United States
Department of
Agriculture

Forest Service

**Southern Forest
Experiment Station**

New Orleans,
Louisiana

Proceedings Reprint

HaREM: HARDWOOD LUMBER REMANUFACTURING PROGRAM FOR MAXIMIZING VALUE BASED ON SIZE, GRADE, AND CURRENT MARKET PRICES

C.J. Schwehm; P Klinkhachorn; C.W. McMillin; H.A. Huber

In: Proceedings: Eighteenth annual hardwood symposium of the hardwood research council. Present and Future timber and non-commodity demands on eastern hardwood forests in the 1990s; 1990 May 6-9; Cashiers, NC. Memphis, TN: Hardwood Research Council, National Hardwood Lumber Association: 67-75.

Southern Forest Experiment Station

ISSN 0193-8495

PROCEEDINGS:

EIGHTEENTH

ANNUAL HARDWOOD SYMPOSIUM

OF THE

HARDWOOD RESEARCH COUNCIL

PRESENT AND FUTURE TIMBER AND NON-COMMODITY DEMANDS
ON EASTERN HARDWOOD FORESTS IN THE 1990S

High Hampton Inn

Cashiers, North Carolina

May 6-9, 1990

An Activity of the National Hardwood Lumber Association

HAREM: HARDWOOD LUMBER REMANUFACTURING PROGRAM FOR MAXIMIZING VALUE BASED ON SIZE, GRADE, AND CURRENT MARKET PRICES[†]

C.J. Schwehm[1], P. Klinkhachorn[2], C.W. McMillin[3], H.A. Huber[4]

[1]Department of Electrical and Computer Engineering, Louisiana State University, Baton Rouge, LA 70803
[2]Department of Electrical and Computer Engineering, West Virginia University, Morgantown, WV 26506
[3]Southern Forest Experiment Station, 2500 Shreveport Highway, Pineville, LA 71360
[4]Department of Forestry, Michigan State University, East Lansing, MI 48824.

Abstract: This paper describes an expert system computer program which will determine the optimum way to edge and trim a hardwood board so as to yield the highest dollar value based on the grade, size of each board, and current market prices. The program uses the Automated Hardwood Lumber Grading Program written by Klinkhachorn, et al. for determining the grade of each board based on the National Hardwood Lumber Association Rules. It checks several possibilities for edging and trimming each board to determine if the grade can be increased. If so, it determines whether the value of the board is also increased based on the current market prices. Based on these measures, the program makes a determination on how the board should be edged and trimmed. Currently, the program is capable of considering six grades: FAS, Selects, #1 Common, #2 Common, #3 Common, and Below Grade.

[†] This paper has been accepted for publication in the Forest Products Journal

Introduction

The hardwood lumber producers can assure the highest value for their product by considering each board for remanufacturing based on computer calculations The remanufacturing of boards can be accomplished to obtain the highest possible grade. But, more importantly, the highest dollar value, including the cost of remanufacturing, can be determined. Even though every board will not be remanufacturable, this program will examine every board to determine if its value can be increased.

For example, consider the board in Figure 1 with the assumed market prices for this particular species of $1000/MBF, $950/MBF, and $650/MBF, for the grades FAS, Selects, and #1 Common, respectively. The board, as is, grades 8 board feet of #1 Common, with a value of $5.20.

