

*Opportunities for the Hardwood Lumber
Producer: Improving Recovery,
Productivity and Markets*



*Advancing the
lumber and
wood-based panel
industries*

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Possible Computer Vision Systems and Automated or Computer-Aided Edging and Trimming Systems for Future Hardwood Sawmills

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POSSIBLE COMPUTER VISION SYSTEMS AND AUTOMATED OR COMPUTER-AIDED EDGING AND TRIMMING SYSTEMS FOR FUTURE HARDWOOD SAWMILLS

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The title of this paper could also read, "Are computer vision systems and automated or computer-aided edging and trimming systems in the future of hardwood sawmills?". Hopefully, the answer is "yes" for many reasons, such as improved recovery, increased productivity, improved marketability, reduced costs, and accurate lumber grading.

Hardwood sawmiller are facing many different situations. Production has been increasing to a reported 11+ billion board feet (Figure 1), exports have been growing (Figure 2), but low grade is still a major problem (Figure 3). Inconsistent product quality and less than optimal processing are problems for many producers. Log costs have been increasing, while lumber prices seem to have stabilized. Hardwood sawtimber resources in our forests have been increasing (Figure 4) and may be getting better. With the increased demands, however, keeping enough logs in sawmill yards, is not getting easier.

In recent surveys (Bush 1989 and Sinclair and others 1989), hardwood lumber customers reported several major concerns: (1) inaccurate lumber grading by producers, (2) inconsistent thickness of lumber, and (3) poor quality of the lumber they were purchasing.

To keep and satisfy hardwood lumber customers, hardwood sawmiller need to improve the accuracy of their lumber grading and provide consistent products. They also need to get more value out of the logs they are processing.

RESEARCH EFFORTS ADDRESSING THE PROBLEMS

Research is underway to help our industry reduce costs, increasing product volume and value recovery, and market more accurately graded and described products. The research is part of a team effort to help the hardwood sawmill industry automate with computer vision systems, and computer-aided or computer controlled processing. In the following discussion, I will review our major efforts and goals.

Computer Vision Research to Grade and Analyze Hardwood Lumber

The goal of this research is an automated system for lumber grading and describing potential furniture cuttings in hardwood lumber. To do this, defects must be located, properly sized, and identified, and board outlines must be determined. Then a computer program is needed to grade the boards with the National Hardwood Lumber Association Grading Rules. A separate program is needed to determine the possible furniture cuttings located in the boards. This last program could also determine if it would be better to use rip or cross cut first processing for each board. The resulting system would generate packages of computer-graded and marked lumber, including information on potential cuttings, and the best initial rough mill processing step.

The basic research on detection, sizing, and identification by computer vision is underway. The status of this work was presented at the 3rd International Conference on Scanning Technology in Sawmilling (Conners and others 1989a). Our challenge is to create one general analysis method for our many different hardwood species. This method also must be computationally simple enough to allow real-time industrial processing.

Computer detection, analysis, and identification of defects on rough lumber with a vision system is a complex problem. Lumber changes in visual appearance as the surface dries. Outside storage and drying can cause color changes, along with problems with dirt. Surfacing boards would take care of most of these problems, but, we need to grade rough rather than surfaced lumber. Our research is addressing these problems.

We have recently built a prototype image system to collect data from 4 foot long boards. The complete system includes a material handling device, a line scan camera, special lighting, a customized data transfer device, and a computer system. The system is working. We are designing the image system to process 16-foot-long boards at a realistic industrial processing speed.

A computer program is available for grading hardwood lumber by the standard rules of the National Hardwood Lumber Association (Klickhachorn and others 1989). The program is being enhanced to increase the rate of computer processing to a practical industrial speed. We are changing the standard shape of presentation of defects from rectangular to any polygon to reduce the data needed to describe defects or void areas. The program is also being written in C to increase computational speed to compensate for the additional complexity arising from nonrectangular defect presentations. The program will also have an active database that will allow a user to choose the proper set of grading rules for a species.

Another computer program determines the cuttings available in each board. It also compares the yields in cuttings for cross cutting or ripping the board as the first cut-up process. The program is called CORY (Brunner and other 1989). Refinements to CORY may be necessary to increase processing flexibility and computer speed.

The information provided from the system for packages of lumber will be similar to that shown in Figure 5. Grade mix, total board footage, potential yield in cuttings, and potential distribution of cuttings are on the tally sheet. As shown in Figure 5, the simulation program can calculate the cuttings in standard or specific lengths. Output information easily can be modified and expanded. Individual board information will also be available.

