
	Decrease	2	25	0	0	2	5
	Increase	2	25	3	9	5	13
Others	Same	6	75	29	91	35	88
	Decrease	0	0	0	0	0	0

However, there was a negative attitude regarding increased sales to the US within the North American group of mills due to the US quota. More than 80% of the respondent mills indicated that they expected a decrease in shipments to the US in next three years. Only 16% expected to export at the current level, and just 5% expected increasing exports to the US market. However, 63% of mills in this group expected increased sales in the Canadian market which was regarded as a way to offset the decreasing sales in the US market. Quota restrictions obviously had a major impact on decisions regarding future market development among sawmills currently focused on the North American market.

Overall, Western Canadian lumber manufacturers will focus on the Japanese market in the next three years. There were 73% of responding mills interested in increasing sales in the Japanese market, with the remaining 27% expecting to remain at current levels. Not a single mill indicated an expected decline in exports to the Japanese market.

Future strategies for the Japanese market were different between the two groups. Mills focusing on the North American market showed more interest in increasing shipments to Japan in the next three years than those already focused on Japan. This could be explained by two reasons. First, due to export restrictions to the USA, mills that mainly shipped lumber there in previous years have to find alternative markets for their products. Second, the large consumption of wood products in Japan attracted Canadian lumber manufacturers to switch to this market. As a result, several issues regarding to the Japanese market have to be considered. First, how large will the Japanese market become; that is, how much more lumber and/or other wood products can the Japanese absorb? Second, how much market share can Western Canadian sawmills capture given competition from other exporting regions? Third, what kinds of products do the Japanese prefer and what technology should be adopted to produce the right products for this market?

Japan is the biggest net importing country of wood products (calculated based on VIII-7&8, Selected Forestry Statistics Canada, 1996). Because of this, all wood products-exporting countries have targeted Japan. However, Japan is a small country. There is a question concerning what the maximum consumption of the Japanese is, and how much market share Canadian lumber producers can capture. Although Canada has a long history of exporting lumber to Japan, exports from BC to Japan have accounted for less than 20% of total annual export volume for each of the last ten years (British Columbia Forest Industry Statistical Table - April 1996 by COFI). This may be due to the geographical distance, cultural differences, and limits to the quality of timber supply. How to help Canadian sawmills understand and develop the Japanese market is a continuous challenge for marketing researchers.

5.1.1.3 Products

Surveyed mills provided information regarding the types of products they produced as well as the proportion of each product shipped in 1995. There were eight products listed in the questionnaires (see Table 5.1.5). Dimension Lumber was the most important product, accounting for approximately 53% of total production. The other products, ordered by production volume, were: Specialty Metric Sizes (14%), Studs (9%), MSR (6.5%), and Clears (5.6%). It is interesting to note that Specialty Metric Sizes was the second major product group by volume for Western Canadian sawmills (Table 5.1.5). This fact might indicate an increasing trend towards offshore exports since the Specialty Metric Sizes is a major product demanded by overseas markets.

Table 5.1.5 - Products Volume Shipped to Different Markets (MMBF)

	Overseas n=9	% of OS	North A. n=38	% of NA	Total Mills n=47	% of Total
Dimension	152.8	10.9	3,485.7	64.1	3,638.5	53.1
Studs	23.1	1.6	605.7	11.1	628.8	9.2
Boards	63.6	4.5	209.8	3.9	273.4	4.0
MSR	0	0	445.2	8.2	445.2	6.5
Siding	0	0	67.6	1.2	67.6	1.0
Timbers	23.4	1.7	35.3	0.7	58.6	0.9
Clears	256.4	18.2	123.7	2.3	380.1	5.6
Metric Size	880.9	62.7	106.8	2.0	987.7	14.4
Fingerjointed	5.4	0.4	31.7	0.6	37.1	0.5
Others	0	0	329.3	6.1	329.3	4.8

The average proportion for each product category were quite different between the overseas group and the North American group. Specialty Metric Sizes, with 63% of production volume, was ranked first by the overseas group, Clears with 18% was second, and Dimension Lumber with 11% was third. The North American group ranked Dimension Lumber first with 64% of production volume, followed by the Studs with 11%, and then MSR with 8%. The different production volumes in each group represented the different needs of overseas and North American markets. Specialty Metric Sizes was the most preferred product for overseas markets, particularly in Japan and other Asian countries, while Dimension Lumber, as a traditional construction product, dominated the North American market.

Approximately 48% of overseas shipments and 83% of North American shipments were kiln dried. Approximately 75% of overseas shipments and 95% of North American shipments were planed (Table 5.1.6). It seems as though the North American market preferred more finished products compared to the overseas market. Usually, products shipped to the overseas market are a larger dimension and are more difficult to dry. Higher moisture content timber harvested from coastal areas could be another reason for less production of kiln dried products in the overseas group in which majority were coastal BC mills. Drying this lumber is not only more difficult, but also very expensive.

Table 5.1.6 - Kiln Dried and Planed Lumber Shipments in Different Groups

		Overseas Group n=9		NA Group n=39		Total Mills n=48	
		Volume (MMBF)	%	Volume (MMBF)	%	Volume (MMBF)	%
Kiln Dried	to NA market	87.4	38	4,088.3	86	4,175.7	84
	to OS market	207.2	18	536.6	89	4175.7	42
Planed	to NA market	143.4	62	4,577.3	96	8,351.4	95
	to OS market	706.0	60	581.3	96	12527.0	72
Total Shipments	to NA market	229.7		4,750.7		20,878.4	
	to OS market	1,176.3		605.3		167.0	

With the development of new technology for wood drying and shipping and wrapping, as well as the acceptance of standard of North American products by major importing countries, dried and planed lumber is becoming preferred by some overseas markets.

Mills with a predominant overseas focus shipped a small proportion of kiln dried lumber to both overseas and North American markets in 1995, at 18% and 38%, respectively. The proportion of kiln dried lumber shipped by the North American group was much higher with the proportion shipped overseas at 88% which was even higher than the 86% shipped to North American markets. The proportion of planed lumber shipped by the overseas group to both overseas and North American markets was about 60%. This was much less than the proportion of planed lumber shipped by the North American group which was about 96% to both markets. The reason may be the lack of drying and planing facilities for coastal mills who were used to shipping green lumber overseas.

5.1.1.4 Species

Species used in Western Canadian sawmills (see Appendix I for scientific names) were mainly lodgepole pine, spruce, hemlock, true fir, Douglas-fir, and cedar (see Table 5.1.7 for proportion of each species). Geographic location was the main reason for mills to select species. In BC coastal areas, the dominant species used in sawmills were hemlock, cedar, and Douglas-fir while in the BC Interior and Alberta, the majority species were lodgepole pine, spruce, and true fir (see details in Table 5.1.7).

Table 5.1.7 - Species Distribution

	OS Group n=9			NA Group n=39			Total Mills n=48	
	Volume	% of OS production	% of Species Total	Volume	% of NA production	% of Species Total	Volume	% of Total
lodgepole pine	90.0	6.4	3.9	2,209.8	40.6	96.1	2,299.8	68.5
true fir	0	0	0	654.4	12.0	100.0	654.4	9.6
spruce	49.2	3.5	3.0	1,610.7	29.6	97.0	1,659.9	24.2
D-fir	226.3	16.1	39.7	343.1	6.3	60.3	569.4	8.3
hemlock	759.9	54.1	81.7	170.3	3.1	18.3	930.2	13.6
cedar	9.0	0.6	2.1	417.3	7.7	97.9	426.3	6.2
larch	0	0	0	24.6	0.5	100.0	24.6	0.4
others	271.6	19.3	96.2	10.9	0.2	3.9	282.5	4.1

Differences in preferred species between the two groups were a result of the mills' geographical location. Because the majority of mills in the overseas group were from the BC coast area, the typical species in this group were the western coastal species (e.g. hemlock and Douglas-fir). Since most mills in the North American group were from the BC interior and Alberta, the species in this group represented the western interior species (e.g. lodgepole pine and spruce). Timber size and timber quality may be two of the reasons that there were more mills from coastal BC mills focusing on overseas markets than those from interior BC and Alberta.

5.1.1.5 Distribution Channels

There were four types of distribution channels listed in the questionnaire: Office Wholesaler (takes no ownership but arranges for lumber to be shipped from mill to customer without acquiring lumber), Agent or Distributor (takes ownership of lumber and redistributes to customers often grouping different mills lumber together, break bulk and regroup), Direct sales to industrial users or retailers, and Other Channels as specified by the respondents. Results indicated that the distribution channel most used was the Wholesaler. Both the overseas group and the North American group had more than 35% of their sales through this kind of selling mechanism. The Agent or Distributor was the second most important selling channel for the overseas group and accounted for 27% of total shipments in 1995 while it was the third most important distribution channel for the North American group (about 20% of production). Mills focusing on the North American market ranked Direct Sales as the second important distribution channel responsible for 25% of their shipments, but mills in the overseas group shipped only 12% of production through this channel (see Table 5.1.8).

Table 5.1.8 - Distribution Channels by Groups

	Total Shipment (MMBF)	Office Wholesaler (takes no ownership)		Agent/Distributor (takes ownership)		Direct Sale Industry or Retailers		Others	
		Shipments	% of Group Production	Shipments	% of Group Production	Shipments	% of Group Production	Shipments	% of Group Production
OS Group n=9	1,406	498	35.5	376	26.7	167	11.9	364	25.9
NA Group n=33	4,481	1,935	35.6	1,067	19.6	1,333	24.5	146	2.7
Total Mills n=42	5,887	2,433	41.3	1,443	24.5	1,500	25.5	510	8.7

Volume shipped through Other Distribution Channels, mainly specified as customer's distributors and Japanese distributors, was much higher in the overseas group (26%) than in the North American group (3%). Shipping products to overseas markets is more complex than selling in North America because of the different culture and formalized distribution systems.

Mills in the overseas group had to deal with more diversified distribution channels, including the channels in the importing country. Therefore, customer's distributors and overseas selling agents are becoming more popular channels for the overseas group to distribute their products to offshore markets.

5.1.2 QUALITY CONTROL(QC) ACTIVITIES

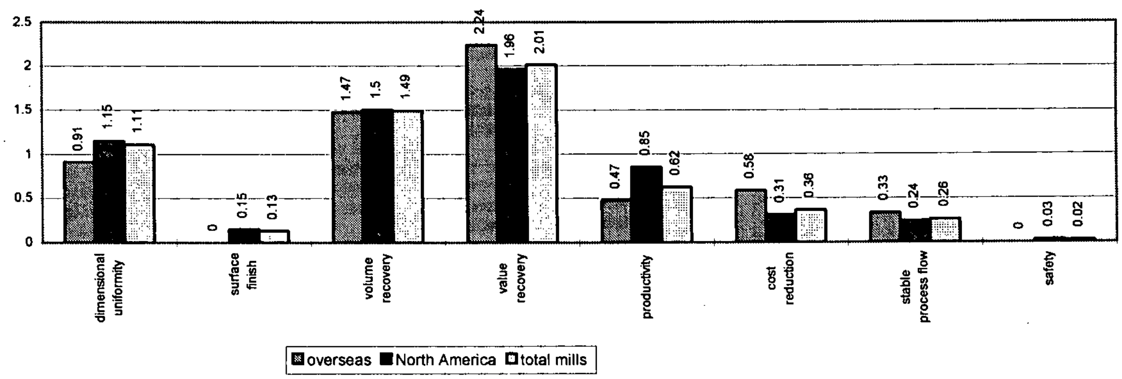
There has been much interest in QC activities in the sawmill industry in recent years because of two factors: higher expectations of product and service quality in the market and more expensive raw material requiring more efficient manufacturing. QC activities are discussed under five topics: Factors Impacted by QC Activities, Important Work Centers for QC Activities, QC Staff Training, Lumber Grading, and Size Control.

5.1.2.1 Factors Impacted by QC Activities

Respondents ranked the three most important factors that could be modified by QC activities (see figure 5.1.1). Ranked orders were converted to Evaluation Points (EP) that gave the first ranking 3 points, the second one 2 points and the third rank 1 point. All points were summed for each factor to create a relative numeric rating (EP) with the higher numbers being the more important factors in terms of QC results.

Among all 48 responding mills, Value Recovery was ranked as the most important factor with an average EP of 2.01. Volume Recovery was second with an average EP of 1.49, followed by Dimension Uniformity with average EP of 1.11 (Figure 5.1.1). Rankings were fairly consistent between the two different marketing groups, even though the average EP for Value Recovery from the overseas group (2.24) was higher than that from the North American group (1.90) and the average EP for Volume Recovery and Dimension Uniformity from the North American group were higher than for the overseas group. These differences indicated that the Value Recovery was more important to the overseas group whereas Volume Recovery and Dimension Uniformity were more important to the North American group.

Figure 5.1 - Factors Impacted by QC Activities

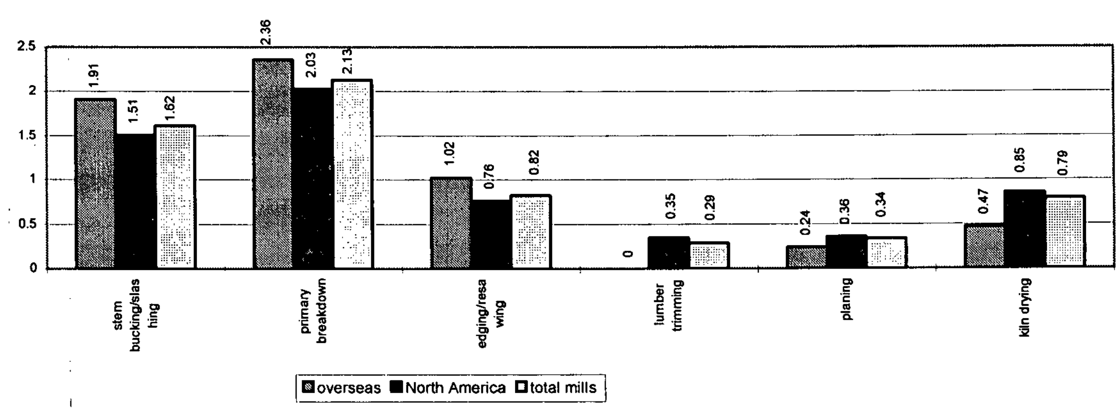


The higher rank for Value Recovery by the overseas market group might result from the use of more expensive, large size, first growth timber commonly used in mills with an overseas marketing focus. Therefore, increasing Value Recovery from the costly logs through various QC activities seems more important to these mills. The higher rank of Volume Recovery and Dimension Uniformity by the North American market group could be caused by the large volume of commodity dimension lumber manufactured by this group of mills. Thus, they would put more emphasis on these factors to maximize profit to the companies.

5.1.2.2 Important Work Centers for QC Activities

From the rough logs coming into the production line to the finished dried lumber shipped out of the mill, there are usually six steps or work centers for processing: bucking, primary breakdown, secondary breakdown, edging, trimming, planing, and drying. All six steps are not necessarily followed in each mill. Respondents were asked to rank the relative importance of each of the six work centers, in terms of QC activities, for lumber processing. Results indicated that Primary Breakdown was the most important work center with an average EP of 2.13. The second most important was Stem Bucking with EP of 1.62, and followed by Edging (0.82), Drying (0.79), Planing (0.34), and Trimming (0.29) (Figure 5.1.2). The higher EP for Drying and Planing relative to Trimming indicated that moisture uniformity and surface finishing was more important than uniformity of the timber length, or that trimming was always exact and therefore there was little need for control.

Figure 5.2 - Important Work Centers for QC Activities



Ranking for work centers between the two market groups was slightly different. Primary Breakdown and Stem Bucking were still the most important work centers with an average EP of 2.36 and 1.91 for the overseas group and an average EP of 2.03 and 1.51 for the North American group. The third important work center for the overseas group was Edging (EP of 1.02), followed by Drying and Planing with EPs of 0.47 and 0.24. Trimming was ranked last with an EP of zero. However, in the North American group, Drying was ranked third with and EP of 0.85, followed by Edging with EP of 0.76 and then Planing and Trimming with EP's of 0.36 and 0.35.

It is understandable that drying and planing were thought less important by the overseas group because of the small portion of dried and planed lumber they produced. Trimming was ranked as having "no importance at all" by the overseas group, mainly because of the special lumber lengths required by the Japanese market (three or four meters). Therefore, mills that mainly focus on the Japanese market had no need to put much QC efforts on Trimming.

Higher rankings for Drying and Edging than Planing and Trimming in the North American group reflected the quality demanded in the North American market. Drying quality has a direct impact on moisture uniformity of lumber, and drying defects could dramatically lower the lumber grade. Edging has the function of controlling the lumber sizes which may be changed frequently depending on market prices.

5.1.2.3 Lumber Grading

Lumber grading sometimes was misunderstood by respondents as QC. Actually, lumber grading is only a process of classifying lumber into product groups. However, lumber grading is important to quality control as it functions as the final check of lumber quality and classifies the lumber according to generally accepted grades. Only one question regarding lumber grading was asked in the questionnaire and that was how many employees worked over 50% of their time in lumber grading. The results may represent the importance of lumber grading in the responding mills to some degree, but it should not be the only criteria to evaluate the mills' emphasis on lumber grading. Some mills required all on-site employees to have a Lumber Grading Ticket, and they believed that knowledge of grading lumber helped the operators to produce higher quality and higher value products.

