Liriodendron tulipifera Juglans nigra Prunus serotina Quercus alba

HARDWOOD RESEARCH BULLETIN

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1997 Hardwood Research Award Winner:
"Automatic Color Sorting of Hardwood Edge-Glued Panel Parts"

The National Hardwood Lumber Association's 1997 Hardwood Research Award was presented to D. Earl Kline, Richard Conners, Qiang Lu and Philip Araman at the 25th Annual Hardwood Symposium for developing an automatic system for color sorting hardwood edge-glued panel parts. The researchers comprise a team from Virginia Tech University and the USDA Forest Service in Blacksburg, VA. Their work was selected as the research which had the most significant implications for the hardwood industry. The following article summarizes the winning research paper.

Color sorting of edge-glued panel parts is an important manufacturing step where color uniformity has an impact on the value of the final products. Figure 1 illustrates how color uniformity can affect the look of the panel product. Manual color sorting of panel parts is very labor intensive and inexact, as different people have different perceptions about color uniformity in hardwood panels. Additionally, color uniformity and consistency of manually sorted panels further decline at production speeds.

Because a distinct market preference for color uniformity exists, a number of researchers have developed systems to better characterize color in wood. However, none have led directly to commercially available systems. A color sorting system that will meet the demands of the wood processing industry must (1) be able to accurately and consistently separate parts into appropriate color classes, (2) be able to keep up with production requirements, and (3) be easy to operate by plant production personnel.

A team of scientists with Virginia Tech University and the USDA Forest Service in Blacksburg, VA, D. Earl Kline, Richard Conners, Qiang Lu and Philip Araman, has developed an automatic color sorting system which meets all of these requirements. The system simultaneously examines both faces of a panel part, determines which face has the "best" color, and sorts the part into one of a number of color classes at plant production speeds. Tests of a prototype system generated over 91 percent acceptable panels from

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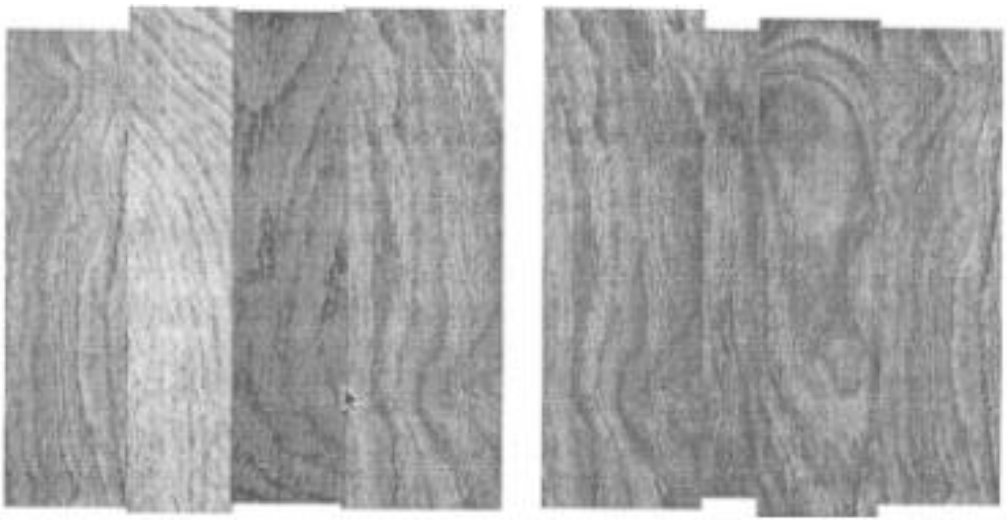

(a) (b)

Figure 1. Red oak panel color variation (shown here as brightness variation) for(a) improperly sorted panel parts and (b) properly sorted panel parts.

Hardwood Research Award: Automatic Color Sorting System

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automatically sorted red oak panel parts, which exceeded target plant production goals. The color sorting system is now commercially available.

Dan Meyer, NHLA Director of Technical Services (l), presents the 1997 Hardwood Research Award to Phil Araman, USDA Forest Service, Blacksburg, VA.

System Hardware & Software

Figure 2 shows the overall system used to perform real-time color sorting operations. The system employs two color line scan cameras to image the parts, one for each face. Tungsten halogen bulbs provide a consistent and uniform illumination source for the system. An illumination control system adjusts voltage supplied to the bulbs when lighting intensity falls outside specified tolerances. Controllers govern camera speed and convert the signals from analog to digital data. The digital data is fed into specially built image processing, or "MORRPH", boards, which output the color measurements used to sort parts into appropriate color classes.

Testing the System

The accuracy of the color sorting system was evaluated in an actual panel glue-up operation. A set of 25 color samples was selected to define each of six reference color classes for southern red oak panel parts. The selected samples were chosen by experienced mill operators such that any combination of the 25 parts within a class would result in a clear panel. The samples were then used to "train" the color sorting system.

After training the system, the part sorting algorithm was tested. This particular glue-up operation graded edge-glued panels into three categories: clear, acceptable and unacceptable. Clear panels have approximately the same color across the better face and are the most valuable panels. Acceptable panels have color characteristics that are within acceptable bounds but have some allowable color variation that can be compensated for with darker finishes. Unacceptable panels have widely varying color characteristics and can typically be used only for painted panels.

The researchers tested 17 pallet loads of parts, with each load containing 900 to 1000 pieces. Each of these pieces were color sorted with the prototype color sorting system and then glued up into panels.

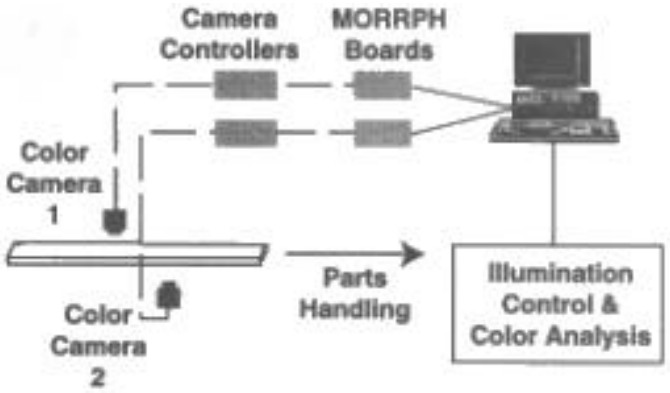

Figure 2. Schematic of award-winning automatic color sorting system.

The prototype system scanned and sorted parts at the rate of 2 feet/second, with a 4-inch space between parts. An inkjet printer then printed the color class and best face on each part. Alternatively, the system could drive an automated part sorting system.

The average rate of clear and acceptable panels produced for the entire experiment was 91.3 percent, although production of high quality panels from individual parts loads varied from 83.0 to 99.1 percent. The poorer performance of some loads was attributed to miscalibrated light levels, dust, and parts that had significantly different color variations that were not represented by any of the six color classes used to train the system.

The results indicate that the system is capable of creating high-quality edge-glued panels, although proper color class training and maintenance of uniform lighting are critical for accurate results.

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Color Sorting

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Current Status

The system has demonstrated reasonable service maintenance requirements and has been well received by plant personnel. Continued in-plant testing has led to enhanced software to better characterize the large color variations present in red oak panel parts, including those variations due to small knots and mineral streaks. Commercial versions of the color sorting system are currently being marketed by Group Seven Systems in Hudson, North Carolina.