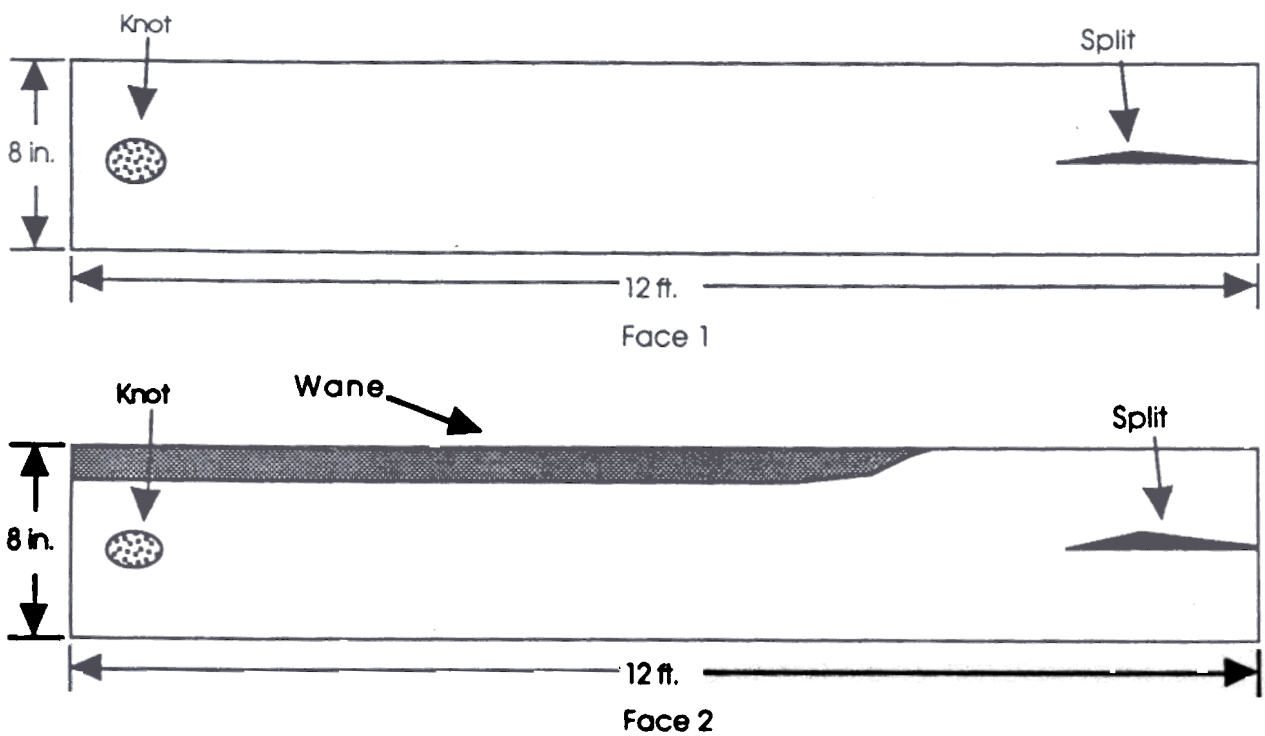

Figure 1 An Example Board (Note: Face 2 of the board is drawn as it would appear when viewed through face 1 of the board.)

If 1 foot were edged from the left end of this board and 1 foot were edged from the right end, the result would be the board shown in Figure 2. The grade of the board would increase to Selects but the size would be decreased to 7 feet. However, the value would increase to $6.65. In this case, remanufacturing would be a wise decision because the cost of remanufacturing would more than likely be less than the difference of $1.45.

