NewsLine
Forest Products Laboratory
Volume 5, Issue 3 Summer 2006

In This Issue

- 3-D Engineered Fiberboard
- Producing Quality Lumber and Pulp
- Wood You Believe

Also Inside

- FPL Research is Basis for Two New Books
- Ask FPL

Producing Quality Lumber and Pulp from Forest Thinnings

Collaboration Looks to Maximize Value from Thinning Operations in the West

By Rebecca Wallace, Public Affairs Specialist

Lumber produced from thinning operations

A recent focus of research at the USDA Forest Products Laboratory (FPL) has been finding high-value uses for forest thinnings to offset the cost of expensive, but necessary, treatments that improve forest health and decrease the risk of catastrophic wildfires.

Ironically, availability of pulpwood from public and private lands in the western United States is diminishing, and the pulp and paper industry has become increasingly reliant on availability of residuals from sawmill operations.

A team of FPL researchers may have found a way to simultaneously address both of these forestry-related issues: Their results have shown that small-diameter, thinned trees, once thought to be inferior, are in fact suitable for both lumber and pulp production.

The team has discovered compelling evidence indicating that fibers produced from thinned forests are at least equivalent to those from traditional wood supplies. Initial research showed that small-diameter (suppressed-growth) trees have narrower annual rings, more uniform fiber cell structure within the rings, and a higher volume fraction of mature wood. These factors should improve pulp properties in the production of thermomechanical pulp (TMP).

Pulping trials undertaken by FPL in an industrial pilot-scale facility confirmed these findings. Furthermore, less refining energy was required to produce pulp from forest thinnings than from conventional wood supplies.

However, to convince the pulp and paper industry that thinnings are a good alternative source of wood fiber, researchers needed to demonstrate their findings at an industrial-scale pulp and paper mill.

"We needed to find a way to bring years of laboratory research into a mill environment," said FPL research general engineer Junyong Zhu. "We were able to accomplish this through a partnership with interested parties from both the forest health and forest products sides of the issue."

The diverse partnership consisted of representatives from FPL, University of Idaho (Moscow), USDA Forest Service Pacific Northwest Research Station (PNW), Colville National Forest, Ponderay Newsprint Company (PNC), and Ponderay Valley Fiber (PVF).

Bringing these institutions together helped ensure that issues were being addressed from all angles and possible solutions were feasible in every arena.

University of Idaho professor Lou Edwards said the key to success for this project was the various expertise that different partners brought to the table.

"FPL's extensive testing of wood, fiber, and paper products was essential to the success of this project," said Edwards. "The University of Idaho and the commercial companies involved don't have the comprehensive testing capability, but we can provide the necessary familiarity with the local infrastructure that FPL researchers do not have. Bringing these two different, but equally valuable, areas of knowledge together is a big part of what made partnership so successful."

The first step in the research project was to identify an appropriate site for a thinning operation to provide lumber and chips for the trial. Forest Service personnel on the Colville National Forest in Washington selected a 70-acre site at East LeClerc, near Usk, Washington.

(continued on page 5)

Three-Dimensional Engineered Fiberboard: Creating New Possibilities in Forest Products