The number of employees in lumber grading were separated into salaried and hourly employees (Table 5.1.9). The results showed that there were more lumber graders (both in numbers and in proportion) in mills with an overseas market focus than mills with a North American market focus. The reason may be due to the higher product quality demanded by overseas customers, but also the more sophisticated lumber grading criteria required for overseas markets, such as JAS (Japanese Agriculture Standard). The large variety of products sizes and grades for overseas markets may also contribute to the higher number of graders and QC personnel at mills with an offshore focus.

Table 5.1.9 - Employees spent more than 50% of their time on Lumber Grading

	Overseas n=9			North America n=39			Total Mills n=48		
	average	% of employee	MMBF/ grader	average	% of employee	MMBF/ grader	average	% of employee	MMBF/ grader
hourly employees	21.0	7.6	7.4	11.6	6.2	12.0	13.4	6.5	10.7
salary employees	1.3	0.5	120.2	0.5	0.3	279.0	0.7	0.3	203.9
total	22.3	8.0	7.0	12.1	6.4	11.5	14.0	6.8	10.2

5.1.2.4 Size Control

A size control program is a system used to measure, record, evaluate, and control lumber size at each step of manufacturing (Williamston, 1985).

There were 98% of respondent mills using a size control program in their daily production. The measuring devices used for size control were electronic calipers, mechanical calipers, and tape measures. Electronic calipers were the most popular measuring device for both the overseas and the North American group (Table 5.1.10). The second most popular measuring device was the tape measure, followed by mechanical calipers. On one hand, the higher application of electronic calipers indicated more advanced technology involved in the sawmilling industry. On the other hand, the substantial use of tape measures showed that traditional methods were augmenting more modern, technologically sophisticated techniques In fact, 93% of mills using tape measures also used electronic calipers.

Table 5.1.10 - Devices for Size Control

	overseas n=9		North America n=39		Total Mills n=48	
	No. of mills	% of OS	No. of mills	% of NA	No. of mills	% of total
use size control	9	100	38	97	47	98
electronic calipers	8	89	34	89	42	88
mechanical calipers	4	44	16	42	20	42
tape measure	5	56	25	66	30	63
other	1	11	2	5	3	6

Computer programs have shown a very powerful capability in size control because of their accuracy, speed, and capability of using statistic to analyze large amounts of size data.

Forty-two of the 48 surveyed mills had installed software to perform the function of size control (89% of mills in each market group). There were 35 mills that indicated the name of the software they were using in size control (Table 5.1.11). They were: L-Size with 50%, and SICAM with 24%, Newness and Lusi (named as others in Table 5.1.11), with 5% of each. When asked the reason for using the software, 50% of mills in the overseas group specified the 'Power of Program' and 50% indicated the 'Ease of Use'. In the North American group, 71% of mills chose the software because of ease of use, and 50% because of the availability. Some mills stated more than one reason.

Table 5.1.11 - Software for Size Data Analysis

	overseas n=9		North America n=37		Total Mills n=47	
	No. of mills	% of OS	No. of mills	% of NA	No. of mills	% of total
use software	8	89.0	34	92.0	42	89.4
SICAM	5	62.5	5	14.7	10	21.3
L-Size	1	12.5	20	58.8	21	44.7
Other	2	25.0	9	26.5	10	21.3

Results indicated that ease of use was the most important reason for mills to chose software for size control (Table 5.1.12). However, mills with an overseas market focus placed more emphasis on the power of the program and mills with a North American market orientation emphasized availability. BC coastal mills were more likely to use SICAM, while L-Size was more popular in the BC interior and Alberta.

Table 5.1.12 - Reasons of Using Software

	overseas n=8		North America n=34		Total Mills n=42	
	No. of mills	% of OS	No. of mills	% of NA	No. of mills	% of total
power of program	2	25.0	12	35.3	14	33.3
ease of use	3	37.5	24	70.6	27	64.3
cost	2	25.0	10	29.4	12	28.6
availability	3	37.5	17	50.0	20	47.6
bundled with equipment	1	12.5	1	2.9	2	4.8
other	3	37.5	12	35.3	15	35.7

5.1.3 Production Technology and Facilities

With more computer technology being used in lumber manufacturing, the overall technology in Western Canadian sawmills is at a higher level than ever before. More automatic equipment and optimization software have been installed in production lines. Technology innovation may be initiated by either market requirements or raw material limits. In this section, five topics are discussed regarding technology innovation in Western Canadian sawmills: facility upgrading, age of processing equipment, automation and optimization of production lines, value added facilities, and technology information. This section will provide information needed to analyze the relationship between technology and markets.

5.1.3.1 Facility Upgrading

The survey results showed that about 96% of the surveyed mills had updated their facilities in the last five years. All of the mills in the overseas group had upgraded their facilities while 95% in the North American group had upgraded theirs.

Table 5.1.13 shows that the reasons for updating the operation lines were mainly: 'to increase fiber recovery' and 'to improve quality'. In the overseas group, 100% of mills specified 'to increase fiber recovery' as one of the reasons for upgrading, and 89% of mills indicated 'to improve quality, to control/reduce the cost, and to change and add new products' as the other three major reasons. In North American group, 89% indicated that 'to increase fiber recovery' was the major reason, 73% chose 'to improve the quality' and 62% stated 'to increase production'.

Table 5.1.13 - Facility Upgrading

	overseas n=9		North America n=39		Total Mills n=48	
	No. of mills	% of OS	No. of mills	% of NA	No. of mills	% of total
upgraded	9	100	37	95	46	96
change raw material	5	56	14	38	19	41
to increase production	6	67	23	62	29	63
to increase fiber recovery	9	100	33	89	42	91
to improve quality	8	89	27	73	35	76
to control/reduce cost	8	89	19	51	27	59
to change/add new products	8	89	8	22	16	35
other	2	22	5	14	7	15

It was clear that 'to increase fiber recovery' was more important for the overseas group than for the North American group, while 'to increase production' was emphasized more by the North American group than by the overseas group. These results support the idea that the overseas group is focusing more on value recovery to offset the higher cost of good quality logs, and the North American group is focusing more on volume recovery to maximize their profit margin in producing a commodity product. Since the products required by overseas market were diversified and customized, mills in the overseas group seem to frequently update their production lines to satisfy their market needs.

5.1.3.2 Age of Equipment

The age of equipment can represent a mill's technology level to a certain degree. Increasing production can require new machine installations. Expanding product variety or changing products is another reason for purchasing new equipment. Therefore, mills with newer machines were more likely to utilize higher levels of process technology.

Generally speaking, mills in the overseas group have younger machines than ones in the North American group. Since the machines used in all the surveyed mills were quite different, the average machine ages of each work center was used to compare the two group of mills. There were five work centers (Stem Bucking, Primary Breakdown, Edging, Trimming, and Drying) with 18 types of machines listed in the questionnaire, and one "other" option in each working center. The average ages in the Stem Bucking center were similar for both groups (Table 5.1.14). Machines in Primary Breakdown used by the overseas group were much newer (average age of 6.5 years) than those used by North American mills (10.6 years). Edging was the only center where the machines in the overseas group were older (9.8 years) than the ones in the North

American group (8.9 years), and the difference was small. Trimmers and Drying facilities were newer in the mills with overseas focus compared to the North American group.

Table 5.1.14 - Age of Equipment (average age of all machines in each working center)

	stem bucking	primary breakdown	edging	trimming	drying
overseas n=9	10.27	6.50	9.83	4.11	6.00
NA n=39	10.45	10.59	8.94	9.20	14.42
total mills n=48	10.42	9.96	9.13	8.77	13.22

The reasons for mills in the overseas group using newer machines in processing may be due to changing products, as well as the higher quality requirement from overseas customers. Newer processing equipment in Primary Breakdown in the overseas group indicated the importance of this process center. Special requirements on lumber length by overseas markets required mills focused on these markets to adapt their trimmers. Newer kilns in these mills indicated the intention of increasing production volume of dried lumber.

5.1.3.3 Automation and Optimization

Mills were asked to specify whether they used optimization (referring to as computerized control in drying hereafter) or manual operation on the five processing work centers. Primary Breakdown was the most highly optimized work center in both the overseas group (89%) and the North American group (85%). Edging was second, followed by Drying, for both groups. Optimized Trimmers were installed more frequently in the North American group (71%) than in the overseas group (33%), while optimized Bucking was the opposite, with higher utilization in the overseas group (56%) than in the North American group (44%) (Table 5.1.15).

The lower volume of kiln dried products from the overseas group resulted in less optimization in drying. Less variety of product lengths, stated in Important Work Centers for QC Activities, reduced the number of mills using an optimized Trimmer in production lines in the overseas group. Again, more expensive logs pushed mills in the overseas group to use an optimized Bucking centers to maximize fiber recovery.

Table 5.1.15 - Operation of Machine Centers

		overseas n=9		North America n=39		Total Mills n=48	
		No. of mills*	% of OS	No. of mills*	% of NA	No. of mills*	% of total
bucking	manual	4	44.4	29	74.4	33	69
	optimization	5	55.6	17	43.6	22	46
primary breakdown	manual	2	22.2	14	35.9	16	33
	optimization	8	88.9	33	84.6	41	85
edging	manual	4	44.4	12	30.8	16	33
	optimization	6	66.7	33	84.6	39	81
trimming	manual	6	66.7	12	30.8	18	38
	optimization	3	33.3	28	71.8	31	65
drying**	manual	2	40.0	9	25.0	11	27
	optimization	3	60.0	29	80.6	32	78
total machine center	manual	18	41.9	76	35.2	94	36.3
	optimization	25	58.1	140	64.8	165	63.7
	total machine	43	-----	216	-----	259	-----

* manual and optimization may exceed # of mills since some mills using both manual and optimization in production
** only 5 mills in overseas group and 36 mills in NA group had drying facilities

Generally, higher utilization of optimization on production lines in the North American group helped these mills to increase productivity and volume recovery targeting the North American market by providing large volumes of residential construction lumber. The lower rate of optimized processing lines in the overseas group resulted from more specialty products being required by the customers and more sophisticated criteria used in offshore markets. Here, one clarification should be raised that shows the difference between appropriate technology and advanced technology. Appropriate technology is the technology which is the most suitable given the raw material supply, the market requirements, and the general skills of the work force.

Advanced technology could be defined as a technology which is more sophisticated and complex. In this case, the lower use of advanced technology in the overseas group did not mean that they produced lower quality products. On the contrary, providing higher quality products was the main reason for the mills to use more appropriate technology to satisfy the needs of the customer and maximize their profit.

5.1.3.4 Facilities for Value Added Products

In sawmilling, the primary value adding processes are kiln drying and planing. The proportions of planed lumber and kiln dried lumber in the surveyed mills were 92% and 71% in 1995 (Table 5.1.16). In the overseas group, these numbers were 71% and 32%, and in the North American group they were 93% and 84%. As a consequence of different market demands, the overseas group again, showed a lower proportion of kiln dried and planed products than the North American group.

Table 5.1.16 - Volume of Lumber Planed and Kiln Dried

	overseas n=9		North America n=39		Total Mills n=48	
	MMBF	% of OS	MMBF	% of NA	MMBF	% of total
Lumber planed	993.7	71	5,085.8	93	6,079.5	92
Lumber kiln dried	321.0	32	4,555.7	84	4,876.8	74

The same results were found regarding the use of kilns and planers. Eight-nine percent of mills in the overseas group used planers and 56% used kilns. In the North American group, 100% of the mills used planers and kilns (Table 5.1.17). Average kiln capacity in the overseas group was smaller than for the North American group, with 516,000 board feet per kiln charge (MBF/Charge) versus 688 MBF/Charge in second group as shown in Table 5.1.18. The average number of kilns was 5.4 per mill in the overseas group while it was only 3.5 kilns per mill in the

North American group. The small kiln capacity in the overseas group may be due to the reason mentioned above that mills focused on the overseas market produced less volume of kiln dried lumber than mills serving the North American market. The large number of kilns possessed by the overseas group could be a sign that the mills in this group were catching up with the increased demand for dried products in overseas markets by gradually installing more drying facilities. The newer kiln age in the overseas group supports this explanation. Larger product size produced in the overseas group also requires much longer in drying process. Therefore, mills in the overseas group need more capacity (more kilns) for the same level of production.

Table 5.1.17 - Facilities for Value Added Products

	overseas n=9		North America n=39		Total Mills n=48	
	No. of mills	% of OS	No. of mills	% of NA	No. of mills	% of total
Planer	8	89	39	100	47	98
Chipper	9	100	39	100	48	100
Kiln	5	56	36	92	41	85

Table 5.1.18 - Kiln Capacity

	capacity (MBF)/charge		# of kilns		total capacity
	total	average	total	average	average
overseas group n=5	2,580	516.0	27.0	5.4	2,786
N. A group n=35	24,103	688.7	127.5	3.5	2,438
total mills n=40	26,683	667.1	154.5	3.9	2,575

Another product made by sawmills are chips which, as a side-product, can contribute to profits when the pulp prices are high. There was no difference between the overseas group and the North American group on the questions concerning chippers used in the mills. Both groups showed 100% chip utilization.

5.1.3.5 Technology Information Needed by the Sawmills

Respondents ranked five choices regarding the most valuable technology information for their production sites (see Table 5.1.19).

Benchmarking for Primary Processing was ranked first by both groups, although the EP of 2.11 in the overseas group was higher than EP of 1.64 in the North American group (Table 5.1.19). The second most valuable type of technology information for the overseas group was General Technology Information which was ranked third by the North American group. The second most important type in the North American group was Information on Specific Machine Centers, ranked third by the overseas group. Benchmarking for Secondary Processing was ranked fourth by both groups, with Logistics and Material Handling ranking fifth. The closeness of the EP's indicates relatively similar importance for the first three types of information.

Table 5.1.19 - Technological Information Needed by Sawmills (EP)

	overseas n=9		North America n=39		Total Mills n=48	
	total EP	Ave. EP	total EP	Ave. EP	total EP	Ave. EP
general technology information	13	1.44	53.0	1.36	66.0	1.38
benchmark for primary processing	19	2.11	64.0	1.64	83.0	1.73
benchmark for secondary processing	9	1.00	41.5	1.06	50.5	1.05
logistics and material handling	3	0.33	13.0	0.33	16.0	0.33
information on specific machine centers	10	1.11	56.5	1.45	66.5	1.39

Because of the more expensive raw material supply to mills with overseas market focus, primary processing seems more important to these mills than to mills in the other group. They were trying to increase sales value by producing higher quality lumber from expensive logs. The higher ranking for General Technology Information trends by the overseas group may have resulted from more diverse competition in the overseas market, and more diversified products manufactured by these mills. Competitors for the overseas group were mainly from other wood exporting countries. Therefore, the General Technology Information from all of the world may attract the attention of mills who were in the international market. They also needed more technology information about the different products in overseas market, as well as the technological trend on equipment to enhance their manufacturing process, to update the production lines, to continuously improve both product quality and production levels, and to secure their competitive levels in overseas markets.

General Technology Information was not as important for the North American group as for the overseas group. Instead, mills were more interested in Information on Specific Machine Centers. This may be because the competition for North American markets was from other North American sawmills using similar technology.

5.2 DATA ANALYSIS BASED ON GEOGRAPHICAL LOCATION

Analysis was also completed examining Western Canadian sawmills based on geographical location. The 48 surveyed sawmills were classified into three geographical groups: coastal BC (13 mills), interior BC (27), and Alberta (8). Analysis was consistent with the methods in the previous section.

5.2.1 MARKET AND PRODUCTS

This section includes three main topics: Production, Markets, Products and Species, and Distribution Channels.

5.2.1.1 Production

The average lumber production per mill for the 48 surveyed mills was 140 MMBF. Alberta mills had a higher average of 147 MMBF, while BC Coastal mills averaged 135 MMBF, and BC interior mills averaged 141 MMBF per mill (see Table 5.2.1). These are only moderate differences and may be caused by the sampling method in which only the mills with higher productions in 1994 (above 50 MMBF) were selected for interviews.

Table 5.2.1 - Production and Employee Data for Respondent Mills in 1995

Sawmill Location	Total Production (MMBF)	Average Production (MMBF)	Total Employees	Avg. Employees per Mill
Coastal BC n =13	1,751	135	3,353	258
Interior BC n =27	3,709	141	4,563	169
Alberta Mill n = 8	1,179	147	1,557	195
Total n = 48	6,729	140	9,473	197

Total employment in the 48 surveyed mills was about 9,500 with an overall average of approximately 200 employees in each mill. BC coastal mills employed more people (258 per mill) than mills in the other two regions (170 for BC interior and 197 for Alberta, see Table 5.2.1 and Figure 5.2.1 and 5.2.2). BC interior mills achieved a higher production per employee than in other regions: BC interior 0.83 MMBF/person/year, Alberta 0.75 MMBF/person/year, and BC Coast 0.52 MMBF/person/year.