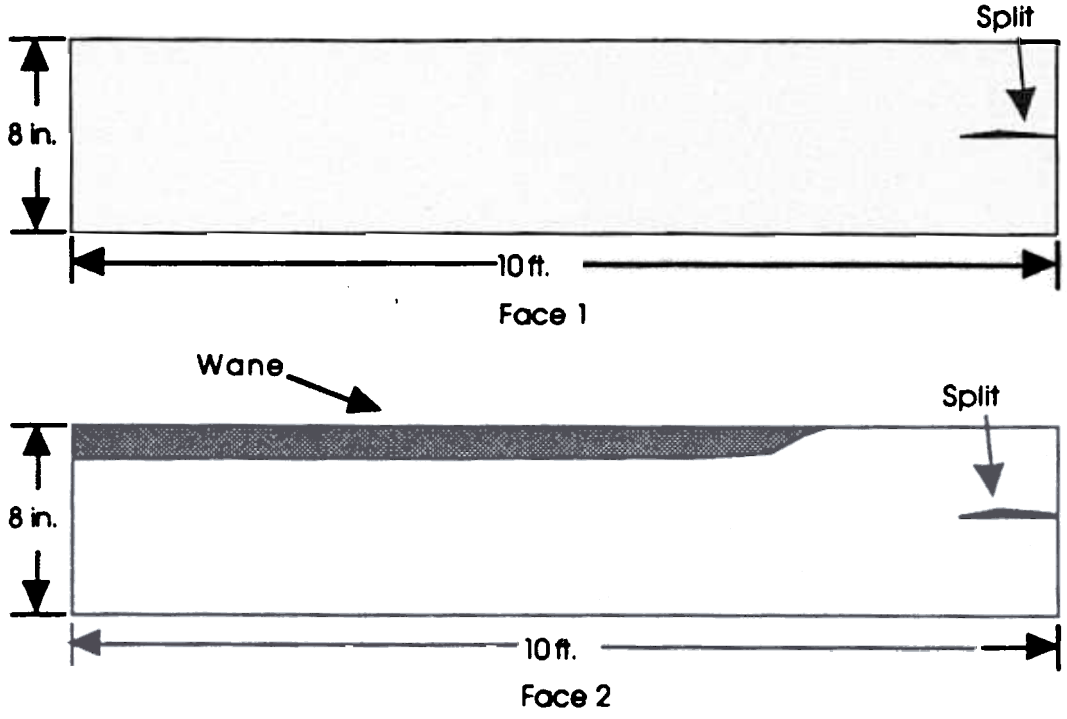

Figure 2. The same board as in Figure 1 with 1 foot removed from the left end and 1 foot removed from the right end.

On the other hand, assume that 1 foot was edged from the left end, 1 1/2 inches was trimmed from the top edge, and 1 foot was edged from the right end. The result would be the board shown in Figure 3. In this case, the board would grade as 5 feet of FAS. The value of the board would now only be $5.00. The grade of the board has increased from #1 Common to FAS but the value of the board has decreased. This level of remanufacturing would not be wise from an economic viewpoint

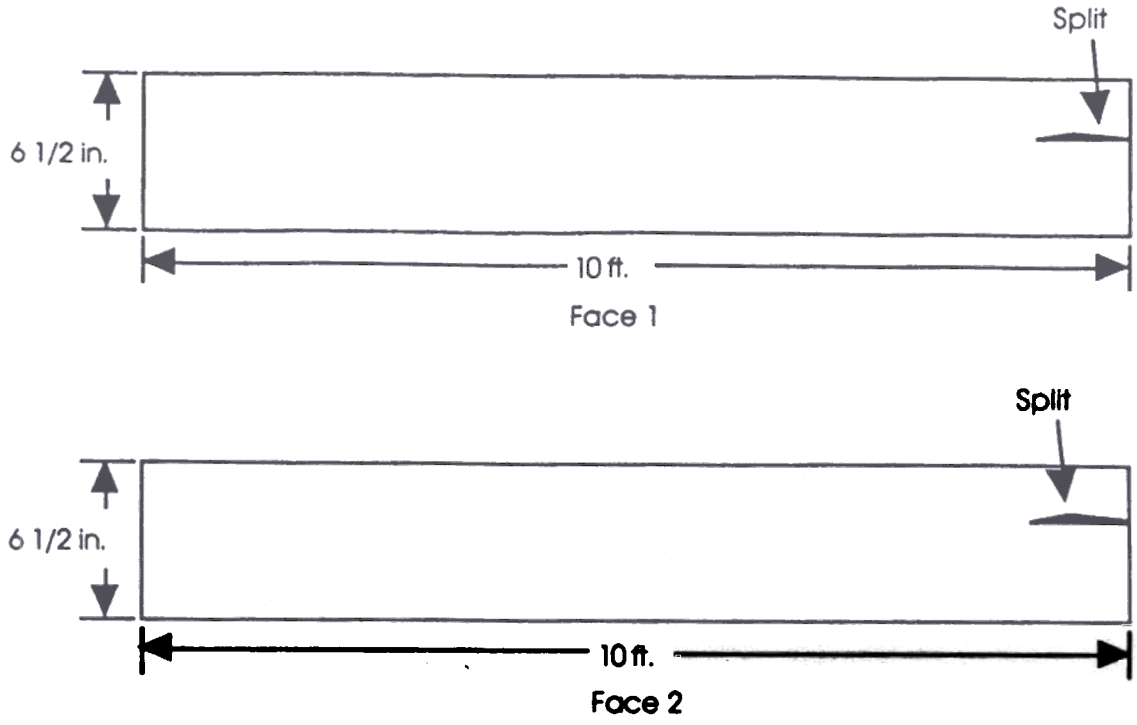

Figure 3. The same board as in Figure 1 with 1 foot removed from the left, 1 1/2 inches removed from the top, and 1 foot removed from the right.

While this example may be oversimplified, it makes an important point about the process of lumber remanufacturing. It is not always a simple task to determine the best way to remanufacture lumber in order to get the highest dollar value. As seen in this example, remanufacturing for the highest grade does not always return the highest dollar value. Currently these decisions about remanufacturing are made by sawyers, edgers, and trimmers. Factors such as numerous alternative choices, fatigue, and lack of time can cause the remanufacturing decision to be made in a less than optimum fashion. Such improper decisions, cumulatively, can prove to be costly to lumber mills over time. This paper describes a computer program, HaRem, which was developed to make the remanufacturing decision so that the highest possible dollar value is obtained from every board.