With the above capabilities, lumber producers could provide the accurately and consistently graded material desired by end users. They could also provide extremely worthwhile information on potential cuttings and processing to end users. End users of hardwood lumber could also use the system to determine which boards should be cross cut or ripped first and the potential cuttings. It could also help determine the proper lumber grade or grade mix that should be use for different situations.

In an extension of our computer vision research, we plan to develop a computer vision grading system for pallet parts. Grading and pallet part separation systems are needed to produce more reliable pallets from low-grade solid wood. Vision grading is one alternative in pallet part quality separation. The grading could be done by sawmiller who want to produce and market pallet parts. Pallet producers could also grade and separate parts before pallet construction.

Computer Aided Manufacturing for Edging and Trimming Hardwood Lumber to Maximize Value and Recovery

Decisions on where to edge and trim many edged boards or to trim other sawmill boards can have a major effect on the performance of a sawmill. Optimal decisions are difficult because of the complexities of the grading rules, the inability of an operator to include lumber prices in his decision, operator skills, and operator fatigue and/or lack of interest at times. A recent preliminary study has shown that an operator could have increased the value of the lumber produced by 19 percent with optimal processing. We are conducting further studies to determine potential inefficiencies. Poor edging and trimming are definite problems in hardwood sawmills. Wasted dollars are being chipped every day.

We are working to develop a semi-automatic or computer-aided edging and trimming system. The system takes a quick picture and display a board on the bottom half of a monitor. The board dimensions are determined and a potential grade is assigned. The computer then tells the operator how much can be trimmed or edged to increase the grade and value of the board. The operator can then decide where to cut the board. The computer will tell the operator if any further options are available. With the present set-up, laser lights and corresponding saw blades would be positioned for the proper cuts.

This particular research will generate a low cost system. Most hardwood sawmills cannot afford expensive systems. However, our next step, as our computer vision abilities expand, will be to develop a system totally operated by computer.

Automated Processing of Logs Directly to Green Dimension Blanks

To more effectively convert medium- and low-grade logs to end products, we are conducting research to produce green dimension blanks directly from logs. We are not stopping with any form of lumber. We hope to improve volume and value recovery while producing higher value products. We are considering European, Japanese, and U.S. processing techniques used in or under development for furniture rough mills.

Yields in green dimension cuttings will be determined in a cut-up simulation program while producing standard sizes determined in previous research (Araman and others 1982, Araman 1987) . One set of standard dimension sizes is for the domestic market and one for the export market. Several log breakdown patterns will be tested.

Some final processing system designs will include potential computer vision stations to make processing decisions after the initial log breakdown. Automatic ripping and cross cutting with the image processing will be used to improve yields and reduce the number of workers needed. We will also design some small mills. These will be for plants desiring to add a low volume logs to green dimension facility next to their existing sawmill.

ARE COMPUTER SYSTEMS TO GRADE LUMBER, AND PROCESS MATERIAL IN THE FUTURE FOR HARDWOOD SAWMILLS?

We hope so. We are putting resources, and research efforts into that prospect. We need your support and the support of the hardwood sawmill companies, industry associations, and equipment manufacturers to accomplish our goals. We know that positive results will move our industry further into the computer age, permitting it to improve product recovery, and remain competitive in the world marketplace and with other competing materials in the United States. These systems will also improve utilization of our hardwood resources. We also hope that more profitable use our abundant low-grade sawtimber will be possible.