Figure 5.3 - Total Production of Surveying Mills in 1995 (MMBF)

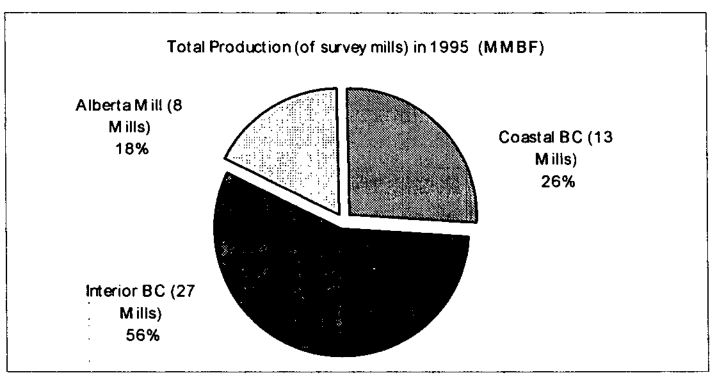
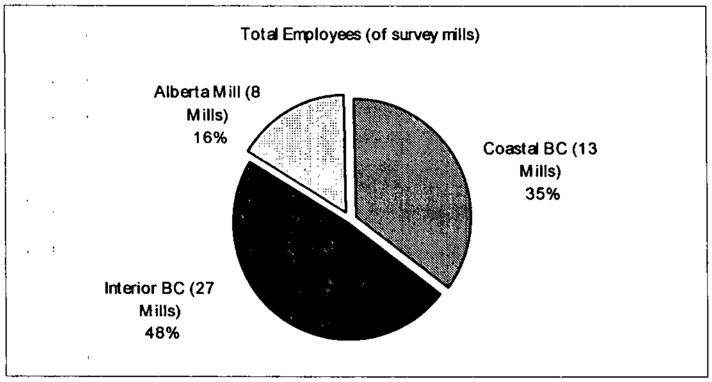


Figure 5.4 - Number of Employees in Surveying Mills in 1995



5.2.1.2 Markets

Survey results indicated that BC coastal mills supplied more lumber to the Japanese market than mills in the other survey areas. In 1995, approximately 64% of respondents' Japanese shipments were from BC coastal mills. Mills in the BC interior and Alberta were more focused on the US market, which accounted for 74% and 57% of their total shipments respectively. Table 5.2.2 provides detailed information regarding markets for each producing region.

The different market preferences were mainly due to different sources of raw material supply and geographical proximity to markets. On the BC coast, logs supplied to sawmills are regarded as old growth with large diameters, high rings per cm and high quality grain and strength properties, which are much preferred by Japanese consumers. Alternately, timber received by mills in the BC interior and Alberta are mostly small diameter trees with lower quality (more knots) than BC coastal wood.

Species is another reason which contributes to market differences between BC coastal mills and interior mills. Natural characteristics of different species, such as cypress, may affect quality or appearance of the products that cause market preference. From this perspective, market focus for the sawmilling industry is heavily impacted by raw material supply.

Table 5.2.2 - Markets of Volume Shipped in 1995

	Coastal BC Mills n=13		Interior BC Mills n=27		Alberta Mills n=8		Total n=48	
	MMBF	% of group	MMBF	% of group	MMBF	% of group	MMBF	% of group
Canada	207.5	11.2	547.2	14.7	336.1	28.5	1,090.7	16.1
USA	471.7	25.2	2,742.8	73.9	675.2	57.3	3,889.7	57.5
Europe	82.1	4.4	26.4	0.7	-	-	108.5	1.6
Japan	988.4	52.9	395.5	10.7	157.1	13.3	1,541.0	22.8
Other Asia	60.6	3.2	1.2	0.0	10.7	0.9	72.5	1.1
Middle East	18.6	1.0	0.9	0.0	-	-	19.5	0.3
Others	40.3	2.2	-	-	-	-	40.3	0.6
Total Production	1,896.00	100.00	3,714.00	100.00	1,179.00	100.00	6,762.00	100.00

Table 5.2.3 - Markets Changes in Next Three Years

		Coastal BC Mills n=12		Interior BC Mills n=20		Alberta Mills n=8		Total Mills (n=40)	
		# of mills	% of	# of mills	% of	# of mills	% of	# of mills	% of
Canada	Increase	5	42	14	70	4	50	23	57
	same	6	50	5	25	3	38	14	35
	decrease	1	8	1	5	1	12	3	8
USA	Increase	2	17	0	0	2	25	4	10
	same	5	42	2	10	1	13	8	20
	decrease	5	42	18	90	5	62	28	70
Europe	Increase	3	25	3	85	0	0	6	15
	same	8	67	17	15	8	100	33	82
	decrease	1	8	0	0	0	0	1	3
Japan	Increase	4	33	17	85	8	100	29	72
	same	8	67	3	15	0	0	11	28
	decrease	0	0	0	0	0	0	0	0
Other Asia	Increase	6	50	0	0	2	25	8	20
	same	6	50	20	100	6	75	32	80
	decrease	0	0	0	0	0	0	0	0
Middle East	Increase	0	0	2	10	0	0	2	5
	same	12	100	18	90	8	100	38	95
	decrease	0	0	0	0	0	0	0	0
Others (Australia N. Z.)	Increase	3	25	0	0	0	0	3	8
	same	9	75	20	100	8	100	37	92
	decrease	0	0	0	0	0	0	0	0

Expected market changes were previously discussed in section 5.1.1.2. Ninety percent of BC interior mills expected that shipments to the US market would decrease (Table 5.2.3) mainly due to the Canadian-US Lumber Export Quota. Japan seems to be the most popular target market for the BC interior and Alberta in the next three years. Table 5.2.3 shows that 85% of BC interior respondents and 100% of Alberta respondents expected that their Japanese sales will increase. The Canadian domestic market is also expected to grow in importance for Western Canadian sawmills to offset the market impacts of the US quota. Seventy percent of BC interior mills and 50% of Alberta mills indicated a potential increase in sales in the Canadian market in next three years. Since the BC coastal mills mainly focused on overseas market, there was no such impact on their marketing strategies (Table 5.2.3).

5.2.1.3 Products and Species

Overall, the major product produced by western Canadian sawmills in 1995 was Dimension Lumber (see discussion in part I - Markets). Special Metric Size was the most important product for coastal BC mills and was responsible for 45% of their production. The second largest volume produced by coastal BC mills was Dimension Lumber which represented 23% of production. Clears accounted for 19% of production (see Table 5.2.4).

Dimension Lumber was the dominant product for both BC interior (63% of production) and Alberta mills (69%), because their major customer was the US construction industry. Other products manufactured by BC interior mills in order of importance were: Studs (13%), MSR (9%), and Boards (4%). Major products, other than Dimension Lumber for Alberta mills were: MSR (10%), Special Metric Size (9%), Studs (8%) and Boards (3%) (Table 5.2.4).

Table 5.2.4 - Products and Volume Proportion

	Coastal BC Mills n=13		Interior BC Mills n=27		Alberta Mills n=8		Total Mills n=48	
	MMBF	% of	MMBF	% of	MMBF	% of	MMBF	% of
dimension lumber	436	23.3	2,461	62.8	818	69.4	3,715	53.1
studs	23	1.2	511	13.5	94	8.0	629	9.2
boards	84	4.5	154	4.1	36	3.0	273	4.0
MSR	-	-	332	8.7	113	9.6	445	6.5
siding	68	3.6	-	-	-	-	68	1.0
timber	45	2.4	6	0.2	7	0.6	59	0.9
clears	345	18.5	33	0.9	2	0.2	380	5.6
special metric	827	44.3	52	1.4	9	9.2	988	14.4
fingerjoined	11	0.6	15	0.7	-	-	25	0.5
others	30	1.6	135	8.0	-	-	164	4.8
total production	1,869	100.0	3,799	100.0	1,179	100.0	6,847	100.0

The proportion of kiln dried and planed lumber shipped to both North America and overseas markets from coastal BC mills was lower than from BC interior and Alberta mills (Table 5.2.5). Only about 13% of overseas shipments and 16% of North American shipments were kiln dried from BC coastal mills. All lumber shipped from the BC interior and Alberta to overseas markets was kiln dried. Information on markets and products for all mills showed that the overseas markets received a lower portion of kiln dried and planed lumber (48% kiln dried and 75% planed) than the North American market (83% dried and 95% planed) in 1995.

Table 5.2.5 - Dried and Planed/Surfaced Lumber Proportion in NA and Overseas

		Kiln Dried Lumber		Planed/Surfaced Lumber		Total Production	
		Overseas	NA	Overseas	NA	Overseas	NA
Coastal BC	MMBF	152.1	110.2	740.0	506.4	1,191	678
n=6	% of	12.8	16.3	62.1	74.7		
Interior BC	MMBF	640.0	2,941.6	639.7	3,100.0	640	3,159
n=27	% of	100.0	93.1	100.0	98.1		
Alberta	MMBF	167.8	995.2	123.5	985.5	168	1.011
n=8	% of	100.0	98.4	73.6	97.5		
Total	MMBF	959.4	4,047.0	1,503.3	4,591.9	1,999	4,848
n=41	% of	48.0	83.5	75.2	94.7		

Table 5.2.6 shows that the major species manufactured in coastal BC mills were hemlock (49%), western red cedar (22%), and Douglas-fir (12%); while in the BC interior, they were lodgepole pine (44%), spruce (30), and true fir (16%); and Alberta mills only manufactured three species: lodgepole pine (54%), spruce (40%) and true fir (6%).

Table 5.2.6 - Species Distribution

	Coastal BC Mills n=13		Interior BC Mills n=27		Alberta Mills n=8		Total Mills n=48	
	Production (MMBF)	% of	Production (MMBF)	% of	Production (MMBF)	% of	Production (MMBF)	% of
Lodgepole Pine			1,664	43.8	636	53.9	2,300	33.6
Fir			587	15.5	68	5.7	654	9.6
Spruce	49	2.6	1,1135	29.9	476	40.4	1,660	24.2
D-Fir	226	12.1	343	9.0			569	8.3
Hemlock	910	48.7	20	0.5			930	13.6
W. Red Cedar	412	22.0	14	0.4			426	6.2
Larch			25	0.7			25	0.4
Hem-Fir	150	8.6					150	2.2
Cypress	108	6.2					108	1.6
Yellow Cedar	14	0.8					14	0.2
Ponderosa Pine / White Pine			11	0.3			11	0.2
Total	1,869	100.0	3,799	100.0	1,179	100.0	6,847	100.0
Total Species	7		8		3		11	

Species manufactured in different areas are due to the natural distribution of the species. Interior BC and Alberta share a similar climate and geography, so that the species distributions are very similar. Species distribution in coastal BC is different from the other two areas.

5.2.1.4 Distribution Channels

Results showed that the Office Wholesaler (see definition in chapter 5.1.1.4) was the most used distribution channel for BC sawmills. In coastal BC, Office Wholesalers distributed 37% of total production, and interior BC mills shipped 53% of their production through this type of channel member (Table 5.2.7). However, Alberta mills used Direct Sales most frequently (47% of their shipments in 1995). An Agent/distributor (see definition in chapter 5.1.1.4) was the second preferred channel for coastal BC and Alberta, responsible for 27% of BC coast shipments and 35% of Alberta shipments. The second most important distribution channel for interior BC mills was Direct Sales, responsible for 26% of the total 1995 production.

Table 5.2.7 - Distribution Channels

	Coastal BC Mills n=13		Interior BC Mills n=23		Alberta Mills n=6		Total Mills n=48	
	MMBF	% of	MMBF	% of	MMBF	% of	MMBF	% of
office wholesaler	605	32.4	1,683	53.3	146	17.0	2,434	41.4
agent/distributor	504	27.0	639	20.2	300	35.0	1,443	24.5
direct to end user	280	15.0	816	25.8	403	46.9	1,5	26.2
others	480	25.7	20	0.6	10	1.1	510	8.7
total production	1,714	100.0	3,159	100.0	859	100.0	5,732	100.0

Some other channels also took distribution responsibility for sawmills, especially for the coastal BC mills. The percentage of sales by other distribution channels, specified mainly as customers' distributors and stock distributors, was 26% in BC coastal mills. This may be due to the use of large integrated Japanese trading houses which distribute much of the special metric sizes in Japan. The more diversified the markets and products, the more complex and diverse distribution channels are needed. This is especially true for the overseas market.

5.2.2 QUALITY CONTROL ACTIVITY

5.2.2.1 Factors Impacted by QC Activities

Quality control is of key concern to Western Canadian sawmills. For evaluating and analyzing the importance of the QC activities, eight factors were listed (see Table 5.2.8). Rank orders of importance among the three geographical regions were quite different. Although all the mills in the three areas ranked Value Recovery as the most important factor, the different EP's indicated that the BC coastal mills focused much more on this factor than the mills in the other two areas

(Table 5.2.8). Volume Recovery was ranked as the second most important factor for both the BC interior and coastal mills, but the rating for the interior was slightly higher than for the coast. Dimension Uniformity was the second most important factor for Alberta mills, but it was ranked third for interior BC mills and fourth for coastal BC mills. The ranking of the QC activities indicated that Value Recovery was the most important factor for coastal BC mills, while the interior BC mills treated Value Recovery and Volume Recovery at the same importance level, and Alberta mills emphasized both Value Recovery and Dimension Uniformity.

Table 5.2.8 - Importance of QC Activities (EP)

	Coastal BC n=13	Interior BC n=27	Alberta n=8	Total Mills n=48
	Average EP	Average EP	Average EP	Average EP
Dimension Uniformity	0.55	1.15	1.88	1.11
Surface Finish	0.08	0.11	0.25	0.13
Volume Recovery	1.55	1.76	0.50	1.49
Value Recovery	2.32	1.87	2.00	2.01
Productivity	0.71	0.65	0.38	0.62
Cost Reduction	0.55	0.15	0.75	0.36
Stable Process Flow	0.23	0.28	0.25	0.26
Safety	0.00	0.04	0.00	0.02

It is understandable that all the mills ranked Value Recovery as the most important factor because of continuously increasing log costs in the past few years. The different ranking on the QC factors could be caused by different raw material supply, different marketing focus, varying technical level of equipment, education level of employees, or management philosophy. More expensive raw material supply and higher product requirements from overseas markets pushed BC coastal mills to focus more on Value Recovery. Large amounts of commodity lumber for the North America residential market required interior BC and Alberta mills to put more emphasis on Volume Recovery and Dimension Uniformity than coastal BC mills.

5.2.2.2 Important Work Centers for QC Activities

A similar measuring technique was applied to evaluate the relative importance of manufacturing centers for QC activities. Six work centers were presented in the questionnaire (see Table 5.2.9). Results showed that Primary Breakdown was the most important work center for mills in all three geographical areas (Table 5.2.9). Stem Bucking/Slashing was ranked as the second most important work center, and Edging/Resawing was in the third place overall, but this was largely due to its very high EP from the BC coastal mills (1.40). Kiln Drying filled the fourth position overall, but was ranked third by both the BC interior and Alberta mills.

Table 5.2.9 - Importance of Work Center (EP)

	Coastal BC n=13	Interior BC n=27	Alberta n=7	Total Mills n=47
	Average EP	Average EP	Average EP	Average EP
Stem bucking / slashing	1.40	1.67	1.86	1.62
Primary breaking	2.55	1.93	2.14	2.13
Edging / Resawing	1.40	0.65	0.43	0.82
Trimming	0.15	0.35	0.29	0.29
Planing	0.25	0.35	0.50	0.34
Kiln drying	0.25	1.06	0.79	0.79

Although all three area groups ranked Primary Breakdown first, the EP of coastal BC mills was much higher than the other two groups. This may be because Primary Breakdown is the key process in producing the highest value recovery, particularly for the Japanese market which often pays a substantial premium for appearance characteristics such as grain direction. Areas which considered volume recovery as very important ranked Stem Bucking/Slashing as a key work center with higher EPs in the interior BC mills (1.67) and Alberta mills (1.86) than in coastal BC mills (1.40), and with a higher proportion of mills in the interior of BC (48%) and Alberta (50%) ranking it first.

5.2.2.3 Lumber Grading

The importance of lumber grading in sawmilling could be measured by the number of employees and their working times spent on lumber grading. Results showed that mills in coastal BC had more employees, both salaried and hourly, who spent 50% or more of their time on lumber grading than mills in interior BC and Alberta (Table 5.2.10). Considering the total employee number in each area group, the percentage of lumber graders employed by BC coastal mills was still higher than the numbers in BC interior and Alberta mills, in term of hourly employees. Alberta mills had the higher percentage of salaried employees in lumber grading, but this may be the result of the small number of mills surveyed in this area.

Table 5.2.10 - No. of Employees Spending 50% More Time in Lumber Grading

	# of Salaried			# of Hourly		
	Total	Average	% of Employees	Total	Average	% of Employees
Coastal BC n=13	13	1.63	0.39	283	35.38	8.44
Interior BC n=27	10	0.37	0.22	268	9.93	5.87
Alberta Mill n=8	8	1.00	0.51	91	11.38	5.84
Total n=48	31	0.65	0.33	642	13.38	6.78

5.2.2.4 Training Programs

Ranking for the importance of training programs in sawmill operations was fairly consistent with the results shown in Table 5.2.11. Coastal BC mills ranked Lumber Grading as the most important training program for their operations with an EP of 1.91 which was much higher than Quality control (in second place) with an EP of 0.99. Alberta mills also gave Lumber Grading the highest EP with 1.57 while BC interior mills gave it an EP of 0.78. Quality Control was ranked as the second most important training program for both coast and interior BC mills. Machine Maintenance was ranked second in Alberta mills, third in BC coastal mills, and fourth in BC interior mills.