Program Description

The HaRem program employs a multi-step heuristic algorithm on each board being processed to determine if any additional edging and trimming can increase the grade and the dollar value of the board. The program examines several possible ways in which each board can be edged or trimmed.

It begins by determining the size and grade for the board using the Automated Hardwood Lumber Grading Program developed by Klinkhachorn, et al.[1] Figure 4 depicts the flow diagram of the remanufacturing program.

The value of the board is then computed using this grade information and the current lumber prices. After determining this initial information, several possibilities for remanufacturing the board are examined. First, if the board grades FAS, then no additional processing can be done to increase its value as the grade cannot be increased. If the board does not grade FAS, it is determined if it was downgraded to the current grade because of its width or length. If this is the case, any amount of edging or trimming can only reduce the value; therefore, processing stops.

If size is not the reason the board received the grade it did, the program checks if an oversized defect caused the board to receive its current grade. If so, the program determines how much of the defect in question must be removed in order for the board to no longer violate that particular rule and specifies the amount the board must be edged or trimmed.

---

[1]P. Klinkhachorn, J.P. Franklin, C.W. McMillin, R.W. Conners and H.A. Huber, "Automated Computer Grading of Hardwood Lumber," Forests Products Journal, 38, no. 3 (March 1988): 67-69.

The program then attempts to remove this amount from the board in one of several ways. If it is possible to remove this amount and still increase board value, the board is regraded and a new value is established for the board. If the new value is higher than the previous value, the program recommends that the specified amounts be removed from the board. If the price does not increase, the process is repeated and several other possibilities are tried for removing the necessary amount of wood.

The program determines whether to trim or edge depending on the type and location of the defect which has to be reduced. Once it is determined whether to remove the defect by trimming and/or edging, the program must then determine from which edge or end to make the cut. There are three different approaches used. The first approach attempts to remove the edge or end of the board lying closest to a defect. The second approach is to remove the defect from the left end or bottom edge. The third approach removes the defect from the right end or top edge. If any of these cases causes the value to increase, then the entire process is repeated using this new board. If the value cannot be further increased, processing is terminated.

Finally, if the board was not downgraded due to an oversized defect, then it must have been downgraded because there was not enough clear area in pieces of sufficient size and number. If so, the program again tries to edge and/or trim the board several different ways in an attempt to increase value by removing a portion of the defective area The algorithm for determining which edge or end to trim is also a heuristic algorithm It works on the idea of attempting to remove a portion of the board from the ends or edges with the most defective area. Here again, several possible choices are attempted and with any increase in the dollar value, the process starts again using this new board. If no increase is obtained, processing for this board is terminated.

