Industrial Development Subsidiary Agreement

THE MARKET POTENTIAL FOR MECHANICALLY STRESS RATED LUMBER

FEBRUARY 1982

Research Report

Province of British Columbia
Ministry of Industry and Small Business Development

Government of Canada
Gouvernement du Canada

Regional Economic Expansion
Expansion Économique Régionale

THE MARKET POTENTIAL FOR MECHANICALLY STRESS RATED LUMBER

FEBRUARY 1982

Prepared for:

FORINTEK CANADA CORPORATION

Prepared by:

WOODBRIDGE, REED AND ASSOCIATES LTD.

Canadian Cataloguing in Publication Data

Main entry under title:
The Market potential for mechanically stress rated lumber

On cover: Industrial Development Subsidiary Agreement research report.
ISBN 0-7719-8922-9

1. Lumber trade - British Columbia. 2. Lumber - Grading. I. Forintek Canada Corp. II. Woodbridge, Reed and Associates. III. British Columbia. Ministry of Industry and Small Business Development. IV. Canada. Regional Economic Expansion. V. Industrial Development Subsidiary Agreement (Canada)

HD9764.C33B75 382'.45674 C82-092129-7

ACKNOWLEDGEMENT

This study was funded by a grant from the Research Program of the Canada-British Columbia Industrial Development Subsidiary Agreement. The Agreement, which provides a variety of programs for industrial development, is cost shared equally by the Governments of Canada and British Columbia through the Department of Regional Economic Expansion and the Ministry of Industry and Small Business Development respectively. Programs under the Agreement are administered by the Ministry of Industry and Small Business development and managed by a joint Federal/Provincial Committee.

The responsibility for the content of this report is the consultant's alone, and the conclusions reached herein do not necessarily reflect the opinions of those who assisted during the course of this investigation or the Federal and Provincial Governments which funded the study.

INDEX

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

The forest industry is seeking ways to improve its timber utilisation "in the mill" and to obtain a better value for the products manufactured. A number of companies perceived, some years ago, that by grading lumber mechanically, these two goals could be met and they therefore installed the necessary equipment. Other companies in British Columbia are considering a similar investment, but have been uncertain about the market outlook for lumber that has been mechanically graded. It was decided that there was a need for an independent and objective study of the market potential and also the economic viability of the required investment.

Forintek Canada Corporation sponsored the study which was funded jointly by the Federal Department of Regional Economic Expansion and the British Columbia Ministry of Industry and Small Business Development. The work was undertaken by Woodbridge, Reed and Associates. The assistance of Phillips Barratt Kaiser Engineering Ltd. was provided for the technical input on machinery, capital and operating costs. Both companies are based in Vancouver, B. C.

The emphasis of the study was on the United States and Canada, but a field trip was also made to the United Kingdom to establish the potential that may exist overseas. It was overseas, particularly in the U.K. and Australia, that the concept of mechanically graded lumber -- known as Machine Stress Rated (MSR) lumber in Canada and the U.S. -- first found favour to any significant extent. Original development of the concept began in the U.S. and overseas at about the same time, in the early 1960's, but it was not until 1977 that a significant number of machines existed in the U.S.

Stress grading lumber by a visual assessment of defects has long been the accepted practice. The strength characteristics of lumber of any particular grade and species have been assessed and design values for a number of different physical properties have been assigned to each grade of each common species or species group. Unfortunately, as lumber is a natural product, it tends to be exceedingly variable; thus, two pieces of lumber of the same species and grade may have very different strength values.

Many of the structural uses of lumber are regulated by engineering codes. These codes must allocate design strength values for each grade and species and, due to the wide variability of visually graded lumber, the values allocated are low compared to the average strength that is evident. In some applications, therefore, lumber can be at a serious competitive disadvantage relative to other building materials such as steel and concrete.

One way to overcome this disadvantage is by grading or sorting lumber to significantly reduce variability in strength and stiffness. This can be done by testing the actual physical properties of each piece of lumber non-destructively. Machines were developed that can achieve this without damaging the lumber. In the U.S. and Canada, the most popular of these is the Continuous Lumber Tester (CLT). This machine can test the lumber very rapidly by deflecting it upwards and downwards by a fixed amount and determining the force required to achieve this. This force can be used to determine the modulus of elasticity (E) for each piece of lumber. Since E is related to strength, lumber can thus be sorted into E and strength categories.

The producer gains because he can recover from a given visual grade a number of specific and higher strength MSR grades. The user gains since much greater confidence can be placed in the product purchased.

MSR grades of lumber are now recognised in all major building codes in the U.S. and Canada. However, these codes do not allow any appreciable design advantage to MSR grades over visual grades (with one relatively insignificant exception). It is believed that more effort is required, at a technical level, in order to ensure that the advantages of MSR lumber grades are recognised in codes.

Up to five years ago, the production of MSR lumber was limited to a few mills in Oregon and Washington. Since then, there has been a dramatic growth every year. This has occurred in B.C., in the Pacific Northwest and in the Southern U.S. By early 1982 there are expected to be 29 mills with MSR facilities capable of producing in the region of 500 million board feet of MSR lumber per year.

Potentially, MSR lumber can be sold to any consumer who is using lumber structurally. However, the principal potential lies in roof and floor systems. The industrial sectors of prime interest, therefore, are the truss and joist fabricators, the laminating industry, and the manufactured housing and mobile home industry. Detailed examination of each of these industries indicates that the total volume of lumber consumed would be in the region of 4.2 billion board feet, or close to ten per cent of total softwood lumber consumption in the U.S. and Canada. These volumes are based on an assumed average year with 1.6 million (1) housing starts in the U.S. and 200,000 in Canada. Close to seventy per cent, or 3.2 billion board feet, of this volume would be consumed by the truss and joist fabrication industries.

(1) conventional housing starts: excludes mobile homes

The purchase criteria among individual truss and joist fabricators vary widely from area to area and company to company. There are, however, three basic factors that influence their decisions, namely:

- secure supply sources

  In early years, MSR lumber was only produced by a few companies and fabricators were reluctant to commit to truss designs for which the lumber supply might become disrupted. This concern is no longer evident since there are now many alternative suppliers of MSR lumber.

- lumber acceptability

  Previously, MSR lumber was not widely known nor was it accepted by some codes and local building authorities. It is now well accepted by all codes, most authorities and most truss designers.

- economy

  Once the two previous criteria are satisfied, the remaining and very significant, factor is economy. This is a function of a number of sometimes interdependent aspects. The principal one, of course, would be price, but the others can have a significant effect. Thus, more expensive lumber can prove, in the final analysis, cheaper once factors such as allowable spans, waste, inventory, product liability, appearance, lengths and so on are taken into consideration. When all these factors are analysed individually, it can be seen that MSR lumber has advantages, or is at least equal, in each.

Analysis of these purchase criteria and discussions with MSR producers indicate that, even though many advantages exist for MSR lumber, price is very critical. Consequently, it cannot be assumed -- at least in the West -- that any significant premium for MSR lumber can be expected on a grade-for-grade basis in the medium term.

For example, an MSR 1650f-1.5E grade does not necessarily command a significantly higher price than visually graded select structural hemfir which has an assigned stress value of 1650 psi. However, at similar prices, MSR lumber should be in a strong competitive position versus visual stress grades. Furthermore, if, by mechanically grading, the producer can obtain grades with higher stress values then, clearly, an increase in returns can be achieved.

Potential also exists for the sales of MSR lumber to the laminating and mobile home industries. It was found, however, that the requirements of these industries tend to be somewhat specialised, either in terms of grade or size. A mill wishing to develop these markets would need to develop special programmes to meet these requirements. It was felt, therefore, that the market potential for these industries should be considered as additional to the basic potential analysed by this study.

Not all of the 3.2 billion board feet consumed by the truss and joist industry can be considered to be market potential for MSR lumber. A significant volume of material is required for webs. Also, a substantial percentage of residential pitch roof trusses are of relatively short span. MSR lumber is not required for either of these applications since #2 or lower grades can satisfy the requirements. Once these factors are taken into consideration, the realistic maximum market potential for MSR lumber in the trust and joist fabrication industries is reduced to 1.5 billion board feet from the level of 3.2 billion mentioned earlier.

This level refers to the U.S. plus Canada, and is based on the current level of penetration by the truss and joist industries into the construction market. The future market potential for B.C. Producers of MSR lumber depends upon three factors:

- market expansion

  The potential expansion of industries that are prospective customers for MSR lumber.

- market location

  The consumption by industries within the competitive range of B.C. producers.

- market penetration

  The amount of the potential that can be realised by MSR lumber in competition with visual grades.

Significant expansion is expected by the truss and joist industries into floor trusses and non-residential trusses. It is believed, however, that the industry is close to saturation level in roof trusses. The market expansion estimated would increase the maximum potential market from 1.5 billion to 2.4 billion board feet.

The use of Southern pine east of a line through Minneapolis, Wichita, Albuquerque to the Mexican border is predominant. It is a species ideally suited for truss fabrication, provided that it is well manufactured. Therefore, it is estimated that the consumption of the market area realistically available to Western producers is 30% to 35% of total U.S. consumption. Even assuming that all Canada is a potential market, this reduces current potential to 550 million board feet, with a possible increase to 900 million board feet, based on market expansion. This must be compared with an estimated MSR lumber production capacity level of close to 400 million board feet located in the West, as of early 1982.

Total lumber consumption in the truss industry has been substantially discounted to exclude applications where MSR lumber would not compete. However, it would appear that, for all western MSR lumber producers to operate at capacity, a 70% level of penetration is required. Bearing in mind the availability of #1 Douglas fir in the area, this could be difficult.

In the long term, mid to late 1980's, there are a number of technical developments likely that will significantly improve the competitive position of MSR lumber. The most significant of these is a new concept of building design known as Limit State Design. This will be incorporated into building codes in Canada in 1985 and possibly at a similar time in the U.S. The much lower variability of MSR lumber, compared to visual stress grades, is likely to prove of very great advantage even on a grade-for-grade basis. This could even have the result of widening the potential for MSR lumber to include use in competition with visual grades for regular floor joists.

Other developments depend on the necessary technical research work being undertaken. If it can be proven that the higher MSR grades of S-P-F have better plate holding capacity than those allowed for visual grades, a significant obstacle to the growth of MSR S-P-F could be removed.

There are, however, imminent technical developments that adversely affect the advantages of S-P-F MSR in Canada. These relate to proposed increased design values for visually stress graded S-P-F lumber. These values will tend to reduce the advantage currently enjoyed by MSR S-P-F lumber in Canada. In contrast, Douglas fir values will be drastically reduced. This may significantly improve the viability of producing MSR Douglas fir grades.

Apart from the design changes within Canada, the future developments that are likely to affect, favourably, the potential penetration of MSR lumber will not occur in the medium term. Consequently, for the next three to five years, MSR lumber will be competing grade-for-grade with visual grades.

Bearing in mind that housing starts are currently very depressed, and seem unlikely to reach the assumed average level of 1.6 million per year until 1983, it is evident that current MSR lumber capacity in the West is more than sufficient to achieve substantial penetration into the market available. There is, however, the potential for market expansion, identified earlier, which would suggest that there is room for future growth in MSR lumber production in B.C. beyond this period.

MSR lumber is well accepted and widely used in the U.K., but the regulations for mechanical grading are very different from Canada. It may even be difficult to obtain acceptance of lumber graded on the CLT let alone graded to Canadian rules. Though visual NLGA rules are accepted, after much industry pressure, it is believed that acceptance of mechanical grades could be more difficult. Additionally, the added value to be obtained is less than that applicable in Canada, and the volumes are not substantial.

There are, however, broader implications. The British are acknowledged leaders in the Common Market relative to truss fabrication and lumber design values. Thus, since the Common Market is working towards a unified code, recognition by the British of Canadian MSR lumber would have a significant impact on its market potential within the whole Common Market. It is believed that, in order to obtain this recognition, a strong technical basis of proof of the validity and reliability of the Canadian system will have to be developed. In the short term, however, the U.K. market cannot be assumed to hold a significant potential for sales of MSR lumber from B.C.

The additional return to be expected by a mill with the ability to grade mechanically is an essential element in the assessment of the economic feasibility of the installation of a CLT operation. Unfortunately, lumber prices and price differentials between grades tend to fluctuate dramatically depending on day-to-day supply/demand balances. This has been particularly evident in the relatively adverse market conditions prevailing during the period of this study when so-called "normal" price differentials between species, grade sizes and lengths have varied from their usual patterns.

In order to provide revenue data for calculating the probable return on investment of selected CLT layouts in a "typical" B.C. mill, an analysis of price data in the U.S. and Canada was carried out. This indicates that the MSR grade of 1650f-1.5E can be expected to return to the mill probably around C.$45 per thousand board feet, in 1982 dollars, more than a standard and better grade. A differential of $65 per thousand board feet, in 1982 dollars, has been assumed for the MSR grade 2100f-1.8E.

Against these increases there is, however, the possibility that the value of the residual standard and better grade may be somewhat reduced, since the better lumber has been removed from the grade. Though this is not inevitable and will depend on markets and mill production practice, it has been decided to assume that a reduction of $5 per thousand board feet, in 1982 dollars, should be used in the calculation of economic feasibility.

The capital cost of an MSR installation is determined by the type of grading machine, the layout required in any individual mill, and the changes required to the sorting. The CLT is the most widely used machine in the U.S. and Canada, but there are at least two layouts that are currently being used. In these, the machine is either placed in line with the planer or is offset. The changes required to the sorting depend on the method of sorting currently being used; this could be a simple chain, trays or bins. Modification to these will each require different capital costs.

An analysis of the various possibilities indicates that the least cost alternative would require a capital cost of approximately C.$343,000 and the highest would need C.$740,000.

For the purpose of estimating the return on investment in a "typical" B.C. mill, two CLT layouts were selected from the range available. The capital costs of these are C.$418,000 and C.$740,000 for an in-line CLT/pull chain and offset CLT/bin sorter, respectively.

The capabilities of these two typical installations in their ability to extract MSR grades in saleable length specifications vary. On the basis of a "typical" 100 million board foot S-P-F mill, the lower cost alternative would provide 11.1 million board feet of two MSR grades in 2 x 4. The highest cost alternative would yield 17.55 million board feet.

On the basis of the differential prices discussed earlier, the internal rate of return on investment (I.R.O.R.) resulting from the incremental revenues obtained would be 59% for the highest cost option and 48% for the lower cost layout. A sensitivity analysis based on reducing the differential prices by $10 per thousand board feet would reduce these R.O.I.'s to 42% and 31%, respectively.

These figures are all based on typical yields and typical installation. The actual figures that would apply to any one mill could vary widely, but the method of calculation and the elements that need to be taken into the analysis are shown in the study. Each mill should apply its own values and do its own analyses for site specific locations.

Assuming a 16% to 20% weighted average cost of capital for a "typical" B.C. mill, both of the layouts selected for analysis clearly indicate a favourable rate of return. The Consultant's financial analysis is detailed in Appendix E and it is a relatively easy task for individual mills to calculate the minimum price differential needed for MSR grades for the selected layouts to be viable.

The most important initial step is to establish the likely grade yield figures, and the method of undertaking this is well documented.

If a mill is considering the installation of an MSR machine, there are a number of marketing strategy aspects that should be taken into account. The market for MSR lumber is highly specialised and technical. Consequently, MSR lumber should not be treated as another commodity product, either at the production level or at the sales level. Production practice must be sufficiently flexible to "tailor-make" the output, depending on the market to which sales are being made. Similarly, a direct and increased sales effort by personnel familiar with the product and the application is needed to ensure that the markets selected suit the production.

Finally, the timing of the investment by B.C. industry needs careful analysis. The indications are that, with the current economic climate and the number of machines currently installed, productive capacity in the West is likely to exceed demand for up to the next two years.

The time required to order and install a machine could be anywhere up to six months, depending on availability. Therefore, a company deciding to proceed in January 1982 would commence sales in the late Summer of 1982. At this time, it would have to overcome strong competition from existing suppliers in order to obtain a market share. It would be unlikely that productive capacity would be reached, at the estimated price differentials, until possibly the end of 1983. There would thus be at least a year during which the facility might be under-utilised.

This could have advantages since, during that time, the mill will be able to learn the best methods of maximizing yields and the sales staff will be gaining knowledge of the markets. It could be, however, that a year is more than really required for this education process.

The investment decision must depend on the corporate strategy of each company. Despite the possibility of over-capacity over the short term, it would appear that the installation of additional MSR manufacturing capacity may still be financially profitable in the West. The long term potential appears even more favourable.

GLOSSARY

AITC	American Institute for Timber Construction
chord	the horizontal or inclined member that establishes lower or upper edge of a truss
CLS	Canadian Lumber Standards
CLT	Continuous Lumber Tester (MSR machine)
CMHC	Canada Mortgage and Housing Corporation
CSA	Canadian Standards Association
CWC	Canadian Wood Council
Engineering Terms	explained in Appendix A
FPRS	Forest Products Research Society
KD	kiln dried
MSR	Mechanical Stress Rating
NAHB	National Association of Home Builders
NFPA	National Forest Products Association
NLGA	National Lumber Grading Authority (Canada)
panel length	the chord segment defined by two succeeding lengths
pitch	the inches of vertical rise in 12" of horizontal run for inclined members
PRL	Princess Risborough Laboratory, Building Research U.K.
SPIB	Southern Pine Inspection Bureau
TPI	Truss Plate Institute
typical trusses	explained in Appendix C

GLOSSARY (Continued)

wane	bark or lack of wood in a specified dimension from any cause, except eased edges, on the edge or corner of a piece of lumber
WCLIB	West Coast Lumber Inspection Bureau
webs	members that join top and bottom chords to form the triangular patterns within a truss
WWPA	Western Wood Products Association

1. INTRODUCTION

In recent years, a number of sawmills in North America have installed the necessary equipment to mechanically grade lumber. By doing so, it appears that average mill net returns can be improved. In B.C., a number of companies have been considering such an installation. The type of machinery necessary is reasonably well known, as is the method of assessing likely grade yields. A major uncertainty, however, has been the market potential. As a result, it was decided that there was a need for an independent and objective study of the market potential for mechanically graded lumber, and the economic feasibility of installing the necessary equipment.

Forintek Canada Corporation sponsored the study which was funded jointly by the Federal Department of Regional Economic Expansion and the British Columbia Ministry of Industry and Small Business Development. The work was undertaken by Woodbridge, Reed and Associates. The assistance of Phillips Barratt Kaiser Engineering Ltd. was provided for the technical input on machinery, capital and operating costs. Both companies are based in Vancouver, B.C.

Valuable and continuous cooperation was provided by Forintek throughout the study.

The study commenced in July 1981 and was completed in the Fall of the same year. The research approach involved extensive direct contact, in the markets, with potential users of mechanically graded lumber or Machine Stress Rated (MSR) lumber in the U.S. and Canada. Though much has been published on MSR lumber identifying its advantages, the bulk of this has originated from sources with an interest in selling MSR lumber or from wood technologists. Little was known of the views of potential customers.

Relative to its use, the concept of MSR lumber is essentially technical. It has, therefore, been inevitable that there is a substantial amount of technical detail found in this report. Since the principal orientation of the report has been to the U.S., most of the data has been expressed in imperial, rather than metric, units. However, in the case of information related to Canada, both are used where it is deemed necessary for improved understanding.

Price and cost data, expressed in dollars, are either Canadian or U.S. as indicated in each case. Financial projections are expressed in 1982 dollars and assume, for the purpose of this report, a Canadian dollar value of U.S.82¢.

The report commences with a description of the objectives and terms of reference, followed by a definition and explanation of MSR lumber. Trends in the installed capacity for MSR lumber are identified, in total and on a regional basis.

A detailed report is given on each of the industry sectors assessed to be of interest to MSR lumber producers. An estimate is made of the total consumption of each of these industries. Since this consumption will vary according to construction activity, all figures have been based on assumed housing start levels of 1.6 million in the U.S. and 200,000 in Canada. (1) There are a large number of technical developments in process which could have a very significant impact on MSR lumber. These are identified and discussed in some depth.

The total current and potential demand in the U.S. and Canada is analysed on a regional basis to develop an indication of the potential for MSR lumber from B.C. The information obtained during the field work forms the basis for the entire report; however, a brief outline is given for each of the market areas visited. This is shown in Appendix D.

Price relationships and differentials between grades are analysed, in order to develop an assessment of the likely increases in value that can be obtained by mechanical grading. A description is presented of the equipment that is required, together with an analysis of the returns on investment likely for some typical mills. In order to discount the effect of location, and thus transportation costs, on the analysis, the approach has been to consider all costs and returns on an incremental basis.

Conclusions are shown at the end of each major section. As a result of what was ascertained at both the consumer and the producer level, certain marketing strategies are proposed for consideration by mills interested in entering the MSR lumber market (Section 12). An analysis of financial and strategy implications is presented in Section 13 in order to assist mills in determining the viability of investment in MSR capacity in their own site specific locations. Finally, the major findings of the study are summarized in Section 14.

---

(1) conventional housing starts: excludes mobile homes

2. OBJECTIVES AND TERMS OF REFERENCE

The overall objective of the study was to provide the B.C. forest industry with an assessment of the potential market for MSR lumber. Furthermore, since the production of MSR lumber in an existing mill requires additional equipment, the study's purpose was to develop analyses of the economic feasibility of the necessary facilities at typical locations. The specific objectives of the study were as follows:

a) To prepare a detailed report of the market potential for machine graded dimension lumber for the commercial species groups currently produced in B.C.

b) To assess the value added, capital cost, and rate of return to the mill through conversion of part or all of the product mix to machine graded lumber.

c) To provide recommendations on approaches for development of an effective marketing strategy for promotion of MSR lumber to current and potential users.

The geographic areas to be considered were the Midwest, South and West of the United States, and B.C., Alberta and Ontario in Canada. Specific cities were identified within these broad regions. It was also decided to include a detailed study on the potential in the U.K. market.

3. DEFINITION AND EXPLANATION OF MACHINE STRESS RATING (MSR)

3.1 Introduction

Where lumber is to be used structurally, the engineer and designer need to know its strength and stiffness characteristics. Grading rules have been established that allowed a visual assessment of defects in any piece of lumber to establish the stress grade. The strength values for these grades were developed by testing small clear pieces of lumber of each species and applying adjustment factors, for variability and for the effect of the allowable defect. Design values were then assigned to each grade and species for each of the strength factors of interest to designers and these are explained in Appendix A. Reference will be made to these factors, without further explanation, throughout the report.

Since wood is a natural product, there is a considerable variation in the properties of one piece of lumber to those of the next -- even though it may be the same species and the same grade. Consequently, the values assigned tend to be very conservative and large volumes of lumber cannot be used to their real potential.

This places wood at a substantial disadvantage relative to competitive structural materials such as steel and concrete, where allowable design values and actual strength values vary less. Traditional structures tended to be overbuilt, therefore visually stress graded lumber was adequate. The increasing trend towards design engineered components demands better knowledge and use of the actual strength value of the material.

In early years, there was no way of establishing how strong a piece of lumber was without testing it until it failed. However, in the late 1950's and early 1960's, a considerable amount of research established that a correlation existed between the Modulus of Elasticity and the Modulus of Rupture. Interestingly, this was discovered almost simultaneously, but independently, in the U.S., Australia and the U.K.

Since Modulus of Elasticity (E) can be measured without breaking the lumber, a practical method now existed to predict strength values. Machines were developed to accomplish this on a commercial basis. The Continuous Lumber Tester, commonly known as the CLT, is the machine used almost exclusively in North America whereas the machine adopted by Australia and Europe is mainly the Computermatic.

3.2 MSR Technology

The CLT is a high speed machine (approximately 1,000 ft/min) which can operate at close to planer speeds. The lumber to be evaluated passes through a series of rollers which deflect the lumber down by a fixed amount and then up by the same amount. The force required to achieve these deflections is measured. This operation is carried out continuously on 4' spans throughout the length of the lumber, with the exception of 2' at each end. The results are fed into a computer and essentially two values are used to determine the machine grade of the lumber. These are the average E and the low point E (the worst E value of the piece). The computer analyses the findings and activates one of a number of coloured sprays. The colour identifies the potential grade applicable to the lumber that has just been evaluated. The lumber is then visually graded in accordance with machine stress grading rules which form part of NLGA, WWPA, WCLIB and SPIB standards. This visual "override" applies to two major aspects.

- checks, shake, skips, splits, wane, warp. All MSR grades have to meet the visual rules for #2 and standard grades.

- edge defects (knots, knotholes, burls, distorted grain, decay). The allowable sizes vary by MSR grade.

The effect of this visual override varies substantially from mill to mill and will depend on the log quality and production practices. Reject levels from 5% to 55% were quoted. The visual grader can agree with the machine or downgrade. He can never upgrade.

In addition to these grading rules, detailed procedures have also been set up by each of the agencies to define procedures for qualification and quality control. In order to satisfy these procedures, a mill requires a proof loading testing machine. This is used to test the actual E of the piece edgewise and also to test the F_b level. The significance of edgewise E is that, whereas the CLT measures E with the lumber going through flat, the lumber is generally used on edge.

The measurement of the F_b level is particularly important in adjusting the machine settings. The quality of logs can vary from one mill to another and within a mill, depending on where the logs are being harvested. This variability can cause a significant difference in the correlation to be found between E and F_b. The machine settings have to be adjusted so that the tests demonstrate that not more than 5% of the pieces will break at a load of 2.1 times the grade F_b.

With some logs, it may be necessary to set the machine for a higher average E than required for the grade in order to obtain the F_b rating. With others, the average E may be the limiting factor and the F_b value may be well above what is necessary. This latter situation occurs a great deal for mills in the South, where the rapidly grown pine tends to have very high F_b values relative to E. For Douglas fir, the reverse holds true.

Once the mill has been qualified, it is required to undertake carefully defined quality control procedures. Briefly, this entails sampling and testing, per shift, five pieces of the lumber produced in each size, grade and species. Sample testing and analysis procedures are also defined.

3.3 Recognised MSR Grades

There are a large number of grades of MSR lumber recognised in the U.S. and Canadian codes. A list of these is shown in Table 1. There are, however, only six that are currently being produced in any quantity. These are:

1200 f - 1.2 E
1450 f - 1.3 E
1650 f - 1.5 E
1800 f - 1.6 E
2100 f - 1.8 E
2400 f - 2.0 E

The nomenclature of the grade is such that the first number defines the design value for single member use for extreme fibre stress in bending (F_b) in pounds per square inch. The second number defines the average Modulus of Elasticity (E) in millions of pounds per square inch. The grade stamp also identifies the species. Though, theoretically, MSR lumber grades are species-independent, there are some design values which vary between species.

It is important to emphasise that MSR lumber is, initially, exactly the same as visually graded lumber. The method of production and the mill run product are identical. What is different is the method of sorting or grading.

It was pointed out, earlier, that wood is at a disadvantage relative to other building materials due to the variability of the material. Much of this variability is removed by machine grading since the mill can define, within fairly close limits, the strength of the lumber required in a grade. In particular, the design value F_b is much more closely controlled for machine graded lumber and, obviously, the E is known since it is measured for each piece. The actual stress values that would be obtained from a large number of pieces of lumber, all visually graded as #2 and better, would show a very wide bell curve, if plotted on a population distribution basis. However, the design values assigned to the grade relate to the lowest 5% of the population distribution. With machine grading, the operator can extract well defined sections of the distributed population and reclassify them into a number of much higher value grades.

Table 1

Recognised MSR Grades

(for which official design values are published)

900f - 1.0E 1/	1950f - 1.5E 1/
900f - 1.2E	1950f - 1.7E
1200f - 1.2E	2100f - 1.8E
1200f - 1.5E	2250f - 1.6E 1/
1350f - 1.3E 1/	2250f - 1.9E
1350f - 1.8E 1/	2400f - 1.7E 1/
1450f - 1.3E	2400f - 2.0E
1500f - 1.3E 1/	2550f - 2.1E
1500f - 1.4E	2700f - 2.2E 1/
1500f - 1.8E 1/	2850f - 2.3E 1/
1650f - 1.4E 1/	3000f - 2.4E 1/
1650f - 1.5E	3150f - 2.5E 1/
1800f - 1.6E	3300f - 2.6E 1/
1800f - 2.1E	

1/ U.S. grade only

The current system of mechanical grading is, however, still far from perfect. Though E has been found to provide a reasonable correlation to bending stress, the variability of lumber is such that this relationship is by no means exactly linear. Therefore, to be confident that the necessary bending stress is applicable for 95% of the pieces of lumber, a low cutoff value must be used. A plot of data showing the typical relationship between E and Modulus of Rupture is shown in Figure 1.

Other systems are being researched that may permit a tighter classification and it seems that the non-destructive evaluation of lumber may have some way to go. New methods may evolve. However, it is significant that, in North America, the basic CLT concept has remained unchanged in close to twenty years. There appears to be no other commercial and practical method developed as yet. Metriguard, the commercial developer of the CLT, advised that it has been endeavouring to develop a high speed, in-line, tension testing machine, but has so far, apparently, been unsuccessful. New machines are, however, being developed for the finger-jointing industry which tension proof-load each piece of lumber. From what was discovered in the course of the study, it does not appear that there is likely to be a significantly improved method of non-destructive evaluation on the horizon. Consequently, it is sufficient to discuss the concept, advantages, disadvantages and potential of MSR lumber as it currently exists, without endeavouring to incorporate an analysis of any new system.

At present, though all codes incorporate MSR grades, the design values shown in these codes allow comparatively little advantage to designing with MSR lumber. The single design factor advantage, for which the proponents of MSR lumber have so far succeeded in obtaining recognition is that of column buckling strength. For this, the factor that is applied in the equation effectively increases the capabilities of MSR lumber by almost 40%, relative to visually graded lumber with the same E. This has resulted from new coefficient of variation factors for E being used for MSR lumber. It is worth noting that the technical backing for this change was first published in 1970 and it took close to ten years before official code acceptance was achieved.

Consequently, though there is little doubt that MSR lumber has advantages over visual grades, these advantages are not fully recognised in design codes. Further comments on this are included in later sections of this report.

Figure 1

Correlation Between E and MOR

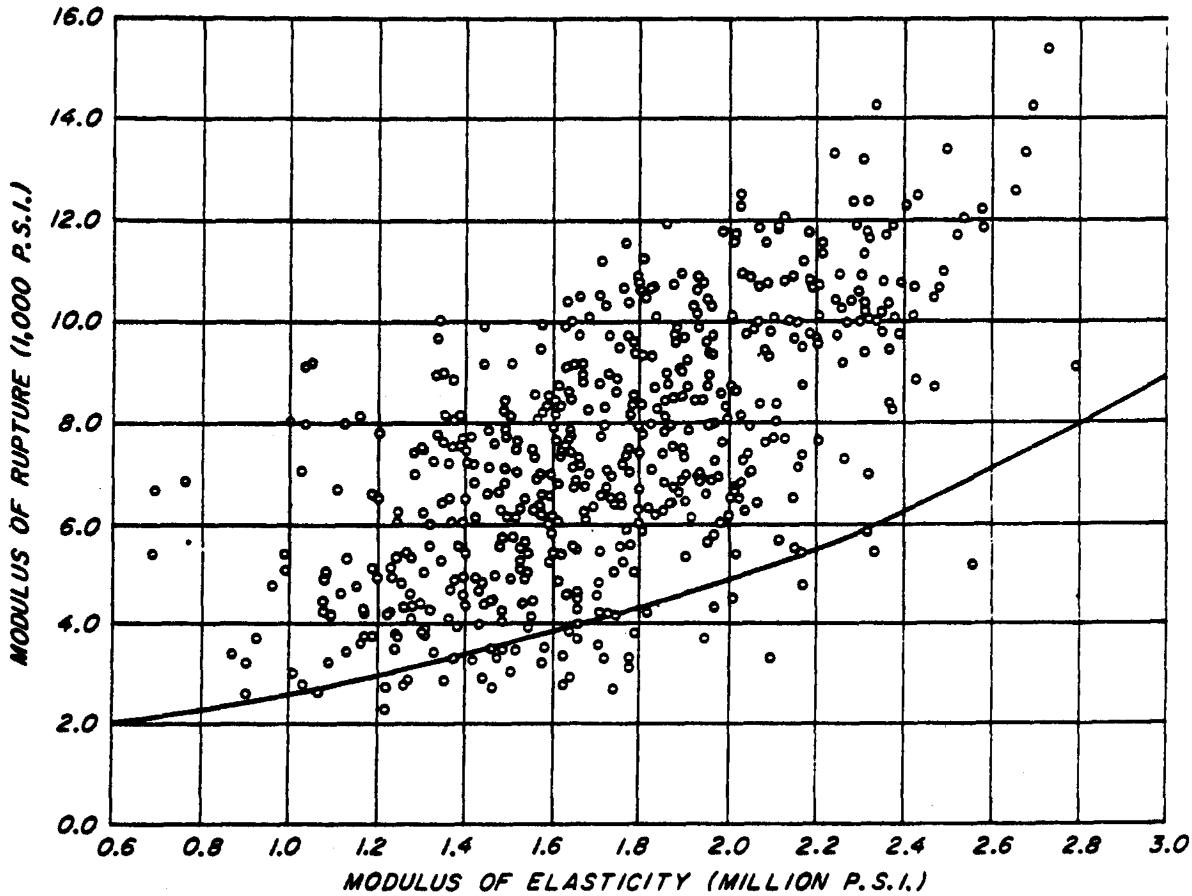


Figure 2. -- A plot of data showing the typical relationship between the strenth predictor, modulus of elasticity (E), and strength (modulus of rupture). The line is drawn to assure that about 95% of all data will be above the line.

(M 139 122)

Source: USDA Forest Service General Technical Report FPL7 Machine Stress Rating: Practical Concerns for Lumber Producers.

3.4 Summary

Traditionally, lumber has been graded by a visual assessment of defects. The actual strength of any given piece of lumber, however, can vary widely with another even of the same visual appearance and species. This variation must be allowed for in the design of a structure. Therefore, codes assign relatively low strength values to lumber in comparison to the actual strength value of most of the individual pieces. This can put lumber at a competitive disadvantage to other building products such as steel and concrete under certain circumstances.

Mechanical grading allows each piece of lumber to be tested physically by a machine in order to accurately estimate its actual strength. This has two results. The producer can obtain an improved yield of higher value grades. The user can buy a product for which the strength values are closely controlled, and in which he can have confidence. The most widely used machine is called the Continuous Lumber Tester. This machine is capable of mechanically stress rating at lineal speeds close to that of a planer.

The MSR grades are defined by a combination of strength values and there are a large number of these combinations. However, there are only about six grades which are commonly used, and three or four account for over 90% of production.

These MSR grades are recognized by the design codes in both the United States and Canada. However, these codes do not allow any design advantage to MSR lumber, apart from one aspect, which is relatively insignificant in its effect on the total volume of lumber used structurally. Therefore, though MSR lumber has technical design advantages, these have not been fully recognized under current code practices.

4. MSR LUMBER SUPPLY

4.1 Introduction

Though the first U.S. mills commenced the commercial production of MSR lumber in 1963, the growth in availabililty of MSR lumber was relatively slow. Ten years later, there were still comparatively few machines and not many fabricators knew about MSR lumber. It was not until the mid 1970's that the expansion really began. At the end of 1977, there were 11 CLT machines operating in the U.S. and Canada, plus some Stressomatics. By early 1982, it is expected that this number will have increased to 29. A detailed list of the mills that currently have MSR machines is shown in Table 2.

4.2 MSR Capacity

Though the initial development of MSR lumber was in Washington and Oregon, followed by British Columbia, there has been a significant growth recently in the U.S. South. Out of a total of six mills in that region with machines, five have been installed within the last two years. A detailed analysis was undertaken of the mills that have been identified as having the CLT and is shown in Table 3.

The total capacity levels are those obtained, where available, from the 1981 Directory of the Forest Products Industry. An assessment of the potential yield of MSR lumber can only be very approximate. Almost every factor that contributes to the ultimate yield varies from mill to mill. Each species and quality of log will give a different yield.

The markets for which the mill is cutting will define how much dimension lumber is produced and, therefore, the volume of MSR lumber. It is known, for example, that at least one of the mills with an MSR machine cuts principally large sizes for the export market. Consequently, though the total production of the mill is very high, the output of MSR lumber is low. However, even this is not really a known factor; the mill in question may change its cutting practices if the market changes significantly. Other factors that affect yield would include the actual grades being sorted. The yield for mills that also grade 1200f-1.2E would be higher than for a mill where 1800f-1.6E is the lowest grade.

It must be emphasised, therefore, that the estimate shown for MSR lumber production is very approximate.

Table 2

North American MSR Supply
Machine Location and Start-up
1963 to 1981

Company	Mill Location	Start-up Date
CLT Machines [1/]		
Frank Lumber Co.	Mill City OR	1963
Simpson Timber Co.	Shelton WA	1963
Bohemia Lumber Co.	Cottage Grove OR	1968
Roseburg Lumber Co.	Roseburg OR	1973
Weyerhaeuser Co.	Snoqualmie Falls WA	1974
Cedar Products	Mill City OR	1974
Pope & Talbot Lumber Co.	Port Gamble WA	1974
Pope & Talbot Lumber Co.	Midway B.C.	1976
Willamina Lumber Co.	Willamina OR	1977
Simpson Timber Co.	Blue Ridge Alta	1977
Weyerhaeuser Co.	Dierks AK	1977
Wickes Forest Ind.	Grangeville ID	1978
Weyerhaeuser Co.	Kamloops B.C.	1978
Pope & Talbot Lumber Co.	Oakridge OR	1978
Weyerhaeuser Co.	Longview WA	1978
Pope & Talbot Lumber Co.	Grand Forks B.C.	1979
Weyerhaeuser Co.	OK Falls B.C.	1979
Hemphill-O'Neill Lumber Co.	Chehalis WA	1979
Weyerhaeuser Co.	Princeton B.C.	1980
Weyerhaeuser Co.	Wright City OK	1980
Masonite Corporation	Hattiesburg MS	1980
North Pacific Lumber Co.	Republic WA	1980
Gulf Lumber Co.	Mobile AL	1981
B.C. Forest Products	Grand Cache Alta.	1981/2
Sandner Bros. Lbr.	Christina Lake B.C.	1981
Plateau Mills	Vanderhoof B.C.	1981/2
Stoltze Lam & Lumber Inc.	Columbia Falls MT	1981
A T & N Lumber Service Inc.	York AL	1981
Union Camp	Folkeston GA	1981
Weyerhaeuser Co.	Plymouth NC	Planned
Weyerhaeuser Co.	Philadelphia MS	Planned
Abitibi	Ontario	Planned
Stressomatic and Other Machines		
Columbia Wood Industries	Scappoose OR	N/A
Crown Zellerbach	Columbia City OR	1975/76
Roseburg Lumber Co.	Roseburg OR	N/A
Thomasson Lumber Co.	Philadelphia MS	N/A
MSR Lumber Co.	Cranbrook B.C.	1981

1/ Trus Joist also has a CLT at Valdosta GA for its own use. Subsequent references in this report to CLT operations do not include this machine.

Source: Companies, Trade Associations and Published Literature.

Weyerhaeuser has made estimates of U.S. and Canadian MSR lumber production, and provided the following data for recent years.

1978	278 million board feet
1979	389 million board feet
1980	300 million board feet

A comparison of the estimates of capacity given in Table 3 with the Weyerhaeuser estimates for production, would suggest that the capacity levels may be somewhat understated by around 15%. Bearing in mind the very general nature of the assumptions and the great variations likely from mill to mill, it is believed that Table 3 can be regarded as a reasonable estimate of current regional capacities.