Table 5.2.11 - Importance of Training Programs (EP)

	Coastal BC n=13	Interior BC n=27	Alberta n=7	Total n=47
	Average EP	Average EP	Average EP	Average EP
machine maintenance	0.57	0.72	1.14	0.74
machine operation	0.34	0.41	0.43	0.39
machine calibration	0.53	0.52	0.29	0.49
lumber grading	1.91	0.78	1.57	1.21
quality control	0.99	1.04	0.43	0.93
size control	0.45	0.48	0.71	0.51
computer programming	0.07	0.00	0.00	0.02
computer skills in operation	0.31	0.20	0.13	0.22
communication	0.31	0.89	0.38	0.66
cross-training	0.31	0.48	0.50	0.45

Although the evaluation points and ranking places were different among the three area groups, the three categories mentioned above were the most important training programs for Western Canadian sawmills. There was one more program, Communication, which ranked second with an EP of 0.89 by interior BC mills, with five of those mills choosing it as the most important program. Communication could be understood in many different ways, such as: internal communication within the sawmilling operation, communication between mills within the same company, or communication between the sawmill and customers, suppliers, or distributors. Further study is needed to properly analyze the results of this question.

5.2.2.5 Size Control

Size control can be used in the different work centers, along with the manufacturing process, to ensure that manufactured lumber attain its target sizes with a minimum amount of waste.

Results indicate that all of the respondent mills in the interior of BC and Alberta used size control as did 92% of the coastal BC mills (Table 5.2.12).

Table 5.2.12 - Measuring Device for Size Control

		size control	electronic calipers	mechanical calipers	tape measure	other
Coastal	# mills	12	9	5	8	1
BC n=13	% of	92	69	38	62	8
Interior	# mills	27	25	11	15	1
BC n-27	% of	100	93	41	56	4
Alberta	# mills	8	8	4	7	1
n=8	% of	100	100	50	88	13
Total	# mills	47	42	20	30	3
n=48	% of	98	88	42	63	6

Three devices were used to measure sizes: Electronic Calipers, Mechanical Calipers and Tape Measures. Electronic caliper, a technologically sophisticated measuring device, was the most popular method (88% of surveyed mills). This was followed by Tape Measures (63%) and then by Mechanical Calipers (42%). The numbers do not add up to 100% since most mills use more than one method of size control. Different measuring devices may be located at different machine centers or used to double check measurements for precision. Electronic Calipers were the major device used for size control in both Alberta mills (100%) and interior BC mills (88%), while they were used in only 69% of coastal mills.

Different software packages were used to analyze size data. Eighty-eight percent of mills indicated that they used one of four kinds of software: SICAM, L-size, Newness and Lusi (Table 5.2.13). Within these software packages, L-Size was widely used by BC interior mills (72%), and SICAM was commonly used by coastal BC mills (70%). All four kinds were used in Alberta with the L-size having a higher proportion of 43%. Availability was the main reason for software selection (80% of respondent mills). This explains the predominance of one type of software for each region: SICAM in BC coast and L-Size in BC interior.

Table 5.2.13 - Software for Size Control

	Coastal BC Mills n=13		Interior BC Mills n=27		Alberta Mills n=8		Total Mills n=48	
	# of mills	% of	# of mills	% of	# of mills	% of	# of mills	% of
Use Software	10	77	25	93	7	88.0	42	88.0
SICAM	7	70	2	8	1	14.3	10	23.8
L-Size	0	0	18	72	3	42.9	21	50.0
Newness	1	10	0	0	1	14.3	2	4.8
Lusi	0	0	0	0	2	28.6	2	4.8
Don't know	2	20	5	20	0	0	7	16.7

5.2.3 PRODUCTION TECHNOLOGY AND FACILITIES

5.2.3.1 Facility Upgrading

The vast majority of the mills (96%) have upgraded their facilities within last five years, with all of the mills in BC completing upgrades.

Mills also indicated the reasons for upgrading (Table 5.2.14). Increasing fiber recovery was the number one reason in all regions. Improving quality was the second most important reason for facilities upgrading. BC coastal mills indicated that Reducing Costs was the third key reason (77% of mills), while the BC interior and Alberta mills considered Increasing Production as the third reason. This is logical given increasing log cost, especially to BC coastal mills.

Table 5.2.14 - Reasons for Upgrading Processing Facilities

	Coastal BC Mills n=13		Interior BC Mills n=27		Alberta Mills n=6		Total Mills n=46	
	# of mills	% of	# of mills	% of	# of mills	% of	# of mills	% of
raw material changing	7	54	9	33	3	50	19	41
increase production	8	62	15	56	6	100	29	63
increase fiber recovery	13	100	23	85	6	100	42	91
improve quality	11	85	18	67	6	100	35	76
control/reduce cost	10	77	14	52	3	50	27	59
change/add new products	9	69	5	19	2	33	16	35
Others	2	15	3	11	2	33	7	15

5.2.3.2 Age of Equipment

Table 5.2.15 shows that equipment used in both regions of BC was older than that used in Alberta mills. In BC mills, the average age of equipment was of 11 years, while in Alberta it was six years. Trimmers were older in coastal BC mills (13.5 years), but kilns were newer than in interior BC mills. This could be due to increasing demand of kiln dried products on overseas markets in recent years. Respondents of BC coastal mills indicated that they were going to install more kilns in the next few years to meet customers' requirements.

All machines in all work centers in Alberta mills were newer than the machines in BC (see Table 5.2.15) due to the recent expansion of processing facilities in Alberta.

Table 5.2.15 - Average Age of Each Working Center

	Coastal BC n=13	Interior BC n=27	Alberta n=8	Total n=48
Stem Bucking	11.6	11.2	5.2	10.4
Primary Breakdown	10.3	11.2	5.4	10.0
Edging	11.3	8.7	5.8	9.1
Trimming	13.5	8.1	3.4	8.8
Drying	9.1	15.7	8.5	13.2
Ave. of all machine center	11.2	11.0	5.7	10.3

5.2.3.3 Automation and Optimization

One very important factor which could be used to evaluate technology levels in the sawmilling industry is the application of optimization systems. These can be used in almost every work center during lumber processing to maximize the lumber production to ensure higher volume and/or value recovery.

Questions were asked about whether the five work centers (bucking, primary breakdown, edging, trimming, and drying) were operated manually or using some form of optimization (see Table 5.2.16). Overall, primary breakdown was the most highly optimized work center (85% of mills), edging was second (81%), and drying was third (78%). Only 46% of the mills used optimization systems at their bucking center (Table 5.2.16). Among the three areas, Alberta mills had the highest utilization of optimization in manufacturing, while BC coastal mills had the lowest levels.

Table 5.2.16 - How Machine Centers Operated

		Coastal BC Mills n=13		Interior BC Mills n=27		Alberta Mills n=8		Total Mills n=48	
		# of mills*	% of	# of mills	% of	# of mills	% of	# of mills	% of
bucking	manual	9	69.2	20	74.1	4	50.0	33	69
	optimized	4	30.8	12	44.4	6	75.0	22	46
primary breakdown	manual	7	53.8	8	29.6	1	12.5	16	33
	optimized	9	69.2	24	88.9	8	100	41	85
edging	manual	9	69.2	5	18.5	2	25.0	16	33
	optimized	6	46.2	26	96.3	7	87.5	39	81
trimming	manual	10	76.9	6	22.2	2	25.0	18	38
	optimized	3	23.1	22	81.5	6	75.0	31	65
drying**	manual	4	66.7	6	22.2	1	12.5	11	27
	optimized	2	33.3	22	81.5	8	100	32	78
total machine centers	manual	39	61.9	45	29.8	10	22.2	94	36.3
	optimized	24	38.1	106	70.2	35	77.8	165	63.7
	total	63	-----	151	-----	45	-----	259	-----

* # of manual and optimization may exceed # of mills since some mills using both manual and optimization in production
** only 6 coastal BC mills had drying facilities

The lower utilization of optimization in BC coastal mills may be due to the complicated quality requirements of products for the offshore markets, especially in terms of appearance characteristics such as, color and grain direction. While scanners and optimization are useful in maximizing the amount of product produced from logs or lumbers based on their shapes and sizes, they can not yet deal with some appearance factors of wood such as color or grain direction.

5.2.3.4 Facilities for Value-added Products

The primary value-added products in Western Canadian sawmills are planed and kiln dried lumber and chips for pulp production. Planers, kilns and chippers are the main facilities used to manufacture these value-added products. Survey results indicated that 100% of surveyed mills used chippers in their mills, and 100% of interior BC and Alberta mills used planers and kilns as well (Table 5.2.17). Only on the BC coast did some of the mills not have planers (8%) or dry kilns (54%).

Table 5.2.17 - Mills Using Planer, Chipper, and Kiln

	Use of Planer		Use of Chipper		Use of Kiln	
	Total	Percentage	Total	Percentage	Total	Percentage
Coastal BC n=13	12	92	13	100	6	46
Interior BC n=27	27	100	27	100	27	100
Alberta Mill n=8	8	100	8	100	8	100
Total n=48	47	98	48	100	41	85

Table 5.2.18 - Percent of Lumber Planed and Kiln Dried

	Lumber Planed		Lumber Kiln Dried	
	Total production	% of production	Total production	% of production
Coastal BC n=13	1,398	87.3	197	12.3
Interior BC n=27	3,625	95.4	3,435	90.4
Alberta Mill n=8	1,058	89.7	1,147	97.3
Total n=48	6,080	92.4	4,690	71.3

Table 5.2.18 shows the proportion of lumber planed and kiln dried in the three regions. BC interior mills produced a higher proportion of planed lumber (95%) than the mills in Alberta

(87%) and on the BC coast (87%). Alberta mills manufactured a higher proportion of kiln dried lumber in 1995 (97% of total production) than either the BC interior (90%) or the BC coast (12%).

Among the mills with kilns (Table 5.2.19), those in the BC interior had an average kiln capacity of 716 MMBF/charge, while in BC coastal mills kilns were much smaller (455 MMBF/charge). However, the average number of kilns in BC coastal mills (5.83) was higher than in interior BC mills (3.46) and Alberta mills (3.42). Those mills on the BC coast that did have kilns had a higher average capacity per mill (2.65 MMBF/mill) than the BC interior (2.48 MMBF/mill) or Alberta (2.25 MMBF/mill).

Table 5.2.19 -Kiln Capacity

	Total Capacity MMBF / per charge	Ave. Capacity MMBF / per charge	# of Kilns	Ave. # of Kilns	Ave. Capacity MMBF / per mill
Coastal BC (6)	2,730	455	35.0	5.83	2,653
Interior BC (27)	19,343	716	93.5	3.46	2,477
Alberta (7)	4,610	659	24.0	3.42	2,254
Total (40)	26,683	667	153.0	3.83	2,554

5.2.3.5 Technology Information

To improve product quality and enhance the technology level of the processing facility, sawmills often need technology information. Mills were asked to rank the types of information that could be provided by government agencies, industrial organizations, consulting companies, and/or universities. Benchmarks for primary processing was considered the most important type of information for sawmills, followed by information for specific machine centers, and general technology information (Table 5.2.20). Different preferences were found in different areas. Both

BC coast and interior mills thought information on primary processes and specific machine centers were more important, while Alberta mills preferred general technology information and benchmarks for secondary processes.

Table 5.2.20 - Technical Information Need (EP)

	Coastal BC Mills n=13		Interior BC Mills n=27		Alberta Mills n=8		Total Mills n=48	
	total EP	avg. EP	total EP	avg. EP	total EP	avg. EP	total EP	avg. EP
general technology trend	14	1.1	37.0	1.4	15	1.9	66.0	1.4
benchmark for primary process	26	2.0	46.0	1.8	11	1.4	83.0	1.7
benchmark for secondary process	13	1.0	24.5	0.9	13	1.6	50.5	1.1
logistics & material handling	6	0.5	6.0	0.2	4	0.5	16.0	0.3
inf. for special machine centers	19	1.5	42.5	1.6	5	0.6	66.5	1.4

5.3 DATA ANALYSIS BASED ON COMPARISON OF RESULTS FOR SURVEYS IN 1991 AND 1995

A survey was completed in British Columbia sawmills to assess quality control activities in 1991. This information provides a benchmark to monitor changes to the British Columbia sawmilling industry over four years by comparing responses to similar questions for 1995. Only the data from BC mills is comparable, since Alberta mills were not included in the 1991 survey.

The main objective of the previous research was to assess QC activity in the lumber manufacturing industry. However information regarding products, technology and markets was also collected. Comparative analysis between the two surveys will be as consistent as possible for Production, Markets and Products, and Quality Control Activities.

5.3.1 RESPONDENTS DESCRIPTION AND PRODUCTION

The 1991 survey used a sample frame of all BC mills with annual production of over 35 MMBF. This sample frame changed for the 1995 survey. To keep the number of site visits reasonable, an increased production cut-off point (from 35 MMBF in 1991 to 50 MMBF in 1995) was used in the 1995 survey, while the 1991 study could incorporate more mills as a mail survey was used and the cut-off point was lower. That said, results of 1991 survey showed that all mills, except one, had annual productions of over 50 MMBF. In other words, the comparison of the average annual production between the two surveys (1991 and 1995) was reasonable. The annual production in the 1995 survey was 140 MMBF per mill which was higher than 116 MMBF for the 47 surveyed mills in 1991 survey (Table 5.3.2).

Total softwood lumber production of BC sawmills in 1991 was 13,308 MMBF (Table 5.3.1) which was only 3.7% lower than 13,819 MMBF in 1995 (British Columbia Forest Industry Statistical Table - COFI, April 1996). Table 5.3.1 shows the total production and the average production in coastal BC mills, interior BC mills, and total surveyed mills in 1991 and 1995. The annual production of BC sawmills in the two surveys (5,338.5 MMBF in 1991 and 5,460 MMBF in 1995) were both responsible for 40% of total production of BC sawmills in 1991 and 1995. It should be noted that although the production criteria for sample mills increased from 35 MMBF in 1991 to 50 MMBF in 1995 (30% higher) and the number of mills surveyed decreased from 46 in 1991 to 39 mills in 1995, both groups of respondent mills represented the same proportion of total provincial production. This fact indicated that the large BC sawmills had expanded production, while the total production of BC sawmills remained relatively stable. Growth in average production for BC coastal mills (23.3%) was higher than for interior mills (15.5%), although the average production in both regions had grown for the last four years.

Table 5.3.1 - Lumber Production in 1991 and 1995

Sawmill Location	Total Production (of survey mills in MMBF)		Average Production (of survey mills in MMBF)	
	1991	1995	1991	1995
Coastal BC n=22/ n=13	2,408	1,715	109.5	135
Interior BC n=25/ n=26	2,931	3,709	122.1	141
Total n=46/ n=39	5,339	5,460	116.1	140

5.3.2 MARKET AND PRODUCTS

Similar product categories and market regions were used in both surveys, to facilitate a comparison of markets and products.

5.3.2.1 Markets

Results of the survey in 1991 classified two distinct markets served by BC sawmills: the onshore market (Canada and the United States) and the offshore market (predominantly Japan). Of the responding mills, 43% of interior mills shipped at least 75% of their annual production to the United States which represented nearly 70% of the total production in 1991 (Table 5.3.3). However, among the 20 surveyed coastal mills, only 5% of them focused on the US market which took 23% of coastal mill's annual production. Meanwhile, Japan was the biggest market for BC coastal mills, responsible for 44.7% of total production and 18% of the coastal mills shipped at least 75% of their production to this destination.

Results from 1995 showed that the regional differences in market focus in the BC sawmills has not changed since the last survey. Interior mills still focused on the US market while coastal mills still focused on the Japanese market. However, the proportion of the production volume shipped from these two distinctive areas to their preferred markets has increased, from 44.7% to 52.9%

for coastal mills' shipments to Japan, and from 69.7% to 73.9% for interior mills' shipment to the US (Table 5.3.2 and Table 5.3.3). This increased reliance on a single market for each region could be considered specialization and may represent over reliance on a single market.

Table 5.3.2 - Markets of Volume* Shipped in 1991

	Coastal BC Mills n=20		Interior BC Mills n=22		Total Mills n=42	
	MMBF	% of group total	MMBF	% of group total	MMBF	% of total
Canada	292	13.8	432	16.2	724	15.1
USA	487	23.0	1,855	69.7	2,342	49.0
Europe	302	14.2	60.0	2.2	361	7.6
Japan	948	44.7	304	11.4	1,252	26.2
Other offshore	91	4.3	12	0.4	103	2.2
Total Production	2,120		2,663		4,783	

*volume counted only from complete responses

Table 5.3.3 - Markets of Volume* Shipped in 1995

	Coastal BC Mills n=13		Interior BC Mills n=26		Total Mills n=39	
	MMBF	% of group total	MMBF	% of group total	MMBF	% of group total
Canada	208	11.2	547	14.7	755	13.5
USA	472	25.2	2,743	73.9	3,215	57.3
Europe	82	4.4	26	0.7	109	1.9
Japan	988	52.9	396	10.7	1,384	24.7
Other offshore	120	5.4	2	0.1	121	2.2
Total Production	1,896	100.0	3,714	100.0	5,610	100.0

*volume counted only from complete responses

BC lumber shipments to local Canadian markets slightly decreased from 15.14% of total production (1991) to 13.45% (1995). However, shipments to the European market decreased dramatically in the past four years, from 7.6% to 1.9% of total production. Both BC coastal and interior mills reduced their shipments to the European market. Export proportion to other offshore markets remained at the same level.