By Madelon Wise, Technical Publications Editor

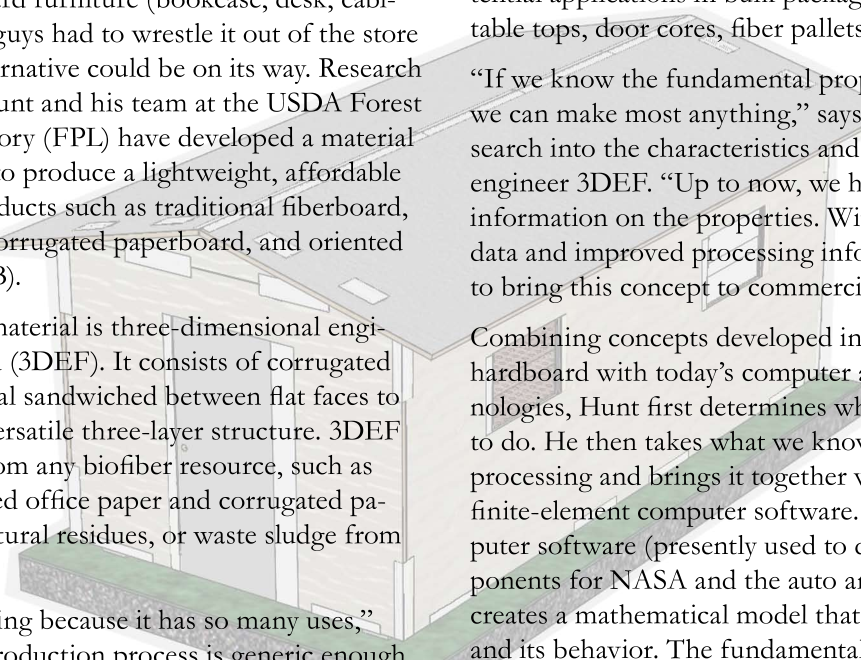
Remember the last time you purchased ready-to-assemble hardboard furniture (bookcase, desk, cabinet) and two big guys had to wrestle it out of the store on a cart? An alternative could be on its way. Research Engineer John Hunt and his team at the USDA Forest Products Laboratory (FPL) have developed a material that can be used to produce a lightweight, affordable alternative to products such as traditional fiberboard, double or triple corrugated paperboard, and oriented strandboard (OSB).

This innovative material is three-dimensional engineered fiberboard (3DEF). It consists of corrugated composite material sandwiched between flat faces to create a strong, versatile three-layer structure. 3DEF can be formed from any biofiber resource, such as pine slash, recycled office paper and corrugated paperboard, agricultural residues, or waste sludge from paper mills.

“3DEF is promising because it has so many uses,” says Hunt. The production process is generic enough to create a material that can be used in multiple ways, from soft, low-density cushioning to structural housing components, all from the same fiber resource. Preliminary research has focused on developing potential applications in bulk packaging, office furniture, table tops, door cores, fiber pallets, and concrete forms.

“If we know the fundamental properties of the fiber, we can make most anything,” says Hunt about his research into the characteristics and properties needed to engineer 3DEF. “Up to now, we have had limited or no information on the properties. With material property data and improved processing information it is possible to bring this concept to commercial reality.”

Combining concepts developed in the 1970s for making hardboard with today’s computer and processing technologies, Hunt first determines what the product needs to do. He then takes what we know about materials and processing and brings it together with state-of-the-art finite-element computer software. Finite-element computer software (presently used to design high-end components for NASA and the auto and aircraft industries) creates a mathematical model that describes a product and its behavior. The fundamental properties Hunt is researching can be entered into a computer simulation to help design fiber-based products. With individually engineered 3D processing methods, Hunt can develop a fiberboard product with specific performance attributes.



NewsLine Team: Gordie Blum, Rebecca Wallace, Madelon Wise, Tivoli Gough, Jim Anderson, Bill Ireland

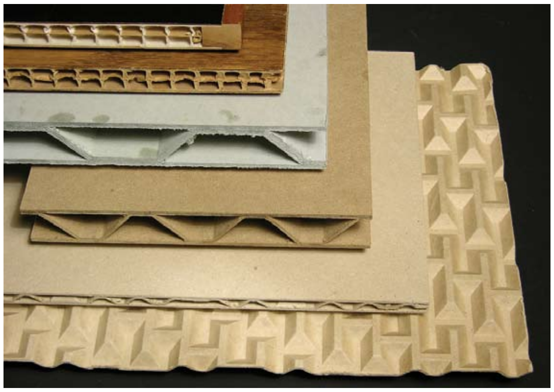
Published quarterly by USDA Forest Service Forest Products Laboratory, One Gifford Pinchot Drive, Madison, WI 53726–2398. Articles may be reprinted provided credit is given to the Forest Products Laboratory and NewsLine. To receive this newsletter electronically or to be removed from our mailing list, write Public Affairs Director Gordon Blum at the address above or at gblum@fs.fed.us or call Forest Products Laboratory at 608–231–9200.