The principal species of MSR lumber produced in Washington and Oregon tend to be Douglas fir and hemfir. In the South, it is exclusively Southern pine, whereas in Canada and the Inland Empire, the species classifications are S-P-F and lodgepole pine respectively. There is also a limited volume of Douglas fir run at these Interior locations.

Further expansion of production appears likely. Currently, however, market conditions are such that many companies are somewhat hesitant to commit to capital expenditure. It is said that Weyerhaeuser is committed to the establishment of a CLT at all of its dimension mills sooner or later, although this has not been confirmed with the company. In contrast, very few of the other major U.S. and Canadian companies have, as yet, committed to the MSR lumber concept. In fact, out of the top 15 producers of lumber in the U.S. and Canada, the only company apart from Weyerhaeuser that will have MSR availability by early 1982 will be B.C. Forest Products at its new mill in Grande Cache.

Consequently, there are effectively no data on which to base projections of future growth in supply of MSR lumber. Installation of equipment will depend on the assessment by each company of yields, costs and returns. The concept is still at the early stages of acceptance, and it must be assumed that the development of supply will largely be dependent on the market.

Table 3

MSR Lumber Capacity
Early 1982

	Estimated Total Capacity of Mills with CLT	Number of Machines	Estimated Capacity of MSR Lumber Production
Washington	890	6	110
Oregon	425	6	85
B.C.	650	7	115
Alberta	200	2	45
U.S. South	750	6	100
Inland Empire	150	2	35
TOTAL	3,065	29	490

Assumptions:

1. Average mill throughput for 2 x 4 - 50%.
2. Average yield standard and better - 80% to 85%.
3. Visually accepted 1650f-1.5E MSR or better yield from standard and better - 45%.
4. Some volume of larger sizes machine graded - 15% of MSR total.

Source: Woodbridge, Reed and Associates.

4.3 Summary

MSR lumber was commercially produced in the early 1960's. Capacity did not grow rapidly, however, until the mid-1970's. Over the past four years or so, the number of machines operating in the U.S. and Canada has jumped from 11 to 29.

Recent growth in MSR capacity has been significant in the U.S. South. Much of the total North American capacity, however, is in the West.

MSR output varies according to a number of factors. Consequently, any estimates of MSR production are only very approximate.

The "best estimate" available of MSR capacity in the U.S. and Canada combined is around 490 million board feet, in early 1982. Of this, B.C. has an estimated capacity of approximately 24% of the total, or 115 million board feet.

5. POTENTIAL CONSUMERS OF MSR LUMBER

5.1 Introduction

Potentially, markets exist for MSR lumber in any application where strength or stiffness of the lumber is of importance. In practice, however, many of these applications also have criteria, other than the lumber strength, which govern use. A typical example would be stud walls, where the spacing of the studs is determined not so much by the ability of the studs to bear the necessary load, as by other factors, such as the spans required for the exterior and interior sheathing, the racking strength requirements, and so on. Consequently, the availability of a machine stress rated stud tends to be of little practical value at this time.

The principal potential, therefore, for MSR lumber currently lies in roof and floor systems. Thus, the industrial sectors that are of greatest relevance to the producer of MSR lumber are the following:

- the truss fabrication industry
- the joist fabrication industry
- the laminated beam industry
- the manufactured housing and mobile home industry

Each of these industries is discussed in this section with particular emphasis being given to the truss industry. Producers of fabricated joists have been identified and discussed separately.

The potential for the sale of MSR lumber, and the marketing strategies to be adopted, depend heavily on these industries. Consequently, it has been considered necessary to analyse and discuss the potential customers in considerable depth.

5.2 The Truss Industry - United States

Background

The wood truss industry in the U.S. is well established throughout the country. It grew rapidly from the mid 1960's to the late 1970's. Though no published data are available, it has been estimated (1) that, in recent years, the number of companies fabricating trusses in the U.S. was probably around 2,500 at the time of peak construction activity. It is, however, an industry that is heavily dependent on construction activity and is not particularly capital intensive.

Consequently, the numbers of fabricators tend to vary with construction activity. It is currently estimated that the number of fabricators may well be below 1,500. Many of the companies involved were initially in the lumber business, as wholesalers or retailers, and diversified subsequently into truss manufacture. Of the balance, some are purely truss fabricators, while others fabricate primarily for their own use: for example, industrialised home manufacturers.

Though there has been a significant reduction in the numbers of fabricators, the reason that this reduction has not been even greater has been due to a change in direction within the industry. In the earlier years, the principal thrust of the industry was towards the residential roof market. Once it could be shown that it was cheaper to build a house with trusses than with conventional rafters, builders changed their practices rapidly.

Penetration into this market is now close to the saturation point and has been estimated (1) at 80% to 90% of all units constructed. The industry is now developing into two new and important areas. The first is the large commercial/industrial/agricultural truss and the second is the 4 x 2 floor truss (where the 2 x 4 is used flat and not on edge as in a normal roof truss). These new developments are of considerable significance relative to lumber use and the implications are discussed in full in this report.

---

(1) Metal Plate Wood Truss Conference Proceedings. (1979)

Transportation costs have dictated, to a great extent, the location of the truss industry. The majority of the fabricators sell most of their production within a radius of 100 miles. Economies of scale are relatively unimportant, past a fairly low level of production. Consequently, the truss industry is not dominated by a few very large companies as often occurs in many other industries. According to an extensive study undertaken by the Forest Products Research Society (1) in 1976, and updated two years later, the greatest number of companies had between 10 and 50 employees.

The volume of lumber consumed by individual truss fabricators varies significantly -- from less than 1 million board feet to over 40 million. However, in 1977 it was found that, for companies with more than 20 employees, the average annual consumption is around 4 million board feet. Approximately 80% of the lumber consumed by the industry was purchased by companies of this size.

The importance of the manufacturers of the metal plate connectors must be emphasized. Even though the cost of the metal plate is less than 10% of the cost of a truss (whereas lumber is 45% to 55%), it is these manufacturers who are primarily responsible for the development of the truss industry. The great majority (90%, according to the study mentioned above) of the truss fabricators rely extensively on truss designs produced by the plate manufacturers.

The plate manufacturing industry is represented by a strong and well respected body called the Truss Plate Institute (TPI). The majority of the industry, and certainly all major companies, belong to the TPI. These companies all have extensive engineering staff to service the requirements of their customers and work together, as TPI, with the various code authorities around the U.S. to standardize design practices (2).

The truss fabricating industry itself is not nearly so well organised. About 400 belong to the Component Manufacturers' Council of the TPI and there are some local truss fabricators' organisations, such as the Central Florida Truss Manufacturers Association with 17 members, or the Wisconsin Truss Manufacturers Association. It was suggested by some fabricators that considerable dangers were inherent in this lack of organisational strength. The market is highly competitive and some companies tend to sacrifice quality in order to get business. Without the ability to police itself, the industry could be in danger of having governmental controls imposed.

---

(1) Factors Affecting the Use of Lumber by Truss Fabricators in the United States - FPRS TS-1 (1977)

(2) Design Specifications for Metal Plate Connected Wood Trusses T.P.I. (1978).

The approach taken by the truss plate manufacturers, regarding the species, grade and size of lumber to be used, tends to be somewhat neutral. They design the trusses on the basis of the strength values published in the National Design Specifications (1) and in accordance with the various building codes in the country. They produce standard designs and span tables based on a variety of grades and species. It is then the task of the individual truss fabricator to choose which design is optimum for the particular contract on hand. The fabricator will be told by the builder the required span, pitch, profile and, often, the spacing. Therefore, on the basis of the required design loading applicable to the area, the fabricator can choose the configuration of truss needed. To a great extent, this choice is dictated by the specification of the lumber that the fabricator is carrying in inventory.

If the invitation to quote, received by the fabricator, does not fall within the standard designs issued by the plate manufacturer, the fabricator will often call for a special design. Part of the computer input data, that the plate manufacturer uses in engineering the necessary design, is the species and grade of lumber normally stocked by the fabricator. Thus, if the fabricator is in Georgia, the design will be based on a variety of Southern pine grades and sizes. The majority of plate manufacturers now include in their design manuals, as part of the grade options, a variety of MSR grades in addition to the regular visual grades. However, though they now include MSR grades and are, conceptually, very much in favour of MSR lumber, they tend to take the approach that it is not their business to dictate to the fabricator what grades, or species, should be used, provided that the engineering requirements are met.

Lumber Utilisation

The species used by truss fabricators vary widely across the country. An analysis of the FPRS study (2) and the more recent update is shown in Table 4. Southern pine is the dominant species in all regions except for the West (3). It is a species group with good strength characteristics and, provided it is manufactured correctly, provides an ideal material for truss manufacture. This dominance would be expected to apply to consumption in the South, but is very evident also in the Northeast and North Central regions where, in 1977, Southern pine had over 80% of the truss market. In contrast, total Southern pine shipments into these two regions represented less than 20% of the lumber consumed (4). It is only in the West that other species, namely Douglas fir and hemfir, are able to compete successfully for truss stock.

---

(1) National Design Specification for Wood Construction (1977) plus July 1981 supplement.
(2) ibid.
(3) for definition of geographical area, see Appendix B.
(4) Softwood Lumber Distribution Estimates by Council of Forest Industries of B.C. - Annual.

Table 4

Species Utilised by Truss Fabricators

(percentage of volume used)

Region[1/] Species	North East 1975	North East 1977	North Central 1975	North Central 1977	South 1975	South 1977	West 1975	West 1977	Total U.S. 1975	Total U.S. 1977
Douglas fir/ Larch	13	7	24	13	1	2	68	57	26	16
Hemfir	7	-	5	3	1	-	29	39	11	8
S-P-F	20	5	5	3	2	1	-	2	4	2
Southern pine	59	88	65	81	96	97	3	2	57	74
Other	1	-	1	-	-	-	-	-	1	-
Total	100	100	100	100	100	100	100	100	100	100

Source: Trade Data.

1/ see Appendix B

Table 5

Sizes Utilised by Truss Fabricators

(percentage of volume used)

Region [1/] Sizes	North East 1975	North East 1977	North Central 1975	North Central 1977	South 1975	South 1977	West 1974	West 1977	Total 1974	Total 1977
2 x 3	-	-	-	-	1	-	2	2	1	-
2 x 4	60	62	74	75	80	83	79	81	76	78
2 x 6	31	26	17	16	16	14	16	13	18	15
2 x 8	9	8	9	5	3	3	3	3	5	4
2 x 10 & over	2/	4	2/	4	2/	-	2/	1	2/	3
Total	100	100	100	100	100	100	100	100	100	100

Source: Trade Data.

1/ see Appendix B
2/ included in 2 x 8

On a subregional basis it should be noted, however, that there are a number of areas in the western part of the North Central region where other species such as Douglas fir and S-P-F are of much greater importance than would be apparent from Table 4.

The great majority of the lumber consumed in trusses is in 2 x 4. There are, however, some significant variations between regions (Table 5). These variations are governed, to a substantial extent, by the required loads in the different regions. In the Northeast, the snow load requirements are very much higher; therefore, the volume of sizes greater than 2 x 4 is larger. There are other factors that can also be important, and which are of greater relevance now than at the time of these surveys. The principal of these would be the expansion of the truss industry into the large span industrial and agricultural truss market.

The principal grades utilised by the industry are #1 and #2 (Table 6). Southern pine producers tend to sell the grades separately. Consequently, grade categories such as #2 and better are of less significance where the majority of consumption is of Southern pine. However in the West, in addition to sales of #1 Douglas fir, there is a large volume sold as #1 and better and as #2 and better. A number of the fabricators sort the latter, in order to obtain the volume of #1 required in their designs. The lower grades shown in the table are used in webs. It is worth noting, however, that the average consumption of web material tends to be around 25%. Therefore, it can be concluded that a significant proportion of the lumber used in webs is cull from the higher grades. It should also be emphasised that grade usage varies significantly, both from one area to another, and also from one fabricator to the next, within areas. Further details on this aspect are given in the information on specific markets.

An analysis of the MSR grades utilised by the fabricators in 1977 indicated that 1650f-1.5E represented 75% of the volume. Of the balance, 2100f-1.8E was the most significant, followed by 1800f-1.6E and then 2400f-2.0E. During the 1977 survey, the fabricators were asked whether they anticipated a change to the use of MSR in 1978. In total for the U.S., only 14% foresaw such a change in their own purchases but it is significant that, in the West and North Central, the percentage was much higher at 20% to 25%.

The lengths purchased by the truss industry depend to a significant extent on the sales practices of the producing regions (Table 7). Southern pine producers tend to sell specified lengths by truck to a much greater extent than producers in the West, where random length carloads tend to be the norm. Thus, whereas only 33% of the purchases in the South were on a random length basis, a level of 60% was evident in the West. Virtually all the volumes purchased in lengths less than 12' are for web material and relate closely to the percentage of lower grades shown earlier (Table 6).

Table 6

Grades Utilised by Truss Fabricators

(percentage of volume used)

Region 1/	North East		North Central		South		West		Total	
Grades	1975	1977	1975	1977	1975	1977	1975	1977	1975	1977
Select Structural (incl. Dense Select Structural)	7	6	5	5	1	1	8	11	4	5
#1 (incl.#1/Btr. & Dense #1)	11	20	27	38	19	24	55	46	30	32
#2 (incl. #2/Btr. & Dense #2)	54	56	55	38	64	55	20	10	50	41
Lower Grades	28	18	13	18	16	20	17	21	16	20
MSR	2/	-	2/	-	2/	-	2/	12	2/	2
Total	100	100	100	100	100	100	100	100	100	100

Source: Trade Data

1/ see Appendix B

2/ not identified

Table 7

Lumber Length Utilised by Truss Fabricators

(percentage of volume used)

Region 1/	North East		North Central		South		West		Total	
Lengths	1975	1977	1975	1977	1975	1977	1975	1977	1975	1977
Random	34	33	40	56	33	30	60	57	42	45
12 feet	13	22	8	12	15	22	10	15	12	17
12 feet	12	12	9	6	11	10	4	3	9	8
14 feet	14	13	21	7	13	12	5	5	13	9
16 feet	17	12	11	8	15	13	7	6	12	10
18 feet	5	4	6	5	8	8	6	7	6	6
20 feet	4	3	4	4	5	5	5	4	5	4
20 feet	1	-	1	2	-	-	3	3	1	1
Total	100	100	100	100	100	100	100	100	100	100

Source: Trade Data

1/ see Appendix B

Lumber Purchase Criteria

The decision factors considered to be important, and how these are ranked in terms of relevant importance, are aspects that vary widely from fabricator to fabricator. However, it is essential to analyse these before any realistic assessment can be made of the potential for MSR lumber in the truss industry.

The principal criteria are the following:

- secure supply sources

In earlier years, one of the principal concerns of fabricators was that relatively few sources of MSR lumber existed. With the sharp increase in plants over recent years, this should no longer be a negative factor, even though there are still some fabricators who are unaware of the proliferation of supply sources.

- ability of the lumber to do the job

In the past, many of the design engineers and the code authorities had been unfamiliar with MSR lumber. It is now, however, widely accepted conceptually, though there are still some specifiers and authorities who have traditional preference for species and visual grades. The bulk of the truss plate companies now include reference to MSR grades in their designs.

- economy

Once the first two criteria have been satisfied, the essential aspect is overall economy. Given that the cost of lumber represents over half of production cost, and that the actual production process is relatively simple, it is clear that it is the economics of lumber purchase and utilisation that control the profitability of a truss operation. These economics depend on a variety of interdependent factors.

a) actual price of each grade/species

b) amount of lumber required to achieve the necessary span. For example, though #2 may be appreciably cheaper than select structural, if the truss configuration must be changed from a Fink truss to a Fan truss (Appendix C) in order to achieve the necessary span, then the additional web material, plates and labour may result in it being less economical. MSR lumber has some advantages here, particularly when larger spans are required. Weyerhaeuser has developed a technical sales programme for MSR lumber and is able to prove, face-to-face with the fabricator, how MSR lumber can save him money.

c) inventory required. Theoretically, every time the truss fabricator uses a piece of #1 lumber when the design only calls for #2, he loses the price differential that exists between the grades. However, against this loss must be offset the cost of carrying in inventory all the necessary lengths of each grade. With 1981 short term interest rates at close to 2% per month, carrying charges alone are a significant factor, without considering cash flow problems. Additionally, the greater the volumes in stock, the longer the turnover and, therefore, the greater the risk of downgraded material. Again, due to the better strength values of some MSR grades, there is an advantage for MSR.

d) the amount of product that can be utilised and how the product behaves in storage. This is particularly significant in the case of #2 Southern pine where the cull factor can be up to 25%. The cheaper price relative to, say, #1 dense will be offset by the volume of #2 that must be downgraded to web materials, which can be bought at a significantly lower price. MSR lumber has a considerable potential advantage here since it tends to be a more uniform product.

e) the nature of the business the fabricator obtains. This controls some of the other factors -- in particular b) and c) above. If the fabricator concentrates on residential roof trusses and is in a low snow load area, he has little need for the higher grades. However, if much of his business is commercial and requires large spans with high loading, it may be more economical for him to inventory only 1650 MSR and accept an overdesign factor on the small proportion of short span business expected.

f) call backs. The economy of using a cheaper grade could be offset if problems arise after the truss has left the factory due to warp, splits and so on. With the greater uniformity of MSR, and the fact that the mills tend to have a more accurate drying schedule in order to get the best yield, MSR lumber should have an advantage.

g) lengths. Theoretically, the lumber can always be spliced; therefore, lengths are not crucial. However, there is a labour and material cost attached to splicing and this must be weighed against the extra cost of purchasing specified lengths. The possibility of truss damage during installation is also increased by additional splices. MSR lumber would have no advantage here since the lengths have been established prior to grading, whether this is mechanical or visual. With only one exception, all truss fabricators insisted that, when they purchase a random length carload, they expect some packages of 18' and 20' lengths.

h) appearance. Though a lower grade of smaller dimension may be entirely justified from an engineering standpoint, the appearance of the truss may not satisfy the buyer. It is claimed by MSR producers that the product has a better appearance. This is arguable.

i) liability. The use of lumber that is either above minimum allowable strength values or is more reliable, provides greater security to the fabricator relative to possible truss failure and subsequent litigation. The principal companies producing and promoting MSR lumber emphasise the benefits obtained relative to product liability. The value to the fabricator of this security tends to be directly proportional to the prevalence of litigation in his market area. Thus, in the Minnesota and Illinois areas, where there have recently been very severe snowfalls, there have been a number of roof failures. Consequently, many of the fabricators have been involved in litigation. They, therefore, tend to be very aware of the liability advantage.

In contrast, fabricators in the South have rarely, if ever, had any problems, so their weighting of this factor is minimal. Most fabricators have liability insurance, but no concrete evidence was found that would suggest that the premiums are actually lower if MSR lumber is used. It is difficult to assess since the premiums tend to be a matter of negotiation, and the use of MSR lumber would be a bargaining factor in favour of the fabricators. It should be noted, however, that the savings would be relatively small. A typical annual premium for liability insurance for a company producing $1.5 million worth of trusses annually would be in the region of $2,500. This is insignificant relative to $750,000 worth of lumber purchased. There is, however, the non-quantifiable element which can be called the "peace-of-mind" factor. The value of this will inevitably vary between fabricators. It is also relevant to note that the importance of liability increases as fabricators become more involved in industrial and commercial trusses.

It can be seen, therefore, that there are a large number of criteria which influence the decision of each truss fabricator. Since many of these are judgmental and vary from one company to the next, it is hardly surprising that there are significant variations in lumber purchase between fabricators, even in the same market area. However, as each of the purchase criteria is analysed, it is clear that MSR lumber is preferable, or at least equal, in all aspects with one important possible exception.

This exception could be price. If the price for MSR lumber, on a strict grade-for-grade basis, is significantly greater than that for visually graded lumber, with the same stress or stiffness values, this disadvantage could offset all the other advantages. This point was emphasised by a number of fabricators and also by a company that has been producing MSR lumber for many years. This company stressed that it would be unrealistic to estimate that any premium, as such, can be obtained for MSR lumber. The significance of this is discussed in the section on prices.

Effectively all the plate manufacturers and, in particular, their engineering staff are very enthusiastic about MSR lumber. However, as was pointed ot earlier, they do not believe that they can enforce the use of any grade or species. Most of the knowledgeable truss fabricators are also enthusiastic in principle about MSR lumber. Many stated the view that, in ten years time, all chord material in trusses would be graded mechanically. Furthermore, many indicated that if codes enforced the use of MSR lumber, they would be delighted. However, until this occurs, no company could afford to use a more expensive lumber in truss fabrication.

Volumes Purchased by the Truss Industry

No precise figures are available for the volume of lumber utilised by the truss industry. For 1975, it was estimated that ". . . total consumption of lumber in trusses probably exceeds 2 billion board feet."(1) In the 1977 update of the report for the TPI, a much higher level of 4.7 billion board feet was estimated. Subsequently, in the course of a major conference on the truss industry (2), a variety of figures were quoted ranging from 3 to 5 billion board feet, with most being above 4 billion. An analysis (3) by the Forest Products Research Laboratory indicates that a little over 2.1 billion board feet of lumber were used in 1978, in metal plate roof trusses for light frame residential construction. This last estimate was based on a detailed, confidential study undertaken in 1978 for the NAHB. On the basis of this estimate, it would seem that truss consumption levels for 1978, after including some allowance for residential floor trusses, would be in the region of 2.2 billion board feet in residential construction. In addition to this volume, there is the lumber consumed in truss manufacture for commercial, industrial and agricultural buildings. This has been estimated by Weyerhaeuser as representing 32% of lumber consumption in trusses. The total volume would, therefore, be in the region of 3.2 billion board feet.

It should be borne in mind that this volume of 3.2 billion board feet relates to the levels of technology and demand that existed in 1978. In that year, housing starts were at the 2 million level, but the truss industry was only at the early stages of development into floor trusses, and had not expanded into the long-span, non-residential truss to the extent that is evident currently. The potential impact of these, and other possible developments, on the volumes consumed by the truss industry are discussed in the next section. At this stage, however, it is estimated that a "base" lumber consumption level of 2.9 billion board feet in the U.S. truss industry can be assumed for a housing start level of 1.6 million, and an average level of activity in the non-residential market. The level of 1.6 million has been chosen as being representative of a reasonable average, for annual housing starts for the 1980's, upon which to base the potential market.

(1) Factors Affecting the Use of Lumber by Truss Fabricators in the United States. FPRS TS-1 (1977
(2) Metal Plate Wood Truss Conference Proceedings. (1979)
(3) Trends in Lumber Used for Housing. Forest Products Research Laboratory. Madison, Wisconsin. (1979)

5.3 The Truss Industry - Canada

Background

The basic approach and method of operation of the truss industry in Canada is very similar to that in the U.S. Consequently, in order to avoid tedious repetition, this section will highlight the principal differences.

The Truss Plate Institute of Canada (TPIC) is the representative body of the plate manufacturers and currently has nine independent members. With one notable exception, the members are the same as the main companies in the U.S.

The Institute has no permanent staff and its affairs are handled by a consulting engineering company on a retainer basis. The TPIC has no component manufacturers section, nor do the truss fabricators have any national association, though there are several small, regional associations. It is usually estimated that there are approximately 200 fabricators operating in Canada. One plate manufacturer, however, suggested that this was far too low and that the figure should be close to 350. On a proportional basis, comparing U.S. housing starts to those in Canada, it would seem likely that the number would be around 250.

The design and engineering of trusses is closely controlled by the National Building Code and by CSA 086: Code for Engineering Design in Wood. With some exceptions, these codes are adopted by all building authorities throughout the country. Furthermore, the CMHC regulations, which control a significant volume of residential housing in Canada, now accept TPIC approved designs for pitched roof trusses. It should also be noted that there are, in Canada, specific standards (CSA S347 and S307) which define the method of evaluating plate values. This is very different from the U.S. approach in that the range of specific gravities used for the test pieces of lumber are closely defined for each species. This imposes a significant penalty on all S-P-F lumber, whether it is of a high value machine grade or visual #2 and better.

Specific reference is included within CSA 086 to MSR lumber, but with a notation which includes the following sentences ". . . The practice of machine grading is limited. The designer is advised to check availability before specifying." Despite this somewhat negative statement, the bulk of the TPIC companies now include reference to MSR in their designs, particularly for the larger spans and for floor trusses.

As in the U.S., there is increasing interest in Canada in floor trusses. However, with the exception of some companies, the fabricators appear to be somewhat behind their U.S. counterparts. Industry experts stated that, so far, the development was principally in Alberta and Quebec. It was found, though, that there is at least one company in B.C. that is heavily involved in floor trusses for multi-family housing.

CMHC requirements for floor trusses in multi-family houses are very stringent in terms of deflection limitations, fire ratings and sound transmission classifications. Though the multi-family housing governed by CMHC building requirements tends to be well below half of total multi-family starts, the CMHC regulations appear to be hampering the development of floor trusses in the Canadian market. The effect of this appears to vary according to local interpretation of the regulations. The impact of these regulations is very significant to the development of floor trusses, since the greatest potential market is in multi-family housing.

The use by the industry of the larger spans for commercial, industrial and agricultural building varies across the country. In the West, the use of lumber is predominant, with the exception of some parts of Alberta where precast concrete systems are well accepted. However, in Ontario and Quebec, roofing systems using wood face severe competition from the local steel industry.

According to some of the companies contacted, a substantial proportion of so-called "floor" trusses are actually being used in cathedral style roofs. One plate manufacturer, that produces a metal web plate system for floor trusses, estimated that half of the trusses probably went into roofs, and not floors.

Lumber Utilisation

The pattern of lumber consumption in the Canadian industry is very different from that in the U.S., and the predominant species used is S-P-F. The design concepts and the code requirements appear basically similar to the U.S., though snow loads in Canada tend to be greater than those in the U.S. However, despite these factors, the Canadian truss industry appears generally to use lumber of much lower strength values than the industry south of the border.

In principle, it would appear illogical that a fabricator in the southern states should regard #1 Southern pine (F_b rating at 1700) as essential, whereas a fabricator in Ontario sees no need for anything stronger than #2 S-P-F (F_b rating of 1050 in Canada and 1000 in U.S.) for the bulk of the pitched roof, residential trusses. Even in areas in the U.S. where S-P-F is competitively available and widely used in construction, fabricators do not use #2 S-P-F.

No really satisfactory answer is found to identify the root cause of this. It appears to be a combination of design philosophy, traditional practice and lumber availability. Though engineering is meant to be an exact science, there are so many variables of species, grades, plate sizes, truss configurations, code interpretations and so on, that no two engineers are likely to develop exactly the same truss design for any given set of conditions. It is primarily for this reason that the principal level of competition between plate manufacturers is not so much in the type of plate sold, but in the quality of engineering expertise supplied.

From Manitoba east, fabricators use S-P-F almost exclusively, unless some special designs require greater strength, in which case they purchase Douglas fir. There are even some companies that are said to purchase Southern pine. The majority is purchased as #2 and better since producers do not sell the grades separated. Where the design calls for #1, the fabricators sort this from the bundles and, typically, assess a cost of about $20 per thousand board feet for undertaking the sorting.

A limited volume is being used in the higher MSR grades for floor trusses. A very significant element is this area is the availability of 2 x 5. This size appears to be of great advantage to the truss industry and represents about 15% of purchases in the East. The use of 2 x 3 is also extensive and, including web material, can amount to 25% to 30% of volumes used. These sizes appear to be readily available from mills in Ontario and Quebec. They are prepared to supply uneven lengths such as 15', 17' and 19'. The availability of uneven lengths appears to be of considerable value to fabricators in reducing waste. The standard practice in this area appears to be the purchase of green lumber. Though all designs are based on 19% moisture content maximum, the fabricators appear to be confident that the lumber will have reached this level by the time it is in use in the structure. Any problems they may encounter due to shrinkage appear to be outweighed by the additional cost of purchasing dry lumber.

From Manitoba west, though S-P-F in #2 and better remains predominant, there are a number of differences in lumber utilisation. Douglas fir is of more significance than in the East, particularly in B.C., and there is a limited volume of hemfir being used. It is interesting to note, however, that even on Vancouver Island, the principal fabricators use S-P-F in preference to the local coastal species.

In addition to the #2 and better grades, some fabricators also purchase S-P-F in select structural where greater spans are required. There is, however, effectively no availability, and therefore no consumption, of 2 x 5 or uneven lengths, and the volume of 2 x 3 in stress grades is negligible. There are some companies using substantial volumes of MSR lumber, but it was found that these companies tended to be those which had developed into floor trusses and long span trusses. Very few appear to be using MSR lumber for standard residential pitched roof trusses.

It is important to emphasise, moreover, that a significant number of those contacted in B.C. and Alberta were very critical about the amount of wane in MSR lumber. They emphasised that the current grading rules, relative to wane in MSR lumber, are totally unrealistic for a product that is to be used in truss manufacture. The strength of a truss depends on both the strength of the materials used and on the strength of the connection between them. If there is wane where a plate is to be placed, the lumber is worthless, however strong it may be. Many of these fabricators are accustomed to purchasing select structural grades, where wane is restricted. This, no doubt, influences their attitude.

Volumes Purchased by the Truss Fabrication Industry

There are even less hard data concerning lumber consumption in the truss industry in Canada, than are available for the U.S. On the basis of the most recent information (1), it would appear that the volume of lumber used in framing roofs and ceilings of residential construction is in the region of 250 million board feet, when housing starts are at 200,000 units annually. The consensus of those involved in the truss industry is that 70% to 80% of roofs are framed with trusses. This would, therefore, indicate a lumber consumption level in trusses of close to 200 million board feet in residential construction. Bearing in mind the somewhat lower level of development than the U.S. into floor trusses and the non-residential truss market, it appears questionable that the truss industry would consume much more than 275 million board feet, based upon housing start activity at 200,000 units annually.

5.4 Joist Fabricating Industry - United States

It has been found necessary to make a distinction between the truss fabricating industry, which manufactures both pitch and flat trusses, and the companies which are solely concerned with a product that replaces joists. There are basically three categories of fabricated joist. These are:

- a fabricated I beam. This often has a plywood web and the top and bottom chords can be lumber or laminated veneer strips.

- wood web trusses. The web members are wood and are joined to the chords by metal plate connectors.

- metal web trusses. The web members are metal and are joined to the chords by pins. Some proprietary methods also have a metal plate connector on the ends of the metal web members.

The wooden web trusses have, essentially, been covered under the previous section on the truss industry. Where the proprietary webs are being developed and promoted by the metal plate manufacturers, these have also been covered. However, there are a number of companies that have developed different systems of joist fabrication and have established their own manufacturing facilities. These tend to operate in a different manner to the truss industry which, as was explained earlier, consists mainly of a large number of small to medium independents, operating locally. In contrast, joist fabricating companies have manufacturing and sales coverage across large areas of the continent. For example, Trus Joist has 14 plants in North America.

---

(1) The Use of Wood and Wood Based Building Materials in New Residential Construction in Canada - 1969. Dept. of the Environment, Ottawa.

The joist fabrication industry has developed closely engineered products and appears to very conscious of the inherent dangers in visually stress graded lumber. Consequently, the majority of the companies involved appear to be purchasing MSR lumber. Another reason is the need for higher tension values than can be obtained with readily available visual grades. The principal size is 2 x 4 and most of the companies finger-joint in order to obtain the necessary lengths.

The MSR grades depend on location to some extent but appear to be principally 2100f-1.8E and 2400f-2.0E, though one of the more recent companies has selected 1650f-1.5E. Since the connectors are being used on the 2" face, and this applies to all 4 x 2 flat trusses, wane is a very serious defect. Knot sizes on the wide face are also critical. The result is that some companies, in particular Trus Joist, have developed their own visual grade requirements to be applied to MSR lumber.

The critical strength factors for this industry tend to be E and F_t values. Consequently, there is some pressure developing from joist fabricators to alter the quality control and calibration system currently in operation for MSR lumber. They argue that the correlation between F_b and F_t, currently used, is too variable and that the proof testing should be undertaken for tension, not bending. This could have a significant impact on MSR operations, since the cost of tension testing is somewhat greater, both for operating and in terms of initial capital. There is also some concern among these fabricators that F_t values vary significantly with the length of the piece.

Problems of this nature are a logical corollary of more sophisticated engineering techniques. As industry begins to use the strength characteristics of lumber more precisely, the need becomes greater to develop a more exact knowledge of these characteristics.

The joist fabrication industry is of very real significance to MSR producers and probably accounts for 25% to 30% of MSR lumber consumed. Though the principal size currently being used is 2 x 4, there are a number of joist fabrication companies, particularly those producing I joists, who are very interested in MSR 2 x 3. In order to obtain this, one of the companies is splitting selected 2 x 6 and then mechanically grading with a Stressomatic. This company advised that it would much prefer to purchase the size but currently had no option since no MSR producers would sell 2 x 3.

Though the joist fabrication industry has been discussed separately, the volumes used are essentially already included in the volume assessed for the truss industry.

5.5 Joist Fabricating Industry - Canada

In contrast to the U.S., where there are several companies manufacturing joists of various types, in Canada there is only one company actually producing at this time. The market area of this company is basically limited to the three most western provinces. The product lines produced are a micro-lam I beam and a metal web joist. For the latter, only MSR lumber is used.

5.6 Laminating Industry - United States

There are approximately thirty companies manufacturing glue-laminated beams in the U.S. Of these, four or five large companies would account for well over 50% of the production. Over 70% of the industry, and most of the larger companies, are located in the West. The controlling body for the industry is the American Institute for Timber Construction (AITC), located in Denver, and the principal production appears to be in straight laminated beams for the large warehouse roofing market, and also for large farm structures. There is also production of specialty "arched" beams, but it appears that this would represent a relatively small part of the business.

Under the regulations of the AITC, the company producing the laminated beam is responsible for the grade of lumber being used and, therefore, all these companies do their own grading. Originally, the standard method of construction was with visually graded lumber. Under more recent design specifications, however, the AITC designs now include what is called E rated lumber. This is not the same E as is measured in MSR and is based on a long span flat test.

When the lumber is tested, 20 pieces are taken from the sample and tested on a long span, the average has to be the Grade E and 90% has to be better than 100,000 psi below the Grade E. One MSR producer, in order to sell to the laminating industry, undertakes a long span test, in addition to the CLT testing, on the product. It appears that the lumber graded as 1.5E on the CLT is roughly equivalent to 1.6E on the long span E basis. This could, however, vary from mill to mill and is certainly not an accepted relationship that exists for all lumber.

On the visual grade basis, the relationships between normal WWPA rules and the laminating rules are as follows for Douglas fir:

Dense select structural	L1
Select structural close grain	L1CL
Dense #1	L2D
#1	L2
#2, #3	L3

The total volume of consumption in the laminating industry is estimated at 200 million board feet. An analysis of consumption within the laminating industry indicates that a typical beam would have the following percentages of the different grades:

L3	60%
L2	between 30% and 10% depending on species
L1	the balance

A laminating grade has a number of special needs relative to normal grading. The principal of these are a 16% maximum moisture content, special wane restrictions and much closer size tolerance limitations. Because of this, some of the larger companies, for example Standard Structures, tend to buy rough green and undertake their own drying and planing.

When the volume of the lower grades involved in considered, in addition to the companies that are buying rough and doing their own planing, it appears likely that the total market for the higher stress grades is limited. Consequently, the current total market potential for MSR lumber, specially produced to relate to the laminating business, is relatively small and is probably less than 30 million feet for the U.S. as a whole.

The sizes used by the laminating industry are larger than the truss fabricators. Basically 65% to 70% appears to be in 2 x 6, 15% to 20% in 2 x 8, with the balance in 2 x 10, 2 x 4 and 2 x 12.

One of the major West Coast laminators is currently considering changing its lumber purchasing approach and buying MSR lumber. The economics appears to be favourable in terms of price and yield, and the MSR producer appears to be confident that the necessary additional grading requirements can be met. If this approach is adopted by other laminators, then there could be a significant increase in the potential for MSR lumber from the current level of only 30 million board feet to over double that volume. It should be noted, however, that one of the larger laminating companies is also a very large producer of MSR lumber, but still uses visually graded lumber.

The laminating industry clearly could represent a significant potential, in the future, for MSR lumber, but any producer would have to make a very specific commitment to the industry. The sizes and the grade requirements are too different from the regular truss and joist industry business to allow the producer to regard the laminating industry as merely one more outlet.

5.7 Laminating Industry - Canada

The Canadian laminating industry is not large and is concentrated in the West. There is a manufacturers' association (Laminated Timber Institute of Canada), and manufacturing procedures are tightly controlled by CSA 0122. The number of companies belonging, or total that exists, is currently less than 10 and their lumber consumption in 1980 was 15.5 million board feet. This was a slight improvement on recent years, but was only half of the volume consumed in 1966.

The laminating companies tend to buy Douglas fir, kiln dried to 10% to 14%, in special laminating grades. Before use, the lumber must be mechanically graded to obtain an "E" rating. This is an essential part of the CSA standard and is the responsibility of the laminators, who usually have their own special machines. The principal sizes are 2 x 6 and 2 x 8, which would account for 78% to 80% of purchases, and most of the balance would be in 2 x 4 and 2 x 10. About 60% to 65% of the volume consumed is in the better grades, while the balance would be of lower quality for use in the less critical parts of the beam.

Due to the low volume of lumber consumed and the very stringent grade requirements, it does not appear that this industry represents a significant potential for regular MSR lumber. However, if a mill decides to specialise in production of laminating stock in MSR for the U.S. industry, then the Canadian market could provide a small incremental potential. It should be noted, however, that it may be difficult to develop a market for species other than Douglas fir or, conceivably, hemfir.

5.8 Manufactured Housing - United States

It is estimated (1) by the National Association of Home Manufacturers that, in 1980, approximately one-third of all housing starts can be identified as factory made. This would include the following categories:

- Pre-cut Homes - defined as a manufactured house sales package for which the many parts are pre-cut but not pre-assembled. Roof trusses could form part of the package. Approximately 20,000 units were produced in 1980.

- Panelized Homes - defined as a manufactured house sales package that includes wall panels and may include roof and floor systems, in addition to a variety of building materials. Approximately 100,000 units were produced in 1980.

---

(1) The Red Book of Housing Manufacturers (1981)

- Modular/Sectional Homes - defined as a three dimensional unit produced in the factory and designed for permanent erection on site with a minimum of labour. Approximately 35,000 were produced in 1980.

- Mobile Homes - defined as a three dimensional living unit totally completed in the factory and conforming to the HUD standards for mobile home construction. All the other units conform to normal residential codes. Approximately 220,000 were shipped by manufacturers in 1980.

Since all these manufactured homes are subjected to more sophisticated design techniques than on-site construction, it would seem logical to conclude that this would be an industry where the strength values of lumber would be of importance. It would, therefore, appear to be an industry where MSR lumber could have a potential. However, it was found that, except for mobile homes, there was no significant difference from on-site housing, in the nature of the lumber utilised. Roof and floor trusses are fabricated in a fashion similar to conventional housing and the wall panels would not appear to benefit from the better stress values to be obtained with MSR lumber.

The mobile home industry is very competitive and tends to use lumber of a smaller cross section. Codes are controlled on a national basis by HUD (1). It does not, at this time, appear to offer a potential market for regular MSR lumber. There is the possiblity, however, that if a mill could produce MSR lumber in the smaller sizes required by the industry, some potential may exist. It is estimated (2) (3) that the mobile home industry consumption of lumber was in the region of 760 million board feet annually in the period 1976-80. Consequently, a significant potential should exist, though the demand may be heavy to the lower MSR grades such as 1200f-1.2E. Contact with some of the principal mobile home fabricators indicated that, at the purchasing level, they have never really considered MSR lumber. However, some of the people involved in engineering design were very enthusiastic about the concept. They have difficulty in obtaining, at present, visually stress graded 1 x 3 and 1 x 4. Many of the trusses used also utilise 1½ x 1½, which they often resaw from 2 x 6 and grade themselves due to the lack of availability.