Generally, exporting was still the main business for BC lumber industry in 1995, although the proportions destined to different export markets had changed. As the US shipments increased from 49% to 57%, offshore shipments decreased. However, this situation is not expected to continue according to the mills surveyed in 1995 due to the US quota restriction. Japan will be the major targeted market for BC lumber shipments in the next three years.

5.3.2.2 Products

Survey results in 1991 showed that interior mills concentrated on producing commodity dimension lumber (76.3%) while coastal mills produced more diverse and specialized products (48.8%) (Table 5.3.4). This did not change according to results for 1995. Dimension Lumber was still the main product for interior sawmills, although its proportion dropped to 52% in 1995 (Table 5.3.5). Special Metric Lumber responsible for 44.2% of total production was the most important product manufactured by coastal mills in 1995. Because Special Metric Sizes were not specified in the 1991 survey, there could not be a direct comparison in this category. However, there must have been an increase in terms of proportion of production for Special Metric Size for coastal mills since the proportion of this single category in 1995 (44.3%) is even larger than the multiple category of "other products" in 1991 (42.1%).

The increase in proportion of production for MSR for interior mills and Special Metric Size for coastal mills is consistent with the increase in shipments to the US market for interior mills and the Japanese market for coastal mills. This may indicate further specialization of sawmills for specific product/markets.

Table 5.3.4 - Products and Volume Proportion in 1991

	Coastal BC Mills n=18		Interior BC Mills n=20		Total Mills n=38	
	MMBF	% of group	MMBF	% of group	MMBF	% of
dimension lumber	467	24.9	1,907	76.3	2,373	62.5
studs	0	0	275	11.0	275	7.2
boards	79	4.2	129	5.1	208	5.5
MSR	11	0.6	70	2.8	81	2.1
siding	59	3.2	0	0	59	1.6
timber	74	3.9	0	0	74	1.9
clears	271	14.4	12	0.5	283	7.4
J-housing	126	6.7	45	1.8	171	4.5
others	790	42.1	61	2.5	852	22.4
total production	1,877		2,498		4,375	

Table 5.3.5 - Products and Volume Proportion in 1995

	Coastal BC Mills n=13		Interior BC Mills n=27		Total Mills n=40	
	MMBF	% of group	MMBF	% of group	MMBF	% of
dimension lumber	436	23.3	2,461	62.8	2,897	52.0
studs	23	1.2	511	13.5	534	9.6
boards	84	4.5	154	4.1	238	4.3
MSR	0	0	332	8.7	332	6.0
siding	68	3.6	0	0	68	1.2
timbers	45	2.4	6	0.2	51	0.9
clears	345	18.5	33	0.9	378	6.8
fingerjoined	11	0.6	15	0.7	25	0.5
special metric	827	44.3	52	1.4	879	15.8
others	30	0.6	135	8.0	164	3.0
total production	1,868	100.0	3,698	100.0	5,566	100.0

Changes for other products were minor, except MSR and Timber. The proportion of MSR almost tripled from 2.1% to 6.0 %, and Timber dropped from 1.9% to 0.9%. The increase of MSR indicated that the market demand has grown for this product, especially for trusses and as chords in I beams used in construction. The decrease in the production of Timber resulted from trends in Japan to more laminated posts and beams and less "timber sized" green support members.

As discussed before, sawmill managers in BC expected the volume of Dimension Lumber produced for the US market to decrease because of the tariff agreement. Most managers were expecting to increase shipments to Japan to compensate for these declines.

5.3.3 QUALITY CONTROL ACTIVITIES

Because the main objective of the 1991 survey concerned the QC activities in BC sawmills, more information was available for comparison of QC issues.

Since the data used in calculating EPs in the two surveys were not same, a direct comparison on EPs would not be appropriate. However, ranking represented by EPs produce some meaningful comparisons, and a modification of the EPs also provides an alternative to compare results for the two surveys.

5.3.3.1 Factors Impacted by QC Activities

For comparing EPs between two surveys, rankings in 1991 data was modified so that the EPs in both data sets were consistent.

There was little difference in terms of ranking for the important factors for QC activities between the two surveys. Value recovery and Volume recovery were ranked as the first and second most important variables in the two surveys, for all surveyed BC mills and for each of the two regions (Table 5.3.6). Ranking order for the other categories were also similar between 1991 and 1995 (Table 5.3.6)

*Table 5.3.6 - **Importance of QC Activities (EP) in 1991 and 1995***

	Coastal BC Mills Ave. EP		Interior BC Mills Ave. EP		Total Mills Ave. EP	
	1991 n=21	1995 n=13	1991 n=25	1995 n=27	1991 n=45	1995 n=40
Dimension Uniformity	1.14	0.55	0.92	1.15	1.02	0.96
Surface Finish	0	0.08	0	0.11	0	0.10
Volume Recovery	1.56	1.55	1.63	1.76	1.56	1.69
Value Recovery	2.33	2.32	2.17	1.87	2.33	2.02
Productivity	0.76	0.71	0.79	0.65	0.76	0.67
Cost Reduction	0.29	0.55	0.42	0.15	0.29	0.28
Stable Process Flow	0.04	0.23	0.08	0.28	0.04	0.26

However, there were some changes between 1991 and 1995. As EPs for Value Recovery (2.33 and 2.32) and Volume Recovery (1.56 and 1.55) remained the same in coastal BC mills after four years, the ones in interior mills changed. The EP for Value Recovery decreased (2.17 to 1.87), and the EP for Volume Recovery increased (1.63 to 1.76). These changes indicated that coastal mills had kept emphasizing Value Recovery, but interior mills had focused more on Volume Recovery.

The average EP of Dimension Uniformity for coastal BC mills had decreased from 1.14 in 1991 to 0.55 in 1995, while the one for interior mills had increased (0.92 to 1.15). Even though Dimension Uniformity was still ranked as the third important QC factor by both regional groups, the relative position switched. It was higher for coastal mills than for interior mills in 1991, but it reversed in 1995. The decline in Dimension Uniformity indicated a decreased in its importance for coastal mills. The EP for Cost Reduction increased (0.29 to 0.55) in coastal mills, but decreased (0.42 to 0.15) in interior mills. All these changes could be better explained by the increased focus and reliance on different markets (Japan and North American). This has been discussed in the preceding discussion of production and markets in this chapter.

5.3.3.2 Size Control

In BC sawmills size control use increased from 89% in 1991 to 98% in 1995 (Table 5.3.7). Among the mills that used size control programs, the proportion that installed computer software for size control increased from 79% in 1991 to 90% in 1995. SICAM and L-size were the most popular computer software systems used in BC sawmills for size control. In 1991, more mills used SICAM (52%) than L-size (39%) in the 33 mills that had computer software for size control. However, in 1995, L-size became more popular (51%) than SICAM (26%), especially in interior BC mills.

Table 5.3.7 - Size Control and Software in 1991

		Using Size control		Using Software*		Software Size Control**					
						L-Size		SICAM		Others	
		1991	1995	1991	1995	1991	1995	1991	1995	1991	1995
Coastal BC	# mills	19	12	13	10	3	0	9	7	1	3
n=22 (1991) n=13 (1995)	% of	86	92	68	83	23	0	69	70	7.7	30
Interior BC	# mills	23	27	20	25	10	18	8	2	2	0
n=25 (1991) n=27 (1995)	% of	92	100	87	93	50	72	40	8	10	0
Total	# mills	42	39	33	35	13	18	17	9	3	3
n=47 (1991) n=40 (1995)	% of	89	98	79	90	39	51	52	26	9.1	8.6

* Numbers in raw of "% of" represent the % of mills using Size Control in its regional group
** Numbers in raw of "% of" represent the % of mills using Software in its regional group

In 1991, 'Availability' was the most important reason for sawmills choosing size control software (61% of respondent mills), followed by 'Ease of Use' with 55% (Table 5.3.8). In 1995, these two factors still were the dominant reasons for BC mills to choose computer software for size control (Table 5.3.8). However, 'Ease of Use' became the most important reason, followed by 'Availability'. More interior mills chose 'Ease of Use', and more coastal mills chose 'Availability' as the most important reason.

Table 5.3.8 - Reason of Software Chosen

		Sophistication*		Ease of use		Cost		Availability		other	
		# mills	% of	# mills	% of	# mills	% of	# mills	% of	# mills	% of
Coastal BC	1991 n=13	4	31	6	46	1	7.7	9	**69**	2	15
	1995 n=10	1	10	5	50	4	40	6	**60**	4	40
Interior BC	1991 n=18	6	33	11	**61**	4	22	10	56	0	0
	1995 n=24	11	46	21	**88**	6	25	14	58	10	42
Total	1991 n=31	10	32	17	55	5	16	19	**61**	2	6.5
	1995 n=34	12	35	26	**76**	10	29	20	59	14	41

* Named Power of Program in 1996 survey

5.3.3.3 Production Technology and Facilities

Because the questions were different in the two surveys regarding processing technology, comparison is limited to data concerning optimization at the working centers.

Three types of operation controls defined in the 1991 survey were: Manual Process Control, Table Driven Process Control, and Optimization. However, the Table Driven Control was not specified as one of the operation technologies in the 1995 survey. Based on the definitions of these three control technologies in the report of 1991 survey (Maness and Cohen, 1992), and the definitions of the two types of controls (Manual and Optimization) in the 1995 questionnaire (Appendix II), comparison of production technology focused on two categories: Manual and Optimization. Table Driven Control and Optimization were combined from the raw data collected in 1991 and compared to the data collected in 1995.

Table 5.3.9 reveals the changes between the 1991 and 1995. Generally, the percentage of mills using optimization technology at each working center increased except for bucking in the overseas group, and for primary breakdown in the North American group.

As indicated in Table 5.3.9, optimized edging and trimming had dramatically increased throughout BC while optimized bucking in the North American group also increased.

Table 5.3.9 - Operations on Production Working Centers

Location		bucking		primary breakdown		edging		trimming	
		Man.	Optim.	Man.	Optim.	Man.	Optim.	Man.	Optim.
Overseas	**1991** n=16	42	58	29	71	79	21	83	17
% of mills*	**1995** n=8	50	50	22	78	44	56	63	38
	Changes %	+19	-14	-24	+10	-44	**+167**	-24	**+124**
North America	**1991** n=31	80	20	29	72	73	27	59	41
% of mills*	**1995** n=32	66	34	33	67	27	73	33	67
	Changes %	-18	**+66**	+14	-7	-63	**+170**	-44	**+63**
Total Mills	**1991** n=47	82	33	29	72	75	25	67	33
% of mills*	**1995** n=40	63	37	31	69	30	70	39	61
	Changes %	-23	+12	+7	-4	**-60**	**+180**	-42	**+85**

* % in 1995 calculated by:
% manual = # of mills using manual / (# of mills using manual + # of mills using optimization) or
% optimization = # of mills using optimization / (# of mills using manual + # of mills using optimization)

Some results of the 1991 survey no longer applied. For example, "sawmills serving overseas markets used more optimization at the bucking center than mills serving North American market" (Cohen and Maness, 1992) is no longer true. Test results showed that there was no significant difference between the two marketing groups based on optimization at the bucking stations in 1995. This change was caused by the dramatic increase of optimized bucking centers in the mills serving the North American market in 1995 (66%). Changes also occurred in the edging station. Results from 1991 survey indicated that "difference of operation technology on edging was minor based on market served". However, this difference was statistically significant for the 1995 data. This indicates that mills serving the North American market used more optimization technology at the edger than mills serving the overseas market. This is also a result of increasing optimization in edging in the North American group

Although the use of optimization increased 124% at the trimming center for the overseas group, it was not high enough to catch up to the North American group. The difference on the trimming station between the two market groups was still significantly different in terms of the application of optimization technology. There was little change in optimization at primary breakdown for the two groups from 1991 to 1995.

5.4 ADDITIONAL INFORMATION NOT INCLUDED IN DATA ANALYSIS

There were some additional information collected that was not part of the data analysis. The major reason for this omission was either that the data were not suitable for statistical analysis or that they were not relevant to the main research objectives of this study.

The questionnaire used in this study was designed as part of a nation-wide research project titled Establishing Technology Benchmarks in Canadian Sawmills for Processing Quality Control and Training Needs. However this thesis is only one part of the larger project, covering only two Western Canadian provinces, and focuses on interrelationship between marketing and processing technology in Western Canadian sawmills. Therefore, not all information in the questionnaire were analyzed for the purpose of this study.

Although some of the information collected was not included in the Data Analysis, they might be valuable for the reader of this thesis. The results from four additional questions are added in this section as followings: Frequency of machine center checked for size control, Feedback from customers about products quality, Communication between mill managers and employees, and Frequency of value table updating for optimized machine centers. There is no sub-classification applied for this extra information.

5.4.1.1 Frequency of Machine Center Checked for Size Control

Respondents were asked to indicated how often their work centers were checked for size control. There were five work centers and seven time periods listed as a cross table in the questionnaire (see Appendix II). Table 5.4.1 and 5.4.2 show that head rigs, edgers and planers were checked more frequently for size control than bucking centers and trimmers. Table 5.4.1 also indicates that mills in the overseas group checked more frequently than mills in the North American group, especially at head rigs and edgers. Table 5.4.2 shows that Alberta mills seemed check their work centers for size control more frequently than BC mills.

Table 5.4.1 - Frequency of Size Control Checking by Group of Marketing Orientations (%)

		quarterly	monthly	weekly	daily	every shift	every 4 hrs.	every 2 hrs.	< 1 hr	if prob. occur
bucking	overseas n=9	0	11	44	11	33	0	0	0	0
	NA n=38	8	13	29	18	21	3	0	0	3
head rig	overseas n=9	0	0	0	0	22	11	44	22	11
	NA n=38	0	0	13	32	34	5	13	3	0
edging	overseas n=9	0	0	0	0	33	11	33	22	11
	NA n=38	0	0	3	39	26	5	18	5	3
trimming	overseas n=9	0	11	11	11	67	0	0	0	0
	NA n=38	3	11	21	32	16	5	8	3	3
planing	overseas n=8	0	0	0	0	25	0	25	25	25*
	NA n=38	3	0	0	11	37	3	18	23	1*

* specified as other frequent category

Table 5.4.2 - Frequency of Size Control Checking by Group of Geographical Locations (%)

		quarterly	monthly	weekly	daily	every shift	every 4 hrs.	every 2 hrs.	< 1 hr	if prob. occur
bucking	coast BC n=12	17	17	33	8	25	0	0	0	0
	inter. BC n=27	0	7	37	26	26	0	0	0	4
	Alberta n=8	13	25	13	0	13	13	0	0	25
	Total n=47	6	13	32	17	23	2	0	0	6
head rig	coast BC n=12	0	0	0	8	33	8	42	8	0
	inter. BC n=27	0	0	15	33	33	4	11	4	0
	Alberta n=8	0	0	13	25	25	13	13	13	13
	Total n=47	0	0	10	25	32	6	19	6	2
edging	coast BC n=12	0	0	0	17	33	8	33	8	0
	inter. BC n=27	0	0	4	33	33	4	19	7	0
	Alberta n=8	0	0	0	50	0	13	13	13	25
	Total n=47	0	0	2	32	28	6	21	9	4
trimming	coast BC n=12	8	8	25	8	50	0	0	0	0
	inter. BC n=27	0	7	22	33	19	4	7	4	4
	Alberta n=8	0	25	0	38	13	13	13	0	0
	Total n=47	2	11	19	28	26	4	6	2	2
planing	coast BC n=12	0	0	0	8	33	0	17	17	17*
	inter. BC n=27	4	0	0	11	41	0	22	18	4*
	Alberta n=8	0	0	0	0	13	13	13	63	0
	Total n=47	2	0	0	9	34	2	19	25	4*

* specified as other frequent category

5.4.1.2 Feedback from Customers about Product Quality

In the section concerning communication about product quality respondents were asked to indicate what types of methods they used to obtained feedback from customers. There were eight categories provided (see Table 5.4.3 and 5.4.4)

Table 5.4.3 - Feedback about Product Quality by Group of Marketing Orientations (%)

	no feedback	customer tour your facilities	tour your customers facilities	surveys	sales department	look at number of claims	initiated by customers	others
overseas n=9	11	90	78	56	78	56	67	22
NA n=39	0	90	85	44	95	67	95	10
total n=48	2	90	83	46	92	65	90	13

Table 5.4.4 - Feedback about Product Quality by Group of Geographical Locations (%)

	no feedback	customer tour your facilities	tour your customers facilities	surveys	sales department	look at number of claims	initiated by customers	others
coast BC n=13	8	85	77	54	85	62	69	15
inter. BC n=27	0	89	85	44	96	67	96	11
Alberta n=8	0	100	88	38	88	63	100	13

Table 4.4.3 and 5.4.4. indicated that obtaining information from 'sales department', 'customer tour of sawmill facilities', 'suggestions initiated by customers', and 'tour customers facilities' were the most common methods of getting feedback from customers. The numbers in the tables also show that mills in the North American group communicate more frequently with their customers compared to mills in the overseas group regarding product quality. The closer geographic location and the common language for North American suppliers and their customers resulted in communication and visits being easier for mills in this group.