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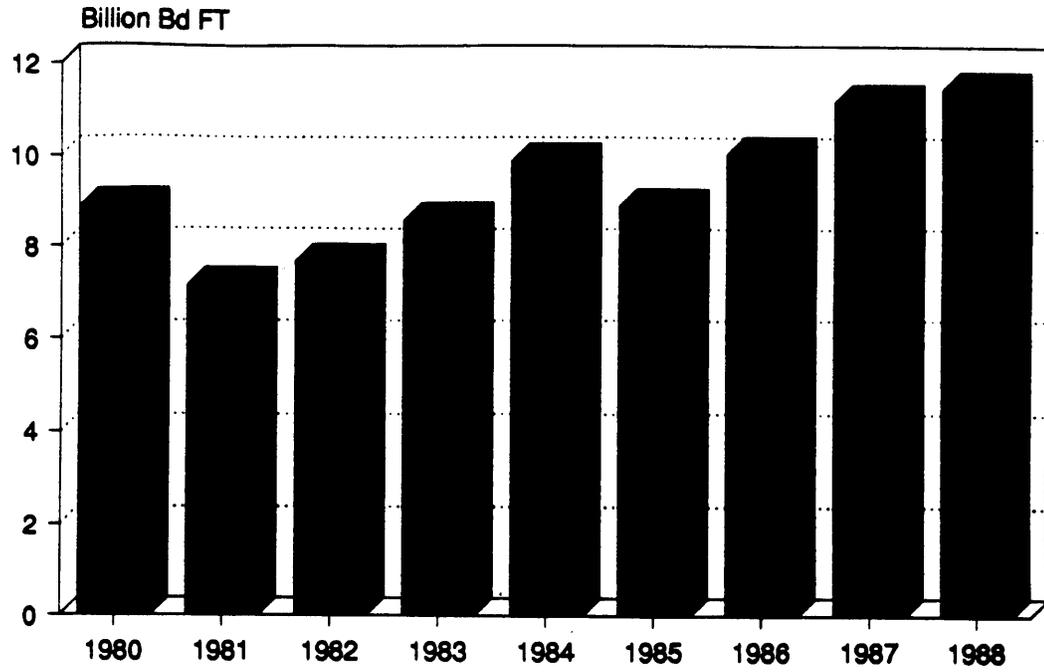
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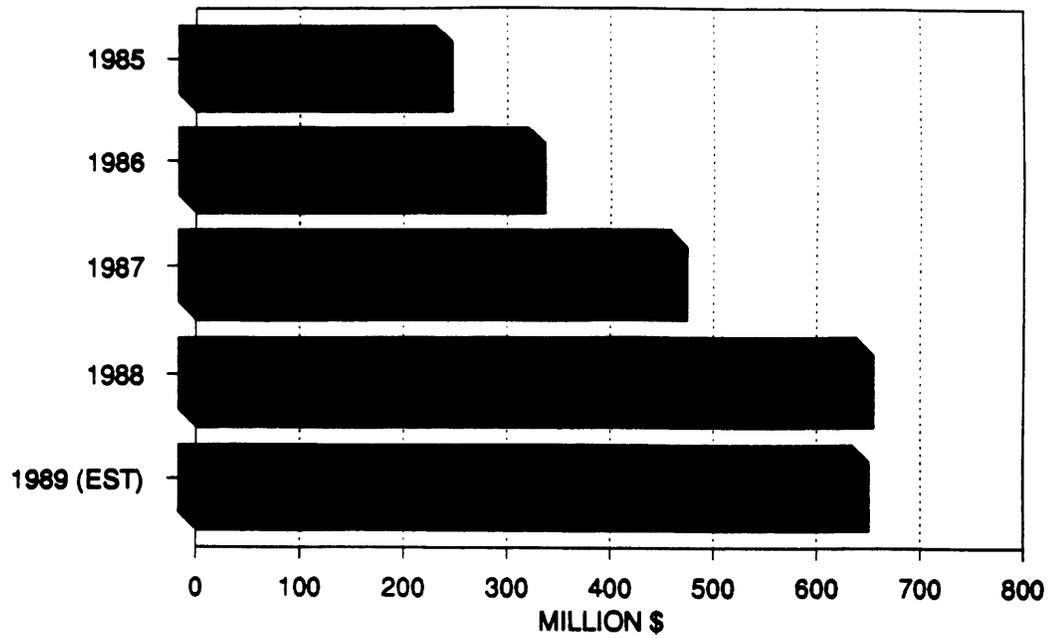
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**FIG. 1 - U.S. HARDWOOD LUMBER PRODUCTION
1980-88 (billion bd ft)**



SOURCE: NATIONAL FOREST PRODUCTS ASSO.