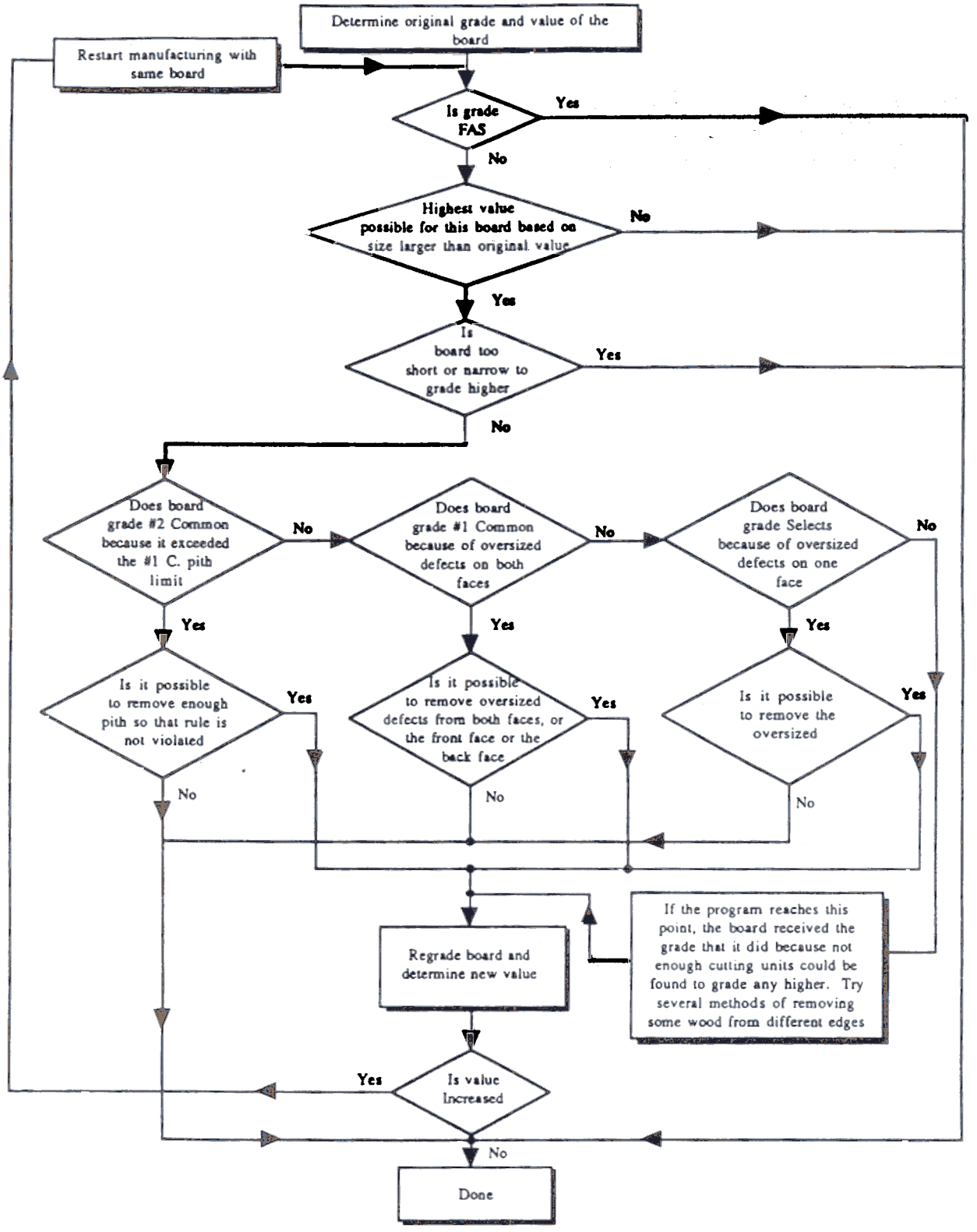

Figure 4 Flow Diagram of HaRem

Program Features

The program contains several features which make it highly functional and practical example, the program is modular and portable making it is easy to develop an interface between the program and a computer vision system similar to the one proposed by McMillin, et al.[2] In other words, this program, combined with a computer vision system, will be a very powerful lumber production tool in the hardwood lumber industry.

A second important feature of the program is the ease of data entry and modification. program provides facilities for adding or modifying lumber price files. This allows the user to easily change lumber prices so that the lumber price information is always current. The format for the files containing board information is also concise and easy to understand so users can easily add or modify board information The program allows the user to obtain a realistic measure of the increase in value by considering the remanufacturing cost. This cost includes a fixed overhead and the dollar per linear foot of edging and/or trimming. This information has to be supplied by the user.

A third attractive feature of HaRem is that it is based on a previously tested Automated Hardwood Lumber Grading Program. This program is very powerful and provides many features not found in other grading programs. For example, the program considers both faces of the board, whereas most other programs only consider one face. The grading program also has a method by which the grading rules can be easily modified so that different sets of rules can be used for species having slight differences from the standard.

---

[2]C.W. McMillin, R.W. Conners, and H.A. Huber, "ALPS -- A Potential New Automated Lumber Processing System," Forest Products Journal, 34, no. 1 (January 1984): 13-20.

Summary

A computer program has been developed to determine the best way to remanufacture boards to obtain the highest dollar value based on board size, grade, and current lumber prices. The program is ideally suited to be interfaced to a computer vision system to create an entire automated hardwood lumber production system. The program is flexible in that it easily allows the user to modify the grading rules used and the current lumber prices.

Additional Information

The program is written in FORTRAN 77 and will run on any computer which has a compiler implementing ANSI FORTRAN 77. An executable version is available for the IBM PC or compatible. The program has no special requirements - 640 KB RAM and a floppy disk are sufficient.

Requests related to evaluation or use of the program for research and developmental purposes should be directed to Dr. C.W. McMillin, Southern Forest Experiment Station, 2500 Shreveport Highway, Pineville, LA 71360.