5.4.1.3 Communication Between Mill Managers and Employees

Information concerning how communication conducted about product quality among employees in the sawmills was also collected. Table 5.4.5 and 5.4.6 indicate that 'informal discussion with supervisors' and 'informal discussion with QC staffs' were the most common communication methods in production. These were followed by 'regular meeting with supervisors' and 'regular meeting with QC staffs'. It seems that supervisors and QC staffs played important roles in ensuring product quality in sawmills. There was little difference between mills based on market focus or on geographical location.

Table 5.4.5 - Communication with Employees by group of Marketing Orientations (%)

	newsletter updates	informal discussion with supervisors	regular meeting with supervisors	informal discussion with QC staffs	regular meeting with QC staffs	chalkboard/ bulletin board	others
overseas n=9	44	78	67	89	44	44	44
NA n=39	51	77	69	69	51	41	23
total n=48	50	77	69	73	50	42	27

Table 5.4.6 - Communication with Employees by group of Geographical Locations (%)

	newsletter updates	informal discussion with supervisors	regular meeting with supervisors	informal discussion with QC staffs	regular meeting with QC staffs	chalkboard/ bulletin board	others
coast BC n=13	69	85	85	92	46	38	46
inter. BC n=27	48	70	63	67	56	41	22
Alberta n=8	25	88	63	63	38	50	13

5.4.1.4 Frequency of Value Table Updated for Optimized Machine Centers

The frequency of value table updates could be used to measure how well the mills utilizing their optimization system. Information about how often the value tables were updated at optimized machine centers was also collected. Table 5.4.7 and 5.4.8 show the results of responses.

Table 5.4.7 - Frequency of Value Table Updated Group by Marketing Orientations (%)

		quarterly	monthly	weekly	daily	< every shift	if prob. occur	market demand	product change
bucking	**overseas n=6**	**0**	**0**	**83**	**33**	**0**	**0**	**17**	**0**
	NA n=21	**33**	**19**	**29**	**0**	**0**	**10**	**5**	**5**
primary breakdown	**overseas n=5**	**0**	**0**	**80**	**40**	**0**	**0**	**20**	**0**
	NA n=31	**29**	**19**	**32**	**0**	**0**	**10**	**6**	**3**
edging	**overseas n=6**	**0**	**0**	**67**	**33**	**17**	**0**	**17**	**0**
	NA n=32	**28**	**22**	**28**	**0**	**0**	**16**	**6**	**3**
trimming	**overseas n=5**	**0**	**0**	**60**	**20**	**0**	**20**	**20**	**0**
	NA n=28	**29**	**21**	**29**	**0**	**0**	**14**	**7**	**4**
drying	**overseas n=3**	**0**	**0**	**33**	**33**	**0**	**0**	**33**	**33**
	NA n=22	**23**	**5**	**18**	**0**	**5**	**36**	**5**	**9**

Table 5.4.8 - Frequency of Value Table Updated Group by Geographical Locations (%)

		quarterly	monthly	weekly	daily	< every shift	if prob. occur	market demand	product change
bucking	coastal BC n=5	0	0	80	40	0	0	0	0
	interior BC n=16	38	19	25	0	0	13	0	7
	Alberta n=6	17	17	50	0	0	0	33	0
primary breakdown	coastal BC n=5	20	0	60	40	0	0	0	0
	interior BC n=23	26	22	35	0	0	9	4	4
	Alberta n=8	25	17	39	6	0	8	8	3
edging	coastal BC n=5	17	0	50	33	17	0	0	0
	interior BC n=16	28	24	28	0	0	16	4	4
	Alberta n=6	24	18	34	6	14	29	0	14
trimming	coastal BC n=4	0	0	50	25	0	25	0	0
	interior BC n=27	32	23	27	0	0	14	5	5
	Alberta n=7	14	14	43	0	14	29	0	14
drying	coastal BC n=2	0	0	0	50	0	0	0	50
	interior BC n=16	25	6	19	0	6	25	6	13
	Alberta n=7	14	0	29	0	0	57	14	0

Because of the high non-response rate (>30% of surveyed mills) on this question, non-response error could be substantial. Therefore, it was not included in the main body of the Data Analysis.

5.5 HYPOTHESIS TESTS

Based on the objectives of this study, that is to understand the technology-market mutual functional relationship in BC sawmills, hypothesis have been tested by several appropriate statistical methods. The hypothesis tested include:

H1: There is no difference in market focus for mills in different locations,

H2: There is no difference in manufacturing technology for mills serving different markets, H3: There is no difference in the level of quality control for mills serving different markets, and

H4: There is no difference in products for mills serving different markets.

Three different statistical techniques were applied according to the different data types. Student T tests were used to test interval data, the chi-square test was applied to test nominal data, and the Z test was used to test proportional data. All the data samples were assumed to be independent with equal variance, with close to a normal distribution. All data used in the tests were collected in 1995.

5.5.1 TEST OF HO 1: THERE IS NO DIFFERENCE IN MARKET FOCUS FOR MILLS IN DIFFERENT LOCATIONS

Data concerning the proportion of volume shipped to the different markets was used to test this hypothesis. There were four shipping destinations for Western Canadian sawmills: North American (US and Canada), the United States only, Overseas (all the other countries other than US and Canada), and Japan only. The reason of testing US and Japan was that they represent the majority of North American. and overseas shipments among the mills surveyed in 1995. The three mill groups tested were based on geographical location: coastal BC, interior BC, and Alberta. For each of the four markets, three T tests, with Bonferroni's tests for adjusting probability levels, were conducted between each pair of groups (coast BC versus interior BC, coast BC versus Alberta and interior BC versus Alberta) to determine if there was a difference on marketing focus based on mill location.

Tests results showed that the marketing focus for coastal BC mills was statistically different from BC interior mills and Alberta mills (Table 5.4.1). Interior mills and Alberta shipped significantly more lumber to both North American as whole and to the US in particular compared to coastal mills in 1995. Shipments from coastal mills to both overseas markets and particularly the Japanese market were significantly higher than for mills in the interior of BC and Alberta. (See Table 5.4.1 for specific probability information on significance testing)

Test results indicated that there were no significant differences between markets for Interior BC and Alberta mills for all four shipping destinations.

Results of tests rejected the hypothesis that coastal mills, interior mills and Alberta mills have the same marketing focus. Coastal BC mills focused more on overseas market, particularly Japan, while interior BC and Alberta mills focused more on North America, especially the United States.

Table 5.5.1 - Results of Tests on Marketing Focuses ($\alpha = 0.03$)

	NA	US	Overseas	Japan
Coastal BC n=13 vs. Interior BC n=26	Reject H1	Reject H1	Reject H1	Reject H1
Coastal BC n=13 vs. Alberta n=8	Reject H1	Reject H1	Reject H1	Reject H1
Interior BC n=26 vs. Alberta n=8	Accept H1	Accept H1	Accept H1	Accept H1

5.5.2 TEST OF HO 2: THERE IS NO DIFFERENCE IN THE PRODUCTS PRODUCED BY MILLS SERVING DIFFERENT MARKETS

Statistical tests for products compared the two different groups of companies serving the North American and overseas market. T tests were used to compare tree species used in each sawmill, the proportion, by volume, of each of the nine products produced in each sawmill in 1995, the proportions of kiln dried and planed lumber shipped to North American and overseas markets, and the proportions of lumber kiln dried and planed in each mill (see Table 5.4.2 for results of tests).

There was a statistically significant difference between some species used by the mills serving different marketing areas (Table 5.4.2). Mills in the overseas group used more hemlock and other species (mainly Cypress) than the mills in the North American group. Conversely, the North American group used more lodgepole pine, and spruce than the overseas group (see Table 5.4.2 for specific probability information on significance testing). There was no statistical difference on the use of Douglas-fir, true fir, cedar and larch.

Table 5.5.2 - Results of Tests on Species Distribution

	L. Pine	Balsam Fir	Spruce	D-Fir	Hemlock	Cedar	Larch	Others
overseas vs. North A.	reject H2**	accept H2	reject H2*	accept H2	reject H2**	accept H2	accept H2	reject H2**

* statistical significance at α=0.1
** statistical significance at α=0.05

The product groups which showed a significant difference were Dimension Lumber, Clears, and Special Metric Sizes (t tests with α=0.05). Mills in the North American group produced significantly more Dimension Lumber than those in the overseas group, while mills in the overseas group manufactured significantly more Special Metric Sizes and Clears than those in the North American group.

The proportion of manufacturing and shipping to different destinations for kiln dried and planed lumber were both significantly different (α=0.05) between the two marketing groups (Table

5.4.3). Z test results showed that the proportion by volume for both kiln dried and planed lumber produced by the North American groups were significantly higher than for mills in the overseas group. The same was true regarding shipping volume, that is mills in the North American group shipped more kiln dried and planed lumbers to both overseas and North American market than the mills in the overseas group.

Table 5.5.3 - Results of Tests on Kiln Dried and Planed Lumber (α=0.05)

	lumber kiln dried	lumber planed	lumber kiln dried		lumber planed	
			to NA	to overseas	to NA	to overseas
overseas vs. North America	Reject H2	Reject H2	Reject H2	Reject H2	Reject H2	Reject H2

5.5.3 TEST OF HO 3: THERE IS NO DIFFERENCE IN THE LEVEL OF QUALITY CONTROL FOR MILLS SERVING DIFFERENT MARKETS

Statistic tests for quality control activities were conducted between the two groups of mills (offshore and North American). A t test was applied to test the number of lumber grading employees, and several Z tests compared the proportion of mills using 1) size control, 2) devices used for size control, 3) computer software analyzing size data, 4) type of size control software, and 5) reasons for choosing size control software.

Results regarding size control in different marketing groups are shown in Table 5.4.4. There were no statistical difference concerning the proportion of mills using a size control program, or the proportion of mills using computer software for size data analysis.

Test results also indicate that differences in devices used for size control were not statistically significant between the two groups of mills.

Table 5.5.4 - Results of Tests on Size Control Devices (α=0.1)

	mills use size control	devices used for size control			
		electronic caliper	mechanical caliper	tape measure	others
overseas vs. North A.	Accept H3	Accept H3	Accept H3	Accept H3	Accept H3

However, there was a significant difference between the two group of mills for computer software used in size control (Z tests at α=0.05). More mills in the overseas group used SICAM, while more mills in the North American group used L-Size (Table 5.4.5). The only reason for software selection for size control which showed a significant difference (α=0.05), between groups was "Ease of Use". More mills in the North American group chose it as a reason than mills in the overseas group. No statistical differences were found for the other six reasons: Power of Program, Cost, Availability, Bundled with Equipment, and Others.

Table 5.5.5 - Results of Tests on Size Control Software

	mill used software	software program		reasons for choosing software					
		SICAM	L-size	power	easy use	cost	available	with equipmen t	others
overseas vs. North A.	Accept* H4	Reject** H4	Reject** H4	Accept* H4	Reject** H4	Accept* H4	Accept* H4	Accept* H4	Accept* H4

* statistical significance at α=0.1
** statistical significance at α=0.05

5.5.4 TEST OF HO 4: THERE IS NO DIFFERENCE IN MANUFACTURING TECHNOLOGY FOR MILLS SERVING DIFFERENT MARKETS

Four items were used for testing this hypothesis: facilities upgrades and reasons, age of equipment, operation technology used in the five working centers (manual or optimized), and number of kilns and kiln capacity.

Result of the Z tests indicate that there was no significant difference regarding the proportion of mills that had upgraded their facilities between the two market groups (Table 5.4.6). Among the seven reasons for upgrading sawmill operation, only 'to control and reduce the cost' and 'to change or add new products' showed significant differences among the two groups of mills (Chi-square tests and Z tests at α=0.05). Upgrading their operation facilities to reduce cost and change or add new products were more important to the mills focused on overseas markets than mills with a North American market orientation.

Table 5.5.6 - Results of Tests on Facility Upgrading

	mills upgraded	reasons for facility upgrading						
		change raw material	increase production	fiber recovery	improve quality	reduce cost	add new product	others
overseas vs. North A.	Accept* H4	Accept* H4	Accept* H4	Accept* H4	Accept* H4	Reject** H4	Reject** H4	Accept* H4

* statistical significance at α=0.1
** statistical significance at α=0.05

T test results showed no difference in the age of equipment used in the four primary working centers (bucking, primary breakdown, edging/resaw, and trimming). There was a significant difference (α=0.05) between groups for drying, where the average age was older in the North American group than in the overseas group (see Table 5.4.7).

Table 5.5.7 - Result of Tests on Age of Equipment on Working Centers (α=0.05)

	stem bucking	primary breakdown	edging	trimming	drying
overseas vs. North A.	Accept H4	Accept H4	Accept H4	Accept H4	Reject H4

Operation technology used in sawmills is the most important factor which reflects technology differences. A Z test was used to compare the proportion of mills that used either manual operation or optimization at the five working centers between the two marketing group. Only the trimming and drying stations showed significant differences between mills in the two groups (see

Table 5.4.8 for specific alpha information on significant testing). The proportion of mills that used optimized trimming and drying kilns in the North American group were significantly higher than the mills in the overseas group. There were no statistical differences in the other three working centers in term of the optimization utilization.

Table 5.5.8 - Result of Tests on Working Center Operation

	bucking		primary breakdown		edging		trimming		drying	
	manual	optm.	manual	optm.	manual	optm.	manual	optm.	manual	optm.
overseas vs. North A.	Reject** H4	Accept* H4	Accept* H4	Accept* H4	Accept* H4	Accept* H4	Reject** H4	Reject** H4	Accept* H4	Reject* H4

* statistical significance at α=0.1
** statistical significance at α=0.05

Surprisingly, mills with overseas markets focus that did have kilns had significantly more drying kilns per mill than mills with a North American orientation (t test at α=0.01). However, there was no significant difference in kiln capacity between the two marketing groups, either in total kiln capacity or average capacity for each mill.

Although some assumptions have made before the tests, using the test results with caution is suggested. Because of an incomplete random sampling used in this study, sampling error could be introduced which is incapable of measurement.

6. DISCUSSION

Three parts are presented in this chapter: Discussion of Study Results, Discussion of Theory Application, and Need for Future Study. In the Discussion of Study Results, the results of the data analysis are capsulized and some implications are highlighted. The Discussion of Theory Application focuses on the results of this study in terms of the theories presented in the literature review. Need for Future Study discusses what has been learned from this study and how to improve this study should it be replicated.

6.1 DISCUSSION OF STUDY RESULTS

Discussion of Study Results includes two parts: first, a discussion of the results from the 1995 data concerning markets, products, quality control activities, and production facilities based on mills with different marketing orientations, and second, a discussion comparing the results of the information collected in BC for 1991 and 1995.

6.1.1 RESULTS FROM 1995 - BC AND ALBERTA MILLS GROUPED BY MARKET SERVED

There were two distinct markets served by Western Canadian sawmills: North America (mainly the US), and the overseas market (mainly Japan). Results indicate that there was a difference in technology used in mills with different marketing orientations in terms of manufacturing facilities, quality control techniques, and products. However, not all factors examined showed significant differences.

6.1.1.1 Markets

The United States was the biggest market for Western Canadian sawmills (about 55% of total shipments), but this may change in the next three years due to the US lumber import quota. More than 80% of mills that focused on the US market expressed an expected decline in US shipments. Most of these mills were going to switch their marketing focus to Japan (81%) and/or Canada (63%). As global interest in exporting to the Japanese market increases, Canadian lumber exporters should be aware of more intensive competition in the Japanese market. Competition will be from lumber manufacturers in other countries, from other wood products, such as the engineered wood products and from wood substitutes. How to assist Western Canadian sawmills to be successful in the increasingly competitive Japanese market, or to help find alternative markets, should be of growing concern to industry organizations, government agencies, and research professionals.

The volume of kiln dried and planed lumber shipped to both overseas and North American markets from the mills with an overseas marketing focus was much lower than for mills with a North American marketing focus. This situation resulted largely from the traditional preference for large size and high density lumber or squares by the Japanese housing construction industry. However the attributes of timber from the BC coast makes them costly and difficult to dry. The low production of kiln dried and planed lumber from this group could change gradually in the near future for several reasons. First, the Japanese culture is becoming more and more westernized and some North American standards are already accepted by the Japanese construction industry. Second, coastal BC mills are increasing their drying capacities to catch up with market changes. Third, mills in the BC interior are increasing their exports of kiln dried lumber to Japan. These factors will contribute to an increase in kiln dried and planed lumbers to overseas markets from Western Canadian sawmills.