---

(1) Housing and Urban Development, Mobile Home Standards
(2) Forest Policy Project, Washington State University. (1981)
(3) Use of Wood in Mobile Homes is Increasing FPL4 USDA (1978)

It must be emphasised, however, that -- as with the laminating industry -- a mill wishing to sell MSR lumber to the mobile home industry would need to develop specific programmes with users. It is not merely one more outlet for regular MSR lumber.

5.9 Manufactured Housing - Canada

The situation relative to the potential for MSR lumber within the manufactured housing industry in Canada is basically similar to that found in the United States. It is, however, an industry that is smaller, even on a proportional basis, than the U.S. and therefore cannot be regarded as offering any substantial outlet for MSR lumber at this time.

5.10 Summary

The industry sectors of particular interest to MSR lumber producers are the truss and joist fabricating industries and, to a lesser extent, the laminating industry. The mobile home industry is also of potential interest, though the sizes required are very different from regular dimension sizes.

An analysis of lumber consumption by these industry sectors indicates that the total volume consumed would be in the region of 4.2 billion board feet per year:

Estimated Total Lumber Consumption

(million board feet)

	U.S.	Canada	Total
Truss Industry (including fabricated joists)	2,900	275	3,175
Laminating Indstry	200	15	215
Mobile Homes	760	50	810
Total	3,860	340	4,200

Source: Woodbridge, Reed estimates.

Not all of this can be considered, at present, as a potential market for MSR lumber. This is discussed in the section on the market potential for MSR lumber, where the impact of future developments is considered relative to current potential and the maximum market penetration levels.

When each of the factors that influence lumber purchase are considered, it becomes clear that MSR lumber has some advantages in almost all cases. The most important factor, however, is price. It is, therefore, concluded that MSR lumber cannot be assumed to command any significant premium over comparable visual grades. At a similar price, however, it can compete very strongly due to these many advantages.

6. FUTURE DEVELOPMENTS AND IMPLICATIONS FOR MSR

6.1 Introduction

During the past ten years, there has been a great deal of activity among the scientific and engineering community relative to structural analysis. As a result of this, very sophisticated designs and design techniques have been developed in the whole field of engineering with wood. Unfortunately, this effort has not been matched by an equivalent amount of research and time on the part of the lumber industry.

The result, therefore, to quote Professor Stan Suddarth of Purdue University, is that "the engineering is now better than the material." Sophisticated analytical modelling techniques have been developed that will allow almost any roof, wall, floor or combination structure to be analysed in endless detail on a computer. Yet, the design strength information fed into the programme, relative to the lumber, could be significantly different from the actual strength of the piece of lumber that is used when the structure becomes a physical reality.

The problem, essentially, is that lumber is not a manufactured product; it is extracted, with no substantial alteration, from a product of nature -- a tree. Consequently, it is subject to all the vagaries of nature. Until the forest industry reaches the stage where trees are broken down into fibre and then reconstituted into the required product, this situation is likely to continue -- unless lumber can be graded more precisely.

6.2 Design Values

In recent years, "in-grade" testing programmes have been initiated. The objective of these programmes has been to develop reliable information on the strength characteristics of lumber that is within a particular grade. These tests were initiated somewhat earlier in Canada than in the U.S. The findings of earlier series of tests were that there was a substantial reduction in values for a given grade as the cross section of the piece became greater. Tests in Canada also demonstrated that the allowable unit stresses for tension parallel to grain for Douglas fir should be reduced. This resulted in a change in the Engineering Design Code CSA 086.

The most recent series of tests in Canada have resulted in recommendations that further and very significant changes should be made. A comparison of the current and recommended values for F_b is shown in Table 8. Perhaps the two most surprising aspects of the recommended values are that Douglas fir should be given a lower design value than S-P-F (except for select structural), and that #1 and #2 grades should be rated the same.

Table 8

Comparison of Current and Recommended Design Values for 38 x 89 mm (2 x 4) Lumber

Extreme Fibre Stress in Bending

		Metric Units (MPa)		Imperial Units (psi) 1/	
		Current	Recommended	Current	Recommended
Douglas fir	SS	15.0	14.7	2200	2100
	#1	12.8	8.25	1850	1200
	#2	10.6	8.25	1550	1200
	#3	5.8	5.7	850	825
hemfir	SS	11.2	13.5	1650	1950
	#1	9.5	9.75	1400	1400
	#2	7.8	9.75	1150	1400
	#3	4.3	7.2	625	1080
S-P-F	SS	10.5	13.5	1500	1950
	#1	8.9	9.75	1300	1425
	#2	7.3	9.75	1050	1425
	#3	4.1	7.2	600	1050

1/ converted to nearest round number at a factor of 145.

Source: CSA CAN3-086-M80 and latest recommendations.

The reason for this lies in the variability of a natural product, as discussed earlier, and the need, within a design code, to allow for this variability. Consequently, though it may be that the average piece of #1 Douglas fir is likely to be stronger than the average piece of #2 Douglas fir or of #1 S-P-F, it is the low end of the probable values that is of concern to the code.

It was found during the extensive in-grade tests that, when the bottom 5% to 10% of the grades was evaluated, there was no significant difference in values found for #1 and #2 grades. Similarly, the effect of the defects found in the lowest range of Douglas fir grades, compared to other species, was that poorer results were obtained.

U.S. tests are still underway and it is not known at this stage how the results, and the analysis of these results, will affect current NDS (1) values. It should be noted that at this stage, U.S. testing has been limited to Douglas fir, hemfir and Southern pine. There are, however, plans to extend these tests to other species.

The approach being taken in the U.S. will be to analyse the effect of the values on the total structure. Consequently, the strength values considered may not depend so much on the lowest strength values of a single piece of lumber, but more on the probabilities of low values in repetitive use. A roof truss is rarely used singly and is almost always one of a series of trusses used to form a roof structure. In a recent presentation by E. G. King of NFPA (2), the following comments were included. "Regardless of the results of the in-grade testing research, we know light frame wood structures, made in certain traditional ways, perform satisfactorily. The new methods will help to assure that no unnecessary reductions in use recommendations take place."

The effect of the new design values in Canada on the economic potential for MSR lumber in Canada is very significant. It is apparent that the values that had been assigned to S-P-F had been well below the true strength values to be found in the species. This was one of the essential factors that contributed to the economies of mechanical grading in the Interior of B.C. Mills found that, prior to the visual override, an extremely high percentage of the S-P-F put through the machine yielded values in excess of those assigned, even to select structural grades (assessed at 1500f in Canada and 1450f in the U.S.). If these assigned values are to be substantially increased, the economics of an MSR operation must be affected. Though there are a number of other factors in favour of MSR lumber, and these are discussed elsewhere, one of the major elements is the fibre bending stress value in relation to visual grades.

---

(1) National Design Specification for Wood Construction - 1977 plus July 1981 Supplement

(2) Introduction of New Design Methods into Building Codes E.G. King, National Forest Products Association (Nov. 1981)

Table 9

Species and Grades in Order of Design Values [1/] for Extreme Fibre Bending Stress

		Current		New	
Species	Grade	F_b mPa	Rank	F_b mPa	Rank
Any	2400f-2.0E MSR	16.5	1	16.5	1
Douglas fir	Select Structural	15.0	2	14.7	2
Any	2100f-1.8E MSR	14.5	3	14.5	3
Douglas fir	#1	12.8	4	8.25	13=
Any	1800f-1.6E MSR	12.4	5	12.4	6
Any	1650f-1.5E MSR	11.4	6	11.4	7
hemfir	Select Structural	11.2	7	13.5	4=
Douglas fir	#2	10.6	8	8.25	13=
S-P-F	Select Structural	10.5	9	13.5	4=
Any	1450f-1.3E MSR	10.0	10	10.0	8
hemfir	#1	9.5	11	9.75	9=
S-P-F	#1	8.9	12	9.75	9=
hemfir	#2	7.8	13	9.75	9=
S-P-F	#2	7.3	14	9.75	9=

Sources: CWC WP-5 Machine Stress Rated Lumber
CSA 086 and new recommendations

1/ for 38 x 89 mm (2 x 4)

An analysis of design values for the major grades and species used in Canada in truss fabrication is shown in Table 9. This demonstrates that the design values assigned to S-P-F, currently, result in visual grades of S-P-F being of a low rank in terms of F_b value. Consequently, if by machine grading, a mill can obtain a substantial volume of grades such as 1650f-1.5E, 1800f-1.6E or 2100f-1.8E, then the ranking, and therefore the value, of the product to the truss fabricator is dramatically increased.

The effect of the new design values is shown in the same table. Select structural S-P-F moves from ninth ranking to fourth and, consequently, becomes of higher strength than 1800f-1.6E MSR lumber. Select structural S-P-F therefore will apparently be of greater value to the fabricator than 1800f-1.6E MSR. Similarly, the differential in terms of design stress values between a #2 and better visual grade and a 1650f-1.5E MSR grade is substantially reduced.

The situation relative to Douglas fir is, however, quite the reverse. With the new design values, visual grades will be heavily penalised. If, as appears likely, there is a substantial volume of high stress value lumber within the #2 and better grade, then the economics of machine grading are very favourably affected by the new values.

In the interests of comparison, to show the, currently, very low position of even the best visual S-P-F grades, compared to other species used in the U.S., Table 10 has been developed for the products commonly used in the U.S. The effect of the proposed changes has not been included, since there is no suggestion, at present, that the U.S. authorities will be asked to adopt the new Canadian values.

The preceding paragraphs have concentrated on the situation relative to F_b. However, there is another stress factor which is also of great importance to engineers. This relates to tension parallel to grain and is of particular importance to floor trusses and fabricated joists. New design tension values have already been implemented in Canadian codes and, therefore, this can no longer be regarded as a "future development". However, it is appropriate at this stage to analyse the position of MSR lumber relative to visual grades. This is shown in Table 11.

It is again apparent that better values are obtained for visual select structural S-P-F, than for 1650f-1.5E MSR, but that Douglas fir values for #1 and better are well below what can probably be yielded from mechanical grading. It is important to note, however, that in the higher MSR grades the tension values are substantially better than any visual grade. This is of very great importance relative to the floor truss and joist market.

Table 10

Species and Grades in Order of Design Values for 2 x 4 for Extreme Fibre Bending Stress

Rank	Species	Grade	F_b p.s.i.
1	SP	KD Dense Select Structural	2500
2	Any	2400f-1.0E MSR	2400
3	SP	Dense Select Structural (19% MC)	2350
4=	SP	KD Select Structural	2150
=	SP	KD #1 Dense	2150
6=	Any	2100f-1.8E MSR	2100
=	DF-L	Select Structural	2100
8	SP	#1 Dense (19% MC)	2000
9	SP	KD #1	1850
10=	Any	1800f-1.6E MSR	1800
=	SP	KD#2 Dense	1800
12	DF-L	#1	1750
13	SP	#1 (19% MC)	1700
14=	Any	1650f-1.5E MSR	1650
=	HF	Select Structural	1650
16	SP	KD #2	1550
17=	DF-L	#2	1450
=	Any	1450f-1.2E MSR	1450
=	S-P-F	Select Structural	1450
20=	SP	#2	1400
=	HF	#1	1400
22=	S-P-F	#1	1200
=	Any	1200f-1.2E MSR	1200
24	HF	#2	1150
25	S-P-F	#2	1000

Source: National Design Specifications Supplement July 1981

NOTE:

SP	Southern Pine
DF-L	Douglas fir - larch
HF	hemfir
S-P-F	Spruce-Pine-Fir

The most important physical characteristic to most floor trusses and fabricated joists is the Modulus of Elasticity. Here, again, there are changes proposed, though of considerably less impact. The advantages of MSR lumber are still evident (Table 12), but not as great as before. There is, however, a further element which could have a great impact on the comparative value of MSR.

In addition to the average Modulus of Elasticity, the recommended changes include the proposal that design should recognise the fifth percentile values. This value defines the bottom 5% of the population, i.e., 95% of the lumber would be expected to be above this value. Since MSR lumber has a much tighter distribution curve, there would be substantial advantages should fifth percentile Modulus of Elasticity values be identified in the codes.

6.3 New Code Concepts

The Canadian authorities have set 1985 as the deadline for a total change in design concept for the National Building Code. This new concept is known as Limit State Design and can briefly be defined as follows:

> The onset of various types of collapse or unserviceability are called limit states. The primary aim of limit state design is to prevent the attainment of limit states. Existing design methods put emphasis on various structural theories, none of which is universally applicable. Limit state design provides a unified rational basis for design calculation for design of the whole structure taking into consideration all elements and all materials being utilised.

A similar approach is being developed in the U.S. to obtain improved, probability-based concepts for load and resistance factor design. Emphasis is being given to the structure as a whole rather than the individual components. Thus, in flooring the effect of the plywood sheathing is being considered in addition to just the joist behaviour.

The initial impact in Canada on material use in construction will be minimal. Basically, the same cross sections and span tables that exist at present will be used and the new design concepts will be applied to establish the safety factors that currently exist throughout the structure. However, the next step will be to rationalise the safety factor and work back to developing new minimum standards for the materials to be used.

Table 11

Species and Grades in Order of Design Values for 38 x 89 mm (2 x 4) for tension parallel to grain

Species	Grade	F_t mPa	Rank
Any	2400f-2.0E MSR	13.3	1
Any	2100f-1.8E MSR	10.8	2
Douglas fir	Select Structural	8.6	3=
hemfir	Select Structural	8.6	3=
Any	1800f-1.6E MSR	8.1	5
S-P-F	Select Structural	7.8	6
Any	1650f-1.5E MSR	7.0	7
Douglas fir	#1	5.6	8=
Douglas fir	#2	5.6	8=
hemfir	#1	5.6	8=
hemfir	#2	5.6	8=
Any	1450f-1.3E MSR	5.5	12
S-P-F	#1	5.2	13
S-P-F	#2	5.2	13=

Sources: CWC, ibid.
CSA 086 and new recommendations.

Table 12

Species and Grades in Order of
Design Values for Modulus of Elasticity

(mean)

Species	Grade	Current		New	
		E	Rank	E	Rank
		mPa		mPa	
Any	2400f-2.0E	13,800	1	13,800	1
Any	2100f-1.8E	12,400	2=	12,400	3
Douglas fir	Select Structural	12,400	2=	12,600	2
Douglas Fir	#1	12,400	2=	10,900	9=
Douglas fir	#2	11,200	5	10,900	9=
hemfir	Select Structural	11,100	6=	11,700	4
hemfir	#1	11,100	6=	11,100	5=
Any	1800f-1.6E	11,000	8	11,000	8
Any	1650f-1.5E	10,300	9	10,300	11
hemfir	#2	10,000	10	11,100	5=
S-P-F	Select Structural	9,300	11=	11,100	5=
S-P-F	#1	9,300	11=	10,200	12=
S-P-F	#2	8,400	13	10,200	12=

Sources: CWC, ibid.
CSA 086 and new recommendations.
= equals joint ranking

One of the very significant factors that is used in Limit State Design is a coefficient of variation. In the equation applied, the greater the coefficient of variation that must be applied to the design strength value of the lumber, the worse the resulting safety factor. By its very nature, lumber is a variable product and the coefficient of variation for lumber that has been visually graded is high. Consequently, in competition with man-made products such as steel or concrete, lumber will be severely penalised. However, when lumber is mechanically graded, the coefficient of variation can be dramatically reduced.

The full implications of this, in practical terms, are impossible to assess, since the codes have not yet been developed. It is clear, however, that the relative rankings shown earlier will change and, consequently, so will the value of MSR lumber relative to visual grades. The impact could even extend to normal on-site construction and a substantial potential could develop for lower MSR grades in wider widths. MSR lumber of equivalent fibre stress and E ratings could be allowed significantly greater maximum allowable spans than visual grades.

6.4 Forest Resource Base

It is generally recognised that the volume of large, mature timber is declining as a proportion of the U.S. and Canadian harvest. An inevitable consequence of this must be a decline in the volume of long length, wide lumber. Due to normal supply/demand pressures, this is likely to lead to a widening in the price differentials between sizes. An analysis of the price differential between 2 x 4 and 2 x 10 green Douglas fir is shown in Table 13. Though there is a great deal of variation over the 11 year period, it is clear that a definite upward trend exists in the dollar amount. This was particularly high in the first half of 1981 though the differential has recently dropped somewhat to $40 per thousand board feet. When the figures are analysed in terms of percentage, the upward trend is not quite so dramatic but, nevertheless, it exists and is particularly apparent in recent years. It is the opinion of most experts contacted that a continued increase in the differential is very likely.

The potential development of floor trusses and fabricated joists depends, to a substantial extent, on how well they can compete with solid wood joists. At present, it is significantly more expensive, in the normal, relatively short spans, for a builder to buy a floor truss than a solid wood joist. A simplistic analysis shows that if lumber represents 50% of the cost of a truss, then the cost of the truss is twice that of lumber. Therefore, since about the same volume of board feet are used, until 2 x 4 is half the price of 2 x 12, the solid joist will be cheaper. There are, however, a number of other aspects that are taken into account by the builder.

Table 13

Comparison of Premiums for Width
2 x 4 and 2 x 10 DF R/L green

(U.S. $ per 1000 board feet Net FOB mill)

Over	2 x 4	2 x 10	Premium for 2 x 10 $	Premium for 2 x 10 %
1970	77	79	2	3
1971	104	110	6	6
1972	122	140	18	15
1973	167	181	14	8
1974	137	160	23	17
1975	140	149	9	6
1976	179	206	27	15
1977	212	231	19	9
1978	241	255	14	6
1979	263	304	41	16
1980	207	239	22	11
1981 (1st half)	193	249	56	29

Source: "Random Lengths"

Note: Prices are annual averages with the exception of 1981.

- easier installation of ducting and other services

- ability to span greater lengths, thus reducing the need for bearing walls and providing larger clear areas

- availability of the exact lengths required

- uniformity and ease of installation

- wider chords for nailing floor sheathing

- wider joist spacing

- reduction in pilfering. This item was quoted by several of those contacted. It appears that on-site pilferage of lumber is a very significant cost factor to a builder.

At present, the impact of these aspects has proved insufficient for floor trusses to develop the very great market penetration achieved by roof trusses. Though it appears unlikely that floor trusses will achieve this level of penetration, it is nevertheless the consensus of those contacted that there will be increasing quantities of floor trusses. Weyerhaeuser believes that "production in flat chord trusses for floor joist replacement and commercial roof systems adaptation will double in the next few years." (1) There is already substantial use in multi-family housing and in commercial construction. As designers and builders become more familiar with floor trusses, it is believed they will no longer restrict their designs to spans that can be met by solid wood joists.

All these factors, coupled with decreased availability of wide, long length lumber and thus higher prices compared with 2 x 4, appear to support the belief that floor trusses have an excellent potential. An important element that could have a significant impact on this development would be the availability of high strength value 2 x 3 lumber. This would allow the fabricator to reduce the lumber content by a significant percentage and be substantially more competitive. At present, the 2 x 3 available is not in the stress grades required; therefore, the fabricator is unable to develop the spans needed without going to great depth.

---

(1) MSR Workshop October 1981

The ratio of span to depth is an important element in the floor truss market. Builders are anxious to minimise the depths of their floor joists. The depth of the joist required for any given span is very dependent on the strength values of the chord members. The critical values appear to be those relative to E and to F_t. It was shown earlier (Table 11) that the tension value levels now accepted in Canada (similar levels also apply in the U.S.) are very much higher for MSR grades than those for visual grades. It is for this reason that the majority of companies producing floor trusses or fabricated joists utilise 2100f-1.8E and 2400f-2.0E.

It is estimated that the growth of floor trusses will have a significant impact on the potential for MSR lumber. This potential will tend to be primarily for the higher grades. There is the possibility, however, that, where fabricators are endeavouring to rationalise and reduce the variety of product stocked, they could choose 1800f-1.6E grade which would allow them to replace Douglas fir #1 (1750f at current design values in the U.S.) in roof trusses and, at the same time, have lumber that can perform substantially better for floor trusses. Though a 1650f-1.5E grade would also have an F_t value better than that of Douglas fir, it appeared to be the general belief among those contacted that it would not be widely used in floor trusses. This could primarily be due to the much lower E value which tends to be a critical aspect in design.

There is a further aspect relative to the forest resource which encourages the development of MSR lumber. It is generally recognised that U.S. and Canadian fibre resources are far from limitless. All members of the community, from producer to consumer, must therefore work towards ". . . better utilization of raw materials and producing more highly engineered products, such as machine stress-rated lumber . . . . . .". This quotation is taken from a recent report to stockholders by the President of Weyerhaeuser.

6.5 Finger-Jointed MSR

A future development, which could have a significant impact on the supply opportunities of MSR, is the concept of a stress graded finger-jointed material. From the demand point of view, this could offer considerable benefits relative to lengths available and the need to splice with metal connector plates.

Industry experts suggest that the manufacturing method to be followed would be:

a) Run the lumber to be finger-jointed through the CLT before defects are cut out. A programme can be developed to ensure that the points in the board with a low E rating can be identified. An average E can be developed for the board, discounting the effect of the parts that will be removed prior to finger-jointing.

b) Separate the boards by E classifications.

c) Cut out visual defects and the identified low E points.
d) Finger-joint.
e) Plane.
f) Proof test for tension.

By following this conceptual production flow, very high quality MSR lumber could be developed. Problems exist, relative to joints in the plate area, but these are not significantly greater than the restrictions that already exist for knots in the plate area. The greatest hurdle to be overcome will probably be consumer prejudice. However, in the case of MSR lumber, the initial consumer, the fabricator, is reasonably technically oriented.

It is anticipated that finger-jointed MSR should, therefore, have a better acceptance potential than finger-jointed random length lumber. A product with controlled and proven strength factors, which is stable in extreme climatic conditions and can be supplied in specific lengths, appears likely to be of value to the user. The initial market areas could be those which have already realised the advantages of finger-jointed structural lumber, such as Texas (1). It must be emphasised, however, that the market study did not investigate the concept of finger-jointed lumber in depth.

6.6 Plate Holding Capacity

The strength of the lumber is only one element in the strength of a truss. Equally important is the strength of the joint between the lumber. This is determined by the size of the plate and the "plate holding capacity" of any given plate. At present, the plate holding capacity is species- dependent and S-P-F is rated low. The effect of this low rating is that the truss fabricator must use a larger plate if he is using S-P-F than if he is using Douglas fir. The difference is not very dramatic but is, nevertheless, significant in that it could cost the fabricator 20¢ to 30¢ more per truss of a typical configuration. This represents about 1% of the truss value. When considered in terms of per cent of profit, it becomes somewhat more significant. It is also considerably more important in floor joists where the number of plates is much greater.

The principal reason for the lower values applicable to S-P-F relate to the average specific gravity of the species group. In Canada, the regulations are particularly strict and -- when plates are tested -- the specific gravity of the lumber to be used is defined. Consequently, whatever the grade of S-P-F, the same specific gravity is assumed effectively and, therefore, the same plate holding capacity applies. The same holds true in the U.S. though there are not the same detailed standards for tests.

(1) See also: The Market Potential for Spruce-Pine-Fir Specialty Sawn Products, prepared for the Cariboo Lumber Manufacturers' Association by Woodbridge, Reed and Associates Ltd. - Ministry of Industry and Small Business Development, Government of B.C. May 1981.

There is strong evidence to support the concept that there is a close relationship between the specific gravity and the E value of a given piece of lumber. This is not yet totally proven and a detailed study has been proposed, by Forintek, to ascertain the relationship.

Since MSR lumber is sorted on the basis of E values, it is, therefore, logical to suppose -- assuming the relationship is proven -- that it is also effectively being sorted by specific gravity. Consequently, all S-P-F lumber that, for example, qualifies for a 2100f-1.8E rating will have a specific gravity well in excess of the species group average. As a result, it should also have a better plate holding capacity.

The implications, therefore, are that S-P-F MSR lumber should be allowed higher plate holding values than visual grades of S-P-F. Whether this can be extended to proving that MSR lumber can be species independent for plate holding values, as it is for many strength values, is rather less likely. It is worth noting at this stage that there are other values such as horizontal shear and compression perpendicular to grain which are species -- not grade -- dependent. There may be a case for identifying the influence of specific gravity of these values. If a high value MSR grade can be shown to be better in perpendicular compression, this could have a significant impact on the potential for S-P-F MSR lumber in high snow load areas such as Minnesota.

Plates are of greater significance in floor trusses than in roof trusses. The potential growth of floor trusses has been shown earlier to be of great significance to MSR lumber. This potential would be greatly enhanced, particularly relative to S-P-F, if plate holding values can be related to MSR grades.

6.7 Summary

New design values are being developed for various species. The immediate effect of these changes will be felt in Canada, where the strength values of visually graded S-P-F are likely to be increased substantially. This will have a direct, and negative, impact on the value of S-P-F MSR lumber in the low to medium grades. However, the effect of the changes relative to Douglas fir would favour mechanical stress grading of Douglas fir since visual grades are to have much lower values. A similar move in the U.S. is unlikely to occur until new design concepts are also included.

These new concepts could be of great advantage to MSR lumber, since product variability will be an important factor. MSR lumber is much less variable in strength than visual grades due to the method of sorting. The new design approach will tend to penalize visually graded lumber relative to other structural building materials. This uncompetitive position can be overcome by mechanical grading. Though the practical implications of the new design approach are not yet clear, it is possible that the potential market for MSR lumber could be widened dramatically to include standard floor joists.

The influence of the changing forest resource is also significant. The decline in the availability of large logs from which to obtain long lengths of wide dimensions is likely to increase the economics of manufacturing structural components from smaller dimensions. These components will be designed for applications currently satisfied by solid wood. More sophisticated use of wood as an engineering material will demand greater reliability of the material. MSR lumber would satisfy this demand.

The need for improved utilization of the diminishing forest resource is also likely to encourage development of finger-jointed MSR lumber. With the correct production process, well-manufactured, reliable and proven lumber can be produced to tightly controlled strength values.

The knowledge of the inherent strength values that are established by mechanical grading is not being fully exploited. When E is evaluated, there are a number of physical characteristics that it may be possible to deduce other than just F_b, F_t and F_c. Further research appears necessary to develop additional advantages, with respect to characteristics such as plate holding capacity, for MSR lumber compared to visually stress graded lumber.

7. MARKET POTENTIAL FOR MSR LUMBER

7.1 Introduction

The analysis of each industry in Section 5 indicated that the best estimate of lumber demand by the industries of potential interest is approximately 4,200 million board feet. Not all of this can be considered potential for MSR lumber. In order to assess some base line potential from which to develop future projections of demand, a number of factors need to be analysed.

7.2 Components of Base Line Market Potential

Initially these relate to the need for -- or real value of -- MSR lumber if a lower grade of wood is adequate.

- Webs

  The truss fabricators would be unlikely to buy MSR lumber for webs. Though the proportion of web material to chords will vary with the configuration of the truss, an estimate of 25% appears to be generally agreed for pitched roof trusses. For floor trusses, this is estimated to be higher, at close to 35%.

- Short Spans

  In many of the shorter spans, the stress values assigned to visually graded #2 and better are quite sufficient for the truss design. The FPRS study (1) analysed the roof truss length distribution and the results are shown in Figure 2. This has been plotted as a cumulative probability curve and demonstrates that, for the U.S., 76% of the spans would be expected to be 28' or less.

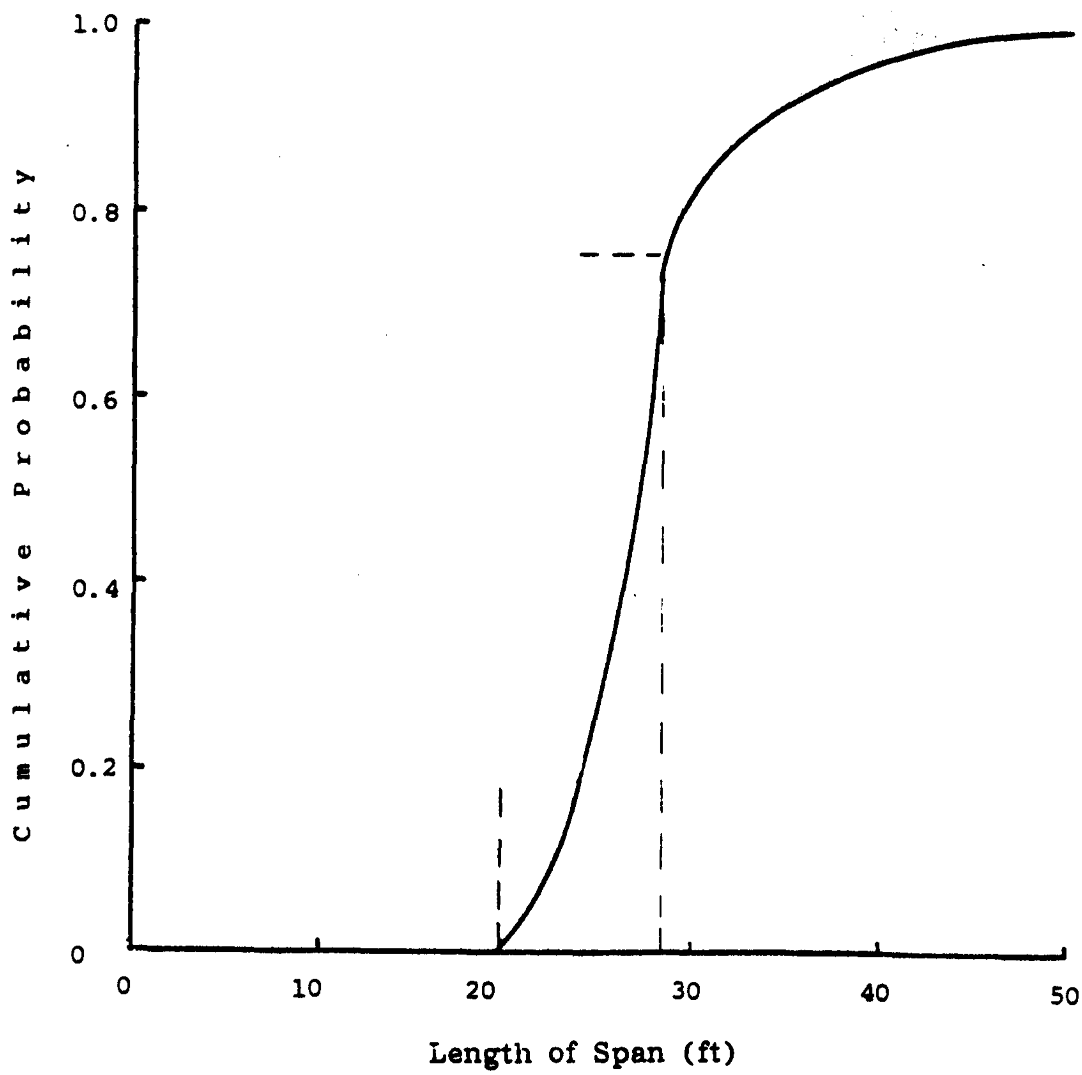
  Similar data are not available for Canada; however, a comparison can be made of average house sizes in Canada relative to those in the United States (2) (3) (4). Such a comparison reveals that Canadian houses tend to be smaller. It is therefore logical to assume the truss spans are likely to be less.

---

(1) ibid.
(2) "Characteristics of New Housing: 1980", U.S. Dept. of Commerce.
(3) Canadian Housing Statistics - CMHC.
(4) Data Resources Inc., Forest Policy Project, Washington State University (1981).

Figure 2

Distribution of Spans for Roof Trusses



Source: Based on TPI field study data

> Bearing these factors in mind, it is estimated that, for the U.S., a minimum of 50% of all residential trusses can be constructed with #2 and better visually graded lumber. For Canada, it is believed that this figure should be raised to 70%. Though floor trusses can be built with lower grade lumber, it is estimated that, for all chord material in these flat trusses, MSR lumber offers potential advantages. For non-residential trusses, it is assumed that 80% of the time the spans tend to be large and MSR lumber would be of value.

On the basis of these assumptions, an approximation can be made of the maximum potential market for MSR lumber. The calculations are shown in Table 14. The volumes obtained are 1,390 million board feet for the U.S. and 95 million for Canada.

At this stage, only the potentials of the truss and joist fabricating industries -- as they currently exist -- have been analysed. The very specific needs of the laminating industry, outlined earlier, would be additional. Similarly, the even less standard and somewhat uncertain potential requirements of the mobile home industry have not been included. It is felt that, for the purposes of analysing MSR potential at this time, it would be preferable to exclude the potential demand from these two industries. The laminating industry is small, relative to the potential in the truss industry, and the mobile home industry potential is one that would be essentially peripheral to the main thrust of dimension MSR lumber production.

Having developed a "base line" maximum market potential for MSR lumber of approximately 1,500 million board feet, it is necessary to analyse the factors that would influence: first, the maximum potential and, second, the likely volumes of MSR lumber within that potential. The first, therefore relates to the expansion of industries likely to use MSR lumber. The second relates to how much penetration MSR lumber can expect in competition with visual grades.

7.3 Maximum Potential as a Result of Industry Expansion

As explained earlier, the truss industry has already reached close to saturation level in the roof market. Any growth here is, therefore, limited to growth in residential construction. It was pointed out, however, that the truss industry is expanding into two other areas -- floor trusses and large non-residential trusses.

Table 14

Analysis of Maximum MSR Potential Utilization

	U.S.	Canada
Residential		
Lumber used in pitched roofs		
million board feet	1,680 1/	225
percentage web	25%	25%
percentage short span	50%	70%
MSR potential million board feet	630	50
Lumber used in floor trusses	200 2/	50
percentage web	35%	35%
MSR potential million board feet	130	10
Non-residential		
Lumber used in pitched roofs		
million board feet	400 3/	25
percentage web	25%	25%
percentage short span	20%	20%
MSR potential million board feet	240	15
Lumber used in flat trusses		
million board feet	600 3/	30
percentage web	35%	35%
MSR potential million board feet	390	20
TOTAL MSR POTENTIAL		
million board feet (approximately)	1,390	95

1/ Based on Forest Products Research Laboratory levels for 1978 but factored down to 1.6 million housing starts.

2/ FPRL figures increased to allow for recent penetration.

3/ Based on Weyerhaeuser calculations.

- Floor truss potential

The volume of lumber used in framing floors in residential construction will vary, depending on the proportion of multi-family housing, where the average square feet per unit is lower, and the geographic mix of new housing. In the South, houses are very often built on a concrete slab. Using the average of the figures available for the past five years in the United States (1) and published information on lumber use (2), it can be estimated that the total volume of lumber used for framing floors in residential construction is approximately 2 billion board feet. In 1978, it was estimated (3) that floor trusses represented only 5% of wood floor systems. On the basis of the findings during this study, it is believed that this level is now close to 10%. Clearly, it is unlikely that floor trusses will ever achieve the penetration achieved by roof trusses; however, it is believed that growth to 40% would be possible.

On the basis of 1.6 million housing starts, a 40% penetration level would suggest that an additional 600 million board feet of lumber would be needed for floor trusses. Allowing for web material, this permits a U.S. growth potential for MSR lumber of 390 million board feet over the "base line" volume of 1,500 million board feet.

A similar analysis for Canada indicates a further 60 million board feet potential based on an average housing start level of 200,000 units per year.

In both the U.S. and Canada, the growth potential is at the expense of solid wood joists.

- Non-residential truss potential

The primary growth potential for non-residential trusses and fabricated joists would be in competition with steel and concrete. Though some solid wood joists and rafters may still be used, it is believed that the proportion is well below that prevalent in residential construction.

---

(1) Characteristics of New Housing: ibid.
(2) Wood Products used in Single Family Houses - SB452 USDA (1970)
(3) Trends in Lumber Used for Housing - Forest Products Research Laboratory, Madison, Wisconsin.

Many of the truss fabricators visited, particularly in the U.S. and western Canada, indicated that non-residential business was of ever increasing importance to them. To some extent, this was a natural consequence of the fall in the residential market. Thus, though the proportion of non-residential trusses was greater, the actual volume may not have increased significantly. Where actual increases were found, few of the fabricators were able to identify that the competition had been steel or concrete. Their competition had effectively been with other truss fabricators, with wood joist fabricators or with laminated beams. In many ways, this is inevitable since the decision to construct with wood, steel or concrete had, in all likelihood, been taken well before the truss fabricators were asked to quote.

It is difficult therefore to identify the size of the potential for expansion in trusses and fabricated joists in non-residential construction. Clearly, the large high-rise office and apartment buildings do not offer any potential. On the other hand, warehouse and agricultural buildings are a significant market. However, the current level of penetration into this market is impossible to assess on the basis of available secondary data. To develop the required primary data was beyond the scope of this study.

The TPI believes that development of trusses into the non-residential market is still a small proportion of its potential. (1) However, the Institute has not undertaken any detailed study to establish what this is. It appears to regard the current level of penetration somewhat akin to that currently achieved in the floor truss market. It was shown earlier that the potential for increase in residential floor trusses was from the current 10% level up to 40%. If this potential growth was applied to the non-residential market, the increase over the base line volume potential for MSR would be in the region of 1,900 million board feet. It is felt that it would be totally unrealistic to consider such a very large increase. Furthermore, observation of construction practices around the U.S. and Canada would suggest that wood truss systems are already being used in a significant number of buildings.

For the purposes of this analysis, it has been decided to use a much lower level of 500 million board feet for both the U.S. and Canada. This would suggest that the truss and joist fabrication has already reached 60% of saturation in the non-residential market. Industry experts may regard this as overly conservative.

---

(1) Metal Wood Truss Conference Proceedings - 1979.

The result of the analysis of growth in the floor and non-residential truss and fabricated joist market indicates that a potential growth volume in the region of 950 million board feet can be added to the "base line" volume of 1,500 million boad feet. Thus, as the truss and joist fabrication industries reach their saturation levels, the volume of stress rated lumber required could reach close to 2.5 billion board feet (Table 15). This is very substantially above the current level of MSR lumber production at only 500 million board feet.

7.4 Potential Market for MSR Lumber from B.C.

For the purposes of this study, the potential market for MSR lumber produced in B.C. is of more significance than the total potential throughout the U.S. and Canada.

During the course of the field trips, it was established that Southern pine is totally dominant in all U.S. markets east of a line that can be drawn through Minneapolis, Wichita and Albuquerque down to the Mexican border. The strength characteristics of the species group are such that it is well suited for truss fabrication. It is also well suited for grading mechanically, and it has been shown that many of the newest CLT machines have been installed at Southern pine mills. It is expected that this trend will continue and that, therefore, the major potential for sales of MSR lumber from B.C. to U.S. industry would be west of the line defined. It is assumed, however, that the total Canadian potential is available as a market for B.C.

This has a very significant impact on the volume levels developed earlier. An analysis of construction activity (1) (2) indicates that, over the past five years, the area now defined as holding potential for MSR lumber from B.C. represents about 30% to 35% of total U.S. activity. Consequently, of the total future maximum potential developed earlier (2.4 billion), only 905 million can be considered relevant to the study (Table 15). Furthermore, the "base line" volume is reduced to 545 million feet.

On a national basis, it appears that estimated current MSR lumber production capacity (Table 3) only represents 20% of the maximum likely volume. However, when this is considered on a regional basis, it appears that capacity is already equivalent to over 40% of the maximum in the West and Canada.

The extent to which MSR lumber volumes can reach towards this maximum depends on a number of factors. In the medium term, the next three to five years, the principal factor is one of price competition with visual grades. In the long term, however, the developments relative to design and code changes discussed in Section 6 appear likely to have a substantial impact. This impact could have the result that almost all engineered structures using lumber will use lumber that has been graded mechanically.