**FIG. 2 - U.S. HARDWOOD LUMBER EXPORTS,
1985-88, 1989 est., (million dollars)**



SOURCE: USDC, ITA

**FIG. 3 - ESTIMATED SAWTIMBER LOG GRADES
IN EASTERN FORESTS FOR SELECT HARDWOODS**

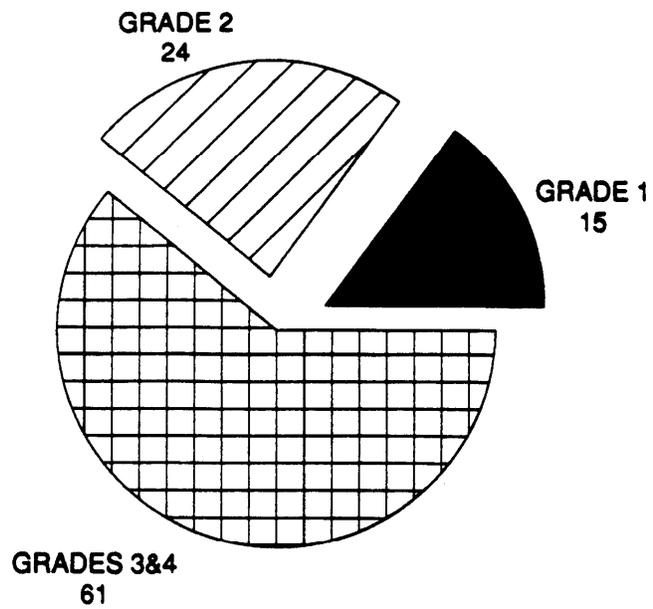
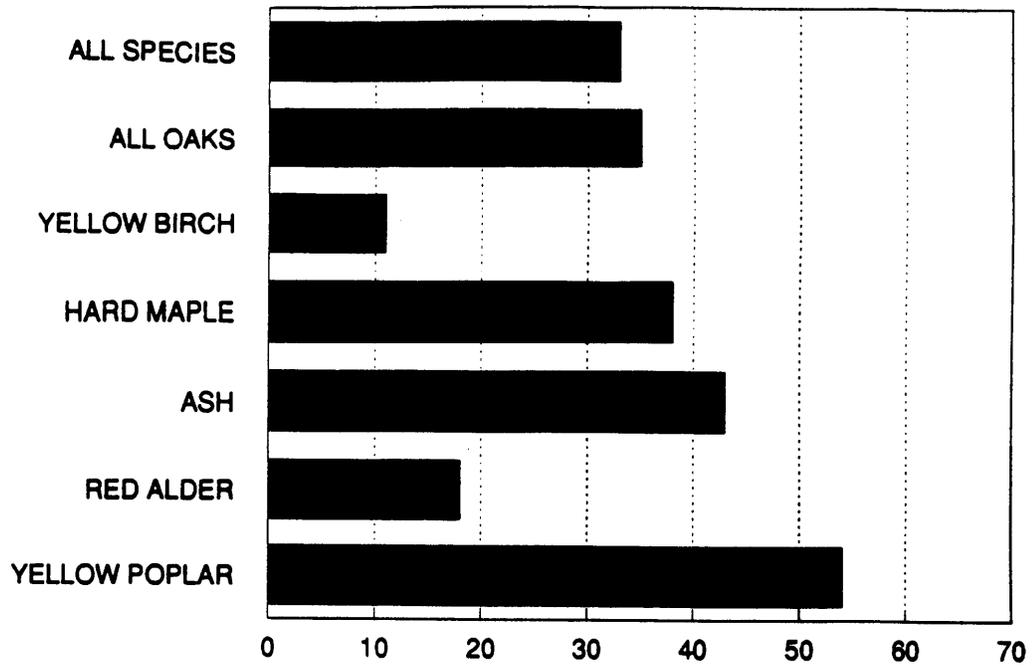


FIG. 4 - PERCENT CHANGE IN SOME HARDWOOD SAWTIMBER RESOURCES FROM 1977-1987



SOURCE: BONES, 1987

FIG. 5- EXAMPLE TALLY SHEET FOR THE
COMPUTER ANALYZED LUMBER

BATCH INFORMATION	GRADE MIX
SOURCE <u>HARDWOOD CO.</u>	FAS <u>5%</u>
SPECIE <u>RED OAK</u>	SEL <u>3%</u>
LENGTHS <u>9 & 10</u>	1C <u>67%</u>
THICKNESS <u>5/4</u>	2C <u>25%</u>
TOTAL BD FT <u>1500 BD FT</u>	3C <u> </u>
DATE <u>1-15-90</u>	

POTENTIAL YIELD IN:
 STANDARD LENGTHS
 SPECIFIC LENGTHS
 (LENGTHS ARE DISPLAYED
 IN GRAPH BELOW)
 (WIDTHS ARE RANDOM)
 IS 72 %

DISTRIBUTION OF POTENTIAL CUTTINGS
BY LENGTH