Check out our website at http://www.fpl.fs.fed.us

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, sex, religion, age, disability, political beliefs, sexual orientation, or marital or family status. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audio tape, etc.) should contact USDA’s TARGET Center at 202–720–2600 (voice and TDD).

To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, Room 326–W, Whitten Building, 1400 Independence Avenue, SW, Washington, DC 20250–9410 or call 202–720–5964 (voice or TDD). USDA is an equal opportunity provider and employer.

Mention of commercial services, products, and firms is for information purposes only and should not be construed as U.S. Department of Agriculture Forest Service endorsement over other products, services, or firms that may be suitable.



The 3DEF process includes combining a corrugated core with flat biocomposite panels to produce an integrated engineered biocomposite system.

The shape of 3DEF is achieved by innovative wet-forming methods. Depending on the particular intended use, the 3DEF core is engineered to shape the fiberboard and distribute fiber to make the product strongest where it will be carrying the greatest load. This process allows flexibility and the ability to use whatever fiber sources are available. If a company were set up to process 3DEF and ran out of one fiber source, it could switch to a different kind of fiber with known fiber properties.

The FPL has produced 3DEF from forest thinnings harvested off the floor of the Bighorn National Forest (Wyoming), so 3DEF may be a way to add value to today's unwanted no- or low-value bioresources. Using treetops, thinnings, or invasive species to form 3DEF could benefit our national forests and reduce hazardous fuels. Recycled office paper and old corrugated containers have also been used to make 3DEF. Because of the refining process, many of the inks, oils, and other waste materials that historically contaminate recycled fiber from municipal waste will not adversely affect 3DEF for most applications.

Hunt is also using water-resistant adhesive resins and incorporating them into the 3DEF manufacturing process to produce a more water-resistant material. Although 3DEF does not yet have all the durability properties of OSB, it weighs much less than OSB per square foot of product.

"Weight is money," says Project Leader Jerry Winandy, when it comes to shipping and handling the material. Weight is an important consideration in potential uses of 3DEF panels such as emergency or military shelters. For these applications, the 3DEF could be shipped with the corrugated and flat faces nested together. These pieces could then be assembled in the field by people equipped with adhesives and minimal instruction (see sidebar).

Another potential use for 3DEF is pallets that can be engineered and produced to accommodate whatever is being shipped on them. For instance, pallets can be engineered to act like a spring and accommodate brittle materials, expensive electronics, or easily bruised fruits and vegetables. Engineering can fine-tune the pallet to remove road vibrations, make the pallet strong enough to be air-dropped, or make it impact resistant, cushioned, disposable, lightweight, and recyclable.

> Emergency housing following catastrophic events is a recurring national and international need. The Forest Products Laboratory has developed a new concept for producing safe, secure, weather resistant, and energy-efficient emergency shelters that could be efficiently stored in strategic locations and transported to emergency housing sites as needed. Government and industrial partners must work cooperatively to develop this technology to commercial viability. Once available commercially, this material can be made in large sheets—as large as the manufacturer's platen—designed to serve as single-piece prefabricated wall, floor, and roof units. These prefabricated units could be easily transported and quickly assembled into lightweight shelter structures wherever needed.

The FPL's goal is to move 3DEF research forward from the laboratory to commercial reality in partnership with industry and other research organizations. Our research partners will help us expand the number of potential uses of 3DEF, while with our industry partners we will begin the work of transferring the technology to manufacturing. Look for 3DEF to start popping up at loading docks, in your furniture, or in your new home in five to ten years.