(1) Characteristics of New Housing. ibid.
(2) Data Resources Inc. ibid.

Table 15

Maximum Potential Market for MSR Lumber

(million board feet)

	U.S.		Canada	
	Current Level (1) of Truss Penetration	Maximum Penetration	Current Level (1) of Truss Penetration	Maximum Penetration
Residential				
roof	630	630	50	50
floor	130	520	10	70
Total	760	1,150	60	120
Non-residential total	630	1,080	35	85
TOTAL	1,390	2,230	95	205
Potential available to B.C. producers	450	700	95	205

Source: Woodbridge, Reed and Associates

(1) referred to in the text as "base line" potential

Key assumptions:

a) Annual level of U.S. housing starts 1.6 million and 200,000 for Canada (excludes mobile homes)
b) Potential for growth in roof trusses is negligible, at starts levels noted.
c) potential for growth in floor trusses up to 40% of all residential flooring.
d) Current penetration of non-residential market at 60% of saturation level in the U.S. but at only 40% in Canada.
e) B.C. producers can only sell in the West and Mid-West where the combined total consumption is 30% to 35% of U.S. total.
f) The total Canadian market holds potential for B.C. producers.

Sensitivity Analyses

These can be applied to any one of these assumptions. For example, a change in U.S. housing starts to 2.0 million would change the current total potential available to B.C. from 450 to a level of 510 million board feet.

The advantages to the producer of extracting the best quality material more precisely, and the advantages to the user of the improved allowable design values may become so overwhelming that neither party can afford to produce or use visually graded lumber. This is still very much in the future. Conceptual changes in codes and, even more so, their implementation at the user level tend to take a long time. It seems unlikely, therefore, that the scenario that appears to be very favourable to MSR lumber can occur before the mid to late 1980's.

In the meantime, MSR lumber must compete on the basis of current advantages. Visually graded lumber is well established and generally acceptable to the majority of the truss industry.

A significant element, however, is the likely growth in floor truss and joist fabrication. Here, with the exception of producers basing their system on a micro-lam chord, MSR lumber has a substantial advantage and has, already, most of the market. Similarly, an advantage exists for large span non-residential trusses and joists where high strength values can be of great advantage. It is these two areas of growth in the truss and joist industry that present the greatest medium term potential for MSR lumber.

It was shown earlier (Table 15) that, at the current level of penetration by the truss and joist industry, the maximum potential market for MSR lumber in the West is in the region of 545 million board feet. With the inclusion of all the most recent expansions, the MSR lumber production capacity in the West is about 390 million board feet. Consequently, for all these mills to produce at capacity, MSR lumber must achieve a market penetration level of close to 70%. Even though the total truss industry consumption has already been substantially discounted to exclude applications where MSR lumber would not appear competitive, 70% penetration is considered high, bearing in mind the availability of good visual stress grades in the West.

It must be emphasised that these figures are all estimates and can only give orders of magnitude, not precision. Given this proviso, it can, at least, be concluded that the market potential for a large number of MSR installations in the West does not appear to exist in the short term. On the other hand, the advent of a strong housing market, with more than 1.6 million starts, would change the supply/demand balance. Thus, if housing starts rise to the 2 million annual level, the current maximum potential market shown above at 545 million board feet would increase to 600 million board feet. This is equivalent to the production capacity of at least two more MSR installations.

7.5 Summary

The market potential for MSR lumber produced in B.C. is determined by a number of factors. Essentially, these are market expansion, market location, and market penetration. They can be defined as follows:

- market expansion

  The potential for expansion in industries that are potential users of MSR lumber.

- market location

  The geographic location of the potential markets relative to B.C. and other sources of supply of both MSR and visual grades.

- market penetration

  The ability of MSR lumber producers to compete with visual grades.

It is estimated that, apart from any growth in overall construction activity, there is likely to be significant market expansion. This would be in residential floor trusses and in non-residential trusses. It is not expected that there would be any substantial growth in residential roof trusses. After discounting uses that can be readily satisfied by visual grades, such as #2 or lower, the current maximum potential for MSR lumber is assessed at just under 1.5 billion board feet in the U.S. and Canada.

The market expansion that is judged possible would increase this total to 2.4 billion board feet. These figures exclude the potential in the laminating industry and the mobile home industry, since the requirements of these industries are somewhat different from the product available from a standard dimension MSR lumber operation.

The location of B.C. supplies, relative to the total maximum possible demand, is such that only 30% to 35% of the U.S. demand can be regarded as a potential market. Southern pine is a species group well suited for structural use if manufactured correctly. Consequently, it is generally accepted that Southern pine will be dominant in all areas east of a line through Minneapolis, Wichita, Albuquerque to the Mexican border. The market potential for western producers is, therefore, essentially limited to the the industries west of that line. This reduces the maximum market volume to a current level of 545 million board feet. Market expansion would increase this to 900 million board feet.

In the medium term, three to five years, market penetration of MSR lumber will depend on competition with visual grades, on a grade-for-grade basis. In the long term, the competitive position is likely to be very favourably improved by factors such as the new design concepts discussed earlier.

It has been shown that the estimated capacity of MSR lumber production in the West is in the region of 390 million board feet, once all the new installations are operating. For all these mills to operate at capacity, the market penetration would need to be at a level of 70% of the current maximum market volume of 540 million board feet. It should be emphasised that, in the development of the maximum market potential, consumption volumes are substantially discounted for uses where #2 or lower grades would be adequate. However, bearing in mind the availability of Douglas fir in #1 and better grades, it would seem that such a level of penetration would be close to the maximum that can be achieved.

The rapid recent increase in production capacity has been such that adequate supply sources now appear to exist to satisfy current levels of consumption. These levels, however, are based on a static level of construction activity at 1.6 million housing starts. Should the widely predicted level of 2 million be achieved, then the market potential would increase. At current depressed levels it is, of course, very much less. A further favourable factor is that some of the MSR producers, with experience in the product, are tending to expand the market serviced into areas such as the laminating industry. As they achieve success, the total potential demand increases.

Consequently, though current supply and demand appear, at best, in balance, there are a number of factors that lead to the conclusion that there is room for future growth in MSR lumber production in B.C. in the medium and long term. These would be market expansion by the current truss and joist industries, MSR penetration into other industries, and the overall growth expected in construction activity once interest rates decline from the present relatively high levels.

8. OFFSHORE MARKET POTENTIAL

8.1 Introduction

The concept of mechanically grading lumber is well established in a number of countries outside the U.S. and Canada. The principal of these are Australia, South Africa, the U.K and Scandinavia. It is estimated (1) that there are currently over 130 different machines operating overseas. Most of them are the "Computermatic". This section presents the results of the market study undertaken in the U.K. It should be noted that considerable activity has also taken place in Australia, where Weyerhaeuser has successfully started to develop a market for lumber that has been mechanically graded in Canada to Australian stress grades.

Analysis of the U.K. Market Potential for MSR Lumber

8.2 Timber Frame Construction

The great majority of the softwood lumber consumed in the U.K. is imported. The volume of these imports has varied dramatically during the 1970's, from a high of over 4 billion board feet in 1973 to a low of 2.2 billion board feet in 1975. The import statistics are shown in Table 16 and it can be seen that, in recent years, imports from Canada have increased as a percentage of the total. Consequently, whereas in the early 1970's and earlier, Canada ranked fourth behind Sweden, Finland and the USSR as a supplier of softwood lumber to the U.K., Canada was the largest supplier in 1980 with 26% of the market.

This has developed as a result of a number of factors, of which probably the most important have been a poor U.S. market and a favourable Canadian dollar exchange rate. Increases in the exchange rate over the next few years, related to other suppliers, could make it difficult to maintain Canada's market share. It should also be noted that 25% of imports from Canada, in the last two years, have been from eastern Canada, not B.C. (Table 17).

The majority of the softwood lumber used in the U.K. is consumed by the construction industry for housing, non-residential buildings, repair and maintenance, and civil engineering. This is estimated to account for around 75% of consumption. The remaining volume is spread between a large variety of uses such as packaging and pallets, shop and office fittings, furniture, and so on.

---

(1) Why Machine Stress Rating?, Paper at Metriguard Workshop by R.F. Pellerin, Washington State.

Table 16

Imports of Softwood Lumber

000 cubic meters

	U.K. Total	USSR	CANADA		FINLAND	SWEDEN	Others
1970	8,007	1,726	1,463	18%	1,666	1,873	1,279
1971	8,089	1,568	1,099	14%	1,892	2,296	1,234
1972	8,243	1,578	811	10%	2,009	2,618	1,227
1973	9,815	1,806	1,217	12%	2,028	3,194	1,570
1974	8,530	1,288	1,761	21%	1,745	2,397	1,339
1975	5,215	1,160	618	12%	947	1,548	942
1976	7,181	1,599	1,368	19%	1,173	1,749	1,292
1977	6,380	1,317	1,401	22%	1,084	1,479	1,099
1978	6,456	1,270	1,113	17%	1,237	1,639	1,197
1979	7,214	1,244	1,564	22%	1,470	1,569	1,367
1980	6,012	1,038	1,582	26%	1,457	1,006	1,129

Source: Timber Trade Journal (U.K.)

A significant trend relative to lumber consumption has been the steady growth in importance of timber frame housing. It is estimated that this amounted to between 40,000 and 50,000 units in 1980. Bearing in mind that total starts were well below 200,000 units last year, it can be seen that timber frame housing now represents over 25% of the total. The majority of the units are constructed on a prefabricated basis by large builders.

It appears that this trend towards timber frame housing is likely to continue as the concept becomes more widely known. Once the necessary materials become readily available from the regular builders' merchants, smaller builders should also become more interested. From the overall lumber consumption point of view, the actual increase is not very substantial since the volumes used in flooring and roofing remain basically unchanged whether traditional or timber frame construction is used. It could, however, have a significant impact on the volume of CLS lumber, since it is this specification that is principally being used for wall sections by the prefabricated house industry.

8.3 Building Regulations and Lumber Codes

The approach taken to construction in the U.K. is very technical and is strictly controlled by a number of codes. These codes, particularly where lumber use is concerned, are based on extensive testing and design programs and they dictate very specifically the grades, species and specifications of the lumber that can be used in each application. The result is that all lumber used in a structural application -- roofs, floors, bearing walls -- must be stress graded. Consequently, over 40% of the lumber consumed in the U.K. has to be stress graded. (1)

Since the U.K. imports many types of lumber from many sources, a new approach is being developed for the building codes. (2) This will identify a number of strength classes for lumber and will specify which strength class must be used for which application. It will also categorise by strength class, each species and grade of lumber.

This code has been in draft for some time and a number of aspects are still being argued by all those concerned. The COFI representatives, for example, are working to improve the position of S-P-F and hemfir within the strength classes. Though the timing of the implementation of the new code is still uncertain, it appears likely that by the end of 1982 it will be authorised, and could have a significant impact on the relative values of different grades and species to the builder.

---

(1) Imported Softwood - End Use Survey - Timber Research and Development Association.

(2) Timber Strength Classes for BS 5268 - A.R. Fewell, Princess Risborough Laboratory - October 1981.

Table 17

Canadian Softwood Lumber
Exports to U.K. by Species

million board feet

	hemfir	S-P-F*			Douglas Fir/ Larch	Cedar	Total
		B.C.	Other Canada	Total			
1976	306	152	57	209	52	26	593
1977	242	224	70	294	17	20	573
1978	201	174	66	240	14	19	474
1979	710	272	169	441	18	17	686
1980	172	287	164	451	11	13	648

* includes all spruce, pine and fir

Source: Statistics Canada, COFI

Considerable emphasis is placed, in the U.K., on the most efficient use of lumber. Therefore, a great deal of attention has been devoted to optimising design and this has lead to a need for better quality control on the materials used. Consequently, in 1973, the British Standard BS 4978, Timber Grades for Structural Use, was developed. This defines two principal grades, General Structural (GS) and Special Structural (SS) and establishes rules to enable these grades to be selected either visually or mechanically. Two other grades are also defined which can only be selected by machine. These are M50 (50% of the bending stress of a clear piece of lumber) and M75 (75%). Design stress values for each of these grades for a number of species are defined in the British Standard Code of Practice CP112 part 2 1971 The Structural Use of Timber. As a result of pressure from the industry, led by COFI, lumber which has been stress graded under NLGA rules was also accepted and design stress values included in CP112.

The stress grades for lumber recognised in the U.K. for structural use are as follows:

M75
SS or MSS
NLGA #1 and #2
M50
GS or MGS

Note: values are also assigned for studs and light framing grades but these are lower.

It should be noted that the U.K. approach to machine grading is entirely species dependent. Consequently, the strength value of a piece of lumber graded to M75 will vary depending on the species involved. This is very different to the North American approach where lumber with a "1650f-1.5E" stamp will have that strength whether it be hemfir or S-P-F.

Stress Grading by Machine

The concept of using a machine to stress grade lumber, as an alternative to visual grading, was introduced in the U.K. in the early 1960's. After extensive testing and some development work by the Building Research Establishment Princess Risborough Laboratory (PRL), the Computermatic stress grading machine was introduced around 1969. Initially, while no official codes and procedures existed, the PRL acted in an advisory and quality control capacity. In 1973, an official British Standard Institute (BSI) Kitemark scheme was introduced. Under this scheme, all lumber graded by machine, whether in the U.K. or elsewhere for use in the U.K., has to have a BSI Kitemark stamp, and companies can only use the stamp if they have approval from BSI. To obtain this approval, the company must, firstly, be using a make of machine that is approved and, secondly, it must be operating under the BSI Scheme of Supervision and Control.

At present, the only machines that are approved are:

Computermatic
Cook-Bollinders
Rau-te Timgrader

The Computermatic is by far the most popular. A modification of the Cook-Bollinders to permit single-pass higher volume throughput is currently underway.

PRL have developed, on behalf of BSI, a very large number of settings for each of these machines, which are to be applied for each species and dimension of lumber. Thus, the operator of a Computermatic wishing, for example, to machine grade Swedish whitewood with the dimensions of 35 x 97 mm will be instructed on the exact setting required for the machine in order to grade M75 or M50 lumber. This setting is sacrosanct and cannot be altered. Strict records must be kept of each job showing sizes, species, settings used and outturn. These records are inspected by BSI who also make at least four unannounced inspections each year of each location. Where the facility is outside the U.K., BSI subcontract responsibility for inspection to recognised authorities in the exporting country.

The emphasis of the quality control is, therefore, on machine operation and not on the lumber produced. PRL argues that really adequate quality control on the lumber would be totally uneconomic. It insists that, by a thorough and extensive testing of the relationship for any one species between Modulus of Elasticity (MOE), the Modulus of Rupture (MOR) and the settings for individual machines, reliable results can be obtained for machine settings. By strictly controlling these settings, the quality of the lumber can thus be assured. From the comments made by PRL representatives, it appears there would have to be a radical change in philosophy before the U.K. authorities would accept a machine grading system that allowed mills to develop their own machine settings.

The companies that initially purchased stress grading machines were the large lumber importers and merchants who had truss fabrication facilities. Their standard practice was to purchase rough lumber from Scandinavian and Russian sources. This would be run through planers to the exact sizes required for truss fabrication, then graded and stamped. They purchased the stress grading machines partly just as a more reliable tool for grading, and partly in the belief that an improved grade yield would be obtained from the lumber. It should be noted that, though there is a visual grading override, this appears to be of considerably less significance than in North America. The principal defects being considered are wane, rot, insect attack and dimensional aspects such as warp.

These companies, therefore, were able to develop, basically out of the same input, lumber with higher stress values. Consequently, they were able to produce trusses using lumber of a smaller section than companies using lumber graded to "Composite" grade. This also effectively applied to the wider specifications for floor joists. A demand was therefore created by some of the smaller companies, without machines, for the higher stress valued lumber. Scandinavian sawmills regarded this as an opportunity for a value added product, and a number also purchased machines and operated them under the BSI Kitemark system.

The current situation is that there are 67 companies licensed under the BSI Kitemark scheme. These are distributed as follows:

U.K.	48
Sweden	12
Finland	5
Poland	1
Eire	1
	67

It is generally believed that many of the machines operated by these companies are very underutilized and it appears there are even some which are not operated at all.

The majority of the lumber that is machine stress graded, particularly the high value M75 grade, is used in truss manufacture. It is estimated that this use accounts for close to 75% of the consumption. The remaining volume appears to be used in a variety of applications, of which floor joists are probably the most important. There is, however, a new BSI specification BS 2482-1981 Timber Scaffold Boards which identifies specific values for machine graded lumber and specifies the settings required on the machines for grading lumber to be used in scaffolding. There may also be a small volume used in laminated beam construction, but the consensus was that this would be relatively insignificant.

The sources of machine graded lumber available to the U.K. consumer are as follows, in order of importance:

a) European whitewood/redwood imported rough in an "unsorted" grade (excluding the lowest grades), dressed and machine graded in the U.K.

b) Scandiavian whitewood/redwood imported already dressed and machine graded.

c) Canadian lumber (hemfir or S-P-F) imported rough in larger dimensions and then remanufactured, dimensioned and machine graded in the U.K.

d) Canadian lumber regraded by machine in the U.K. This can be CLS but is more usually 1-7/8" material in the wider widths for floor joists.

Of these, the most significant, in volume, are the first two, and the amount of regraded Canadian lumber is relatively small.

The yields obtained from lumber from the different sources within Europe, when it is machine graded, varies significantly. The Russian unsorted grade is said to yield around 90% of the M75 grade. Swedish and Finnish lumber yields somewhat less at around 80% to 85%, and the yields from other sources such as Poland and Czechoslovakia tend to be lower still. It should be noted that an "unsorted" grade is one from which the lower grades of lumber have been removed. It is not, therefore, mill run.

Some tests are being undertaken at present to identify the yields that can be obtained from Canadian lumber. The programme is not yet completed, and the results appear to be confidential. It seems likely, however, from some of the comments made, that Canadian lumber yields somewhat less than the Scandinavian supplies. There is also a considerable amount of wane which causes rejection during the subsequent visual grading.

A number of widely varying figures were given for the cost of machine grading in the U.K. It appears to be only marginally more expensive than visual grading (without taking into account the cost of the machine), particularly when it is being undertaken immediately after the planer. It is even suggested that it is, in fact, cheaper since visual grading in the U.K. tends to be a very slow process. The approximate cost of running European whitewoods through the planer and machine grader appears to be in the region of C.$30 per thousand board feet. One company quoted a level of around C.$20 per thousand board feet and advised that it was able to run at 300 ft/min which was close to the capacity of the planer.

It was reported by some of the companies contacted, that Weyerhaeuser has been actively pursuing the possibility of selling machine graded lumber into the U.K. It appears that Weyerhaeuser has been concentrating on the large prefabricated timber frame companies who operate on an international basis. These companies are, therefore, not totally bound by the restrictive nature of the U.K. codes.

8.5 The U.K. Truss Industry

The historical development of the truss rafter industry in the U.K. has an important bearing on the way the industry operates. The major initial development came from the large lumber importers and merchants, rather than from the building industry. These importers and merchants saw the fabrication and sale of trusses as another way of moving lumber in the form of a value added product. Therefore, as the building industry became aware of the advantages of the truss system, it was the importer with his own fabricating plant who obtained the sale. Other importers then had to establish their own plants in order to retain a share of the roofing market.

The U.K. truss rafter industry is now well established, and it is estimated that 90% of all residential roofs are built with trusses. There is also some penetration into light non-residential construction, but concrete and steel dominate agricultural and heavy industrial construction.

There are around 140 to 160 truss fabricators, and they basically operate on what can be regarded as a licensing system. The system holders are the truss plate manufacturers, and they tend to be responsible for the development of the basic truss designs and span tables. The principal of these are Hydro-Air, Gang Nail, BAT, Truswal and Twinaplate. Though one of these companies is now trying to promote a floor truss system with a metal web, so far truss manufacturers have not yet developed trusses for uses other than roofs.

The total volume of lumber consumed in truss fabrication is in the region of 100 million board feet per year in recent years, and the most common practice tends to be the use of 35 mm (1-3/8") material which is dressed from rough 38 mm (1-1/2"). The widths used vary, depending on the spans and truss design, and in order of importance are as follows:

97 mm (3-7/8") from 100 mm (4")
72 mm (2-7/8") from 75 mm (3")
120 mm (4-7/8") from 124 mm (5")
145 mm (5-7/8") from 150 mm (6")

There is also a certain amount of CLS lumber being used, but it is estimated that this is unlikely to be more than 10% of the volume consumed in trusses. Though there is one truss fabricator using hemfir, the majority who have committed to CLS are purchasing S-P-F. The most important sizes are 2 x 4 and 2 x 3 and the fabricators are tending to demand a structural light framing grade with a minimum of 75% stamped as #1.

Truss fabricators must conform to a strict building code (CP112 Part 3 - Trussed Rafters for Roofs of Dwellings) which defines very specifically the permissable spans, the sizes and the grades of the lumber that may be used. The truss plate manufacturers have developed detailed designs and span tables based on the building code. These have been computer programmed, and the fabricator can utilise the programmes to calculate which design best suits any particular requirement.

Most of these programmes allow the fabricator the flexibility to test, on the computer, different truss designs and grades, species, sizes and prices of lumber to identify the optimum truss. It was found, however, that the majority of the truss fabricators tended not to investigate the relative advantages or disadvantages of a variety of different species.

When an order for trusses is received, the fabricators tend to investigate configurations that allow them to manufacture the order from material they have in stock or on order. It was also commented by one truss plate manufacturer that many of the smaller fabricators were not particularly sophisticated and often tended to stay with what they knew.

Hydro-Air, the largest system holder with about 65 fabricators, advised that an analysis of the programmes used by its customers indicated the following grade breakdown:

GS or MGS	-	over 50%
M75 and M50	-	15% to 20%
SS or MSS	-	5% to 10%
NLGA	-	5% to 10%

These figures are based on numbers of fabricators using the different grades and not on a volume basis. Consequently, since it is the larger manufacturers who tend to have their own stress grading machines, and it is these companies that are using the higher grades, a breakdown on a volume basis would show a much higher percentage of the M75, SS or MSS grades.

There are said to have been two major factors that have discouraged fabricators from using CLS lumber from Canada. The first is a lack of confidence in the continuity of supply at a stable price. The U.K. trade has the fear, based on past experience, that Canadian suppliers are only interested in the U.K. when the U.S. market is poor. Consequently, the U.K. trade believes that, when the U.S. market is strong, and prices high, supplies available for the U.K. are likely to be curtailed. The second factor relates to quality. There is, unfortunately, a general consensus that the quality of Canadian lumber is well below that of European lumber. The principal criticism relates to wane, rot and size of knots.

8.6 Prices

There is no consistent pattern of prices from which a definitive and reliable indication can be obtained on the value of lumber graded to M75, compared with that graded at M50 or GS/MGS. Though the current poor market conditions were often quoted as being the cause for this, it is believed that the principal reason lies in the structure of the truss industry itself.

Many of the U.K. companies operating stress grading machines also have their own truss fabricating plants. Furthermore, virtually all of them also are in lumber sales and distribution, and a number of them have diversified into prefabricated housing. These companies tend to purchase rough European whitewoods which they dress to exact dimensions and mechanically grade. As pointed out earlier, they get a high yield of M75 or MSS material from this input and have more than sufficient demand, within their own operations, for any lumber that does not meet this grade.

A number of the people contacted indicated that these companies tend to take a cost approach rather than a value approach. Thus, all the lumber costs the same to buy, to plane and to grade. Therefore, since it was all usable, it was all worth the same and no price differential was applicable. In fact, it appears that the majority of the companies tend to use the same grade of lumber throughout the truss even though some of the webbing could be of a lower grade.

Though the major companies tend to undertake their own stress grading, there is, nevertheless, some trade in dressed and graded lumber from Scandinavia. Current prices quoted for Swedish whitewood in a sawfalling grade (rough) were around C.$470 per thousand board feet CIF (1). Under good market conditions, the Swedish suppliers would expect to get C.$55 per thousand board feet more if they were undertaking the planing, the grading and selling a M75 grade. Currently, however, this tends to be much less, at around C.$30 per thousand board feet.

The price relationships between European whitewoods and Canadian CLS had changed dramatically over the past eighteen months. This has been due partly to a drop in Scandinavian prices but, principally, because of changes in exchange rate. In the last year, the Canadian dollar has strengthened, against the pound, by almost 20%, whereas the Swedish Kroner has weakened somewhat.

(1) Converted at C.$2.30/£

The consequence of this was illustrated by the comments of the president of one large truss fabrication company in the Midlands which had converted to CLS eighteen months ago. His concern is the price in pounds sterling per linear metre of material in the truss. In the first half of 1980, CLS cost him £31 per 100 linear metres relative to European whitewood (after planing and grading) at £37. By July 1981, the Canadian lumber had risen to £39 whereas the European lumber had dropped to £33. He stated that he now intended to change back to European supplies. Others contacted confirmed the trend but indicated that these figures overstated the situation somewhat.

From the point of view of this study, the price relationship between species is less relevant than the relationship between grades. Early in 1981, Hydro-Air was developing programmes which would permit the fabricator to optimise lumber grades in the construction of any given truss. In order to test these programmes, it investigated price relationships between grades. As a result of these investigations, it used the following prices:

GS	£110/cubic meter	= C.$597/thousand board feet
M50	£114/cubic meter	= C.$618/thousand board feet
SS	£115/cubic meter	= C.$624/thousand board feet
M75	£118/cubic meter	= C.$640/thousand board feet

This demonstrates that the price differential between the M50 grade, which equates approximately to NLGA #1 for S-P-F, and the highest (as accepted in the codes) machine rated grade of M75, which would approximate to a 1650f-1.5E S-P-F, is only C.$22 per thousand board feet.

The success of industry and COFI in obtaining British code acceptance of visual NLGA grades and satisfactory strength values has been such that the additional benefits of machine graded lumber have been reduced. Under the proposed codes, if the builder uses the strength classification approach, he will be able to use #2 S-P-F in a C3 rating, but will only be able to increase by one class to a C4 rating for M75 S-P-F.

At this stage, there is no allowance for the introduction of any design values for a grade equivalent to higher Canadian MSR grades such as 2100f-1.8E.

8.7 Summary

Lumber that has been mechanically graded is well accepted and used in the U.K.; however, the U.K. industry has developed a mechanical grading concept that is significantly different to that which has developed in Canada and the U.S. Since Canada has always been a major supplier to the U.K. of softwood lumber for construction purposes, British authorities have proved amenable, in the past, to providing special recognition, in building codes, to Canadian visual grades. It must be emphasised, however, that a great deal of effort and pressure was required by the Canadian industry to obtain this recognition.

The information obtained during the study leads to the conclusion that the technical authorities in the U.K. have become deeply entrenched in their approach to the mechanical grading of lumber. It is felt, therefore, that it will require a very great deal of technical effort, combined with industry pressure, to persuade them to recognize Canadian MSR grades. The effort required is judged to be much greater than that which was needed relative to visual grades. Due to the large number of machines that already exist in the U.K. and Scandinavia, there may also be a significant opposition against such recognition.

The price differential to be obtained for lumber graded to 1650f-1.5E, or its equivalent, compared to a visual stress grade, appears to be less than that applicable in the U.S. There appears to be no allowance, within the building code, either as it currently exists or in the form proposed, for MSR grades higher than the equivalent of 1650f-1.5E.

It is estimated that the U.K. truss industry currently consumes in the region of 100 million board feet per annum.

As a result of the difficulties expected, the relatively low volume, and the comparatively small price gain, the initial conclusion must be that it does not appear worthwhile considering the U.K. market. There is, however, another important factor. The U.K. building code authorities are working closely with other Common Market governments to develop a unified approach.

The British are recognized as having a substantial background of knowledge in the area of truss fabrication and mechanical grading. Therefore, their lead is likely to be followed by the other countries. This has a significant impact on the size of the potential market. Roof trusses in these other countries have been slow to start, but are well accepted in France and becoming increasingly popular in Germany.

Consequently, though efforts to obtain recognition for Canadian MSR grades may not appear justified in the U.K. alone, consideration of the long term broader market that could develop changes the situation.

It is believed that if an industry programme is to be developed, with the objective of obtaining recognition of Canadian MSR grades, the first, and essential, step will be to prove the competence of the CLT. Any initial efforts should be entirely at the technical level.

There is already some information available regarding the reliability of the CLT compared to the Computermatic. This was developed by Weyerhaeuser for its sales efforts into Australia. Forintek now has a Cook-Bollinders machine in its laboratory in Vancouver. The capacity, therefore, exists to develop technical correlations between the results that can be obtained from the CLT and those from a machine approved by the U.K. authorities.

9. PRICES

9.1 Introduction

The additional return to be expected by a mill having the ability to grade mechanically is an essential element in the assessment of the economic feasibility of the installation of a CLT operation.

Unfortunately, lumber prices, and price differentials between grades, tend to fluctuate dramatically depending on day-to-day supply/demand balances. This has been particularly evident in the relatively adverse market conditions prevailing during the period of this study when so-called "normal" price differentials between species, grade sizes and lengths have varied from their usual patterns. Moreover, even under "normal" market conditions, the price differential for any individual item still depends to some extent on the negotiating situation of buyer and seller.

Assessment of return on investment, based solely on recent short term variations, therefore, would be misleading. Consequently, in order to ascertain the incremental values of MSR lumber, the approach taken has been to examine long term price trends for particular grades and species, and then to evaluate the relative situation of MSR grades.

9.2 Previous Studies of Grade Differentials

It is worthwhile noting two previous studies which refer to stress grade premiums. In an analysis of the MSR lumber situation (1), members of the U.S. Forest Service calculated that the increase in value, over the past few years, of 1650f-1.5E in hemfir relative to standard and better was between U.S.$40 and U.S.$50 per thousand board feet. A separate analysis of the returns for MSR lumber undertaken by Metriguard (2) assumed a value of U.S.$45 per thousand board feet as the differential for 1650f-1.5E Douglas fir relative to a standard and better grade. These figures appear generally acceptable to the trade as being a valid basis on which to calculate costs.

---

(1) Mills May Profit with MSR Grading - Forest Industries October 1980.

(2) Machine Stress Rating - Mill Potential - Metriguard March 1980.

9.3 Further Analysis

For the purposes of this study, it was believed necessary to undertake a more detailed analysis of the validity of these figures. Five grades of 2 x 4 R/L were selected for analysis, as shown below. Also show, for comparison purposes, are the 8-year average net FOB mill prices for these grades. The eight years correspond to the duration of the most recent complete lumber cycle commencing from its low point, in 1974, through its peak in 1979, to the recent market low point reached in 1981.

8-Year Average of Net FOB Mill Prices

	U.S.$/MFBM
hemfir (Coast) KD Sel. Str. R/L	224
Doug Fir, Green (1) #1 & Btr. R/L	221
Doug Fir, Green Std. & Btr. R/L	195
hemfir (Coast KD Std. & Btr. R/L	178
S-P-F (Western) KD Std. & Btr. R/L	167

(1) Portland Rate

Source: "Random Lengths"

The price relationship between Douglas fir, green, #1 and better and hemfir select structural 1650f has been very close over the twelve years, 1970-1981, as illustrated in Figure 3. Price variations between the standard and better grades shown in Figure 4 have tended to be more significant. While dramatically diverging trends are not apparent, the price chart confirms the standard and better species rankings indicated in the above table. It should be noted that the price chart and other data discussed below are based on a smoothed series using a five-month moving average to reduce short term price aberrations.

Analysis of hemfir select structural and standard and better price differentials, in current dollars, over the period 1970-81 supports the assumption of a U.S.$45-65 premium for select structural. These data, shown on a quarterly average basis, are illustrated in Figure 5. Since late 1976, most of the plotted values fall within this range. It might be expected that, as prices rise and supply tightens, select structural would be able to enhance its premium over standard and better. On the basis of the graphed data, there is no consistent evidence of this expectation. Figure 6 shows the same analysis for the Douglas fir grades.

Part of the reason for this may be that MSR lumber is destined specifically for the construction market and it has been this market that is currently most affected by economic conditions. Visual grades have outlets in other market sectors, such as repairs and alterations, industrial uses and so on, whereas MSR lumber tends not to be sold through the distribution channels that reach these other outlets.

It became clear during the course of the field visits that some MSR lumber was being sold at relatively low prices. It is worth noting also that prices for standard and better tend to start moving up slightly earlier than stress grades as wholesalers start to build inventory for the spring and summer, whereas, stress grades seem to hold prices later into the Fall. This is also true of the turning points in the cycle (compare Figures 3 and 4).

Examination of Douglas fir, green, #1 and better and green standard and better price differentials suggests a U.S.$25-35 premium for #1 and better in current dollars. The overall pattern in the case of Douglas fir is less clear than that for hemfir and it is disturbing to note the recent relatively low premium in the Douglas fir grades. As noted earlier, Figure 3 does not indicate any unusual weakening of Douglas fir #1 and better relative to hemfir select structural.

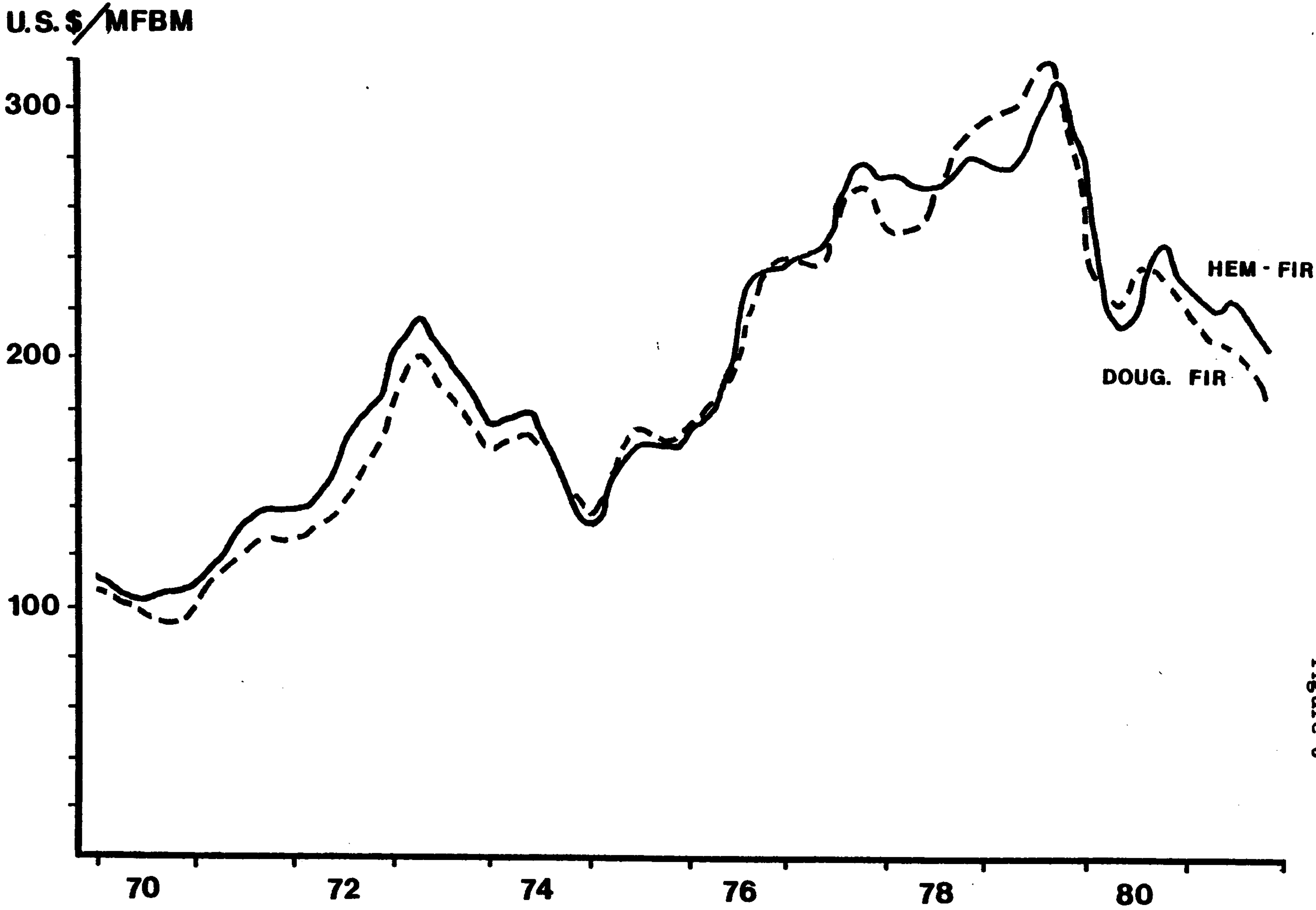
There are no price series available from which to develop a relationship between S-P-F standard and better, and MSR grades. Figures quoted by individual companies tend to be unreliable as indicators of the overall market, and vary widely as the market fluctuates. It appears, however, that, for S-P-F, the increase to be expected for 1650f-1.5E MSR lumber over the price for standard and better is somewhat higher than that evident for hemfir. This would appear logical from the point of view that the increase in design value for 1650f-1.5E grade over the design values current for normal visual grades is greater in the case of S-P-F. It must be borne in mind, though, that is is essentially only in Canada that visual stress grades of S-P-F are used and MSR is soon to lose much of the current advantage in design values.

The analysis so far has discussed grade differentials in terms of current U.S. dollars. When fluctuations in U.S.-Canadian exchange rates are taken into account, it becomes clear that the returns to a B.C. mill, in Canadian dollars, have been somewhat higher, notably since 1977. This point, based on hemfir price differentials, is illustrated in Figure 7.

Projections of future stress grade premiums are difficult to assess. Despite the comprehensive analysis of probable supply/demand balances in MSR developed in this study, the trend in future price premiums is not readily apparent. As a general guide, Figure 8 suggests an average 20% to 30% for hemfir select structural over standard and better. Projections based on this historical relationship would involve the assumption that MSR supply and demand factors will maintain their historical balance with standard and better grade demand determinants, which is by no means certain.

