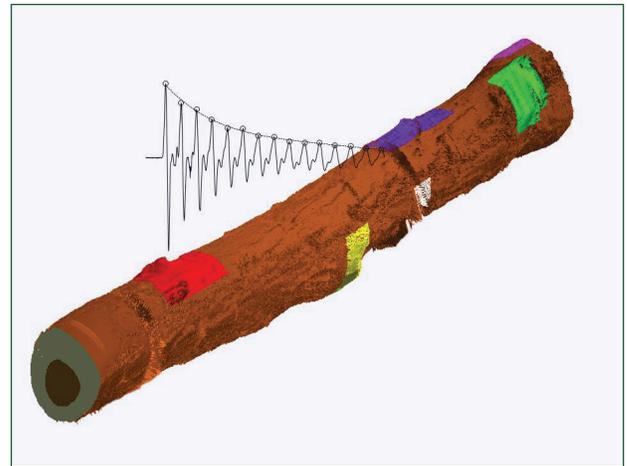# RESEARCH in Progress

Combining Complementary Scanning Methods to Improve Log Defect Detection

High-resolution laser surface scanning of hardwood logs provides detailed imagery from which log surface defects can be located, classified, and measured. These data can be used to generate internal defect maps of logs and predict quality and value of lumber and other products. However, a system based entirely on log surface inspection may incorrectly predict internal quality. Some defects give the appearance of being solid or sound and effectively hide an unsound or rotten area, thereby reducing the accuracy of predicted internal product quality and value. On the other hand, acoustic wave propagation methods are very accurate at determining the soundness of a log but provide no data about defect locations. Combining the two approaches could yield a system that can accurately determine exterior defects and interior soundness.

High-resolution laser scan image of a log with detected defect areas highlighted and acoustic waves passing through.

Background

The location, type, and size of defects on hardwood logs dictate the potential grade and value of the resulting lumber. Hardwood lumber is bought and sold using National Hardwood Lumber Association (NHLA) grades reflecting the value of each board. The fewer the defects, the greater the length and width of clear areas, which results in higher lumber grade and value. Hardwood log sawing begins with the log face that is clearest and will yield the highest valued boards. The sawyer attempts to saw the log such that any defects will be on the edges of boards. Such defects can then be edged from the sides of the board to make a higher valued board. (This is very different from the sawing of softwood logs, where defects do not significantly affect the value of the board.) Thus, scanning systems that find defects on and inside hardwood logs could

dramatically improve the sawing process and the grade and value of sawn lumber.

Objective

The main goal of this research is to examine the technical feasibility of combining acoustic wave data with high-resolution laser scanning data. Indications of "soundness" in a particular log should allow the internal prediction system to flag suspicious defects as potentially unsound. This information could then be applied to the sawing processes to optimize utilization.

Approach

A random sample of 15 yellow-poplar and an additional 15 hardwood species trees will be procured from the central Appalachian region. Each tree will be bucked to commercial lengths to obtain three to five logs from each tree. Logs will be laser-scanned using the

Princeton, West Virginia, high-resolution laser scanner. Acoustic wave measurements will be recorded for each log to assess internal soundness. The soundness data will used to refine internal defect predictions, possibly by developing an inference table using the Forest Service Hardwood Defect Databank to help determine external indicator types, sizes, and shapes most likely to produce an unsound or rotten internal manifestation. Thus, given a log with several different defects, we could determine those most likely to be associated with an internal rotten area.

Expected Outcomes

At a minimum, this study will determine surface defects and characteristics associated with the highest probability of an unsound internal defect, and the use of acoustic wave technology will identify logs with invisible internal unsound defects. An optimal outcome will be a combined scanning approach that uses these data to identify potentially unsound defects and facilitate sawing of each log to optimize value.

Timeline

Laser scanning and acoustic wave measurements and statistical determination of soundness of defects will be completed by February 2015. Data processing and system integration will be completed by August 2015, and testing and refinement of the combined laser–acoustic system will be completed by May 2016.

Cooperators

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