

Computer Integrated Hardwood Processing

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Abstract: The planning of how hardwood logs can be sawn to improve recovery of high-value lumber has always been hampered by the limited information provided by external defects, and whatever internal defects are eventually revealed on the cut log faces by the sawing pattern. With expanded markets, lower-quality logs, increased competition from non-wood products, social pressures to manage public lands for nontimber resources, and the reduced profit margin between log costs and lumber prices, the hardwood products industry has been exploring alternative means of improving value yield. The goal of this project is to provide science and technology-based methods and information that will benefit the hardwood products industry and related fields.

Summary: Hardwood timber is a substantial economic staple in the Eastern United States. Primary hardwood processors there produce more than 10 billion board feet of sawn hardwoods annually. Most of their facilities are relatively small (< 10 MMBF/year) and are located in rural areas. To survive in a highly competitive marketplace and meet current and future consumer needs for hardwood products, sawmill operators must: (1) produce high quality and consistent products from current stocks of increasingly lower-grade timber, and (2) increase the value of each board sold.

To manufacture the highest value products possible from hardwood logs, decisions made during the first stage of processing must be good ones. The hardwood log breakdown practice is both geometric and defect-oriented, owing to the nature of the hardwood end utilization in fine furniture, flooring, and millwork. For producers of hardwood lumber, the objective is to maximize the volume and grade of lumber that generates the highest dollar value. Higher lumber grades have larger proportions of clear wood on each face, which requires highly judgmental breakdown decisions in patterns such as grade sawing, or around-sawing with resaw. Perhaps the greatest obstacle is the uniqueness of each log--every log is different in terms of shape, size, and internal defect configuration. Over the years, the human sawyer has been making saw placement decisions based on limited information provided by the external view of log shape, visible external defects, and whatever internal defects are eventually revealed on already cut log faces. Non-invasive internal scanning of solids has opened up new avenues in the log breakdown planning problem.

In this project, we have developed a method for rapidly converting non-invasive scan data into polyhedral solid models [1], which has practical value not only for the hardwood industry but also to other applications requiring non-invasive scan-to-CAD data conversion. To manage the huge data sets generated by non-invasive scanning, we have developed a robust method for reliably reducing geometric data while preserving the representational integrity of geometric information [2]. This method will be useful as well to other applications that involve huge data sets. In an effort to compensate for the scarcity of log CT scan data, we have taken the available data and developed a method which can computationally “grow” additional log and defect data using a hybrid generation technique combining Fourier descriptors and mode analysis [3]. This method for shape regeneration has far-ranging potentials, from computer graphics to medical prosthesis development. We have constructed a library of log and defect data which we are experimenting with to develop a profile for log, defect, process, and yield relationships that will allow us to dynamically generate a breakdown solution that incorporates downstream process considerations and put non-invasively obtained information to best use. To accomplish this, we are using a microcomputer based interactive graphic sawing

simulator [4] based on solid modelling principles which allows us to nondestructively examine different manufacturing process strategies. This simulator can also be used as a training tool for sawyers.

The eventual product will be an operational model that will integrate decision-making in hardwood processing, initially in the sawmill, but which can later be expanded to a vertical integrated system from log harvesting through sawlog breakdown to the end-use product manufacturing. We are bringing various state-of-the-art tools and methods to bear on this problem, as well as developing novel methods where no known effective methods apply. To ensure that we realize our goal, we have initiated communication with CT scanning equipment OEMs [5] and hardwood processors [6].

This research has several long term impacts. Firstly, it is environmentally beneficial to improve the utilization of wood resources, Wood is a natural and renewable resource. Improving the extraction of valuable wood from every hardwood log means that in the long term fewer hardwood trees need to be cut. Tree stand inventories indicate a growing number of lower grade timber, suggesting the need for more efficient methods of primary processing. Secondly, it helps the rural economies. The primary beneficiaries of the technologies arising from this type of research will be family-run hardwood sawmills which are mainly situated in rural communities with fewer than 300 employees. Yet current reports show that small businesses such as these are instrumental in helping our economy grow. Thirdly, the proposed method of integrating the decisions for downstream operations in primary hardwood processing is a full realization of the integration philosophy. Finally, many of the problems encountered in the domain of hardwood processing have parallels in the more traditional contexts of design and manufacturing which are not fully resolved or have sub-optimal solutions. As such, this project also offers the prospect of returning viable solutions to intractable problems in non-hardwood domains, through insights gained from looking at similar problems from a different perspective.

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