D. FIR GREEN, #1 & BTR. AND HEMLOCK-FIR, R.D.,

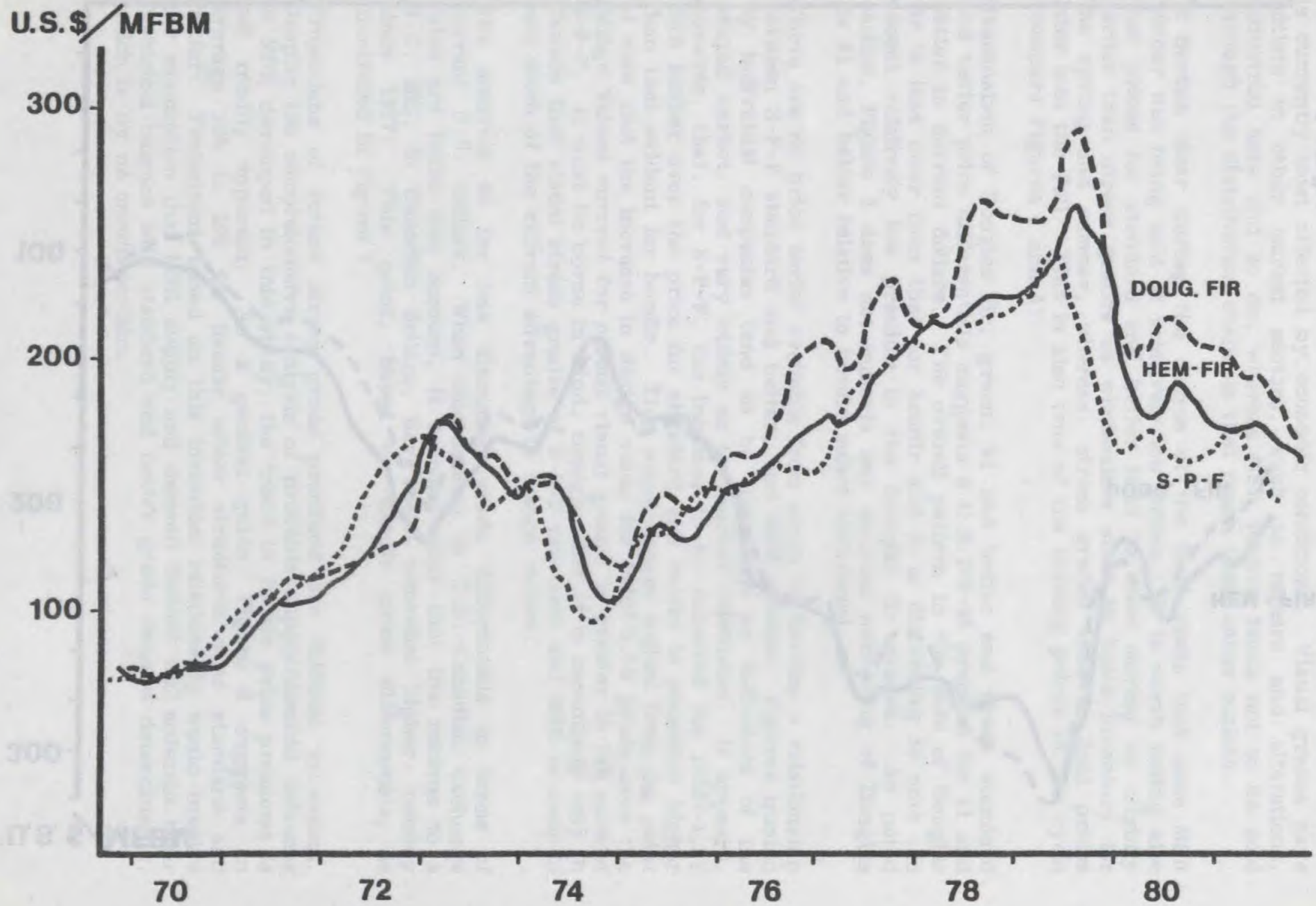
SEL. STR. 2×4 R/L NET FOB MILL



SOURCE: 'RANDOM LENGTHS' PRICE DATA

Figure 3

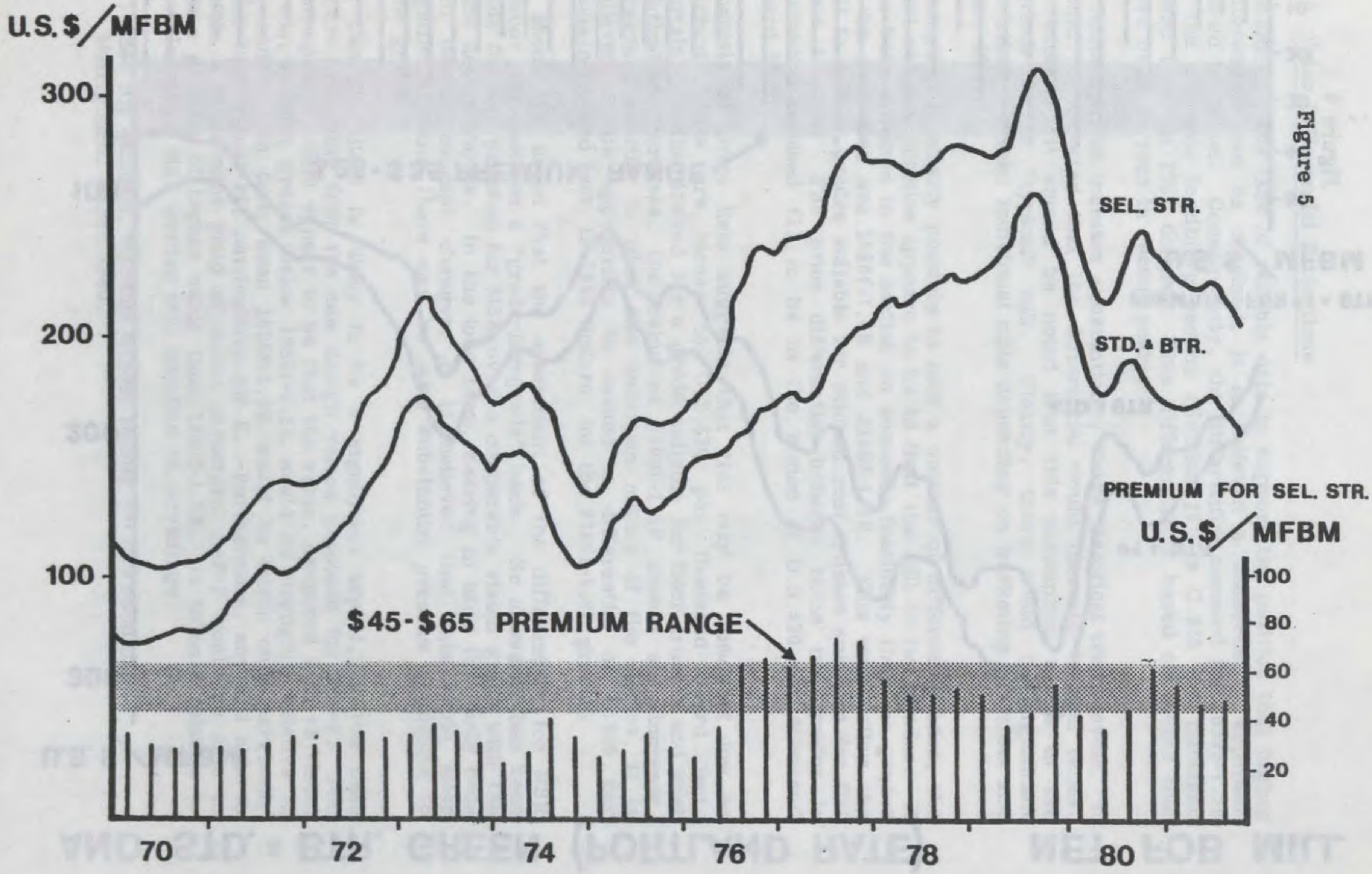
D. FIR, GREEN: HEMLOCK-FIR (COAST) K.D.: SPF (WESTERN) K.D. 2×4 R/L STD. & BTR. NET FOB MILL



SOURCE: 'RANDOM LENGTHS' PRICE DATA

Figure 4

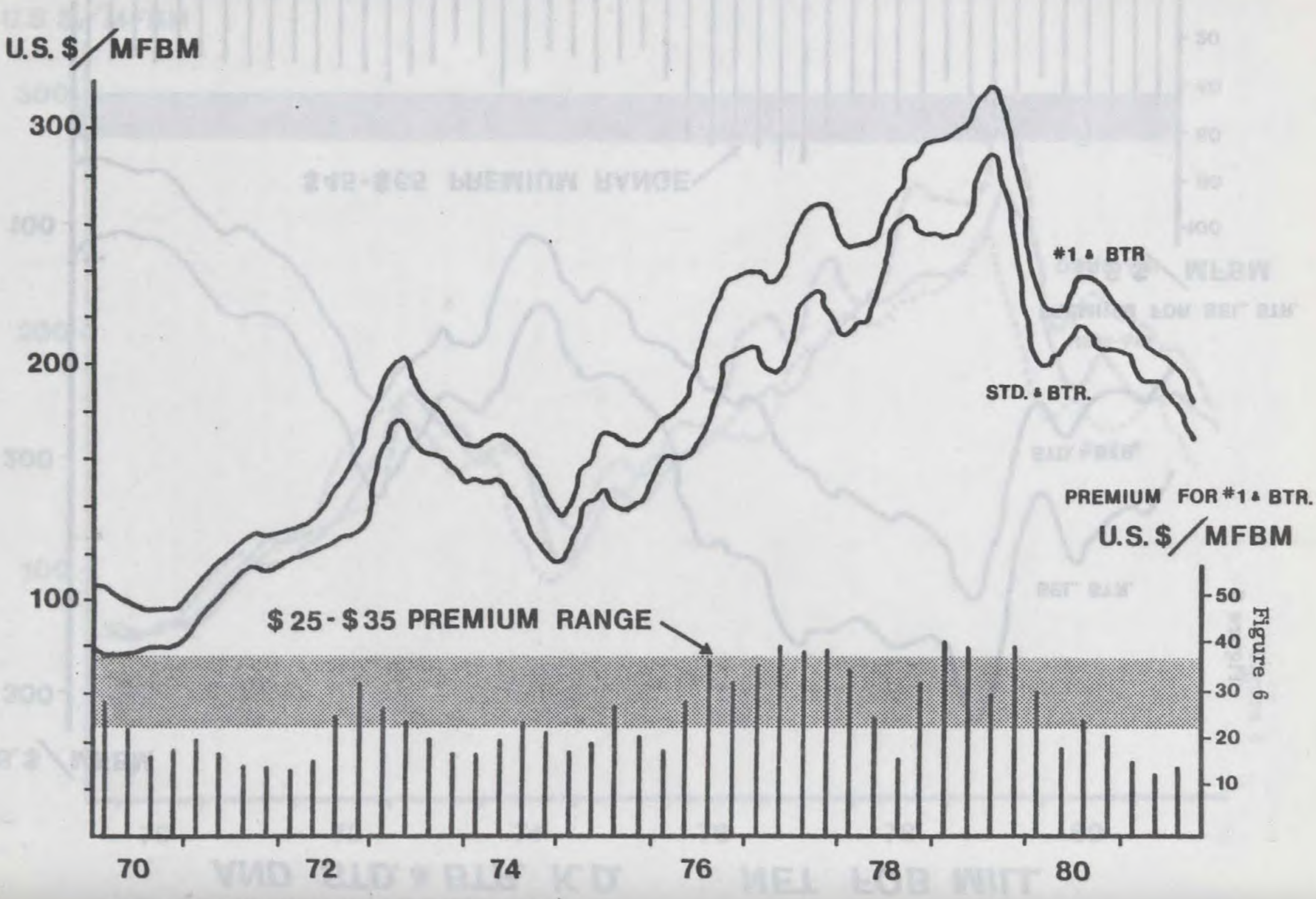
HEMLOCK-FIR (COAST), K.D., SEL. STR. 2×4 R/L
AND STD. & BTR. K.D. NET FOB MILL



SOURCE: 'RANDOM LENGTHS' PRICE DATA

Figure 5

D. FIR, GREEN, #1 & BTR. 2×4 R/L AND STD. & BTR. GREEN (PORTLAND RATE) NET FOB MILL



SOURCE: 'RANDOM LENGTHS' PRICE DATA

Figure 6

9.4 Price Differential Projections

Considering the lack of reliable data to support the position that higher differentials can be obtained, it is believed a conservative approach should be taken. Consequently, the differential assumed for 1650f-1.5E in the economic feasibility section (Section 11) is C.$45 per thousand board feet, in 1982 dollars. This differential is based on prices that have been current in recent years.

If lumber prices increase substantially, above historical trend levels, it would be expected that the differential would increase in real terms. In addition, it should be noted that this assumption refers to the outlook for a "typical" mill. Clearly, there could be significant variations between individual mills depending on marketing practices and sales effort.

Though it is clearly possible to sort a number of different grades, the most common practice appears to be to limit the mill to two grades. It has been assumed in the section on economic feasibility that the grades to be developed are 1650f-1.5E and 2100f-1.8E. This would allow the mill to market grades suitable for pitched roof trusses and also for flat floor trusses. The price differential between these two grades is commonly assumed (1) to be in the region of U.S.$20 per thousand board feet.

Analysis of price lists suggests that this may be somewhat low as current levels are closer to U.S.$30 per thousand board feet. Certainly as the demand for a grade suitable for floor trusses and joist fabrication increases, the value of 2100f-1.8E should also increase. However, bearing in mind the uncertain nature of the market, it is believed to be appropriate to assume a differential of C.$65 per thousand board feet, in 1982 dollars, for the 2100f-1.8E grades.

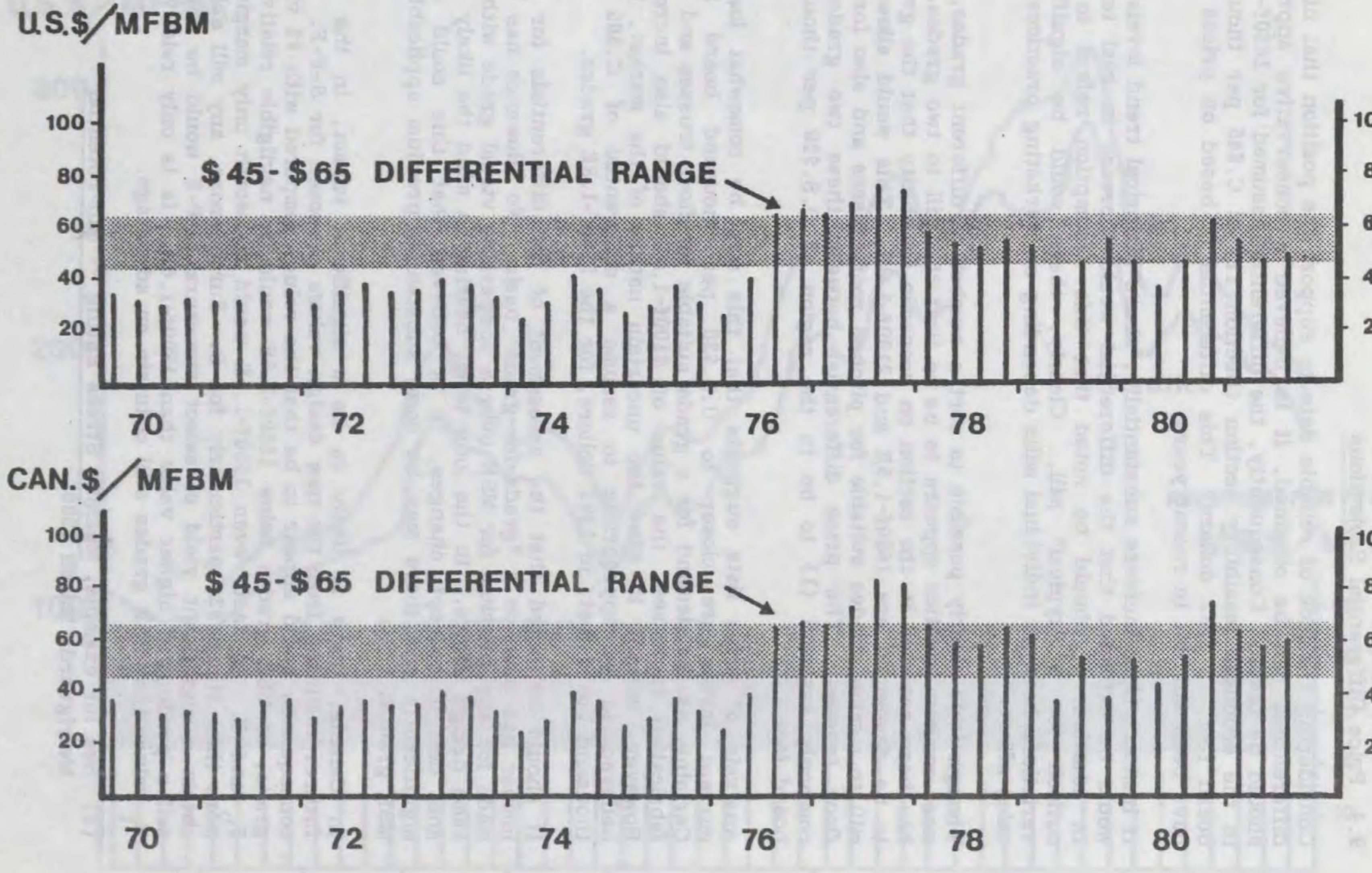
It should be noted that the assessment of the differentials for MSR lumber has been on a "grade-for-grade" basis. No allowance has been made for any premium for MSR over a comparable visual grade with the same design values. In the long term, bearing in mind the likely code and design concept changes, it is believed that this could alter significantly and there may be some substantial premium applicable to MSR grades.

In Canada, there is likely to be a significant impact, in the near future, resulting from the new design values proposed for S-P-F. The consequence would appear to be that the value, compared with #2 visual grade, of MSR grades below 1650f-1.5E would be negligible relative to F_b and E. In fact, even 1650f-1.5E would be worth only marginally more than visual #2, particularly for E. Furthermore, any mill able to obtain a significant yield of select structural S-P-F would be able to sell a product of higher value than 1800f-1.6E. Is is only relative to F_t values that MSR grades still maintain an advantage.

(1) See for example, Machine Stress Rating -- Mill Potential Metriguard, March 1980.

Figure 7

PRICE DIFFERENTIAL OF HEMLOCK-FIR (COAST), K.D. 2×4, SELECT STRUCTURAL R/L OVER STD. & BTR. NET FOB MILL



SOURCES: 'RANDOM LENGTHS' (PRICE DATA) AND BANK OF CANADA (EXCHANGE RATES)

It appears likely, therefore, that the differential levels considered valid for the U.S. may not be applicable in Canada -- at least not for the medium term, until the full influence of new design codes is felt. When the maximum MSR potential in Canada was assessed (Table 14), the volumes of lumber used in residential roofs were heavily discounted in terms of potential for MSR lumber. The result is that the principal potential for MSR grades in Canada tends to be in the higher grades. In these, MSR still has a substantial advantage, particularly for F_t. Furthermore, the Canadian volume is a relatively small percentage of the total potential.

Consequently, the new design values proposed for S-P-F are not likely to have a significant effect on the incremental prices to be used in the economic analysis. It is possible that, eventually, U.S. design codes may also accept higher design values for visually graded S-P-F. However, it seems that this is unlikely to occur in the immediate future, and would be introduced at a time when design concepts are changed in such a way that MSR lumber benefits due to lower variability and so on.

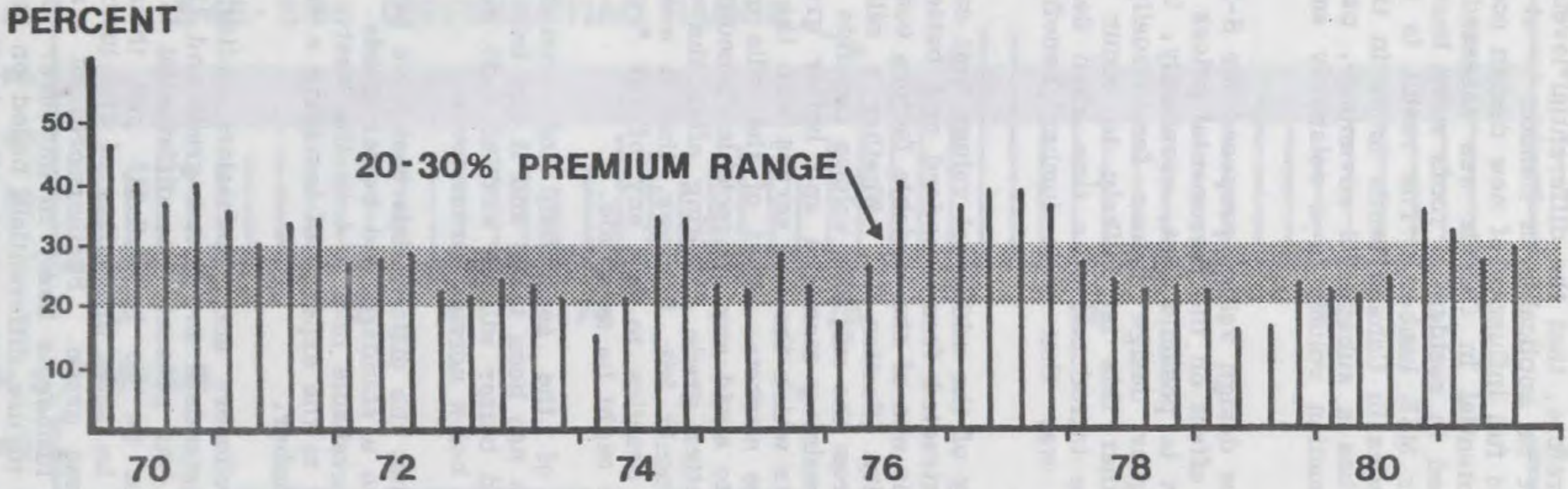
An important corollary of the additional values that can be obtained for the higher grades extracted from standard and better is the value of what remains. This is one of the variable factors commented on earlier regarding mill capacity (Section 4). Whether a mill can extract the maximum MSR yield from the mill run volume depends on the effect this will have on the remaining standard and better grade. It will also depend on the markets which the mill serves with the lower grade, and the strength of those markets. Most of the mills contacted indicated that they were able to avoid any appreciable discount being applied to the standard and better grade resulting after the extraction of MSR lumber. It was commonly felt, however, that it was neither practical nor good marketing practice to sell any of the "residue" as #2 and better even though it might be on-grade.

For the purposes of the assessment of economic feasibiiity, a conservative approach has been taken and it has been assumed that the residual standard and better will be sold at C.$5 per thousand board feet, in 1982 dollars, below normal market levels.

It should be noted that the differentials that have been discussed have been those relative to a standard and better grade. A limited volume of #2 and better is available in 2 x 4 in the West. Any mill has the option, without going to the expense of installing a machine, to visually stress grade 2 x 4 lumber.

Discussions with producers and wholesalers indicate that the price relationship between standard and better grade and #2 and better grade varies significantly. At present, the differential is negligible but in good markets it can be up to U.S.$15 per thousand board feet. However, there will be some proportion of the lumber which will not meet the visual stress grade. Furthermore, in strong markets, the differential for MSR lumber is likely to increase. Consequently, it is believed to be valid to use differentials based on standard and better grades and to discount the option of visually stress grading S-P-F 2x4.

PRICE DIFFERENTIAL OF HEMLOCK-FIR (COAST), K.D. 2×4 SELECT STRUCTURAL R/L OVER STD.&BTR. PERCENTAGE BASIS



SOURCE: 'RANDOM LENGTHS' PRICE DATA

Figure 8

9.5 Summary

Previous studies of grade differentials indicate that the premium for a 1650f-1.5E stress grade, over standard and better, is between U.S.$40 and $50 per thousand board feet.

Further analysis, undertaken in this study, leads to the conclusion that, conservatively, a premium of C.$45 per thousand board feet, in 1982 dollars, can be expected for 1650f-1.5E relative to standard and better S-P-F.

In addition, the analysis concludes that, conservatively, a premium of C.$65 per thousand board feet, in 1982 dollars, can be expected for 2100f-1.8E grades relative to standard and better S-P-F.

The conclusions are based on an examination of prices and grade differentials over at least the past ten years.

Actual premiums obtainable will vary in practice. In particular, variations in grade differentials vary according to the species in question.

Although there is some doubt, in practice, that a decline occurs in the residual standard and better grades, a conservative approach has been taken for the purposes of providing data for the economic feasibility analysis in Section 11. Consequently, it is assumed that there would be a decrease in the value of the residual standard and better of C.$5 per thousand board feet, in 1982 dollars.

10. TECHNICAL ANALYSIS

10.1 Introduction

Six completed MSR installations in B.C. were visited and key personnel interviewed at each location. In addition, twelve U.S. installations located mainly in the Northwest were contacted and the Metriguard MSR Workshop was attended. A summary of some of the findings of the mill survey is shown in Table 18. In this section, emphasis has been placed on reflecting what is actually being done at existing MSR installations.

10.2 Estimating MSR Yield

Analysis of Raw Material Yield

A complete description of a procedure for determining the expected Machine Stress Rated (MSR) lumber yield for a given mills is contained in a recent U.S. Forest Service Report (1). Additional material is contained in a publication by Metriguard (2). Since these procedures have been well documented, this report is limited to some additional general comments on estimating yield based upon discussions with suppliers and users.

a) If possible, the sample to be analysed should be run at a nearby MSR installation. This has several advantages:

   - Lumber is visually graded by graders experienced in handling MSR lumber at operating speed and conditions.

   - Both the average and minimum E values will be measured. Since the minimum E value is related to bending strength, some indication of the relationship between bending strength and Modulus of Elasticity can be derived.

   - The percentage of lumber downgraded from MSR grades due to a low minimum E value is available. From the mills contacted, this percentage varies from approximately 15% to 50% of the material fed to the stress rating machine.

---

(1) Machine Stress Rating: Practical Concerns for Lumber Producers - USDA Forest Service General Technical Report FPL 7.

(2) Machine Stress Rating - Mill Potential - ibid. March 1980.

Table 18
INSTALLATION & OPERATING DATA - EXISTING MSR INSTALLATIONS CONTACTED

Mill/Address Contacted	Installation Date	Sizes,Lengths	Major** MSR Grades Normally Sorted	Flow Plan Type	Sorting	MSR Machine	Max. MSR Feed Speed	Machine Infeed Type
Crown Zellerbach Columbia City OR	1975/76	H 2 x 4 10' to 20'	1650	Separate MSR Facility	Pullchain	Stress-o-Matic	350 FPM	Planer type
Frank Lumber Mill City OR	1963	D, DF 2x4, 2x6	1650, 2100	Offset	Pullchain	CLT	800 FPM	Belt Conveyor
Hemphill O'Neill Chehalis WA	1979	DF 2x4, 2x6 10' to 20'	1800, 2400	In-line	Pullchain	CLT	700 ± FPM	Belt Conveyor
Plateau Mills Division B. C. Timber Engen B.C.	Approx. Nov/81	SPF (not yet running)	*1450, 1650 1800, 2100	Offset	Pullchain/ Bin Sorter	CLT	1100 ± FPM	Planer Type
Pope & Talbot Grand Forks B.C.	May/80 2x4, 2x6	SPF,H, F/L 2100, 2400	1450, 1650	In-line	Trays & Pullchain	CLT	950 ± 1000 FPM	Rollcase & Holddowns
Pope & Talbot Midway B.C.	1976	SPF, H, F/L 10' to 24'	1450, 1650	In-line	Pullchain	CLT	950 ± 100 FPM	Rollcase & Holddowns
Pope & Talbot Oakridge OR	1978	Hem/Fir 2x4 10' to 20'	1650 2100 2400	In-line	Pullchain	CLT	1000 ± FPM	Belt Conveyor
Sandner Bros. Christina Lake B.C.	Sept/81	SPF,LP, F/L, H	1650, 1800 2100	Offset	Pullchain	CLT	350 ± FPM	Belt Conveyor
San Poil Lumber Republic WA	1979	SPF/F/L 2x4, 2x6 10' to 20'	1450, 1650 2100, 2400	Offset	Tray Sorter	CLT	1000 ± FPM	Planer Type
Simpson Timber Whitecourt Alta.	1977	SPF 2x4, 2x6 10' to 20'	1650, 2100	Offset	Trays & Pullchain	CLT	950 FPM	Belt Conveyor
Weyerhaeuser Dierks AK	Dec/78	SYP	SYP	Separate MSR Facility	Pullchain	CLT	800 FPM	Planer Type
Weyerhaeuser Kamloops B.C.	1977	SPF	1650 1800-DF only	Offset	Pullchain	CLT	700 FPM	Lug Loader/ Belt Conveyor
Weyerhaeuser Okanagan Falls B.C.	June/79	DF, SPF 2x4, 2x6 10' to 20'	1650,2100 or 1450 & 1800 2400	Offset	Pullchain	CLT	1200 ± FPM	Planer Type Rollcase with Pineapple Roll
Weyerhaeuser Princeton B.C.	May/81	PSF, DF 2x4, 2x6	1650, 2100 or 1450, 1800	Offset	Pullchain	CLT	1170 ± FPM	Planer Type
Weyerhaeuser Snoqualmie Falls WA			1650, 2100 1450, 1800 2400	Separate MSR Facility	Pullchain	CLT	700 FPM	Planer Type
Weyerhaeuser Wright City OK	1981	SYP, 2x4 10' to 20'	SYP	Offset	Trays/ Pullchain	CLT	1000 ± FPM	Planer Type
Wickes Forest Ind. Grangeville ID	Oct/77	LP, HF, DF 2x4, 2x6 10' to 20'	1650, 2100 2100	In-line	Pullchain	CLT	600 FPM	Belt Conveyor
Willamina Lumber Willamina OR	1976	Hem 2x4, 2x6 10' to 20'	1450, 1650 2100	In-line	Pullchain	CLT	900 ± FPM	Belt Conveyor

F/L - Fir/Larch; SYP - Southern Yellow Pine; H - Hemlock; LP - Lodgepole Pine; HF - Hemfir; DF - Douglas fir.
* MSR Line not yet in operation.
** Planned sorts only. 1450 = 1450f-1.2E; 1650 = 1650f-1.5E; 1800 = 1800f-1.6E; 2100 = 2100f-1.8E; 2400 = 2400f-2.0E.

- If the mill has a similar timber supply to the mill contemplating an MSR line, it is likely the boundary E values set for the MSR grades will be suitable.

b) The MSR yield seems to improve as the mill personnel become familiar with the effects of kiln drying, edging, timber location, species, and sizes on MSR yield at their own installation on their timber supply. Hence, the yields obtained from the initial test run may be conservative if the test sample is typical of the mill output.

c) The MSR yield from #3 grade (or utility) may or may not be significant. According to NLGA grading rules, only that portion of #3 grade that is #3 because of knot size or decay can be machine graded. It appears that, at most mills, this portion may be insignificant. Hence, in this study, it is assumed that there is no MSR lumber recovered from #3. If a portion of the #3 is conservatively graded, it could possibly yield some MSR grades.

d) The yield study should be designed to ultimately maximise marginal sales returns, once yield volumes are known. For example, it can be shown for most installations that the marginal sales revenue is greater if two MSR grades are recovered instead of three or four. Also, the demand and price differential for some MSR grades may be extremely good or non-existent. Obviously, this must be taken into account. In this study, for initial consideration, it is assumed that 1650f-1.5E and 2100f-1.8E grades will be sorted and that there is a market for them.

e) Clearly, the MSR yield study results will be more accurate if the test sample is representative of the lumber to be fed to the MSR line. If possible, the test sample should contain the correct proportions of #1 (or construction grade), #2 (or standard grade), profiled lumber, different species, and moisture contents that will be handled by the MSR line.

<u>Mill Factors Affecting MSR Yield</u>

a) <u>Planer-Profiled Lumber</u>

In this context, planer-profiled lumber is defined as lumber split in the planer to narrower widths. At most mills contacted, profiled lumber had at least a noticeably different MSR yield from sawn lumber. In some cases, the MSR yield was higher for profiled 2 x 4's. One possible reason for this may be that profiled lumber comes primarily from centre cants where the grain tends to be tighter. However, the reverse was true at some mills contacted, possibly because a high percentage of the sawn 2 x 4's was lodgepole pine.

Profiled lumber usually comes in longer average lengths which are in demand in MSR grades. Hence, being able to stress grade profiled lumber enables the mill to improve the length distribution.

b) Species

Virtually all the inland mills contacted stated that lodgepole pine provided the best MSR yield, while balsam provided the lowest yield. Otherwise, no clear trend appeared for all mills collectively. Some mills were selecting species specifically for, and because of, their high MSR yield but generally this was not practiced.

c) Kiln Drying

Generally, the dryer the wood, the stronger it becomes. For example, one guideline (1) states that for every 1% decrease in moisture content, the Modulus of Elasticity increases by 2%. This has to be balanced against the higher degrade volumes and case hardening in some areas as the wood is dried further. Most MSR mills targeted for moisture content of 15% to 17%, instead of 17% to 19% without MSR. The extra drying time required (approximately one to three hours) did not concern the mills visited. However, a significant problem was drying quality control, i.e., consistently attaining 15% to 17% moisture content. No mills contacted had installed any wet board dropout or moisture detector in front of the planer after installing their MSR line.

d) Edging and Trimming

Theoretically, lumber that is scant (2) by 1% will lower its E value by 3%. Also, very scant lumber (e.g., .030" scant) will not feed properly through some grading machines such as the CLT.

Trimming ends to reduce wane from #2 or standard and better will make more bearing surface for truss plates, but also wastes lumber. One mill that trimmed after the stress grading machine stated it did not pay them to trim more than 2' from a #2 and better board, or more than 4' from a #3 board to make 1650f-1.5E.

e) Frozen Lumber

To avoid inaccuracies due to the stiffening effect of freezing, all lumber selected for proofloading should be at moderate temperature (15°C). Hence, the grading machine must be adjusted for this effect. Relatively little measurement of this effect has been done. However, some mill tests indicate a 4% to 5% increase in MOE above -35°C with a large increase (up to 20%) in MOE at lower temperatures.

(1) MSR Workshop ibid.
(2) i.e., below specification sizes.

10.3 Review of Available Equipment

To aid in planning and estimating costs, three of the grading machines suitable for installation in a modern planer mill are surveyed in this section for capital cost, operating principles, speed, product, lumber size range, specifications, and installations. The information was obtained from manufacturers and users in mid-1981. The machines surveyed are the Metriguard Continuous Lumber Tester (the most commonly used in recent North American MSR installations), Rau-te Timgrader, and Innotec Finnograder. Other machines such as the Stress-O-Matic, Computermatic, and TRU Timber Grader are surveyed in the U.S. Forest Service Report (1).

1. Metriguard CLT

a) Manufacturer

Irving Moore	and	Metriguard
P.O. Box 23058		P.O. Box 396
Portland OR 97223		Pullman WA 99163

b) Machine Cost (FOB Portland OR/Pullman WA, Canadian Funds)

CLT	$ 183,600	
Spare Parts	2,400	
Sub-total	$ 186,000	
Prooftester	14,000	
Total	$ 200,000	- No duty or federal sales tax

Source: Appendix E2

c) Operating Principles

The method of feeding and deflecting the lumber in a CLT is shown in Figure 9, along with the controls required to complete the measurement of the average and minimum E values. The board is deflected over a 4' supported length at any one time. Hence, approximately 2' at each end of the board is not measured as thoroughly as the middle section.

Operating Speed	- to 1200 linear feet per minute (factory set)
Material Sizes	- 2 x 3, 2 x 4, 2 x 6, 2 x 8, 2 x 10, 2 x 12 (nominal) - 3" to 10" or 4" to 12" width range options. 2½" maximum thickness.

(1) Machine Stress Rating: Practical Concerns for Lumber Producers ibid.

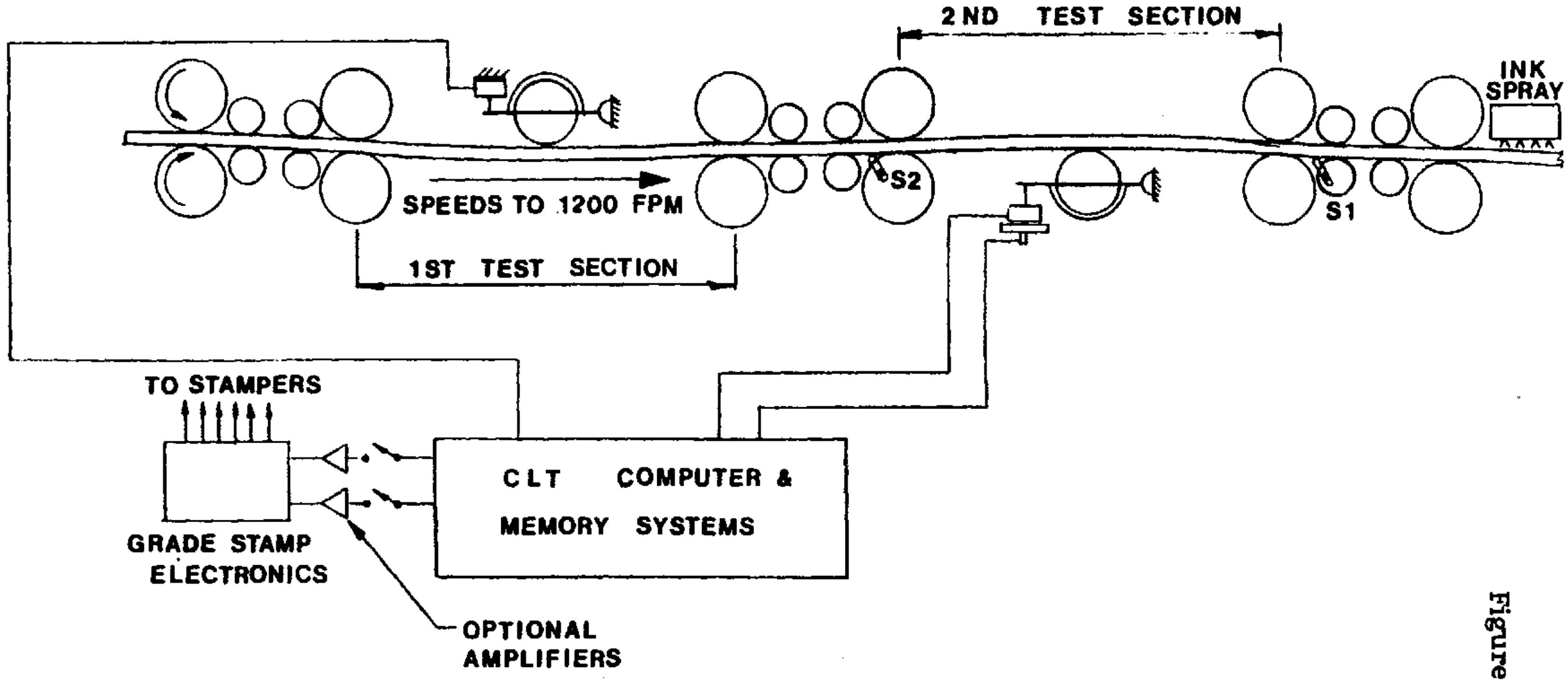


Figure 9

ILLUSTRATION OF THE OPERATION OF THE CLT

MOE Range	- 0.0 to 5.0 x 10^6 psi
No. of Grades	- 4 (plus reject)
Power Requirements	- 2-10 HP motors 3P60H (typical) - 1 KVA - 1 phase for electronics
Machine Size	- 17'-2"L x 3'-7"W x 4'-8"H
Machine Weight	- 11,000 lbs (approximately)

d) Comments

Virtually all recent MSR installations in the U.S. and Canada use the Metriguard CLT. All except one of the 18 mills contacted for this study have installed the CLT.

The feed speed of the CLT is sufficient to keep up with high speed planers so it can be placed in the same material flow and save operating cost (see MSR Layouts section). The noise level for a typical CLT installation is approximately 92 to 95 dBA so a sound enclosure should be included in the capital cost estimate. Because of its predominance in existing mills, the capital cost estimates included in this report assume CLT machinery installed.

A recent list of CLT installations is shown in Table 2.