6.1.1.2 Products

Products are the bridge that connects markets and process technology. A change in market orientation will lead to a technological change through information transferred by the products. Process technology improvement will increase market competitiveness by producing higher quality products. This study showed that mills with a different marketing focus produced different products.

Dimension lumber was the most important product for Western Canadian sawmills, responsible for about 53% of total production in 1995. Mills mainly serving the North American market produced much more dimension lumber than the mills serving the overseas market with average production for each mill almost six times greater than for a mill in the overseas group. However, shipments to the US market are expected to decline in the next three years, replaced by increased exports to the Japanese market.

Metric Sizes were the second most important lumber product for Western Canadian sawmills in 1995, representing 14.4% of total production. Although much lower than the production of dimension lumber, it is expected to increase since most mills expect to increase shipments to Japan, the major market for Metric Size lumbers.

Differences were also found in the species used by mills with different marketing orientations. However, these difference were most likely not caused by market needs, but were due to geographical location, and the inherent natural species distribution. Because the majority of mills in the overseas group were from the BC coast area, the typical species of this group were the western coastal species: hemlock, Douglas-fir, and yellow cedar. Abundance of natural growth, high quality timber gave coastal BC sawmills an advantage to access overseas markets where large size hemlock and Douglas-fir lumber with tight rings and preferred color are desired by Japanese customers. In 1995, more than 50% of the production from mills in the overseas group was hemlock and 17% was Douglas-fir. Since most mills in the North American group were from the BC interior and Alberta, the species used in this group were mainly western interior species: lodgepole pine, spruce, and true fir with 37%, 29% and 12% of production, respectively.

Timber size and quality may be the reasons for more coastal BC mills focusing on overseas markets than interior BC and Alberta mills. However, mills in the interior of BC and Alberta intend to increase their shipments overseas. It will be a challenge for these mills to successfully shift their market focus given their lower quality timber supply. One solution may be the development of engineered wood products such as laminated lumber and finger joined lumber, all made from smaller size and lower quality material. The acceptance of more North American products by Japanese customers may also help these mills enter the Japanese market.

6.1.1.3 Quality Control

Similarities and differences in QC between the two groups of sawmills with different marketing orientations were observed. Both the overseas group and the North American group ranked Value Recovery as the first important factor in QC activities, Volume Recovery as the second one, and Dimension Uniformity as third. However, Value Recovery and Cost Reduction were considered more important for the overseas group with higher EPs than in the North American group, and Dimension Uniformity and Productivity were considered more important in the North American group than in the overseas group.

The higher ranking for Value Recovery and Cost Reduction by the overseas group may be the result of more expensive, larger size, first growth timber in coastal BC mills. Thus, increasing Value Recovery through various QC activities seems more important to these mills. The higher rank of Dimension Uniformity and Productivity in the North American group could be caused by the large volume of commodity dimension lumber demanded by the US construction industry. Thus, they would put more emphasis on Productivity and Dimension Uniformity by QC activities to maximize profits.

Mills in both marketing groups considered Primary Breakdown as the most important work center and Stem Bucking as the second. The North American group ranked Drying as third which was higher than it was in the overseas group who ranked Drying as fourth. The higher ranking of Drying in the North American group reflected the demand of product quality in the North American market, since drying quality is important in housing construction. The overseas group ranked Edging higher than in the North American group since lumber sizes change frequently depending on Japanese market prices. It was commonly accepted that the closer the QC activities were to the front end of the process, the more value recovery could be gained. Based on the ranks of the importance at work stations, mills that served overseas markets tended to focus more on the front end of processing to obtain higher value recovery and lower the cost, while mills with a marketing focus on North American emphasized the back end for better finishing and uniformity.

In 1995, 98% of mills surveyed used size control in their daily production and nearly 90% of them analyzed size data by computer software programs. SICAM and L-size were the two most popular software systems used in Western Canadian sawmills. Results of the data analysis indicated that mills with different marketing focuses used different size control software. Mills serving the overseas market tended to install SICAM for size control while more mills serving the North American market used L-size. Availability could be the main explanation for software selection.

More than 70% of mills in the North American group thought that Ease of Use was the most important reason for selecting size control software, compared to 38% for mills in the overseas group.

6.1.1.4 Production Facilities

The overall technology used in Western Canadian sawmills was at a higher level than ever before. More automatic equipment and optimization software have been installed in the production lines. This technological innovation may be initiated by either market requirements or raw material limits.

Survey results showed that 96% of mills had updated their production facilities in the last five years. The major reason for the upgrading was 'To increase fiber recovery', which was stated by both marketing groups. 'To reduce cost' and 'To change or add new products' were stated as the other two important reasons for the mills in the overseas group, since products required by overseas markets were diversified and customized. Mills in the overseas group may frequently update their production lines to satisfy their overseas customers.

Equipment used in the manufacturing process was older in mills with a North American marketing focus. This fact again proved that mills in the overseas group upgraded their facilities more frequently than mills in the North American group.

Approximately 91% of mills had installed optimization systems in at least at one work station on the processing line. In general, mills in the North American group had higher optimization control at each work center (73%) than the mills in the overseas group (61%).

More mills in the overseas group used optimization for stem bucking and primary breakdown, while more mills in the North American group applied optimization at edging, trimming and drying. Here again, more expensive timber supply may have pushed the mills in the overseas group to use advanced technology (here referring to Optimization) on the front end of the process to maximize fiber recovery. Meanwhile, less product variety limited the number of mills in the overseas group using optimized trimmers. More specialty products required by customers and more sophisticated criteria used in offshore markets forced mills in the overseas group to use a lower but more appropriate technology (here referring to manual operation) at the edging center.

6.1.2 Results from 1991 and 1995 - BC Mills Only

The information in the 1991 survey provides a benchmark to monitor changes to the British Columbia sawmilling industry within the past four years. Only data from BC mills is comparable, since Alberta mills were not included in the 1991 survey. The comparative analysis between the two surveys is as follows: Markets, Products, Quality Control Activities, and Production Facilities.

6.1.2.1 Markets

Comparison of the two surveys showed that the regional differences on market focus in BC sawmills has not changed since the last survey. Interior mills still focused on the US market, while coastal mills still focused on the Japanese market. However, the proportion of the production volume shipped from these two distinctive areas to their preferred markets has intensified. This increased reliance on a single market for each region could be considered specialization or over-reliance on a single market.

6.1.2.2 Products

There was no change in products based on the markets served by the two regional groups of mills in BC. Dimension lumber was still the main product for interior sawmills, although its proportion had dropped. Special Metric lumber was the most important product manufactured by coastal mills in 1995, and the proportion of production increased.

Changes in other products were minor, except that the production of MSR increased dramatically, and Timber production decreased sharply. The increase of MSR production reflected increased market demand for this product, especially for trusses and as chords in I beams used in residential construction. The decrease in export of green timber to Japan was due to the growth of more laminated posts and beams and less "timber sized" green support members.

Sawmill managers in BC expected that the volume of dimension lumber produced for the US market by BC sawmills would decrease because of the tariff agreement concerning exports to the US market. Most managers were expecting to increase shipments to Japan to compensate for these declines.

6.1.2.3 Quality Control Activities

There was little difference in terms of ranking for the important factors for QC activities between the two surveys. Value Recovery was ranked first, in terms of importance, and Volume Recovery ranked second in both surveys. Rankings for the other categories were also similar between two surveys. However, the detailed changes in EPs between the surveys by the two regional groups indicated that: 1) interior mills placed more emphasis on Volume Recovery, 2) there was a decrease in importance of Dimension Uniformity in coastal mills, but an increase in interior mills, and 3) the importance of Cost Reduction increased in coastal mills, but decreased in interior mills. Different marketing demands and raw material supply may be responsible for these changes.

Ranking orders on the importance of work stations were also the same between the two time periods. Since question formats were different in the two surveys, no comparison was made in terms of work station ratings.

BC sawmills using size control in processing increased from 89% in 1991 to 98% in 1995. The installation rate of computer software for size control has also increased from 79% to 90%. The increase of size control may reflect sawmills having more interest in 1) improving lumber recovery, 2) minimizing waste (reduce the cost), and 3) integrating operations.

The most popular computer software package used in BC sawmills for size control were SICAM and L-size, and each one had its geographical market. SICAM was more popular in coastal area and L-size was more popular in interior, as indicated by the both surveys. Availability and the Easy of Use were the two main reasons for BC sawmills choosing software in size control. Further study may be needed to understand the differences between the two software packages, and to identify the causes of this geographical preference.

6.1.2.4 Production Facilities

Generally, the percentage of mills using optimization technology in all four working centers has increased (except for Bucking in the overseas group and Primary Breakdown in the North American group). Optimized edging and trimming has increased dramatically in both marketing groups, along with bucking in the North American group. In 1995, mills serving the North American market used more optimization technology than mills serving the overseas market.

6.2 DISCUSSION OF THEORY APPLICATION

In this section, study results are used to test the theories stated in the Literature Review to see how these theories apply to the Western Canadian sawmilling industry.

6.2.1 TECHNOLOGY INNOVATION MODEL

The relationship between products and process was explained by the model of dynamic of process innovation in industry (see Hill and Utterback Technology Innovation Model in the Literature Review). Results of this study indicate that the current situation for technology and marketing in Western Canadian sawmills is located in the third period of this model.

Table 6.2.1 - Application of Technology Innovation Model in Sawmills

	Third period of model	Study results
predominate type of innovation	cumulative improvement in productivity and quality	96% of mills updated the processing equipment in last five years increasing application of size control and optimization technology
innovation stimulated by	market pressure of cost reduction and quality improvement	higher ranking for increasing fiber recovery, improving quality, increasing production and reduce cost as the reasons of facility upgrading increasing number of QC staffs and lumber graders
marketing competition emphasis on	cost reduction	higher ranking on value recovery as the important factor for quality control
production process	efficient, capital intensive, and high cost of change	increasing installation of optimization on major working centers
equipment	special-purpose, mostly automotive with labor tasks mainly monitoring and control	higher ranking on specific machine centers as the most valuable technology information

6.2.2 "ACTIVE" PROCESS TECHNOLOGY THEORY

This study found that "Active" Process Technology is not completely suitable for Western Canadian sawmilling industry. There are four reasons listed by the "Active" Process Technology Theory which show how an institution actively gains competitive advantage by improving process technology. The following table shows the study results and the theoretical reasons.

Table 6.2.2 - Application of Active Process Technology Theory in Sawmills

"Active" Process Technology theory	Study results
companies can gain advantage by increasing speed of manufacturing process, and therefor increase productivity	Yes, increasing application of software for size control that speed up the size control process and increase both productivity and products quality
investment in process technology can improve flexibility of production to enable moving from one product to another	Yes, increasing installation of optimization on major working centers to produce different lumber products precisely and quickly No, lower ranking for change/add new products as the reason for facility upgrading
process innovation could decrease time in moving from initial concept to final product by using CAD, CAM, and FMS	No, there is not much products design involved in manufacturing and no CAD, CAM and FMS in processing
Process innovation can improve ability of production process to deliver product with special quality and lower production coast	Yes, higher ranking of cost reduction as the reason for facility upgrading and increasing application of computer software for size control and optimization on working center No, lower optimized Edging and Trimmer in overseas group because current technology on scanner and optimization can hardly deal with special requirement of overseas market, such as color and grain direction

The study results cannot support the "Active" Process Technology theory due to the special characteristic of the sawmilling industry and its products (see section 3.3 for details).

6.2.3 Integrated Technology Innovation

Five aspects were discussed in integrated technology innovation: technology of communication and information system, quality control, value added products, research and development, and environment and resources. All of these factors have been confirmed as the key elements in lumber manufacturing technology innovation.

Communication played an important role in sawmills both internally and externally. Communication was ranked as the third most important training program by the surveyed mills (proceeded by lumber grading and QC). More than 70% of the responding mills indicated that their line employees had regular meetings with supervisors and informal communication with QC staff[1]. Sawmills also closely communicated with their customers by inviting customers touring their facilities and by getting feedback from customers, as well as obtaining information from their sales departments[2] .

Since QC is one of the major parts of this study, there was much supporting information on the importance of QC in sawmills technology innovation. Lumber grading and QC were ranked as the two most important training programs, and mills spent considerable amounts of money on both in-house and outside training in QC[3]. More than 50% of responding mills indicated that their QC staff level would increase in the next three years and the remainder indicated that they would stay at the same level[4]

Value added products increased in proportion of the total products produced. More than 90% of lumber manufactured was planed and approximately three quarters was kiln dried. However, fingerjointed lumber was unexpectedly less than 1% of the total production.

There was no question asked regarding research and development in sawmills in this survey. Further study is needed as this topic becomes an interest.

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[1] this information was in the questionnaire, but not included in the data analysis

[2] this information was in the questionnaire, but not included in the data analysis

[3] this information was in the questionnaire, but not included in the data analysis

[4] this information was in the questionnaire, but not included in the data analysis

6.2.4 MARKET PULL AND TECHNOLOGY PUSH

Both market pull and technology push occurred in the sawmilling sector. Different marketing requirements for products distinguished the technology used in the two groups of mills having either an overseas markets focus or a North American market orientation.

Results of this study showed that, because of varying market demands, differences occurred in the production of some products such as more Dimension Lumber produced in the North American group, and more Special Metric Sizes in the overseas group, and more planed and kiln dried lumber in the North American group (Marketing Pull - competitive led innovation, see details in Literature Review). Operation technology was also different in the two groups because of the distinct marketing focuses. Mills in the North American group used more optimized trimmers and kilns than mills in the overseas group and drying kilns were older in the North American group. More mills in the overseas group rated 'reduce cost' and 'add new products' higher than the North American group because of the more expensive raw material supply (Technology Push - demand led innovation, see details in Literature Review). More new products were manufactured by the overseas group.

6.3 NEED FOR FUTURE STUDY

Two kinds of experience have been gained during the process of this research. The first concerns the research methods that include sample selection, questionnaire design, interview technique, and statistical tests. The second one is about the additional information needed either to improve the current study or extend it for further research.

Personal interview is an appropriated interview technique in industrial marketing research, because of its capability of achieving higher responses and of dealing with complex technical questions. However, it is difficult to apply the complete random sampling in sample selection, and therefore restricts the statistical tests in data analysis. To improve sampling method of this study, a combination of stratified sampling and cluster sampling is suggested to randomize the samples without a cost increase. The details of the suggested sampling method are: 1) stratify the samples into large geographical regions (e.g. BC coast, BC interior, and Alberta), 2) within each stratum, sub-stratify the samples into geographical clusters and then randomly select sample clusters, 3) interview all samples in each cluster. Cluster sampling is regarded as less costly than simple or stratified random sampling (Mendenhall *et al.*, 1971).

In questionnaire design, collecting the appropriate type of data for later statistical tests must be carefully considered. Ordinal data could prohibit application of many useful statistical tests. Therefore, designing questions with interval or nominal answering data is recommended.

Several subjects should be added to the survey if this study is replicated. Raw material supply is a very important factor that initiates technological innovation in sawmills. From the stand point of Technology Push, it could have considerable influence on the mills' marketing strategy (see Market Pull and Technology Push in Literature Review). The British Columbia wood product industry has been facing a decline of raw material supply both in quantity and quality, and the technological innovations initiated by limited natural resources have been found in this study.

Therefore, a comprehensive study on how raw materials supply causes technology innovation and how technology affects marketing strategy in the sawmills is needed.

Results of this study indicate that Western Canadian sawmills are targeting Japan as their future market. More than 70% of sawmills expected to increase their sales to Japan in the next three years. How large can the Japanese market be? How much market share can Western Canadian sawmills capture? What kinds of products do Japanese prefer and what technology should be adopted to produce the right products for the Japanese market? The industry needs the answers to these questions and more studies are needed to assist Western Canadian sawmills industry to understand and develop the Japanese market.

Question about R&D in sawmills was not studied in this research. It is commonly thought that R & D in sawmills is not as active as in other sectors in the wood products industry such as, panel production and secondary manufacturing due to the market maturity and standardized products of lumber. Is this still true? Could market changes, limited raw material supply, and global competition of other products initiate and promote R & D in sawmills? Future study is needed.

7. SUMMARY AND CONCLUSION

7.1 SUMMARY

This study examined the current situation on marketing orientation, products, QC activities, and process facilities in 48 Western Canadian sawmills with annual production over 50 MMBF. The study was conducted by interviewing sawmills mangers and QC staff to complete 43 pre-designed questions. The objective of the study was to find the relationship between marketing and technology in sawmills, and assist in providing direction to the sawmill for healthy development.

Results of the study show two distinct markets served by Western Canadian sawmills: the United States and Japan. More than 81% of surveyed mills (mainly from interior BC and Alberta) shipped more than 50% of production to the US market in 1995, which represents 79% of all respondents' production. The remaining 20% of mills (mainly from coastal BC) shipped more than 50% of their production to Japan, which was the destination for 21% of total respondents' production. Mills mainly focused on US market were titled as the North American group, while mills mainly focused on Japanese market were classified as the overseas group.

Regional differences in market focus in the BC sawmills has not changed since the 1991 survey. Interior mills still focused on the US market while coastal mills still focused on the Japanese market. However, the proportion of the production volume shipped from these two distinctive areas to their preferred markets has increased. This increased reliance on a single market for each region could be considered specialization and may represent an over reliance on a single market.