2. Innotec Finnograder

a) Manufacturer

Innotec Oy
Luoteisrinne 4E
SF-02270
Espo, Finland

Sales

Plan - Sell Oy
P.O. Box 24
SF 18101
Heinola 10, Finland

b) Machine Cost - $130,000 (approximate)

- FOB Espo, Finland
- Canadian funds
- No duty or federal sales tax required
- Provincial Sales Tax and freight additional as required.

c) Operating Principle

The Finnograder does not contact the board to measure Modulus of Elasticity but, instead, continuously measures the density, number and size of knots, slope of grain, and moisture content along the board length and then predicts the bending strength and MOE on the basis of a formula. The board is measured flatwise by four sets of sensors which enable the machine to estimate the pure compression or tensile strength, distinguish the stronger edge of the board for truss design, give data on knots, measure the moisture content of the board, and measure the board completely from end to end. Grades are automatically sprayed or stamped similar to other units. The system of sensors used is diagrammed in Figure 10.

d) Specifications

Operating speed	100 to 1000 fpm
Material sizes	5/8" to 3" thickness; 2½" to 12" width
Material length	10' minimum (approximate)
No. of grades	5 (plus reject)
Power requirements	0.24 kW (infeed and outfeed conveyors not included)
Machine size	4'-3" x 2'-0" x 1'-4" (sensor cabinets only)

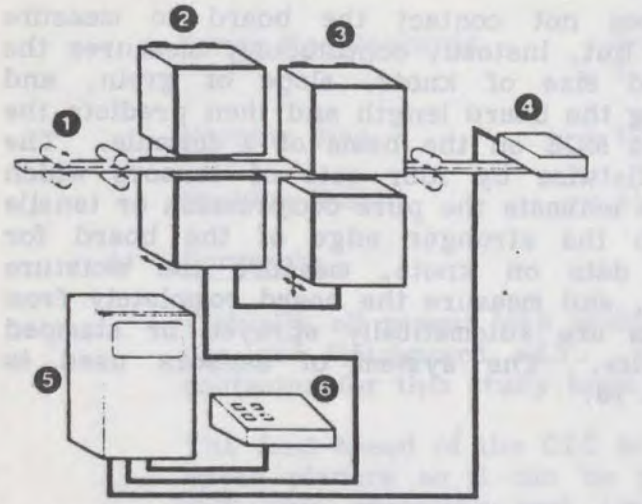
e) Comments

According to the manufacturer, Finnograder can measure with normal accuracy when the temperature is above -20°C. However, the piece must not be green (i.e., moisture content must be below the fibre saturation point) and the temperature must be the same on the surface and inside the piece to get accurate results. As of September 1981, the only installation is at the prefab house factory of Enso-Gutzeit Oy, Saenatsalo, Finland.

The feed speed is high enough to permit installation of this machine in the planer mill flow.

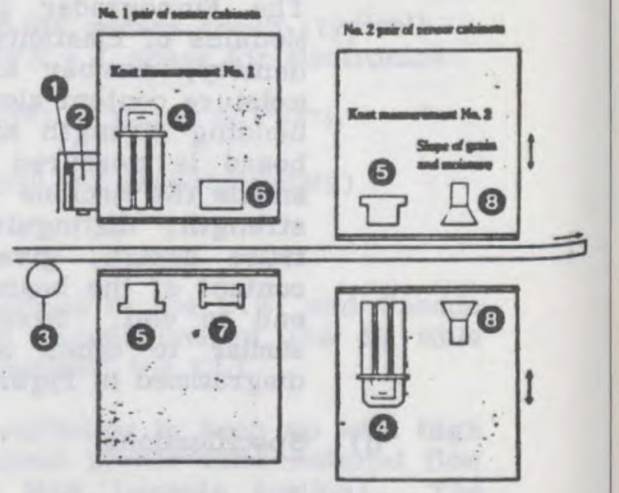
Figure 10

FINNOGRADER
PRINCIPLE OF OPERATION



FINNOGRADER SYSTEM ILLUSTRATION

1. Conveyor
2. No. 1 pair of sensor cabinets
3. No. 2 pair of sensor cabinets
4. Dye marker
5. Electronics cabinet
6. Control desk



FINNOGRADER SENSOR ARRANGEMENT

1. Board end detector
2. Surface temp. sensor
3. Conveyor speed sensor
4. Microwave transmitter
5. Microwave receiver
6. Density Gamma ray source
7. Gamma ray detector
8. Microwave transmitter / receiver

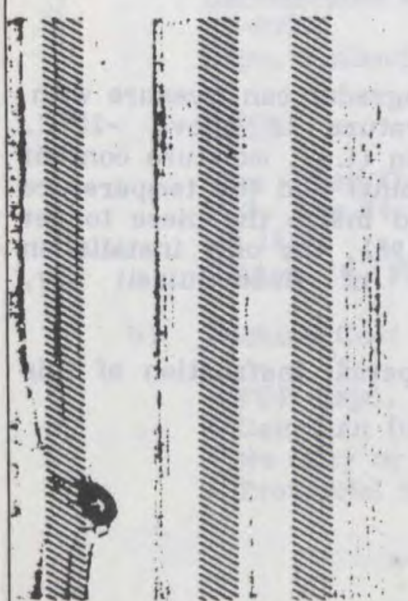
The sensors utilize various kinds of electromagnetic radiation:

a) The gamma rays penetrate the board and their intensity on the reverse side is proportional to the density.

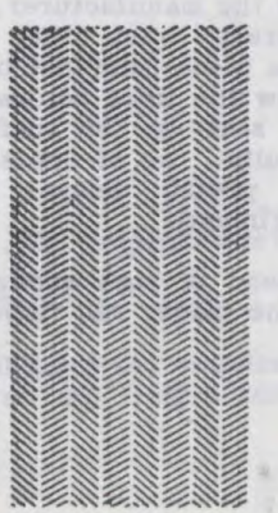
b) Individual knots and their sizes are detected by microwave radiation, on the basis of the disturbances they cause in the electromagnetic field. The location of the knots — also a factor affecting the strength — is taken into account by weighting the corresponding signals.

c) Microwave radiation is also used to obtain the slope of the grain, but this time as a different kind of change in the field: a turn of the polarization plane.

d) The moisture content is also obtained in connection with the last-named measurement. This information, complete with temperature correction, is used for the subtraction of the part represented by water in the density value.



The density is measured parallel to the centre line of the board.



Knots are detected in 20 mm wide sectors covering the full board width.

The slope of the grain is estimated from the 100 mm wide area around the centre line.

3. Rau-te Timgrader

a) Manufacturer

Rau-te Oy
Helsinki, Finland

Sales

Raute, Inc.
1377 Barclay Circle, Suite D
P.O. Box 1287
Marietta GA 30060

b) Machine Cost

- FOB Helsinki, Finland
- Canadian Funds (approximate)
- No duty required
- Provincial Sales Tax and freight additional as required

Timgrader	$ 125,000	
Grade Printing Attach.	15,000	
Sub-total	$ 140,000	
Recommended spares	5,000	(approximate)
Total	$ 145,000	

c) Operating Principle

The method of operation is somewhat similar to the CLT. The Modulus of Elasticity of each piece is measured while the piece is fed flatwise, and the wood is sprayed at 4" intervals according to the stress level measured for that interval. Hence, average E value is indicated by looking at all the spray marks on a piece. Lumber is bent in opposite directions horizontally (i.e., edgewise).

d) Specifications

Operating Speed	- 164 to 444 ft/min
Material Size	- 1" to 3" thickness - 2-1/3" to 11-3/4" width - Minimum 1" x 2-1/3" - Maximum 2" x 11-3/4" or 3" x 9"
Material Length	- 6' to 26'
No. of Grades	- 4 (plus reject)

Power Requirements	- 2-10 HP motors - 1.5 KVA 1-phase for electronics
Machine Size	- 10.9'L x 16.5'W x 5.5'H
Machine Weight	- 8,600 lbs

e) Comments

The maximum feed speed of 444 ft/min limits its in-line use to behind slower planers. As of mid-1981, there were no installations in Canada or the United States, but several in Europe and elsewhere as shown in Table 19.

10.4 MSR Layouts and installations

Typical Layouts for MSR

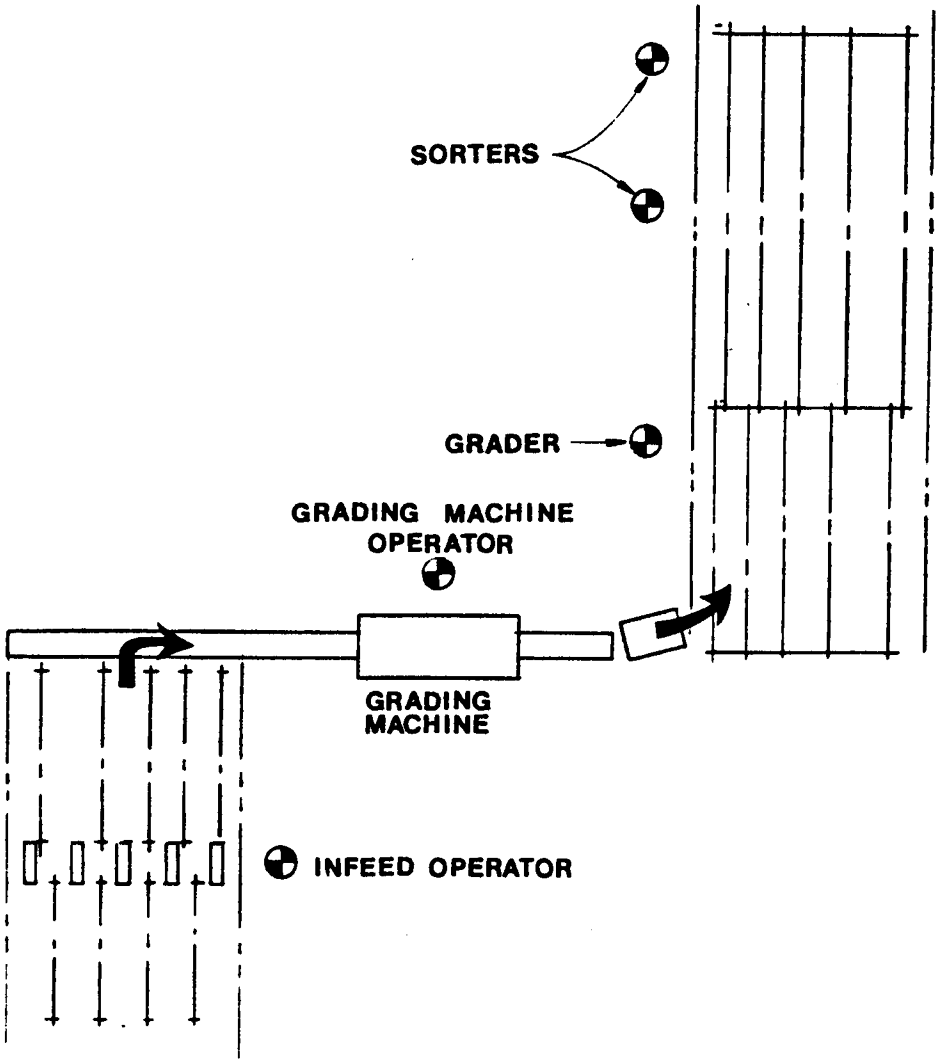
Four main types of layouts are seen in the existing North American MSR installations: separate MSR facility, offset stress rating machine, in-line stress rating machine, and dropout to stress rating machine. The latter three layouts could be incorporated into a new or existing planer mill. To reflect the most typical installation, emphasis in this report is placed on installing MSR lines in existing planer mills.

a) Separate MSR Facility

In this type of layout, illustrated in Figure 11, the grading machine has its own building and infeed and outfeed sections, and is able to run completely independently of the planer. The two known facilities of this type were built over four years ago. This layout has the advantage that materials can be selected to feed the stress grading line. Also, the planer mill and MSR line both have more operating flexibility.

Compared to installations in existing planer mills, two significant disadvantages of this type of layout are the high capital cost, especially if a new building is required, and the high operating cost, since three or more extra people are required (one tilt hoist operator, one or more visual graders, one or more sorters, forklift operating, grading machine operator). In situations where there is no room in or adjacent to an existing planer mill for an MSR line, a separate MSR facility may be the only alternative.

Figure 11



SEPARATE MSR FACILITY
TYPICAL MATERIAL FLOW

Table 19

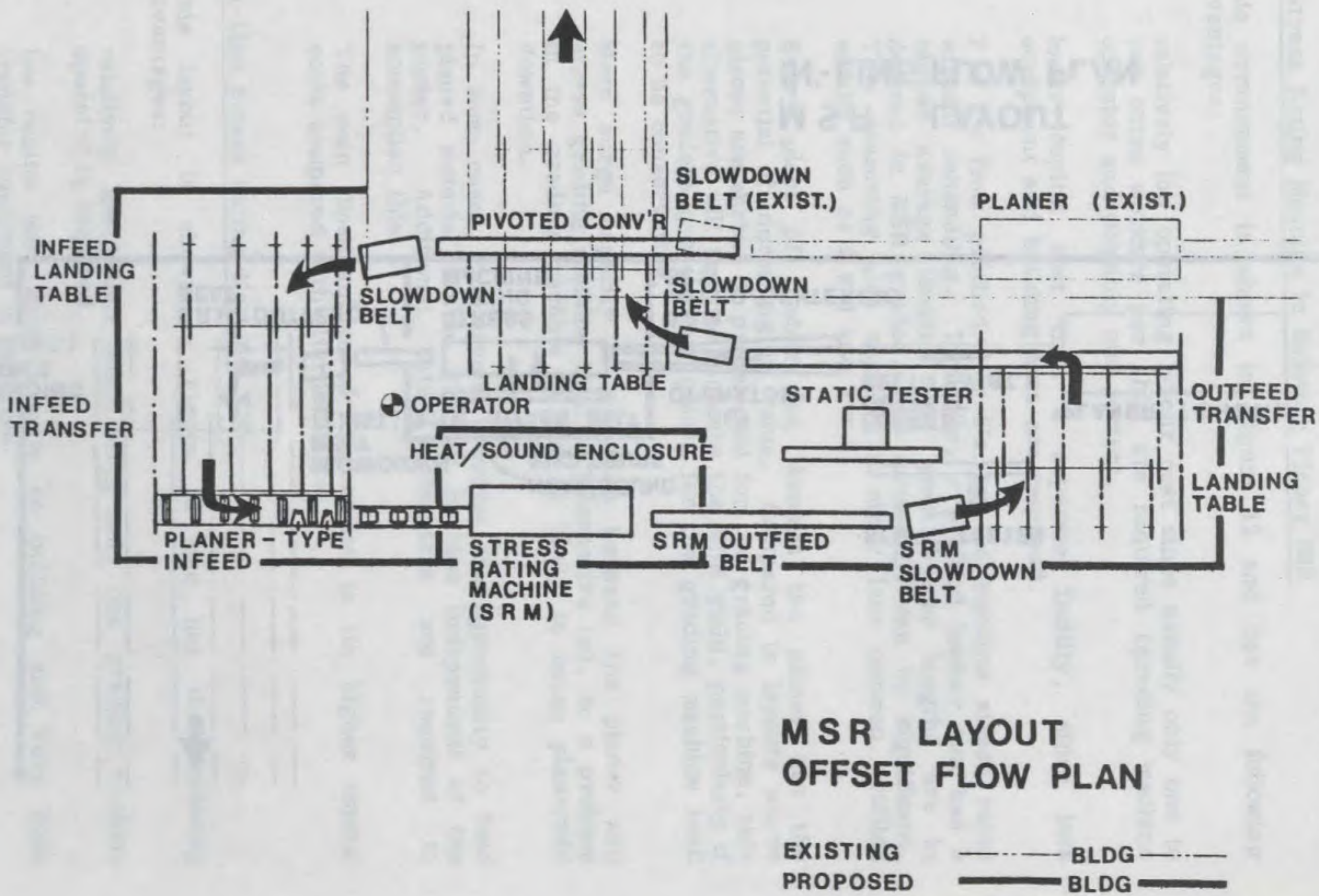
TIMGRADER STRESS GRADING MACHINE
LIST OF INSTALLATIONS

Note: Ref. No.'s marked TGP are installations which include a Timgrader Market

Ref.No.	Organization	Location	Year*
TGP 001	Technical Research Centre of Finland(Timber Laboratory)	Otaniemi, Helsinki Finland	1974
TGP 002	Vierumaen Teollisuus	Vierumake, Finland	1974
TGP 003	Lahden Rautateollisuus	Lahti, Finland	1975
TG 005	Haapaniemen Saha	Viitasaari, Finland	1978
TG 006	Kitulankosken Saha	Kitula, Finland	1978
TG 007	Lauttaniemi Ky	Vaaksy, Finland	1978
TG 008	Leivonmaen Saha Oy	Leivonmaki, Finland	1978
TG 009	Oy Kaukas	Lappeenranta, Finland	1978
TG 010	Alavuuden Puunj.Oy	Alavus, Finland	1979
TG 011	Polimex-Cekop	Murow, Poland	1979
TG 012	Polimex-Cekop	Slawno, Poland	1979
TG 013	Rauma-Repola Oy	Lahti, Finland	1979
TG 014	Keski Suomen Puutuote Oy	Vaajakoski, Finland	1979
TG 015	Pyhannan Rakennustuote	Pyhanta, Finland	1979
TG 016	Southern Evans, Ltd.	Widnes, England	1980
TG 017	Rauma-Repola Oy	Martinniemi, Finland	1980
TG 018	V/O Prommashimport	Riika/Latvia Russia	1980
TG 019	Casa Prefabricadas del Guadiana S.A.	Durango, Mexico	1981

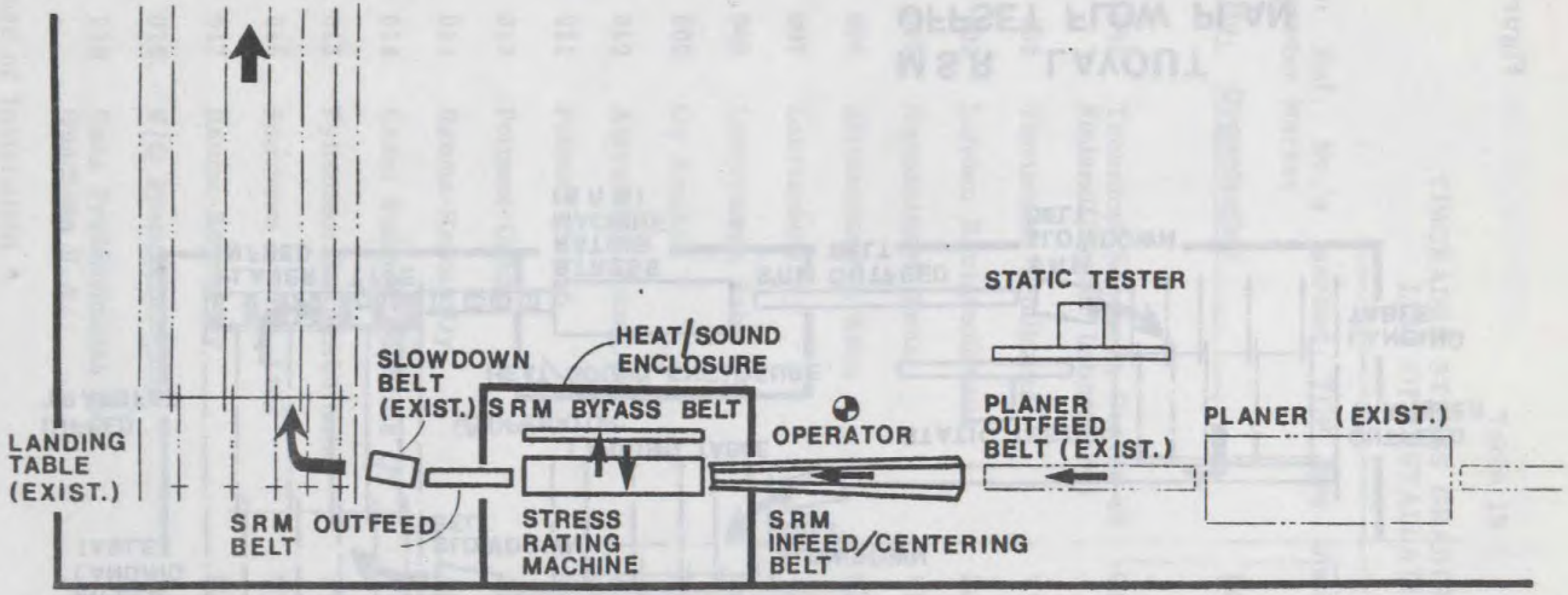
* Year of Installation

Figure 12



MSR LAYOUT
OFFSET FLOW PLAN

Figure 13



M S R LAYOUT
IN-LINE FLOW PLAN

M S R LAYOUT
IN-LINE FLOW PLAN

Offset Stress Rating Machine in Existing Planer Mill

This arrangement is shown in Figure 12 and has the following advantages:

- relatively low operating labour cost since usually only one to two extra workers per shift are required (grading machine operator and possibly one sorter).

- lower capital cost than a separate facility, since less equipment and building area are required.

- 2 x 4's from profiled 2 x 8's can be machine stress rated without rehandling. Typically, a profiled lumber run has a higher average length and, since longer lengths are in demand in MSR grades, this advantage can be significant. This reasoning also applies to other less common profiled widths such as 2 x 3 and 2 x 6.

- Every piece of lumber fed through the planer has the potential of increasing in value. Compared to layouts where pieces are sorted or preselected for the grading machine, this alternative will tend to increase the MSR yield, particularly if the graders preselecting pieces for the grading machine tend to be conservative.

- More surge capacity is provided between the planer and stress grading machine than in alternative (c), so a problem in the grading machine is not as likely to cause planermill downtime.

- In some cases, this layout provides the opportunity to feed planed material to the grading machine independent of the planer. Additional infeed transfers are required to accomplish this.

The main disadvantage of this option is its higher capital costs compared with alternative (c).

c) In-Line Stress Rating Machine

This layout is shown in Figure 13 and has the following advantages:

- relatively low labour cost, since only one grading machine operator is required.

- low capital cost since usually no building and very little transfer equipment is required.

- every piece fed through the planer has the potential of increasing in value by being stress graded (as in alternative b)).

This in-line layout of Figure 13 has the following disadvantages:

- Lumber profiled in the planer cannot be stress graded since the grading machine can handle only one piece at a time.
- If a piece jams or breaks up in the grading machine, lumber following will very quickly backup into the planer and its infeed, resulting in downtime and possibly more jamups at the planer infeed.
- It is often impractical to fit into existing planer mills where space is limited.

d) Dropout to Stress Rating Machine

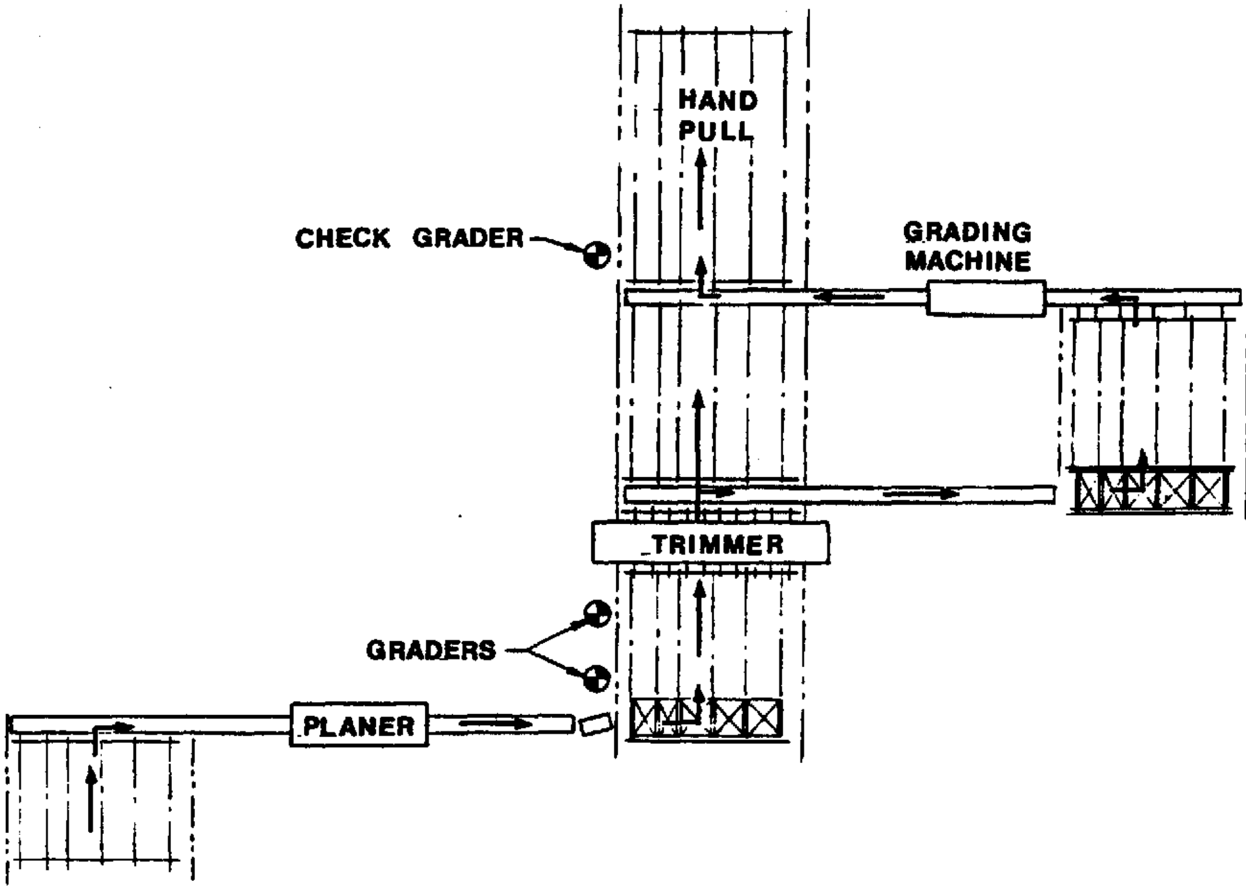
This type of layout is shown in Figure 14 and has the following advantages:

- the capital cost will be similar to an offset grading machine layout since the equipment and building required will be similar. An extra operator may be required (instead of a CLT operator only) in certain cases to ensure smooth feeding and proofloading tests are both accomplished in addition to the check grading.
- obviously defective pieces can bypass the grading machine and greatly reduce the possibility of breakups in the grading machine.
- MSR yield may be increased slightly if trimming is done ahead of the grading machine since end defects will be removed.
- One species can be separated from others being planed concurrently, for stress grading. This, however, is not a common practice.

A disadvantage of this layout is that there may be a tendency for some graders to be conservative about which pieces are sent to the grading machine.

In conclusion, contact with recent MSR installations indicates that the trend is toward the in-line and offset layouts (b) and (c) above, where all pieces from the planer pass automatically to the grading machine and then to the graders. For this reason, capital cost estimates for alternatives (b) and (c) are provided in the section on economic feasibility.

Figure 14



MSR LAYOUT
DROP-OUT TO GRADING MACHINE
FLOW PLAN

10.5 Installation Design Considerations

Some features important to some or all of the above types of layouts are considered here.

Grading Machine Enclosure

A heated sound enclosure should be provided to keep the machine and controls warm enough to operate accurately, and reduce the sound level in the area. For example, the Metriguard CLT can reach levels of up to 92 to 95 dBA. Also, the enclosure can serve to thaw and heat lumber before prooftesting on the static tester in cold weather.

Grading Machine Infeed

Several types of infeeds are in use. For those grading machines installed directly behind the planer, belt conveyors appear to be the most common. Some of these conveyors have moveable sides (for centering) and some have holddown wheels to ensure controlled feeding of warped boards. Rollcases with holddown rolls have also been used.

For those grading machines that are offset from the planer or in a separate facility, provision must be made to speed the piece up to grading machine speed. In some mills, this was done with a belt conveyor, while others used a simplified type of planer infeed with pineapple rolls. At the mills contacted, the minimum distance from the lumber line on the infeed transfer to the front of the grading machine is approximately 12'.

For all three grading machines surveyed in this report, the infeed must be designed so that the centreline of the board matches the centreline of the machines. Also, a short gap is required between boards.

Grading Machine Outfeed

If required, the CLT and Timgrader are capable of discharging directly to a short (3' to 5') slowdown belt and transfer, i.e., a longer conveyor between the grading machine and outfeed transfer is not necessary. At least one CLT installation is laid out this way to save space.

10.6 Effect of MSR on Sorting Facilities

Most MSR lines have been installed in an existing planer mill where the extra sorts for MSR grades were not provided for in the original mill design. The space available for extra sorting and/or the cost of providing these sorts can be a major consideration when deciding how many MSR grades, if any, the mill is going to produce.

Some methods used to increase sorting capacity for the three types of sorters are:

a) Tray Sorters

- Add more trays above and/or below the existing trays. This can become relatively expensive if modifications to the building are involved. Adding trays to the bottom of the tray sorter is usually least expensive if clearance between the bottom tray and pull chain is sufficient.

- Split existing trays longer than the package size to provide accumulating sections. On some large tray sorters, this may free one spare tray. If possible, the package size can be reduced to provide more space for an accumulating section.

- Convert the electronic controls to a self-seeking mode of operation if none exist. For some tray sorters, this may free one or more trays now being used as spares.

b) Pull Chains

- Have longer lengths pulled on the opposite side of the chain now being used. It may be necessary to install an extra grade printer so the sorter is able to see the grade stamp on the far end of the piece. Depending upon the volume, this measure may or may not require an extra sorter, since the opposite side of the pull chain would only be used when long lengths are being pulled.

- If there is room, lengthen the pull chain.

- Combine shorter lengths or economy sorts.

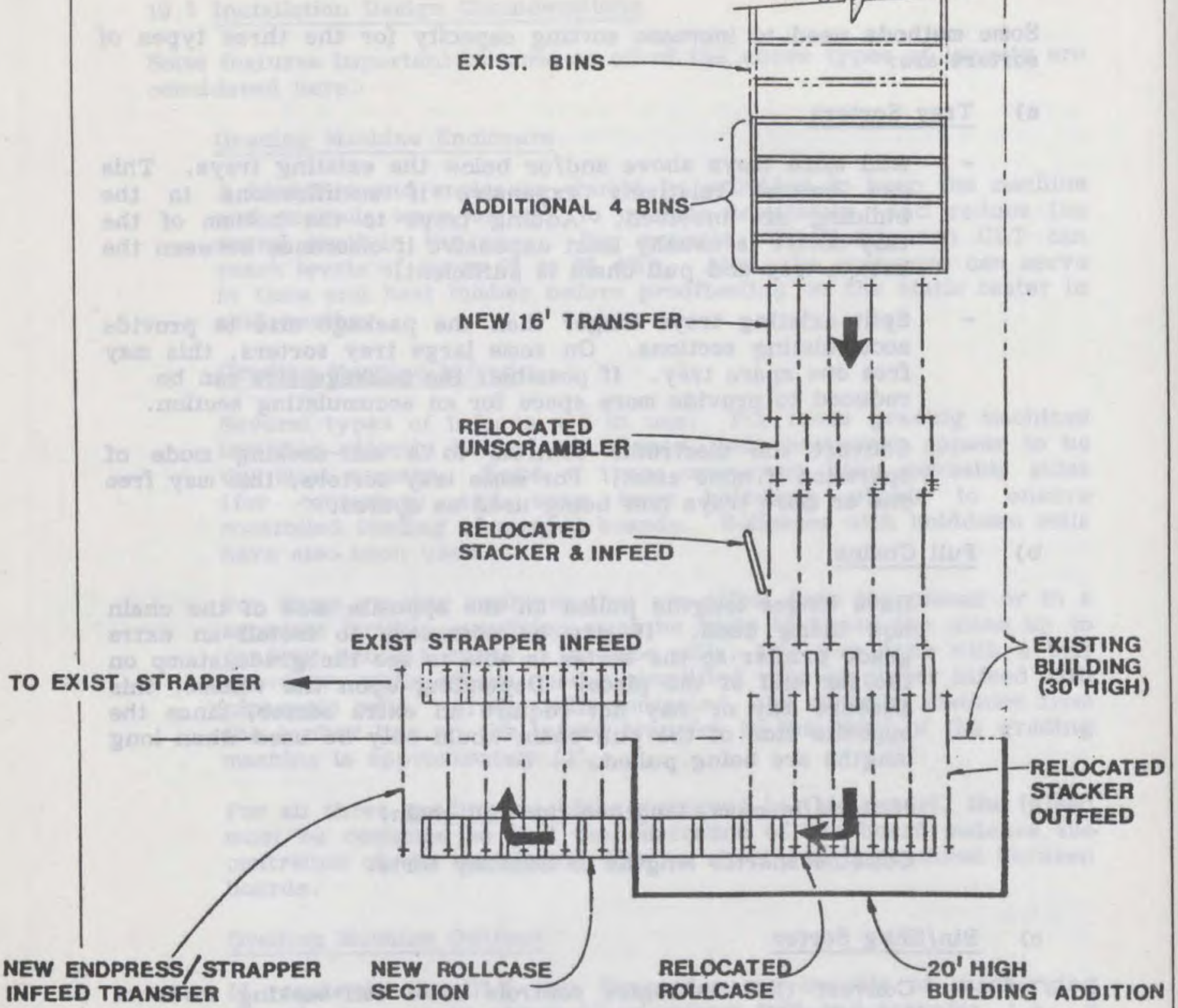
c) Bin/Sling Sorter

- Convert the electronics controls to a self-seeking mode of operation, if not already existing.

- Add more bins. It may or may not be necessary to relocate the stacker and extend the sorter building. A typical modification is shown in Figure 15.

For those planer mills feeding block length loads, the number of MSR sorts required can be limited by sorting only on-length MSR lumber -- i.e., no lumber that was trimmed back would be sorted as MSR. This, of course, will lower the mill's MSR yield but, in some cases, may be the only choice.

Figure 15



M.S.R. LAYOUT

BIN SORTER MODIFICATIONS

EXISTING — - — BLDG — - — -

PROPOSED ———— BLDG ————

10.7 Summary

A large number of MSR installations were visited, or contacted, to ascertain current practices and to identify the problems likely to be encountered. A summary of these installations and their operating data is presented in Table 18.

An initial and important step for any mill considering an MSR installation is the determination of the likely grade yield from projected production. The procedures to be followed are given in detail in a U.S. Forest Service report (1). Though other options are available, the preferable approach appears to be the use of a nearby MSR installation to test and gather data on samples of the lumber produced at the mill under consideration. The sample must be chosen with care, to ensure that it is truly representative of the lumber expected, in terms of grade, species and so on.

The yield of MSR grades is affected by a number of factors.

- planer profiled lumber. The yield of MSR lumber tends to change if planer profiled lumber is included.

- species. Many mills indicate that high yields are obtained from lodgepole pine but those from balsam fir are much lower.

- moisture content. Experience suggests that drying to 15% to 17% instead of 17% to 19% improves grade yield.

- manufacturing. Scant lumber and excessive wane have a negative effect on grade yield.

- temperature. Tests indicate that inaccurate yield results are obtained if the lumber is at a low temperature.

A variety of machines are available for stress grading lumber. For the three reviewed in detail in this section, the prices vary from C.$130,000 to C.$200,000. Others are also discussed in the report referred to earlier. Though there are advantages and disadvantages for each, the most suitable and proven machine for the typical Canadian mill appears to be the CLT.

Four main types of MSR layouts are seen at existing U.S. and Canadian installations. These are

- separate facility for MSR
- offset MSR machine in existing planer mill
- in-line MSR machine
- dropout to MSR machine.

(1) Machine Stress Rating: Practical Concerns for Lumber Producers ibid.

The conditions at each mill are likely to vary, but the most common layouts, in recent installations, are the offset and in-line machines.

Installation of an MSR machine has a very significant impact on the existing sorting facilities. The modifications that are necessary will depend entirely on the situation that exists at any particular mill.

11. ECONOMIC FEASIBILITY

11.1 Introduction

The purpose of this section is to provide guidance to mills considering investment in MSR facilities. It presents a financial analysis based on various cost and revenues assumptions for two selected MSR layouts. These assumptions, and the method of calculating financial viability, are provided in sufficient detail for individual mills to use as a format for their own site-specific locations. The rate of return on investment for the two selected layouts in a "typical" B.C. mill situation are presented.

11.2 Incremental MSR Price Per Unit

Section 9 examined lumber prices and grade differentials. It noted that the incremental revenue to be expected from the sale of MSR lumber is an essential element in determining the economic feasibility of installing a CLT-1. The section concluded that, for the purposes of financial analysis:

- a differential of C.$45 per thousand board feet, in 1982 dollars, should be assumed for 1650f-.15E grades.
- a differential of C.$65 per thousand board feet, in 1982 dollars, should be assumed for 2100f-1.8E grades.
- to allow for the possible lower value of the residual standard and better grade, a reduction of C.$5 per thousand board feet, in 1982 dollars, should be made in the incremental revenues for MSR.

These conclusions were supported by an analysis of past price relationships and an assessment of probable future grade differentials. Section 9 noted, however, that adverse market conditions prevailed during the period of preparation of the study. At times, during 1981, traditional price relationships between grades differed sharply from those assumed. Consequently, it is strongly recommended that individual mills considering an MSR installation should carefully assess grade differentials likely to prevail when their particular installation would come on-stream. Clearly, over the short term, these may vary from the assumptions provided for the purpose of this pro-forma evaluation.

11.3 Assumptions on Typical Mill Output

In order to determine revenues for a representative MSR installation, a hypothetical dimension mill producing 100 million board feet per year is assumed. Further, in order to depict a "typical" dimension mill, the following assumptions are made.

- only 1650f-1.5E and 2100f-1.8E grades are sorted in MSR grades.

- only 2 x 4 in 10' to 20' lengths will be sold in 1650f-1.5E and 2100f-1.8E grades. It is also assumed that sawn 2 x 4's, in lengths 10' to 20', account for 36 million board feet of the total production and that 10.5 million board feet of 2 x 8 production, in lengths of 10' to 20', are profiled to 2 x 4's.

- output is based on two shifts with the following size and grade distributions and MSR yields (in thousand board feet).

	Sawn 2x4 10' to 20'	Profiled 2x8 to 2x4 10' to 20'	Total
Std. and btr.	30,000 Mfbm	9,000 Mfbm	39,000 Mfbm
Utility	4,000	1,000	5,000
Economy	2,000	500	2,500
Total	36,000	10,500	46,500
from which the MSR yield is			
1650f-1.5E	12,000 (40% of std.&btr.)	3,600 (40% of std.&btr.)	15,600
2100f-1.8E	1,500 (5% of std.&btr.)	450 (5% of std.&btr.)	1,950

11.4 Assumptions Regarding MSR Price Differentials in Current Dollars

The basis underlying the incremental revenue assumptions for MSR on a current dollar basis is as follows.

- the MSR price differentials (per thousand board feet), in 1982 dollars (Canadian funds), are inflated at a rate of 12% per annum.

- there is little evidence of a reliable correlation between the widening or narrowing of the stress grade price differential with rising or falling lumber market prices (see Figures in Section 9). Consequently, none is assumed.

11.5 Reduced Sales Value of Residual Standard and Better

Based on the assumptions noted earlier of a C.$5 per thousand board feet reduction in the value of the residual standard and better grade, the related annual reduction of sales revenues is as follows.

	In-Line CLT Layout	Offset CLT Layout
	(Mfbm)	(Mfbm)
Total Volume std. & btr.	30,000	39,000
Less: MSR lumber produced	13,500	17,550
	16,500	21,450
Add 20% 1650f-1.5E not sold (see below)	2,400	-
Total Volume Residual std. & btr.	18,900	21,450

Therefore, the total annual loss in sales revenues for each layout alternative is:

a) In-line CLT - $5/Mfbm x 18,900 Mfbm - $94,500

- expected length of sawn 2 x 4 is such that normal random length specifications can only be obtained for 80% of the 1650f-1.5E produced. The balance cannot be sold at the expected differential and, to be conservative, it is assumed to be worth no more than standard and better.

b) Offset CLT - $5/Mfbm x 21,450 Mfbm - $107,000 (rounded)

- The mill is able to sell all the MSR lumber produced if both sawn and profiled 2 x 4's are stress graded (due to better length distribution).

11.6 Cost Assumptions

It was pointed out earlier that basically there are two principal grading machine layouts now being used and worth analysing in this report. Capital cost estimates for two grading machine layouts and three sorting options have been calculated.

These estimates are intended to depict typical or average situations, in order to be of general use to those considering an MSR line. However, costs at each mill will vary according to labour costs, mill location, mill labour content and so on. Some assumptions basic to all of the five cost estimates are:

- all mechanical, structural, and electrical construction is carried out by an outside contractor using IWA tradesmen.
- the mill is located so that some travel costs are incurred by the contractor but no camp costs.
- a very small amount of weekend and shift work will be required to install the machine.
- the installation times will vary from 3 weeks to 2 months for the various flow plans considered.
- no allowance is made for planer mill downtime due to construction.
- the estimates do not include the owner's overhead costs such as accounting, legal, financing, purchasing, operating supplies, or interest during construction, which could add anywhere between 2.5% and 5.0% to costs.
- the stress grading machine is a Metriguard CLT and the proofloading machine is a Metriguard 312.
- all power is brought from existing motor control centres and lighting distribution panels, expanded as required.

- no underground services need to be relocated.
- a contingency allowance of 10%.
- the estimated capital costs used in the financial analysis are valid for a layout being installed in early 1982.

11.7 Capital Costs

The capital cost estimates, based on assumptions above, for the two layouts and the three sorting alternatives are shown in Table 20. The details of how to develop each of these capital costs are shown in Appendix E. Due to the number of combinations possible, there are a variety of capital costs that may be estimated. The least expensive would be an in-line CLT with no sorting modifications at C.$343,000, while the most expensive would be an offset CLT with bin sorter modification at C.$740,000. This range of costs agrees favourably with U.S. Forest Service estimates (1) and others (2).

In calculating the return on investment, two typical layout options are considered. These are:

- an in-line CLT (as in Figure 13) with modifications to an existing pull chain, the costs for which are detailed in Appendices E-1 and E-5 respectively. This layout option has a total capital cost of C.$418,000.
- an offset CLT (as in Figure 12) with additions to an existing bin sorter (as in Figure 15). The capital cost of this arrangement is estimated to be C.$740,000, as detailed in Appendices E-2 and E-3.

It should be noted that the number of extra sorts provided varies for each sorting method shown (i.e., 2 additional trays or 4 additional bins or 12 carts), because these are an estimate of what would actually happen at a typical installation. It is assumed here that the tray sorter would likely be limited by space to 2 additional trays, and the bin sorter would be enlarged by 4 bins to handle two lengths each of two MSR grades. Putting 12 sorts (2 lengths x 5 grades + 2 spares) on one side of the pull chain may eliminate the need for extra manpower when running longer lengths.

---

(1) Mills May Profit with MSR Grading, ibid.

(2) Machine Stress Rating: Practical Concerns for Lumber Producers, ibid.

Table 20

SUMMARY OF CAPITAL COST ESTIMATES OF MSR LAYOUTS

Alternative	Main Features	Estimated Capital Cost
GRADING MACHINE LAYOUTS		
In-line CLT	- flow plan as per Figure 13 - belt conveyor infeed with holddown rolls and centering sides - bypass conveyor and CLT steel slide base	$ 343,000
Offset CLT	- flow plan as per Figure 12 - planer type infeed to CLT - building addition to existing planer mill uses timber columns and joists, piles, slab floor, insulated plywood siding	$ 550,000
SORTING MODIFICATIONS		
Bin Sorter Modifications	- as per Figure 15 - 4 bins added - stacker & accessories relocated - 16'Lx40'Wx20'H bldg. extension - new transfer to strapper - new transfer to stacker - microcomputer control changes - stacker outfeed rollcase extended	$ 190,000
Tray Sorter Modifications	- 2 trays added: 1 above, 1 below existing trays - top of tower raised & accelerator section shortened - microcomputer control program changes to accommodate extra trays	$ 85,500
Pull Chain Modifications	- 12 sorts added on far side of pull chain c/w carts, rails, concrete slab, roof covering	$ 75,000

The Capital Cost of a complete MSR line as estimated above, can vary from $343,000 to $740,000.

Source: Appendix E.

11.8 Operating and Incremental Selling Costs

The operating costs of the two selected MSR layouts are considered here:

a) The low cost alternative - an in-line CLT layout (as in Figure 13) with modifications to an existing pull chain as detailed in the capital cost section and Appendix E. It is assumed this installation will require one additional sorter on the pull chain, and will not stress grade profiled 2 x 4's.

b) The highest cost alternative - an offset CLT layout (as in Figure 12) with additions to an existing bin sorter (as in Figure 15). It is assumed this installation will require no sorting labour.

Operating Labour

As assumed above, the in-line CLT arrangement with pull chain will require two extra workers per shift -- a CLT operator to watch the infeed and perform static proofloading tests, and an additional sorter. For the offset layout, only the CLT operator will be required.

Based on hourly wages of $13.25 per hour for the CLT operator, $12.00 per hour for the sorter, fringe benefits of 28% of wages, 2 shifts of operation at 2,000 hours per shift per year, the added annual costs are:

- In-line CLT/Pull Chain

  2 shifts x 2,000 hrs/yr/shift x ($13.25 + $12.00)/hr x 1.28 (fringe benefits) = $130,000 per year (approx.)

- Offset CLT/Bin Sorter

  2 shifts x 2,000 hrs/yr/shift x $13.25/hr x 1.28 = $68,000 per year (approx.)

Kiln Drying

Kiln drying costs may increase very slightly due to the extra fuel used. The extra fuel will be minimal, since the kilns are already at maximum temperature. An extra cost of $0.50/Mfbm is used here. Hence, the additional annual drying costs are estimated to be as follows:

a) In-line CLT/Pull Chain
$0.50 x 36,000 Mfbm = $18,000

b) Offset CLT/Bin Sorter
$0.50 x 46,500 Mfbm = $25,000

Power Consumption

Power consumption for each alternative is estimated at $7,500 for the in-line CLT/Pull Chain alternative and $15,000 for the offset CLT/Bin Sorter alternative.

Supplies

Maintenance and operating supply costs at existing operations are relatively small. From mills contacted, an annual cost of $5,000 is used here.

Selling Expenses

Some larger companies have hired sales personnel specifically to sell MSR lumber and develop the market, while others utilise existing sales staff, with one or more salesmen becoming knowledgeable in MSR lumber. It is assumed that no extra sales staff are hired, but that sales expenses increase by $16,000 due to increased direct sales effort (see Section 12 for further discussion of this assumption).

Quality Control

Quality control is usually supervised by an existing staff member who has other duties such as quality control for the whole mill, maintaining production records, etc. Hence, no extra cost is assumed for quality control other than the CLT operator who normally performs proofload tests.

No other overhead costs are assumed.

Summary of Operating & Incremental Selling Costs

Item	In-line CLT/ Pull Chain	Offset CLT/ Bin Sorter
	per year	per year
Operating Labour	$ 130,000	$ 68,000
Selling Expenses	16,000	16,000
Kiln Drying	18,000	25,000
Supplies	5,000	5,000
Power Consumption	7,500	15,000
Total Operating & Sales Costs	$ 176,500	$ 129,000

11.9 Return on Investment

Tables 21 and 22 provide detail concerning the analysis undertaken to indicate the potential provincial attractiveness of the two layout options chosen for consideration.

A brief summary of the major assumptions underlying the analysis is as follows:

- the installation has a seven year economic life, at the end of which no terminal value was assumed.
- equal sales volumes in all years for each option.
- escalation of the price differentials assumed for 1982 at a rate of 12% per year.
- escalation of the operating costs assumed for 1982 at 12% per year.
- a Capital Cost Allowance (CCA) write-off period of two years for eligible equipment, and a longer, 15-year period for buildings.
- an effective tax rate of 49%.
- a weighted average cost of capital discount rate (for present value calculations) range of:
  - 16%; which would generally be applicable for the largest and higher credit-rated companies.
  - 20%; which would generally be applicable for medium to smaller size companies required to finance at relatively higher rate for both equity and debt, and having a lower debt ratio.

In combination, the above set of assumptions yield the following return on investment results for the two options.

	In-line CLT/ Pull Chain	Offset CLT/ Bin Sorter
Required Capital Investment ($M)	$ 418,000	$ 740,000
Internal Rate of Return	47.6%	59.2%
Present Value (M$)		
- 16% discount rate	$ 443,300	$1,152,700
- 20% discount rate	$ 349,600	$ 941,500
Average Accounting Return on Gross Investment	38.4%	52.0%
Payback Period - Years	1.9	1.6

Table 21

FINANCIAL ANALYSIS - A. IN-LINE CLT/PULL CHAIN

	1982	1983	1984	1985	1986	1987	1988
Volumes (Mfbm)							
- MSR 1650f	9,600	9,600	9,600	9,600	9,600	9,600	9,600
- MSR 2100f	1,500	1,500	1,500	1,500	1,500	1,500	1,500
- Residual std. & btr.	18,900	18,900	18,900	18,900	18,900	18,900	18,900
Total	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Prices ($/Mfbm)							
- Increased MSR 1650f	45	50	56	63	71	79	89
- Increased MSR 2100f	65	73	82	91	102	115	128
- Residual std.& btr.(reduction)	5	6	6	7	8	9	10
Net Incremental Revenue							
- MSR 1650f (add)	432,000	480,000	537,600	604,800	681,600	758,400	854,400
- MSR 2100f (add)	97,500	109,500	123,000	136,500	153,000	172,500	192,000
- Residual std.& btr. (subtract)	(94,500)	(113,400)	(113,400)	(132,300)	(151,200)	(170,100)	(189,000)
Net Incremental Revenue	435,000	476,100	547,200	609,000	683,400	760,800	857,400
Incremental Operating & Selling Costs							
- Operating Labour	130,000	145,600	163,100	182,600	204,600	229,100	256,600
- Kiln Drying	18,000	20,200	22,600	25,300	28,300	31,700	35,500
- Power Consumption	7,500	8,400	9,400	10,500	11,800	13,200	14,800
- Supplies	5,000	5,600	6,300	7,000	7,900	8,800	9,900
- Selling Expenses	16,000	17,900	20,000	22,500	25,200	28,200	31,600
Total Incremental Costs	176,500	197,700	221,400	247,900	277,800	311,000	348,400
Incremental Taxes							
Income before CCA	258,500	278,400	325,800	361,100	405,600	449,800	509,000
Capital Cost Allowance	184,000	184,000	4,000	4,000	4,000	4,000	4,000
Income before Taxes	74,500	94,400	321,800	357,100	401,600	445,800	505,000
Taxes @ 49%	36,500	46,300	157,700	175,000	196,800	218,400	247,500
Net Income after Taxes	38,000	48,100	164,100	182,100	204,800	227,400	257,500
Projected Cash Flow							
Project Capital Cost (1/1/82)	(418,000)						
Net Cash Flow (End of Year)	222,000	232,100	168,100	186,100	208,800	231,400	261,500

Project IRR & Present Value

Internal Rate of Return	47.6%
Present Value	
- 16% Wghtd. Avg. Cost of Capital	443,250
- 20% Wghtd. Avg. Cost of Capital	349,600

Other Return Measurements

Accounting Rate of Return on Gross Investment	38.4%
Payback Period	1.9 Years

Source: Woodbridge, Reed and Associates Ltd.

Table 22 — ***FINANCIAL ANALYSIS - B. OFFSET CLT/BIN SORTER***

	1982	1983	1984	1985	1986	1987	1988
Volumes							
- MSR 1650f	15,600	15,600	15,600	15,600	15,600	15,600	15,600
- MSR 2100f	1,950	1,950	1,950	1,950	1,950	1,950	1,950
- Residual std.& btr.	21,450	21,450	21,450	21,450	21,450	21,450	21,450
Total	39,000	39,000	39,000	39,000	39,000	39,000	39,000
Prices ($/Mfbm)							
- Increased MSR 1650f	45	50	56	63	71	79	89
- Increased MSR 2100f	65	73	82	91	102	115	128
- Residual std.& btr. (reduction)	5	6	6	7	8	9	10
Net Incremental Revenue							
- MSR 1650f (add)	702,000	780,000	873,600	982,800	1,107,600	1,232,400	1,388,400
- MSR 2100f (add	126,750	142,400	159,900	177,450	198,900	224,250	249,600
- Residual #2 & Btr. (subtract)	(107,250)	(128,700)	(128,700)	(150,150)	(171,600)	193,050)	(214,500)
Net Incremental Revenue	721,500	793,700	904,800	1,010,100	1,134,900	1,263,600	1,423,500
Incremental Operating & Selling Costs							
- Operating Labour	68,000	76,200	85,300	95,500	107,000	119,800	134,200
- Kiln Drying	25,000	28,000	31,400	35,100	39,300	44,000	49,300
- Power Consumption	15,000	16,800	18,800	21,100	23,600	26,400	29,600
- Supplies	5,000	5,600	6,300	7,000	7,900	8,800	9,900
- Selling Expenses	16,000	17,900	20,000	22,500	25,200	28,200	31,600
Total Incremental Costs	129,000	144,500	161,800	181,200	203,000	227,200	254,600
Incremental Taxes							
Income before CCA	592,500	649,200	743,000	828,900	931,900	1,036,400	1,168,900
Capital Cost Allowance	310,000	310,000	10,000	10,000	10,000	10,000	10,000
Taxable Income	282,500	339,200	733,000	818,900	921,900	1,026,400	1,158,900
Taxes @ 49%	138,400	166,200	359,200	401,300	451,700	502,900	567,900
Net Income after Taxes	144,100	173,000	373,800	417,600	470,200	523,500	591,000
Cash Flow							
Project Capital Cost (1/1/82)	(740,000)						
Operating Cash Flow (End of Year)	454,100	483,000	383,800	427,600	480,200	533,500	601,000

Project IRR and Present Value

Internal Rate of Return 59.2%
Present Value
- 16% Wghtd. Avg. Cost of Capital 1,152,700
- 20% Wghtd. Avg. Cost of Capital 941,500

Other Return Measurements

Accounting Rate of Return on Gross Investment 52.0%
Payback Period 1.6 Years

Source: Woodbridge, Reed and Associates Ltd.

Of the above measures, the internal rate of return and present value calculations are, of course, of greatest importance. However, by all measures, both options provide attractive returns on investment. Between the two, while requiring the greater initial capital investment, the Offset CLT/Bin Sorter option provides a superior return.

11.10 Sensitivity Analysis

Sensitivity analysis was conducted based on the assumption of a reduction of $10 per thousand board feet in the price differentials between the two MSR grades and standard and better. For 1982, the price differential assumptions for the sensitivity analysis were:

MSR 1650f-1.5E	$35 per Mfbm
MSR 2100f-1.8E	$55 per Mfbm
Reduced value of standard & better	$5 per Mfbm

As with the base case analysis, these lower differentials were escalated at 12% per year over the life of the project.

The return on investment results from this price sensitivity analysis were:

	In-line CLT/ Pull Chain	Offset CLT/ Bin Sorter
Required Capital Investment ($M)	$418,000	$740,000
Internal Rate of Return	31.2%	42.0%
Present Value (M$)		
- 16% discount rate	$209,800	$661,800
- 20% discount rate	$140,000	$505,100
Average Accounting Return on Gross Investment	24.8%	35.2%
Payback Period - Years	2.9	2.1

As can be seen, while the sensitivity analysis produced results considerably lower than the base case, the return on investment for both options is still very attractive.

11.11 Summary

Analysis of the economic feasibility of the installation of an MSR facility depends, substantially, on a number of site specific factors. These would include the location and nature of the mill, the timber available, the installation required, the products to be produced, the financial position of the mill, and so on. In the absence of any such specific data, a number of assumptions have been made to develop a feasibility analysis for two alternative MSR layouts and sorting modifications.

The assumptions made have each been identified. All important assumptions can be altered and the consequences of such an alteration can be calculated. Thus, sensitivity analyses can be undertaken on all the major factors that are involved in the calculation of return on investment.

The objectives of the economic feasibility analysis undertaken in this section have been twofold.

- to provide a reasonable indication of the likely profitability of a typical MSR installation;
- to provide a format so that an individual mill can use its own site specific data to develop information on the feasibility of an MSR installation.

The particular installation options analysed were an in-line CLT with pull chain modifications and an offset CLT with modifications to a bin sorter. These were chosen as being representative of high capital cost and low capital cost alternatives.

The results obtained for return on investment on these options were as follows.

	In-line CLT/ Pull Chain	Offset CLT/ Bin Sorter
Required Capital Investment	$ 418,000	$ 740,000
Internal Rate of Return	47.6%	59.2%
Present Value		
- 16% discount rate	$ 443,300	$1,152,700
- 20% discount rate	$ 349,600	$ 941,500
Average Accounting Return on Gross Investment	38.4%	52.0%
Payback Period - Years	1.9	1.6

Even when the expected returns for the MSR grades are lowered by $10 per thousand board feet, the return on investment for these options remains very attractive.

12. RECOMMENDED MARKETING STRATEGIES

12.1 Marketing Approach

The marketing approach taken by the principal existing MSR lumber producers varies considerably. The largest of these believes that MSR lumber is a specialty, added value product that must be handled in a special fashion. It is placing a high priority on developing new uses for MSR and it also sells MSR on behalf of other producers. Other companies, in contrast, tend to regard their MSR lumber production simply as further grades available for trading as a commodity. In most cases, producers interviewed during the survey indicated that they do not assign specialised sales staff to MSR marketing on a full time basis. Instead, a few existing salesmen are trained internally and handle enquiries and MSR sales, or the MSR is sold through outlets developed by other producers.

One of the original producers of mechanically graded lumber tends to adopt a compromise line. The company appears to believe that it is inappropriate for it to have sales engineers travelling the country and demonstrating to the truss fabricators, with the aid of computer terminals, how to design trusses better, using MSR lumber. However, the company has, on staff, very knowledgeable people who know the truss industry and the very technical aspects involved in engineering design with wood.

Overall, the choice of approach to staffing MSR sales depends on individual company circumstances and policies. While sales volume is relevant in this context, other factors such as the need to avoid "idle-time" of specialised MSR salesmen during slack periods, appear to be important to many producers.

Again, as noted above, some mills elect to market their MSR output through other producers who have specialised staff. Even if this route is not chosen, it should be noted that some mills, which carry out their own marketing, sell to only two or three major truss manufacturers. Consequently, their need for specialised, full time MSR sales staff is limited.

It has been shown in this report that the truss industry varies significantly across the U.S. and Canada. Many factors contribute to this variability. These include:

- design loads in each area.
- significance of floor trusses in the market.
- amount of large span non-residential trusses required.
- landed price of lumber from different supply sources.
- different seasonal and economic fluctuations.

As these factors vary, so too will the relative value of any individual MSR grade. Consequently, in order to maximise the opportunities, the company producing MSR lumber must have a good idea of what is required, at any one time, by the truss industry. This knowledge is needed both in order to decide where and what to sell and also to influence what is being produced. If the market for 1650f-1.5E becomes saturated in Denver, for example, then the MSR producer must be aware of the alternatives. Perhaps 1650f-1.5E can be sold to Phoenix, for example, or a better return can be obtained by producing 1450f-1.3E and 1800f-1.6E and selling to other areas.

Ideally, there must be a close relationship between marketing and production strategies with the flexibility in both to make the necessary short term adjustments.

Almost all of the truss fabricators obtain their lumber directly from mills. However, they tend to contact both brokers and mills, and some of the companies seem to be reluctant to deal directly, and only, with mills since they appear to feel that they get better market coverage by going through brokers. There do not appear to be, however, many brokers who have any real knowledge of MSR lumber and the implications of design values. They tend to regard it as simply another grade to be bought and sold.

It is considered that any mill that decides to commence production of MSR lumber should also commit to an increased sales and marketing effort, regardless of the marketing approach selected. The cost of this effort will entirely depend on the personnel position of the individual mills. At the minimum, however, there are likely to be increased costs to allow for considerably more travel and direct contact with potential customers. This cost is estimated at $16,000 per year and has been included in the economic feasibility calculations.

The objective of this effort will be to keep in close contact with a selected group of truss fabricators in the areas where the individual mill can best compete. This is not to suggest that the mill should not also offer, and trade, MSR lumber on the open market. However, it is felt that the mill would optimise returns by adopting a direct sales approach for a large percentage of production.

The truss fabricators are in the business of manufacturing and selling trusses, and are not professional lumber buyers. Many of them would value greatly a trouble-free and constant source of lumber of consistent quality. There are even some who buy on a long term contract basis. This strategy is not, however, recommended since the mill tends to lose under these circumstances. When the market goes up, the mill is supplying at prices below market and when it goes down, the fabricator tends to demand a reduction in price or will not accept supply.

12.2 Promotional Strategy

An important aspect of any sales strategy is promotion. This can be divided into two parts:

- promotion of the concept of MSR lumber, its technical advantages, and so on.

- promotion of the production of a particular mill.

It has long been recognised that promotion of wood products is best handled at an industry association level. Most of the companies currently, or potentially, involved in MSR production belong to the principal industry associations. However, due to the small number of companies actually producing MSR lumber, these associations have clearly not been able to emphasise the advantages of mechanical grading relative to visual grading. It is, in fact, these associations that have developed the visual grading rules and promoted their reliability. So far, the primary emphasis of promotion for the MSR concept appears to have come from the individual efforts of three or four producers. As a result of their efforts, MSR lumber is recognised by the industry associations and design values are included in publications (1) (2). Currently, this is, in effect, the limit of association promotion for MSR lumber. Furthermore, it is difficult to see how it could go further.

This report is not necessarily the best platform from which to suggest the need for a coordinated effort on MSR lumber promotion. However, it is believed that such an effort is essential if MSR lumber is to reach its full potential. Current and potential producers are recommended to consider this in detail, and soon. The future developments in design values and codes appear to favour MSR lumber but, in order to capitalise on the advantages, the industry should take a coordinated approach.

Individual promotion by mills should tend to concentrate on the greater, and direct, sales approach suggested earlier. In addition, the use of distinctive product identification, such as a special company logo on wrapped bundles, promoting the MSR aspect, would probably be valuable. There is one magazine "Automation in Housing and Systems Building News" which is very widely circulated throughout the truss industry. Advertisements in this magazine regarding MSR availability would probably be a worthwhile method of developing business and contacts. Official association with the TPI would also enhance the image of the company.

---

(1) National Design Specification for Wood Construction - 1977 plus July 1981 supplement.

(2) Canadian Wood Council CWC Data File WP-5 Machine Stress Rated Lumber.

12.3 Product Strategy

The marketing of the standard grades of MSR lumber is reasonably complicated. The difficulties of developing the other, more peripheral, areas such as laminating stock and mobile home stock, will be much greater, as will the production of suitable material. It is suggested, therefore, that the first stage of development of a new mechanical grading installation be concentrated on the requirements of the truss and joist fabrication industry. Detailed examination of, and development into, the other potential markets could then follow once the mill is familiar with the concept of producing a tailor-made specialty product.

It is considered that the mill should commence with a product mix based on the following:

- Sizes 2 x 3, 2 x 4, 2 x 6

The emphasis should be on 2 x 4 which represents the greatest part of the potential market. However, the use of 2 x 3 appears to be growing and 2 x 6 is valuable to the fabricators making large span trusses. Widths greater than 2 x 6 represent a very small percentage of the market but could later be developed as a result of specific requirements established with customers.

- Grades 1650f-1.5E 2100f-1.8E

These appear to be the grades with the greatest potential. However, they are also the grades that are most in supply. Once a mill has established a position in the market and strong ties with specific outlets, it may be that production could be changed to develop 1450f-1.3E or 1800f-1.6E. In the case of a Douglas fir operation, it is very possible that a significant volume of 2400f-2.0E could be developed. This could become a very profitable item. It should be noted that wane can be a serious problem in some markets, particularly for the higher MSR grades for floor trusses. The inclusion of wane up to the limits allowed in the grading rule may result in the product being unsaleable in some areas.

- Lengths normal random length specifications (10'/20')

These are generally accepted by the truss industry because this is the most common practice, particularly to market areas open to B.C. However, there is little doubt that mills that can develop additional volumes of longer lengths are favourably placed in the market. Most truss fabricators purchase cars of specific lengths from time to time and accept a higher price.

There is a close economic balance between the cost of splicing and the cost of the longer length, but the breakeven point varies as widely as the labour costs, from region to region. In order to obtain the price differentials estimated, the random length specification should include 2 packages of 18' and 2 of 20'. If a mill is unable to supply these, it is unlikely that the assumed price differentials could be achieved, except in a very strong market. Even in standard and better grades, the lack of a balanced specification has a negative effect in price, but this would be appreciably greater for sales to truss fabricators.

- Species S-P-F and Douglas Fir

The low design value for S-P-F in visual grades have indicated that the best increase in product value can be obtained for this species group. Some of this advantage appears likely to be lost, in Canada, during the next twelve months but, for sales to the U.S., it will probably continue for at least another two to three years. The lower values being proposed for Douglas fir in Canada suggest that mechanical sorting for higher grades, such as 2100f-1.8E and 2400f-2.0E, would yield substantial premiums.

The market for hemfir MSR lumber appears to be limited, except in Washington, Oregon and Northern California. Furthermore, it is in Washington and Oregon that, currently 50% of western MSR lumber capacity is located.

12.4 Summary

The marketing approach taken by current producers of MSR lumber varies. One company has an extensive staff of professional engineers with the ability to design engineered structures with wood. Others simply trade MSR lumber, through normal wholesale channels, as a commodity product. Some adopt a compromise between these two extremes.

In order to obtain the maximum economic benefit from an MSR installation, it is recommended that the company should commit to an increased direct marketing and sales effort. The cost of this will vary, depending on the marketing approach to be taken by the company and the nature of its present sales force. At a minimum, the additional costs would be in the region of $16,000 per year.

The MSR lumber industry should adopt a coordinated approach to promotion. Future developments of codes and design concepts potentially favour MSR lumber, but this potential will not be fully realised without an organised technical promotional campaign by the interested parties.

At an individual company level, promotion based on brand identification and advertising is recommended.

It is suggested that the products, produced in the first years, should concentrate on the needs of the truss and joist fabrication industries. Later production strategies could include expansion into the laminating and mobile home industries. Initially, therefore, the sizes should be 2 x 3, 2 x 4 and 2 x 6 in 1650f-1.5E and 2100f-1.8E grades. The species that would appear to have the best potential for B.C. producers would be S-P-F and Douglas fir.

13. FINANCIAL AND STRATEGY IMPLICATIONS FOR B.C. PRODUCERS CONSIDERING INVESTMENT IN MSR CAPACITY

13.1 Introduction

It has been shown that the market potential for MSR lumber, in the long term, is that significant growth can be achieved. It is even suggested that, ultimately, most stress grading of lumber will have to be done mechanically rather than visually in order to compete. Furthermore, the economic feasibility of typical installations appears viable, assuming all the product can be sold at the estimated differentials. Consequently, at the B.C. industry level, this report concludes that there is a "prima facie" case suggesting that individual mills should give serious consideration to investment in MSR capacity.

In practice, individual mills should examine the viability of such investment on a site-specific basis. Individual circumstances will vary according to factors such as species, timber quality, grade out-turn, production costs, mill location, management and marketing philosophy. Correspondingly, the degree to which any individual mill will compare with the generalised calculations presented in this report, can be established only by undertaking, first, a yield analysis and, second, an engineering and capital cost assessment. This will then allow the mill to develop site-specific information on expected returns on investment.

In order to assist individual mills in these analyses, a check list of factors is provided below.

13.2 Financial Analysis

- Capital and Operating Cost Estimates, as provided in the test, should be reassessed and, if necessary, recalculated for site-specific locations in B.C. Components of the capital costs and operating costs assumed are detailed in Section 11.

- Return on Investment Calculations vary according to the method used. For the purposes of the pro-forma discounted cash flow examples provided, it is assumed that the real price (constant dollar) escalation of costs and revenues is 12%. In individual company cases, the weighted cost of capital varies. So too does the opportunity cost of funds which could be applied to an MSR investment. In the pro-forma examples, the rate of return on investment calculations are based on the assumption of a 16% and a 20% weighted average cost of capital respectively. This is felt to be a valid reflection of the present (1982) cost of funds to most forest products companies in B.C. However, ROI's should be reassessed according to individual capital cost circumstances.

- Sensitivity of Revenue Assumptions. Using the base-line projections provided, it is a relatively simple exercise to develop a number of "what-if" situations regarding incremental revenues from MSR. The methodology adopted in this report has been to assume a constant U.S. dollar/Canadian dollar relationship at recent (1981) levels. Individual mills should recalculate these revenue assumptions according to their own assumptions.

- Sensitivity of Market Volume Assumptions. As individual mills will vary in their plans regarding the on-stream timing of any MSR investment being considered, a base-line market volume has been calculated assuming the housing start levels and market segment penetration percentages outlined. Again, it is a relatively simple task for an individual mill to project market volume (and therefore potential market share) based on alternative assumptions.

13.3 Strategy - Corporate Level

- Timing of Investment. Assuming that a mill believes that mechanical grading may be advantageous, has carried out the necessary analyses and finds the economics viable, it is then necessary to make a decision on the timing of the investment. It was shown earlier that, at present, there is more than sufficient capacity of MSR lumber in the West to satisfy current market needs. Therefore, it is unlikely that a new installation established before the end of 1982 would be able to reach capacity and obtain the price differentials estimated. In fact, few of the present installations are able to run at capacity with the current depressed market. It may be well into 1983, or even 1984, before the demand for MSR lumber appreciably exceeds current production capacity in the West.

  Consequently, any new installation will have to compete with existing suppliers for market share. The mill may find it difficult, therefore, to achieve operating capacity. Nevertheless, some volume will be sold. This volume, even if well below capacity, will permit the mill to develop the necessary knowledge at the production level to maximize the yield of a saleable product. It will also permit the sales staff to commence establishing the necessary contacts and knowledge of the truss industry.

  There are, however, financial disadvantages to this approach. It involves a longer pay-back period and earlier investment would be required. The opportunity cost of capital, and how the longer pay back is judged, are both aspects that will vary substantially with the particular circumstances of any one mill.

- Product Differentiation. It is clear from the market studies carried out during the preparation that there is considerable scope, and need, for promotional efforts to increase the recognition of MSR's advantages at the user level. This is partly technical and partly a function of price. The history of new product entry into the marketplace shows that it often takes a number of years for a new product to become widely recognised and used, and to achieve the required price premium to justify investment across a broad spectrum of the industry.

  Short term over-capacity, and relatively low price realisations, sometimes result when too many producers enter the market during a period of low initial growth in demand. From a marketing viewpoint, producers may be able to avoid some of these potential disadvantages by means of product differentiation, including producing according to users' specifications, the use of distinctive "brand names", protective packaging to ensure a clean, presentable product, and so on.

- Cyclicity of Demand. The major demand determinants of MSR lumber are essentially the same as those for softwood lumber and are tied closely to levels of housing activity. Consequently, MSR lumber production offers a means of upgrading a mill's production and increasing the value added of its output. MSR offers few counter-cyclical opportunities in relation to commodity lumber production.

  Any decision to invest in MSR capacity should, therefore, take account of this, and companies wishing to achieve lesser dependence on the construction industry should consider the relative merits of MSR production and those of specialties geared to other markets.

- Regional Market Analyses. The opportunity exists, as noted earlier, to develop MSR sales to particular geographical regions, and to specific categories of users. Sales strategies should be based on a follow-up market analysis, an assessment of MSR supply-demand balances in a given market, analysis of the potential producers' competitive advantages, and discussions with existing and potential users. It will be essential, in this context, to foster a marketing and sales approach keyed directly into users' needs. In some cases, this may require a shift in the producer's marketing philosophy, directly and through any distribution channels utilised by the producer.

13.4 Strategy - Industry Level

Achievement of the potential market volumes for MSR identified in this study will also require efforts at the industry level. These have been detailed in preceding sections. It is relevant to note, however, that the sooner these objectives can be agreed upon and implemented at the industry level, the greater will be the likelihood of achieving and maintaining a substantial price premium for MSR lumber. In addition, technical and promotional efforts are required overseas to ensure that MSR produced in British Columbia will achieve code, and end user, acceptance.

13.5 Summary

The results of the study indicate that the market potential for MSR lumber is such that significant growth is likely. The financial analysis suggests that typical MSR installations are economically feasible. Therefore, mills should give serious consideration to investment in MSR capacity.

The actual circumstances of any one mill are unlikely to be precisely those assumed in the development of a typical mill. Consequently, site-specific information must be acquired. This can be obtained by undertaking, first, a yield analysis and, second, an engineering and capital cost assessment.

With the data developed from these investigations, the mill is then in a position to undertake its own financial analysis. The results of this analysis will vary, according to the methods used, the assumptions made and the sensitivity analysis of variations in these assumptions.

The timing of the investment is an important factor to be evaluated. It is likely to be some time before supply/demand balances will permit the full capacity operation of MSR lumber installations. However, the gradual introduction of product into the market will permit the mill to become familiar with the production and marketing techniques required. On the other hand, operation at less than capacity will have a negative effect on R.O.I. and pay-back periods.

The sales strategies of companies vary. Furthermore, the location of each company, and its economic access to different regions, also vary. Consequently, individual decisions regarding more specific regional analysis will be required, in order to establish market strategy.

14. CONCLUSIONS

1. MSR lumber is well suited to meet the requirements of truss and joist fabricators.

2. It may also have a potential market in the laminating and mobile home industry but it is difficult to satisfy the requirements of these industries from the normal MSR lumber production of a dimension mill.

3. There are a number of future technical developments that will have a very favourable effect of MSR lumber demand.

4. However, the initial effect of one of these developments will prove very disadvantageous for S-P-F MSR lumber in Canada, except in the higher grades. The situation for Douglas fir MSR lumber is substantially improved relative to visual grades.

5. Greater knowledge and technical proof of the improved characteristics of MSR lumber are required at the user level.

6. There has been a dramatic increase in the installed capacity of MSR lumber recently. Much of this new capacity is concentrated in the West.

7. The predominant species used by truss fabricators in the South, North East and the eastern part of the North Central regions is Southern pine. It is likely that this will continue.

8. The market area available to western producers is, therefore, limited to 30% to 35% of total U.S. consumption in the products under review.

9. Truss and joist fabricators have the potential to expand their markets significantly by development into floor trusses and non-residential trusses. However, at the assumed average level of activity (based on 1.6 million starts), the majority of the potential requirements in the West for MSR lumber can be met by the productive capacity of MSR installations in place in the West by early 1982.

10. Future growth in the market in the medium term is likely to depend on:

    - market expansion by the truss and joist industries

    - development by MSR producers into other industry sectors such as the laminating and mobile home industry

    - increased construction activity

11. In the long term, as a result of new developments in building codes, the potential exists for much greater growth.

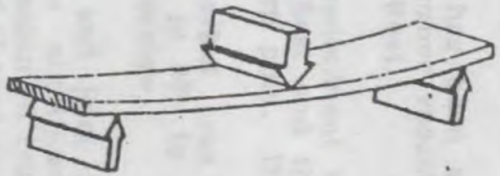
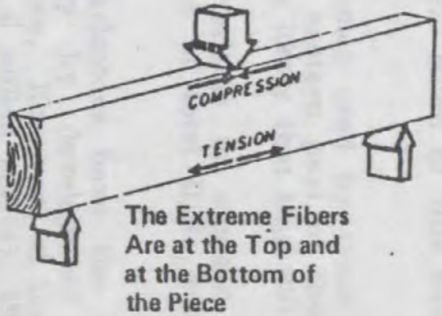
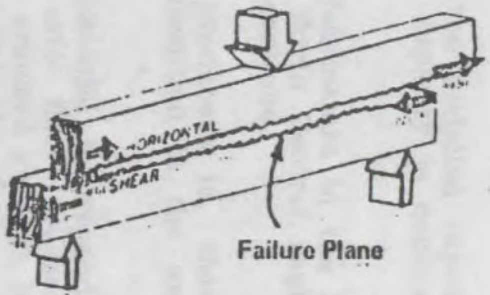
12. An analysis of economic feasibility indicates that the pay-back time for typical MSR installations will be in the region of 1.6 to 2 years. Internal Rate of Return (I.R.O.R.) on investment levels of between 59% and 48% have been developed.

13. These figures will vary substantially for any one mill depending on grade yields, mill layout, capital costs, and the need for additional qualified sales staff.

14. The current potential for the sale of Canadian grades of MSR lumber to the U.K. is not great. A major development programme would be necessary to develop official acceptance of these grades.

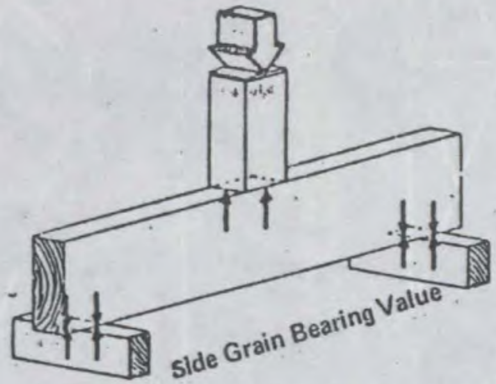
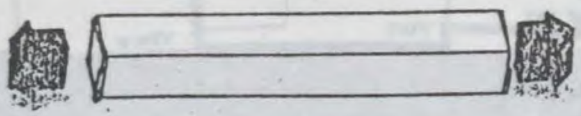
15. In the context of the U.K. alone, this may not be justifiable. However, the long term effect on the greater potential for sales into the Common Market area is significant and suggests that such a programme would be worthwhile.