Although, US shipments were responsible for 58% of total production of surveyed mills in 1995, they were expected to decline because of the US lumber import quota for Canadian provinces. Meanwhile Japan shipments were expected to increase since more than 73% of respondents expected to increase sales to Japan in the next three years.

Products manufactured in Western Canadian sawmills were mainly Dimension Lumber and Special Metric Size. More than 96% of total production of Dimension Lumber came from the North American group, and Dimension Lumber was responsible for 64% of this group's total production. Approximate 89% of the total production of Special Metric Size's came from the overseas group, and Special Metric Size's were responsible for 63% of this group's total production. It is clear that Special Metric Size is a preferred product for overseas markets, particularly in Japan, while Dimension Lumber, as a traditional construction product, dominates the North American market.

Major products produced by different marketing groups have not changed very much since the 1991 survey. Dimension Lumber was still the main product for interior sawmills, although its proportion dropped about 15% from 1991 to 1995. Special Metric Lumber was the most important product manufactured by coastal mills in 1995, and its proportion of production has increased.

Study results also showed that the North American group produced more kiln dried and planed products than the overseas group in 1995, and there was more kiln dried and planed lumber shipped to North American market than to overseas market. This has resulted from North American customers' preference for finished products, and also, the large size of products in overseas group caused drying and planing to be more difficult and more expensive.

There has been much interest in QC activities in the sawmills industry. Both marketing groups ranked Value Recovery as the first important factor for QC, Volume Recovery as the second, and Dimension Uniformity as third. However, results indicated that Value Recovery was ranked higher by the overseas group than by the North American group, while Dimension Uniformity was ranked higher by the North American group than by the overseas group. Comparison between the 1991 and 1995 surveys indicated that the coastal BC mills had increased the ranking for Cost Reduction while interior BC mills had increased the rankings for Volume Recovery and Dimension Uniformity. More expensive raw material supply for coastal BC mills may have required mills in the overseas group (the majority were from the BC coast) to focus more on Value Recovery and Cost Reduction to offset the higher cost of logs, and the demand for large volumes of dimension lumber in the North American market may have caused mills in the North American group (mainly composed of BC interior and Alberta mills) to focus more on Volume Recovery and Dimension Uniformity.

Computerized size control has been applied in the Western Canadian sawmills with 73% of survey mills installed computer software to control size data. SICAM and L-size were the most popular software used by sawmills. Study results show that more mills in the overseas group used SICAM, while more mills in the North American group used L-size. 'Easy of Use' is the main reason to choose software in the North American group, while 'Power of Program' was regarded as the main reason in the overseas group.

The overall process technology in Western Canadian Sawmills is at a higher level than ever before. The majority of mills upgraded their facilities in the last five years. Both marketing groups indicated that 'to increase fiber recovery' and 'to improve quality' were the major reasons for their facilities' upgrading. The overseas group also considered 'to reduce the cost' as an important reason to upgrade their production lines, while the North American group considered 'to increase production' as a major reason. This difference was consistent with different products, QC factors, and important work centers for QC, between the two marketing groups.

Machinery used by the overseas group were newer than those used by the North American group. This may be because products change more frequently in the overseas markets than in the North American market. Utilization of optimization on production lines was higher in the North American group than in the overseas group. Optimization systems can help the mills to increase productivity and volume recovery, the key needs of the North American group. The lower rate of optimization in the overseas group may have resulted from special quality requirements of products in overseas market, in terms of appearance characteristics such color and grain direction that current scanners and optimization system are not yet capable of optimizing.

Utilization of optimization in BC sawmills has increased since the 1991 survey. This increase means that some conclusions from the 1991 survey no longer apply. For example, "sawmills serving overseas markets used more optimization at the bucking center than mills serving North American market" is no longer true. Results of this study showed that there was no significant difference between the two marketing groups based on optimization at the bucking stations in 1995. This change was caused by the dramatic increase of optimized bucking centers in the mills serving the North American market in 1995. Changes also occurred in the edging station. Results from 1991 survey indicated that "difference of operation technology on edging was minor based on market served". However, this difference was statistically significant for the 1995 data. This indicates that mills serving the North American market used more optimization technology at the edger than mills serving the overseas market. This is also a result of increasing optimization in edging in the North American group.

7.2 CONCLUSION

This empirical research gives a relatively complete picture about the current situation of the Western Canadian sawmilling industry. Results of this study will help the sawmilling industry, government agencies, research and education professionals to identify the opportunities for using appropriate technology, marketing strategies, and quality control techniques to maximize the quality and value of products from limited timber resources.

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9. APPENDIX I

SCIENTIFIC AND COMMON NAMES USED IN THE STUDY

Common Name	**Scientific Name**
lodgepole Pine	*Pinus contorta*
true fir (alpine / amabilis / balsam)	*Abies lasiocarpa / Abies amabilis / Abies balsamea*
spruce (engelmann spruce / sitka spruce)	*Picea engelmannii / Picea sitchensis*
Douglas-fir	*Pseudotsuga menziesii*
hemlock (western hemlock)	*Tsuga heterophylla*
cedar (western red cedar)	*Thuja plicata*
larch (western larch)	*Larix occidentalis*
cypress (yellow cedar)	*Chamaecyparis nootkatensis*

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10. APPENDIX II

QUESTIONNAIRE OF SURVEY - 1995

1 Please complete the following identifying information.

Name: ______________________ Job Title: ______________________

Company: ____

Address (optional): ______________________________________

Sawmill Location: Coastal BC ____________ Interior BC ____________ Alberta ____________

Total Production (MMBF): ______________ Total Employees: ______________

Species (%): Lodgepole Pine: _______ Fir: _______ Spruce: _______ D-fir: _______ Hemlock: _______

Cedar: _______ Larch: _______ Others (specify): ________, ________, ________

PLEASE ANSWER ALL QUESTIONS FOR 1995.

The following questions concern the use of **quality control** in sawmills.

2 The following 7 factors can each be modified by quality control (QC) activities. Please rank **three** factors that you consider to be most important to your operation. (Rank from 1 to 3 , with 1 being the most important factor)

_______ dimensional uniformity
_______ surface finish
_______ volume recovery
_______ value recovery
_______ productivity (i.e. piece counts, etc.)
_______ cost reduction
_______ stable process flow

3 Based on the objectives stated in Question 2, which are the **three** most important work centres? (Rank from 1 to 3, with 1 being the most important work center)

_______ stem bucking/slashing
_______ primary breakdown
_______ edging/resawing
_______ lumber trimming
_______ planing
_______ kiln drying

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4 How many employees (full time equivalents, FTE) spend more than 50% of their time **grading** lumber in your sawmill.

salaried: _______ FTE

hourly: _______ FTE

5 Indicate if your mill uses the following:

☐ Planer ☐ Chipper ☐ Dry Kiln

What proportion of your lumber production is planed and what proportion is kiln dried?

_______ % planed _______ % kiln dried

6 Please indicate the number of employees who spend some time in **quality control** activities in your sawmill.

	number of employees	
time spent on QC activities	**salaried**	**hourly**
> 25%		
26-50%		
51-75%		
< 76%		

7 Please categorise your QC employees by their highest level of educational and work experience. (Fill in the appropriate number of employees in each box)

work experience (years)

education	≦ 1	2-5	6-10	11 +
partial high school				
high school grad.				
technical diploma				
university degree				
unknown				

8 How much did you spend on outside training in QC (**excluding grading**) for your employees in 1995?

- ❑ Less than $1,000
- ❑ $1,001 to $5,000
- ❑ $5,001 to $10,000
- ❑ More than $10,000

9 How do you expect your staffing levels in QC to change from 1996 to 1998

❑ Increase ❑ Decrease ❑ Stay the same

10 What are the most important training programs for you operation? (Rank from 1 to 3, with 1 being the most important training program)

___ machine maintenance
___ machine operation
___ machine calibration
___ lumber grading
___ quality control
___ size control
___ computer programming
___ computer skills in machine operation
___ communication
___ cross-training
___ other, (please specify): ______________________________

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The following questions concern the **use of size control** in sawmills.

11 Does your mill use a size control program? ☐ Yes ☐ No

If "NO" please go to Question 16

12 Which measuring devices do you use for size control? (Check all that apply)

____ electronic calipers
____ mechanical calipers
____ tape measure
____ other, (please specify): ______________________

13 Do you use software to analyze size data ☐ Yes ☐ No
If YES, please indicate which software you use: ______________________

14 Please indicate the why you use the software indicated in Question 13. (Check all that apply)

☐ power of program
☐ ease of use
☐ cost
☐ availability
☐ bundled with equipment
☐ other, (please specify): ______________________

15 Please indicate how frequently the following machine centres are checked **for size control:** (Leave blank if not applicable)

machine centre	**frequency**						
	quarterly	monthly;	weekly;	daily;	every shift	only if problem occurs	never
bucking							
head rig							
edger							
trimming							
planing							

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The following questions concern kiln drying at your mill site. **If you have no kiln please go to Question 19**

16 What is your kiln capacity? ________ MMBF

How many kilns do you operate? ________ Kilns

17 How often do you update drying schedules.

- ❑ each quarter
- ❑ each month
- ❑ each week
- ❑ every load
- ❑ whenever a problem occurs
- ❑ other, (please specify): ______________________________

18 When drying, do you ... (Check all that apply)

- ❑ pre-sort by moisture content
- ❑ pre-sort by species
- ❑ obtain MC distribution **before** drying
  by what method?
  - ❑ in-line moisture sensor
  - ❑ manual moisture meter
- ❑ obtain MC distribution **after** drying
  by what method?
  - ❑ in-line moisture sensor
  - ❑ manual moisture meter

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The following questions concern communication about **product quality** within your mill site.

19 For the machine centres in Question 15, please indicate who performs the machine checks and who receives this information.
(Leave blank if no checks occur)

information?
1 = operator
2 = millwright/electrician
3 = manager/superintendent
4 = QC personnel
5 = sawfilers
6 = other ______________
____

machine centre	who performs checks?	who receive
debarking		
bucking		
head rig		
edger		
trimming		
drying		
planing		

20 What types of QC information are presented to mill employees? (Check all that apply)

	salaried	hourly
productivity information	☐	☐
recovery information: grade recovery	☐	☐
volume recovery	☐	☐
control charts	☐	☐
sales information	☐	☐
profit information	☐	☐
other, (please specify): ______________	☐	☐

21 How often are problems with product quality discussed among foreman or supervisors? (Check one)

☐ each quarter
☐ each month
☐ each week
☐ every day
☐ whenever a problem occurs

22 How do you obtain feedback from customers about product quality? (Check all that apply)

- ❑ no feedback obtained
- ❑ customer tours of your facilities
- ❑ tours of your customer's facilities
- ❑ surveys
- ❑ sales department
- ❑ look at number of claims
- ❑ when initiated by customer
- ❑ other, (please specify): ____________________

23 How is this information communicated to line employees? (Check all that apply)

- ❑ newsletter updates
- ❑ informal communication with supervisors
- ❑ regular meetings with supervisors
- ❑ informal discussions with QC staff
- ❑ regular meetings with QC staff
- ❑ chalkboard/bulletin board
- ❑ other, (please specify): ____________________

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The following questions concern your **mill's products and markets** in 1995.

24 **a)** Estimate the proportion of VOLUME shipped to the following in 1995. (Total should add up to 100%).

b) Please indicate whether you think the following markets will grow (note with a "**+**"), decline (note with a "**-**"), or remain the same (note with a "**0**") in the next 3 years.

	a) % of volume shipped	**b) market change**
Canada	________	________
USA	________	________
Europe	________	________
Japan	________	________
Other Asia	________	________
Middle East	________	________
Other ______________	________	________
	100%	

25 a) What proportions of your North American and Overseas lumber shipments are kiln dried?

North America ________ % Overseas ________ %

b) What proportions of your North American and Overseas lumber shipments are planed / surfaced?

North America ________ % Overseas ________ %

26 For each of the products listed below please indicate the proportion of VOLUME that your facility produced in 1995.

________ dimension lumber
________ studs
________ boards
________ MSR
________ siding
________ timbers
________ clears
________ specialty metric sizes
________ fingerjoint lumber
________ other, (please specify) ______________
100%

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27 For each of the following distribution channels, please indicate the proportion of volume that your facility shipped in 1995.

_______ office wholesaler (takes no ownership)
_______ agent/distributor (takes ownership)
_______ direct to industrial users or retailers
_______ other, (please specify) ____________________
100%

The following questions concern information about your **processing facilities**.

28 Has your operation upgraded its production line in last five years? ☐ Yes ☐ No

If YES, what are the reasons for upgrading? (Check all that apply)

- ☐ changing raw material
- ☐ to increase production
- ☐ to increase fibre recovery
- ☐ to improve quality
- ☐ to control/reduce cost
- ☐ to change/add new products
- ☐ other, (please specify) ______________________________

29 Please indicate the type and age of equipment used in the following manufacturing centres. (If there is more than one machine in the centre, give the range of the machine ages).

STEM BUCKING	<u>age of equipment</u>
☐ cutoff saw system	_____________
☐ multiple saw system	_____________
☐ manual bucking in woods	_____________
☐ other _______________	_____________

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PRIMARY BREAKDOWN **age of equipment**

- ❑ circular head rig ____________
- ❑ chipping canter ____________
- ❑ chip n saw ____________
- ❑ single band head rig ____________
- ❑ multi band reducing head rig ____________
- ❑ scrag saw ____________
- ❑ other ____________ ____________

EDGING

- ❑ horizontal arbour gang edger ____________
- ❑ vertical arbour gang edger ____________
- ❑ single band resaw ____________
- ❑ multiple band resaw ____________
- ❑ board edger (not optimized) ____________
- ❑ optimized board edger ____________
- ❑ other ____________ ____________

TRIMMING

- ❑ multisaw trimmer ____________
- ❑ other ____________ ____________

DRYING

- ❑ no drying; green only
- ❑ air drying
- ❑ dehumidifier kiln drying ____________
- ❑ conventional kiln drying ____________
- ❑ other ____________ ____________

30 Indicate how each of the following machine centres operate.

M = manually (no electronics)
O = using optimization (computer simulation chooses optimal cutting/drying pattern)

	M	O	don't know
bucking	❑	❑	❑
primary breakdown	❑	❑	❑
edging	❑	❑	❑
trimming	❑	❑	❑
drying	❑	❑	❑

31 Indicate how frequently machines are calibrated and recovery studies are performed.

1 = quarterly;
2 = monthly;
3 = weekly;
4 = daily;
5 = every shift;
6 = only if problem occurs

	machine calibration	**recovery studies**
bucking	_______	_______
primary breakdown	_______	_______
edging	_______	_______
trimming	_______	_______
drying	_______	_______

32 How often are value tables updated in machine centres that use optimization? (Leave blank if optimization is not used in machine centre)

		frequency
1 = quarterly		
2 = monthly	bucking	_______
3 = weekly	primary breakdown	_______
4 = daily	edging	_______
5 = every shift	trimming	_______
6 = only if problem occurs	drying	_______

33 How many engineers are employed at your mill? _______ engineers

34 Compared to other sawmills in this region, how do you rate your facilities in term of technology? (1 - you are using the least advanced technology of sawmills in your region; 10 - you are using the most advanced technology of sawmills in your region)

1 2 3 4 5 6 7 8 9 10

35 What types of technological information would be most valuable to you? (Rank from 1 to 3, with 1 being the most important information)

general technology trends _____
benchmarking for primary processing _____
benchmarking for secondary processing _____
logistics and material handling _____
information on specific machine centres _____

The following questions concern information for a joint European Study.

36 Please indicate the type of electronic databases you use in market planning, product planning or customer services.

Database for:	Do you have database? (Y=yes)	Used for market planning	Used for product planning	Used for customer service	Describe contents
products	___	___	___	___	______________ ______________
customers	___	___	___	___	______________ ______________
competitors	___	___	___	___	______________ ______________
operations efficiency	___	___	___	___	______________ ______________

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37 Please answer the following items about your firm's electronic data information systems (EDI).

Do you have an information strategy system? ___ YES ___ NO

Is it in written form? ___ YES ___ NO

Which year was the strategy first created? __________

How often is it revised? ____________________

Is it planned jointly with your marketing strategy? ___ YES ___ NO

Who attends information strategy planning meetings? ______________________________

38 Indicate what the relative importance of your electronic information systems (in terms of a percentage out of 100%) for each of the following objectives:

_______% improving production efficiency

_______% improving customer service based on product and/or customer data bases

_______% customising specific products for specific customers

_______% other ______________________________

100%

39 Please indicate how the each of the following strategies can best be described for your mill (each total should equal 100%):

Product Strategy

competitive commodity products _______ %

specialty products _______ %

custom made products _______ %

100%

Customer Strategy

as many customers as possible _______ %

few well-defined end use segments _______ %

known end use customers _______ %

100%

Market Area

as many countries/regions as possible _______ %

few well defined countries/regions _______ %

100%

THANK YOU FOR YOUR CO-OPERATION!!!

Please indicate if you would like a summary of the results Yes _____ No _____