THE SIX ENGINEERING CHARACTERISTICS OF WOOD
THE BIG "E" AND THE FIVE LITTLE "F's"

Engineering Terms		What They Mean
(E) Modulus of Elasticity		The Relationship Between the Amount a Piece Deflects and the Load Causing the Deflection Determines Its Stiffness
(Fb) Extreme Fiber in Bending		How Much We Can Stress a Member in Bending Before Permanently Rupturing Fibers
(Fv) Horizontal Shear		How Much Load We Can Apply as Shown Before Material Will Fail Along the Indicated Failure Plane

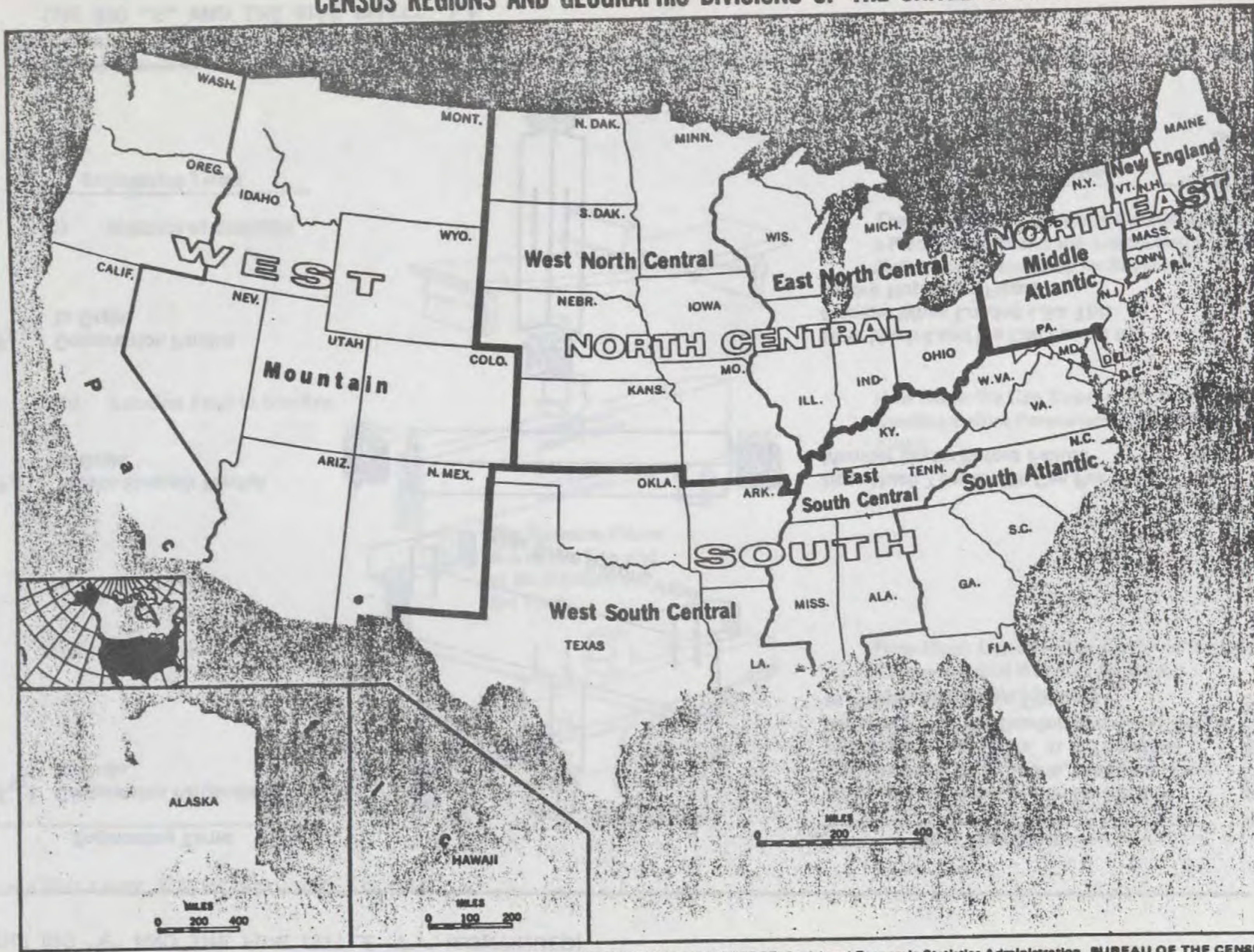
Courtesy Weyerhaeuser Tacoma

THE SIX ENGINEERING CHARACTERISTICS OF WOOD
THE BIG "E" AND THE FIVE LITTLE "F's" (CONTINUED)

Engineering Terms		What They Mean
($F_{c\perp}$) Compression Perpendicular to Grain		Where a Joist, Beam or Similar Piece of Lumber Bears on Supports, the Loads Tend to Compress the Fibers. It Is Therefore Necessary That the Bearing Area Is Sufficient to Prevent Side Grain Crushing
(F_t) Tensile Strength Parallel to Grain		How Much Tension We Can Put This Member Under Before Failure
($F_{c\parallel}$) Compression Parallel to Grain		How Much Load We Can Put on the Member When Loaded Like This Before Rupturing Fibers

Courtesy Weyerhaeuser Tacoma

CENSUS REGIONS AND GEOGRAPHIC DIVISIONS OF THE UNITED STATES



U.S. DEPARTMENT OF COMMERCE Social and Economic Statistics Administration BUREAU OF THE CENSUS

Appendix C

COMMON TRUSS CONFIGURATIONS

T22 KINGPOST

The Kingpost truss is used for short spans such as garage roofs or valley trusses. Spans should not exceed 20'0".

T42 FAN

The Fan truss is also used for short spans as in small residential or farm buildings. Spans should not exceed 30'0".

T43 FINK

The Fink or "W" truss is the most common of all truss designs because of its great strength and low production cost. Spans should not exceed 40'0".

T44 HOWE

The Howe truss is most commonly used for girders or designs requiring higher-than-normal bottom chord loading. Spans should not exceed 48'0".

T63 DOUBLE FAN

The Double Fan truss is used mostly in agricultural and industrial buildings where less-than-normal bottom chord loading is required. Spans should not exceed 45'0".

T66 DOUBLE HOWE

The Double Howe truss is used in commercial and industrial buildings where large spans or higher-than-normal bottom chord loading is required as in girder designs. Spans should not exceed 60'0".

S44 SCISSORS

The Scissors truss is used in residential and church designs where a higher-than-normal ceiling is desired. Spans should not exceed 40'0".

T64 MODIFIED QUEENPOST

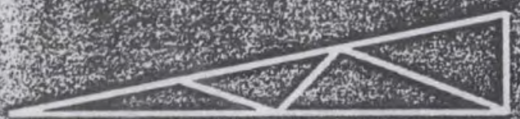
The Modified Queenpost truss is used for larger residential or commercial buildings where normal loadings exist. Spans should not exceed 60'0".

Courtesy Lumbermate Company

Appendix C (Cont'd.)

T65 DOUBLE W

The Double "W" truss is used where large spans are required. It is economical to produce and requires a minimum of lateral web bracing. Spans should not exceed 60'0".



M32 MONO

This is a typical mono or half truss design used where a single slope roof is desired, or where interior bearings exist and the builder wants to handle a half truss. Spans should not exceed 30'0".

F44 FLAT

The typical Flat truss is used where a flat roof is desired and most commonly built with a mansard or parapet overhang. It can also be used as a flat girder. Spans should not exceed 70'0".

T87 TRIPLE W

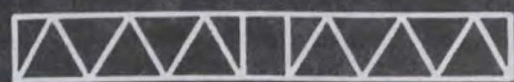
The Triple "W" truss is commonly used where very large spans are required under normal loading conditions. Spans should not exceed 80'0".

H2211 HIP

This is a typical Hip truss design. It is used in Step-down systems as both the common Step-down or the girder truss. Spans should not exceed 48'0".

ROOM-IN-ATTIC

This truss design is used when a storage area or a small additional room is desired. It should be used in high sloped trusses only. Spans should not exceed 28'0".



LOW JOIST

This design is used for floors or flat roofs when a minimal overall height is required. Lumber is turned flat for a maximum daylight opening between members. Spans should not exceed 30'0".

T84 TRIPLE FAN

The Triple Fan truss is used for large agricultural designs or where a low bottom chord loading is required. Spans should not exceed 72'0".

Courtesy Lumbermate Company

Appendix D

INFORMATION ON SELECTED MARKETS

Introduction

Southern California

San Francisco

Phoenix

Salt Lake City

Denver/Colorado Springs

Houston

Florida

Chicago

Minneapolis/St. Paul

B.C. (Lower Mainland and Vancouver Island)

Alberta (Calgary and Edmonton)

Toronto

INFORMATION ON SELECTED MARKETS

Introduction

A number of areas were visited in the course of the study. Though the information obtained relative to each individual area is used, in sum, as the basis for the report, it is considered worthwhile to include in this report a brief analysis of the situation within each of the areas visited.

This analysis includes an indication of the size of the market, the grades and species used, the nature of the truss industry and the attitudes evident towards MSR lumber. It is worth noting that, without exception, all fabricators contacted were aware of the existence of MSR lumber whether they used it or not. Generally speaking, the local building authorities were also aware of the existence of MSR lumber, but awareness at the builder level varied widely.

The distribution channels in all areas were substantially similar. Most fabricators appear to obtain their lumber directly from mills -- some by direct contact with mills and others by negotiations through brokers. Where fabricators obtained visually stress graded material from local distributors, this tended only to be for small requirements of larger sizes.

It should be noted that the visits to these market areas coincided with a period of extremely depressed lumber demand, abnormally low lumber prices and atypical price differentials between grades. The overall mood of the market tended to be reflected in the comments of many users interviewed. Longer term trends were discussed to provide perspective. However, in the view of the consultant, the interview comments provided below may tend to understate the longer term price potential of MSR.

Southern California

The Southern California market, including the Los Angeles area, Riverside, San Bernardino and San Diego, is extremely large with a population of around 13 million. The total consumption of lumber for trusses and joists is estimated to be in the region of 150 million board feet in a normal market.

The truss industry has been severely curtailed recently and, despite the size of the market, it appears that there are fewer than 20 fabricators of any significance currently in operation. The principal activity of truss fabrication companies appears to be in pitched roof trusses. As yet, only a few have expanded, to any extent, into the production of flat floor trusses. This may be primarily due to the presence in the area of fabricated joist companies such as Trus Joist. Additionally, since most housing construction is on a concrete slab, only multi-family housing and non-residential construction offers potential for floor trusses. With the drastic reduction in housing starts in the area, during the time of the study, most companies were concentrating heavily on the non-residential market.

Green Douglas fir represents a very substantial proportion of all the lumber used. This is purchased primarily in random length carload quantities from Oregon. Generally, the fabricators indicated that they purchase #1 grade because the current differential between this grade and a #2 and better grade is small, at $10 to $15 per thousand board feet, during the time of the study. If, as expected, this differential widens substantially, many will tend to buy the lower grade and sort out the #1 grade for the trusses where the design calls for it. Typically, for residential construction in the area, it appears that the values assigned to #2 grade are sufficient for 75% of the trusses fabricated.

Normally, 2 x 4 represents between 70 % and 80% of purchases. However, with the current high proportion of non-residential work, the fabricators suggested that 2 x 6 was also significant. One company uses 2 x 3 in webs, but the general practice appeared to be the use of 2 x 4 Douglas fir in a stud grade. Hemfir is not popular for either webs or chords. The reaction to S-P-F was varied. Some fabricators felt it tended to warp badly once the bundles were opened, but others indicated that, if MSR grades of S-P-F were available at a good price, it would be used.

A limited volume of MSR grades in Douglas fir is currently being used in the 1650f-1.5E grade. There is also a small quantity of 2100f-1.8E being used by the few companies that have developed into the floor truss market. The reaction to the concept of MSR lumber was very favourable but, without exception, all those contacted felt that it would have to compete directly with visual grades and would not command any premium. It was interesting to note, however, that the grade regarded as relating directly to #1 Douglas fir was 1650f-1.5E and not 1800f-1.6E.

The code authorities vary substantially from region to region within the Southern California area. For example, Los Angeles City insists that all truss fabricators be inspected and approved by the building department. In another area, the authorities insist that any piece of lumber, in a truss, over 3' long have a grade stamp. A number of building authorities were contacted and it was found that, though the use of visually graded S-P-F was effectively impossible, if it was an MSR grade there would be no code problem.

San Francisco

Construction activity in the San Francisco, Oakland and Sacramento area is extensive, but there are a limited number of truss fabricators, who dominate the market. There are also joist fabricators and laminated beam manufacturers operating in the area. It is estimated that the volume of lumber used in truss fabrication in the area would be in the region of 50 million board feet.

The truss fabricators are heavily involved in non-residential construction and some concentrate on very large spans for the agricultural market. Most fabricators produce floor trusses and it appears that this type of truss represents 20% to 30% of current business.

The lumber used is Douglas fir and hemfir in both green and dry grades. In the residential market, it appears that green hemfir, #2 and better, is predominant due to the competitive nature of the business. There are, however, some fabricators who claim that the builders they service insist on Douglas fir and are prepared to pay the extra price involved. The majority are not buying MSR lumber to any extent, though one of the largest companies advised that some 1800f-1.6E Douglas fir is purchased since it was found to be a good compromise grade that could satisfy both the pitched roof and flat floor truss market. This company, in common with some others, also purchases small volumes of 2100f-1.8E and 2400f-2.0E, in both green Douglas fir and in green hemfir. The view in this market appears to be that 1800f-1.6E must compete directly with #1 Douglas fir.

None of the companies appear to consider S-P-F as an alternative product that could be used. The species appears to be virtually unknown in the truss business and they believed that it would be difficult to sell to the builders, even with an MSR grade.

A number of the companies have an independent inspection undertaken of their truss fabrication. This is because some municipalities in the area demand it. Apart from this aspect, the building authorities are not overly strict and are satisfied with the seal of a registered engineer on the design. Since the Uniform Building Code is used, the design can be based on any combination of species with visual or MSR stress grades.

Phoenix

Phoenix expanded rapidly during the second half of the 1970's and has been affected very adversely by the current housing market. Substantial volumes of tract housing for sale were observed in the areas surrounding the city. There are, nevertheless, about 25 truss fabricators in the area still operating, though some were said to be close to failure. Lumber consumption by truss and joist fabricators is estimated at 35 million board feet.

The flat truss appears to be of great significance in the area as a result of two factors. There has been a great deal of construction of the warehouse type and approximately 30% of housing in the area tends to have a flat roof.

The principal size used is 2 x 4, which would account for about 80% of the volume, though there is considerable interest in 2 x 3. The species used vary significantly between companies. The majority of the truss fabricators use green Douglas fir in a #1 grade and in #2 and better. Some companies are using MSR grades in Douglas fir, while one company is using primarily MSR S-P-F 1650f-1.5E. Of great concern to all is how the lumber behaves when subjected to the very severe climatic conditions in Phoenix, where the humidity can go down to 10% in the summer.

The past experience which each fabricator has had with different species dictates, to a great extent, his attitude. The company currently using S-P-F claims to take special care in storage and finds that the fall down is no worse than Douglas fir. In contrast, another company claimed to have experienced 25% loss when it experimented with S-P-F. At the same time, this company advised that all web material used was S-P-F since, over a short distance, warp was insignificant.

Apart from the company using 1650f-1.5E S-P-F, a number of companies stocked 2100f-1.8E and 2400f-2.0E grades for flat trusses. In joist fabrication, 2250f-1.9E Southern pine is also being used. One of the companies advised that, whereas it used to use 1650f-1.5E Douglas fir, it had now changed back to #1 Douglas fir since the price was much cheaper.

The building authorities in the area do not appear to be particularly strict. Provided that the builder has a drawing showing that the design of the truss has been approved by a registered engineer, there tend to be no problems.

Salt Lake City

Salt Lake City is a small market area in comparison with some of the others visited. The volume of lumber used for truss fabrication is under 20 million board feet, but there are up to 25 truss fabricators operating in the area. None are particularly large and there are a number who use only one million board feet or less per year. The industry is very competitive and the price of lumber is of great importance.

Most of the companies contacted were very involved in commercial trusses, in addition to the residential market, but there was a substantial variation when it came to flat floor trusses. One company now manufactures these exclusively and has abandoned the pitched roof market, others are only producing pitched roof trusses, while others manufacture both. The market for residential trusses is sufficiently standard so that fabricators are able to manufacture for inventory. The principal sizes are 24', 26' and 28' spans.

Similarly, the grades and species of lumber used vary extensively. Some fabricators only use #1 Douglas fir KD, some #2 and better Douglas fir, whereas others purchase mainly 1650f-1.5E in Douglas fir and S-P-F. A number of those contacted advised that they regarded the MSR grade and #1 Douglas fir as interchangeable, with price being the only factor. One of the larger companies, however, related 1800f-1.6E to #1 Douglas fir. The companies involved in floor trusses mainly require 2100f-1.8E with small volumes of 2400f-2.0E. It appears generally believed in Salt Lake City that 1800f-1.6E is unsatisfactory for floor trusses since the span to depth ratio is insufficient. Virtually no 1450f-1.3E is being used at present. Some fabricators indicated that this was due to the small price difference relative to 1650f-1.5E. If the differential rose to $25 per thousand board feet, this grade might prove attractive.

Apart from the Church of the Latter Day Saints, which specified #1 Douglas fir in all trusses, the market appears to be willing to use any species provided the price is right and the design values sufficient.

A significant difference in Salt Lake City is the presence of MSR lumber inventoried by a local wholesaler. This company is associated with one of the larger truss fabricators and purchases carload quantities, direct from mills, for resale to other truss fabricators.

Building authority requirements appear to be relatively relaxed. Provided the design has a registered engineer's seal, the truss is acceptable.

Denver/Colorado Springs

Until recently, construction activity in the area of Denver had been very strong and there are approximately 15 truss fabricators operating in the area, including one company that manufactures fabricated joists. The truss industry consumes in the region of 25 to 30 million board feet of lumber. This is somewhat lower than might be expected for the size of the market and may be due to the fact that few of the companies have yet developed substantially into the floor truss marekt. Apart from one company that currently has about half of the truss market, the few other companies manufacturing floor trusses indicated that this only represented 10% of their throughput. Similarly, penetration of wood trusses into the non-residential market appears to be less extensive than in other areas.

This market area has converted extensively to MSR lumber. The principal species being used is S-P-F, though some companies are using hemfir. Originally, the industry in the area used Southern pine or select structural hemfir. The first change was to MSR grades of hemfir and, over the past two years, there has been a further change to S-P-F. The main grade used is 1650f-1.5E followed by 2100f-1.8E. There are also companies, however, who use 1450f-1.3E when the price differential from 1650f-1.5E widens.

Similarly, more 1800f-1.6E is used if the differential from 1650f-1.5E narrows. The 2 x 4 dimension represents about 80% of the volume and the next most important size is 2 x 6 which tends to be purchased in a 1650f-1.6E grade. The company that fabricates joists also requires substantial volumes of 2 x 3 in a 2100f-1.8E grade and advised that this was difficult to obtain.

Local building code requirements follow the Uniform Building Code and only demand that the design show the approval of a registered engineer.

Houston

In contrast to most of the country, roof trusses do not totally dominate the roofing market in Houston. It is estimated that, in single family construction, trusses may have only 25% of the market. Even some of the large tract builders appear to find that it is cheaper to construct with rafters rather than with trusses. The wage being paid to house framers is said to be in the region of less than $4 per hour.

As a result, the number of truss fabricators in Houston is extremely small relative to the size of the area. These fabricators tend to concentrate on multi-family housing and non-residential construction. Flat floor trusses represent up to half of their business and the volume of lumber consumed in truss fabrication is in the region of 35 million board feet.

The market uses only Southern pine, principally in #1 and #2 grades. Some of the companies have tried MSR grades of Southern pine, but advise that it is not economic. Currently, Southern pine producers are asking approximately $20 per thousand board feet more for an MSR grade than the equivalent visual grade. The consensus of those contacted was that, if this differential dropped to $5, it would be worth buying MSR. Until then, it was not competitive.

Florida

There is a very large volume of construction in the Florida area and there are a substantial number of truss fabricators servicing the state. Residential construction is almost entirely on a concrete base; therefore, the floor truss development has been limited to small multi-family housing and to commercial buildings. Many of the fabricators are producing floor trusses, but this appears to represent only 10% of their activity. The total volume used in truss fabrication is probably in the region of 150 million board feet.

The species used is entirely Southern pine but a number of grades are purchased. The fabricators are able to obtain their supplies at short notice in truck load quantities and, therefore, do not have the inventory problems experienced by some other areas. Consequently, they tend to be more variable in the lumber grades used. The main grades used appear to be #1 Dense and #2 Dense, which they can obtain from the mills separated by grade, as opposed to combined, as often occurs in other supply areas. Very few appear to be interested in MSR since the price is higher than equivalent visual grades. A comment made by several was that mechanical grading only helped lumber producers and was only of marginal extra value to fabricators.

Substantial volumes of S-P-F are used in general construction and the species is very popular with builders. However, it appears extremely unlikely that MSR S-P-F could ever compete in the Florida market for truss fabrication. This is due to the large freight differential, plus the excellent strength values of even the cheaper, lower, grades of Southern pine.

Chicago

Construction activity in the Chicago area is currently very low relative to the size of the population in the area. As a result of this, about half of the truss fabricators that used to operate in the area are now out of business. There are currently less than ten companies servicing the whole region.

Most of the fabricators have expanded into floor trusses and the largest company in the area indicated that these now represent a third of the throughput. It was found that, though most companies were involved in non-residential business, there appears to be strong competition from the steel industry in the area. The estimated volume of lumber consumption by the truss industries in the area appears to be less than 30 million board feet.

Southern pine is being used exclusively by all companies, and the principal grade appears to be #2. One of the companies had carried out an extensive analysis of 1450f-1.3E S-P-F to see if this could compete with #2 Southern pine, but had concluded that, primarily due to the lower E value, it was inadequate. A number of the companies are purchasing small volumes of mechanically graded lumber for floor trusses and larger span commercial trusses, but indicated that it was not worth the premium being charged. If this was reduced to only $10 per thousand board feet over the equivalent visual grade, at least one company suggested that it would change over to MSR lumber immediately.

Building authorities are quite strict in the area and the State of Illinois has not accepted the design procedures of the Truss Plate Institute (TPI/78). All designs have to be certified under the Illinois building regulations.

Minneapolis/St. Paul

The housing market is relatively small in the Twin City region, but there is a great deal of activity in the non-residential construction market. There are approximately ten companies manufacturing trusses in the area and it is estimated that they consume approximately 50 million board feet of lumber annually. At least half of this would be going to the large companies specialising in big agricultural type trusses. The floor truss market is apparently not doing well at present. A number of companies invested in the necessary facilities some years ago and appear disappointed by the current level of activity.

There is a great variety in the type of lumber purchased and it appears that the only species not used is hemfir. Some of the companies use only Southern pine, but others use S-P-F MSR grades for residential trusses, with Southern pine being purchased for the long span business. At least two of the companies contacted use 2 x 4 Douglas fir #1, larger sizes on Southern pine in MSR grades and also S-P-F in 1650f-1.5E in 2 x 6. It appears that the Minneapolis market represents the boundary between the areas of influence of the Southern and Western producers.

The local Weyerhaeuser office indicated that the trend in the truss industry in the area was towards S-P-F MSR lumber. There is a considerable concern, however, that the design values allowed for compression perpendicular to grain for S-P-F are too low. The Minnesota area has some of the highest snow loads in the U.S. and this factor can become critical in spans above 26'. It was suggested that, since the compression value was related to density, the S-P-F MSR lumber producers should undertake the necessary work to obtain better values for MSR lumber. Without these, a number of the fabricators felt that the potential for S-P-F MSR lumber was limited.

In this market, the fabricators appear to feel that the MSR grade that must compete with #1 Douglas fir is 1800f-1.6E. It was also commented that the percentage of downgrade with MSR was greater than with #1 Douglas fir. However, for those producers purchasing 2250f-1.6E in Southern pine, it appeared that a premium of $20 per thousand board feet over #1 dense was economic.

Building regulations in the area are fairly strict and are based on the Uniform Building Code, with the exception of the City of Minneapolis which is somewhat more relaxed. Many authorities insist that the trusses be independently inspected. This is partly due to the experience of a few years ago when unusually severe snow conditions caused a number of roof failures in the area.

B.C. (Lower Mainland and Vancouver Island)

Housing starts and general construction activity in the Lower Mainland and Vancouver Island areas have been strong until very recently. In 1980, for example, housing starts in these two areas represented two-thirds of all B.C. starts and, even more significantly, over 15% of those in the whole of Canada. There are 10 to 15 truss fabricators in the region with an estimated annual lumber consumption of 40 to 50 million board feet.

The majority of these companies use KD S-P-F in visual stress grades, mainly #2 and better, but some select structural, for the bulk of their consumption. Some volume of green Douglas fir is also used but this appears to be less than S-P-F. Hemfir does not seem to be popular with truss fabricators. The current use of MSR grades appears to represent well under 10% of the volume and tends to be primarily in the 2100f-1.8E grade with some 1650f-1.5E.

The industry has been expanding into the manufacture of residential floor trusses. It also appears that non-residential trusses now represent a major proportion of the business for some companies. These companies purchase a significant volume of larger sizes in Douglas fir. A number of companies advised that 2 x 3 in an MSR grade would be of very great value to them and would develop into a substantial volume.

Most companies indicated a preference for MSR lumber, but felt the price was too high. One major manufacturer advised that the breakeven price differential is C.$40 per thousand board feet over the price for #2 and better.

Should the new design values be adopted, it would appear the differential may drop to C.$20 to C.$25 per thousand board feet. This tends to be the cost assessed by companies when they need to select #1 grade from mixed #2 and better. A comment received from many was that the quality of visual stress grades was declining and the percentage of #1 to be found in a mixed load was often very low. This was quoted by a number of fabricators, as being the principal reason for considering MSR lumber in the future.

Alberta (Calgary and Edmonton)

Though housing starts are below the very high levels evident in the late 1970's, there are still a substantial number. In 1980, the starts in these two cities represented two-thirds of the activity in Alberta and approached 15% for all of Canada. There is also a great deal of non-residential activity though, again, this is below earlier years.

Apart from the companies manufacturing trusses for their own manufactured housing use, there are 15 to 20 truss fabricators operating in these two areas. Not all of these companies have become involved in non-residential trusses, but those who have appear to feel that there is considerable expansion possible in this market and also into floor trusses. Trus Joist have a major facility near Calgary and produce a substantial volume of joists for the area. To some extent, the expansion expected by the floor truss manufacturers could be at the expense of this company. To this extent, there is no increase due for stress graded lumber. It was believed, though, that steel joists would also lose market share to wooden trusses.

The total volume of lumber consumed by the truss and joist industries in the area is estimated to be 40 to 50 million board feet. The principal species used is S-P-F in #2 and better grade and in select structural, with relatively small volumes of MSR grades. Additionally, some Douglas fir is being used where larger sizes or higher strength values are required. Some companies also use select structural hemfir for pitch roof trusses. A few companies are using 2 x 4 1650f-1.5E for residential pitch roof trusses, but the majority of those using MSR grades appear either to be purchasing 2100f-1.8E or else require 2 x 6 in the 1650f-1.5E grade. These would be needed for floor trusses or long span trusses. The fabricator of floor joists, however, uses only MSR lumber wherever solid wood chords are required. The principal grades required are 2100f-1.8E and 2400f-2.0E.

There were a number of companies who were extremely negative regarding the quality of MSR lumber. The main focus of their complaint related to the amount of wane. These companies had been accustomed to select structural, in either S-P-F or hemfir, and found that the wane in the MSR lumber was substantially more. On the basis of the official grading rules that exist, this would be inevitable. This suggests that MSR producers may need to adjust their own visual override rules depending on the market to which they sell.

Toronto

Though the general area of Toronto is heavily populated, the level of construction activity is relatively low at present. The only exception appears to be North Toronto where residential construction is still strong. The truss fabricators in the region concentrate principally on pitched roof trusses for residential activity. It was commented by several fabricators that roof trusses in Toronto have only 70% of the roofing market. In most other areas, this tends to be 80%.

Floor trusses appear to represent a fairly minor share of the fabricators' business, even though there are no joist fabricators operating in the region. Non-residential trusses also appear to represent a relatively low proportion of their business. It was suggested that this is due to the strong competitive position of the local steel industry and the fact that, traditionally, construction companies have tended not to use wood -- certainly not to the extent it is used in the West.

There are 15 to 20 fabricators serving the area. These vary dramatically in size from companies that use less than 500,000 to others that use over 10 million board feet per year. Consumption figures are hard to assess for the Toronto region alone, since fabricators within the region service builders outside. Similarly, a fabricator in London may compete within the Toronto region. Based on current housing starts and what is known of non-residential activity, a consumption level of less than 30 million board feet is estimated.

The principal product used is green S-P-F in a #2 and better grade. A very limited volume of Douglas fir is being used, but no companies were found that used hemfir.

Though 2 x 4 is the size that is used more than any other, there is a substantial volume of 2 x 3 being purchased for webs; some is being used for floor trusses as well. Truss fabricators also purchase a large volume of 2 x 5. For one company, the volume of 2 x 5 was half that of 2 x 4. Though at present 2 x 5 appears to be in regular supply, it appears to be a size produced principally for the truss industry. Some industry experts suggested that an overall strengthening of demand would reduce, considerably, the availability of 2 x 5.

Some volumes of MSR lumber are evident, particularly for floor trusses. One of the major companies advised that it was undertaking a detailed analysis of the advantages of MSR for pitched roof trusses as well. From the comments made by this company, it seems likely that it will conclude that the cost of 1650f-1.5E from the West will be too great. It must be borne in mind that the comparison will be between green S-P-F #2 and better purchased by truck from Ontario or Quebec and KD S-P-F 1650f-1.5E in railcar volumes.

In other parts of Ontario, where snow loads are much greater than Toronto, for example, in the northern part of the province, the evidence of the use of MSR S-P-F is somewhat greater, particularly in sizes such as 2 x 6.

APPENDIX E

CAPITAL COST ESTIMATES

1. In-line C.L.T.
2. Offset C.L.T.
3. Bin Sorter Modifications
4. Tray Sorter Modifications
5. Pull Chain Modifications

Source: Phillips Barratt Kaiser Engineering Ltd.

APPENDIX E-1

M.S.R. CAPITAL COST ESTIMATE
ALTERNATIVE-IN-LINE GRADING MACHINE

ESTIMATE SUMMARY

Total Direct Costs (Details on following page)	$281,800 (rounded)
Equipment Rentals:	
- truck, forklift, welding and burning tools	$ 1,550
Consumables	
- fuel, maintenance	$ 250
Travel Costs	$ 1,000
Overtime Premium	$ 2,500
Contractor's Overhead and Profit	$ 3,000
Employee Fringe Benefits	$ 2,600
Subtotal	$292,700
Engineering Allowance @ 6% (approx.)	$ 18,100
Contingencies @ 10% (approx.)	$ 32,200
Estimated Project Cost	$343,000

APPENDIX E-1

M.S.R. CAPITAL COST ESTIMATE
ALTERNATIVE- IN-LINE GRADING MACHINE
ESTIMATE OF DIRECT COSTS

ITEM	DIRECT MATERIAL COSTS	DIRECT LABOUR COSTS
Structural and Miscellaneous Steel	$ 5,200	$ 900
- operating platform - C.L.T. support steel		
Structural and Miscellaneous Timber	$ 6,300	$ 1,620
- sound/heat enclosure		
Interior Fire Protection	$ 3,000	
- under portions of platform and in sound enclosure - by separate contract		
Furniture and Fixtures	$ 200	
- for C.L.T. operator		
Pipes, Valves, Fittings	$ 500	$ 300
- C.L.T. air supply and blowdown		
Conveyors	$ 27,500	$ 1,400
1. C.L.T. infeed conveyor 2. C.L.T. bypass 3. C.L.T. outfeed (reuse)		
Electrical	$ 7,500	$ 2,200
1. Process Controls 2. Starters and Switches - added to existing MCC 3. Low Voltage Wiring and Control		
Grade Marker	$ 3,500	$ 500
- 2 printing heads added to existing frame		
Grading Machine and Static Tester (as per offset Grading Machine Alternative)	$205,000	$ 400

APPENDIX E-1

M.S.R. CAPITAL COST ESTIMATE
ALTERNATIVE- IN-LINE GRADING MACHINE
ESTIMATE OF DIRECT COSTS (cont'd)

ITEM	DIRECT MATERIAL COSTS	DIRECT LABOUR COSTS
Proofloader	$ 15,500	$ 300
(as per Offset Grading Machine Alternative)		
Total Direct Costs	$274,200	$ 7,620
Combined Subtotal	$281,820	

APPENDIX E-2

M.S.R. CAPITAL COST ESTIMATE
ALTERNATIVE-OFFSET GRADING MACHINE

ESTIMATE SUMMARY

Total Direct Costs (Combined - from estimate of direct costs on following pages)	$441,650
Equipment Rentals:	$ 6,800
- trucks, cranes, welding and cutting equipment, site trailer, forklift, concrete and forming tools, backhoe	
Consumables:	$ 1,000
- fuel, welding and burning supplies, paint brushes etc.	
Travel Costs	$ 5,250
Employee Fringe Benefits	$ 8,300
Contractor's Overhead and Profit	$ 9,000
Subtotal	$472,000
Engineering Allowance @ 6% (approx.)	$ 28,000
Contingencies @ 10% (approx.)	$ 50,000
Estimated Project Cost	$550,000

APPENDIX E-2

M.S.R. CAPITAL COST ESTIMATE
ALTERNATIVE-OFFSET GRADING MACHINE
ESTIMATE OF DIRECT COSTS

ITEM	DIRECT MATERIAL COSTS	DIRECT LABOUR COSTS
Site		
- minimum grading	$ 3,000	
- gravel fill		
- assume by separate contract		
Piling		
- assume by separate contract	$ 6,000	
Concrete	$ 6,500	$ 4,500
- pilecaps		
- footings		
- 5" slab		
- forming, pouring, stepping		
- metal inserts		
Structural & Miscellaneous Steel	$ 5,900	$ 1,200
- operating platform and legs		
- C.L.T. support frame		
Structural & Miscellaneous Timber	$ 11,500	$ 9,200
- building columns		
- joists		
- roof decking		
- cant strip/fascia		
- plywood siding		
Roofing	$ 9,600	
- tar and felt		
- separate contract		
Apertures	$ 100	$ 100
- doors		
Painting	$ 300	
- assume by separate contract		

APPENDIX E-2

M.S.R. CAPITAL COST ESTIMATE
ALTERNATIVE-OFFSET GRADING MACHINE
ESTIMATE OF DIRECT COSTS (cont'd)

ITEM	DIRECT MATERIAL COSTS	DIRECT LABOUR COSTS
Interior Fire Protection	$ 5,000	
- by separate contract - use existing dry value		
Lighting and Electrical Services	$ 3,000	$ 1,500
- fixtures, conduit, wire, receptacles		
Furniture and Fixtures	$ 200	
Pipe, Valves, Fittings	$ 400	$ 250
- C.L.T. air supply - blowdown station		
Conveyors	$ 83,500	$ 5,200
- complete with drives, supports to operating platform 1. Pivoted Conveyor 2. Slowdown Belts (3 req'd) 3. Planer type infeed 4. C.L.T. outfeed belt 5. Conveyor to graders		
Transfers	$ 37,000	$ 3,500
- complete with drives 1. Infeed landing table 2. Infeed transfer 3. Outfeed landing table 4. Outfeed transfer 5. Extension to existing landing table		

APPENDIX E-2

M.S.R. CAPITAL COST ESTIMATE
ALTERNATIVE-OFFSET GRADING MACHINE
ESTIMATE OF DIRECT COSTS (cont'd)

ITEM		DIRECT MATERIAL COSTS	DIRECT LABOUR COSTS
Electrical		$ 14,000	$ 5,000
a) Process Controls - grade marker - C.L.T. microcomputer connections - C.L.T. calibration			
b) Starters and Switches - assume columns added to existing MCC			
c) Low Voltage Wiring and Controls - from starter to motor or end use			
Grade Marker Modifications		$ 3,500	$ 500
- 2 additional printing heads installed on existing frame			
Grading Machine & Static Tester		$ 205,000	$ 400
CLT price U.S.F.	$153,000		
Spares	2,000		
Total U.S.F.	$155,000		
Exhange @ 20%	31,000		
	$186,000		
Freight and tax allow	19,000		
Canadian Funds	$205,000		
Proofloader		$ 15,500	$ 300
CLT 312	$ 11,300		
Gauge	450		
Total U.S.F.	$ 11,750		
Exchange	2,250		
	$ 14,000		
Tax and Freight	1,500		
	$ 15,500		
Total Direct Costs		$615,000	$32,050
Combined Subtotal		$647,050	

APPENDIX E-3

M.S.R. CAPITAL COST ESTIMATE
ALTERNATIVE-BIN SORTER MODIFICATIONS

ESTIMATE SUMMARY

Total Direct Costs (Details on following pages)	$149,050
Equipment Rentals:	$ 1,900
- truck, backhoe, crane, forklift, welding and burning equipment	
Consumables	$ 250
- fuel, maintenance, welding and burning supplies, etc.	
Travel Costs	$ 2,000
Overtime Premium	$ 1,000
Direct Employee Benefits	$ 4,300
Contractor Overhead and Profit	$ 5,000
Subtotal	$163,500
Engineering Allowance @ 6% (approx.)	$ 10,000
Contingencies @ 10% (approx.)	$ 16,500
Estimated Project Cost	$190,000

APPENDIX E-3

M.S.R. CAPITAL COST ESTIMATE
ALTERNATIVE-BIN SORTER MODIFICATIONS
ESTIMATE OF DIRECT COSTS

ITEM	DIRECT MATERIAL COSTS	DIRECT LABOUR COSTS
Site	$ 250	$ 400
- minimal grading, excavation and fill		
Concrete	$ 1,200	$ 650
- slab		
- column footings		
Structural and Miscellaneous Steel	$ 1,100	$ 250
- columns and bracing, etc.		
Structural and Miscellaneous Timber	$ 5,250	$ 2,550
- glulams		
- purlins		
- roof decking		
- cant strip fascia		
Roofing	$ 3,100	
- separate contract		
Apertures		
- door, windows	$ 300	$ 250
Painting	$ 50	$ 250
Interior Fire Protection	$ 1,800	
- by separate contract		
Lighting and Fixtures	$ 750	$ 400
Pipe, Valves, Fittings	$ 100	$ 50
- extend air supply to stacker and cleanup station		

APPENDIX E-3

M.S.R. CAPITAL COST ESTIMATE
ALTERNATIVE-BIN SORTER MODIFICATIONS
ESTIMATE OF DIRECT COSTS (cont'd)

ITEM	DIRECT MATERIAL COSTS	DIRECT LABOUR COSTS
Conveyors	$ 16,350	$ 1,250
1. Relocate defective sticker conveyor		
2. Extend stacker outfeed		
3. Relocate stacker outfeed rollcase		
Total		
Transfers	$ 27,600	$ 6,050
1. Relocate stacker, infeed, unscramble outfeed, roll-case		
2. Strapper Infeed Transfer		
3. Transfer section under bins		
Total		
Electrical	$ 1,300	$ 2,800
1. Process Control - hardwiring to new bins		
2. Relocate 7 drives, connect 2		
3. 2 Starters		
Sorter	$ 75,000	
- supply-and-install contract to sorter manufacturer		
- add 4 indexing slant bins 4' x 20' c/w hydraulic cylinders, hose, extended J-bar transfer, operator consoles, wiring to I/O panel $70,000		
- modifications to micro-computer $ 5,000		
Total $75,000		
Total Direct Costs	$134,150	$ 14,900
Comined Subtotal	$149,050	

APPENDIX E-4

M.S.R. COST ESTIMATE
ALTERNATIVE-MODIFICATIONS TO TRAY SORTER

ITEM	CONTRACT COSTS	DIRECT LABOUR COSTS
Supply and Install Contract to Sorter Manufacturer		
a) Raise tower to accommodate additional tray on top	$16,000	
b) Extend tower chain down for additional tray on bottom	$ 9,000	
c) Install 2 trays including diverters	$51,000	
d) Electronics-modifications to micro-computer program	$ 4,500	
e) Hard wiring to new bins	$ 5,000	
Total Cost	$85,500	

APPENDIX E-5

M.S.R. COST ESTIMATE
ALTERNATIVE-MODIFICATIONS TO PULL CHAIN

ESTIMATE SUMMARY

Total Direct Costs (Details on following pages)	$58,900 (rounded)
Equipment Rentals:	
- concrete tools, forklift	$ 300
Consumables	$ 200
- fuel, maintenance	
Travel Costs	$ 850
Contractor's Overhead and Profit	$ 2,500
Direct Employee Benefits	$ 1,750
Subtotal	$64,500
Engineering Allowance @ 6% (approx.)	$ 4,000
Contingencies @ 10% (approx.)	$ 6,500
Total	$75,000

APPENDIX E-5

M.S.R. COST ESTIMATE
ALTERNATIVE-MODIFICATION TO PULLCHAIN
ESTIMATE OF DIRECT COSTS

ITEM	DIRECT MATERIAL COSTS	DIRECT LABOUR COSTS
Demolition	-	$ 500
- remove building wall section		
Site	$ 1,000	$ 550
- excavate and fill for cart rails and slab		
Structural and Miscellaneous Steel	$ 2,000	$ 400
- cart cover support columns and beams		
Structural Timber	$ 1,800	$ 1,200
- roof decking - side walls in cart area		
Roofing	$ 2,800	
- by separate contract		
Concrete	$ 4,000	$ 1,500
- slab for carts and rails		
Carts and Rails	$ 31,000	$ 1,620
Lumber Grade Marker	$ 10,000	$ 550
Total Direct Costs	$ 52,600	$ 6,320
Combined Subtotal	$ 58,920	