Ask FPL

We get thousands of questions each year about wood and paper products. In each issue of NewsLine we print what we feel are some of the best. Here is one we recently received.

Questions?

Contact us at
Forest Products Laboratory,
One Gifford Pinchot Drive,
Madison, WI 53726-2398

http://www.fpl.fs.fed.us

or write

mailroom_forest_products_laboratory@fs.fed.us

We can also be reached by telephone at

608-231-9200

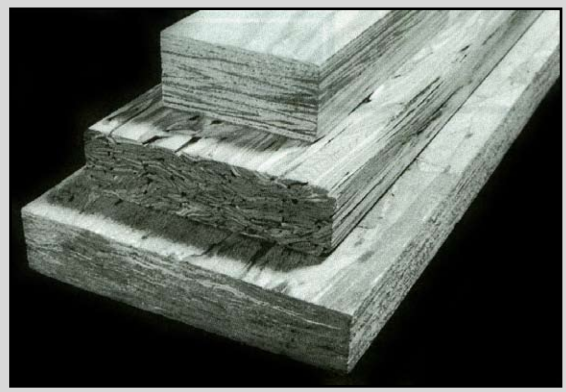
TDD: 608-231-9544

FAX: 608-231-9592

I have seen a lot of composite lumber products on the market recently. Are there advantages to using this material over solid-sawn lumber and can the two be used in similar applications?

Structural composite lumber (SCL) products are made of smaller pieces of wood glued together into sizes common for solid-sawn lumber. These products were developed in response to an increasing demand for high-quality lumber at a time when it was becoming difficult to obtain it from the forest resource.

Common examples of SCL include laminated veneer lumber, parallel strand lumber, and oriented strand lumber. They can be created from underutilized species that are not commonly used for structural applications and can be manufactured into many different widths of lumber.



Examples of structural composite lumber (top to bottom): laminated veneer lumber, parallel strand lumber, and oriented strand lumber.

One advantage of SCL is that it can more fully utilize smaller-sized raw materials in a structural product. In addition, strength-reducing characteristics of those smaller materials are dispersed within the strands or veneers, so they have much less effect on strength properties in SCL than in solid-sawn lumber, resulting in relatively higher design values. Also, SCL products are made from veneers or strands that are dried to a moisture content that is close to most indoor service conditions. This results in a product that is less likely to warp or shrink when used in this service environment.

SCL can be substituted for solid-sawn lumber in various applications, including the manufacture of other engineered wood products, such as prefabricated wood I-joists, which have engineering design values that can be greater than those commonly assigned to sawn lumber. Other common uses include scaffold planks, headers and other load-carrying elements in construction, studs and rafters in wall and roof construction, and even nonstructural applications, such as the manufacture of windows and doors.

More information can be found in our Wood Handbook at http://www.fpl.fs.fed.us

Wood You Believe…

- that one acre of forest absorbs six tons of carbon dioxide and puts out four tons of oxygen? This meets the annual needs of 18 people!

A Producing Quality Lumber and Pulp from Forest Thinnings *(continued from page 1)*

"The Colville was chosen because it has a large number of overstocked small-diameter stagnant stands that need treatment," says Ed Maffei, Timber Management Assistant and Contracting Officer on the Colville National Forest.

The site was then evaluated by members of PNW's Ecologically Sustainable Production of Forest Resources team to determine species distribution, stem densities, and available log sizes.

"Our expertise is on solid-wood recovery, so we focused our efforts on that part of the study," said Dennis Dykstra, research forest products technologist at PNW in Portland, Oregon. "We selected the sample trees to be harvested and were on hand during the harvesting operation to tag all the logs with identity markers so we would know the individual tree from which each log was derived."

Trees were selectively harvested by PVF with Reynolds Logging using a cut-to-length harvester and forwarder according to Forest Service regulations and project specifications. The logs were then hauled to PVF, where they were sorted by species.

For the sawmill trial, all logs with defects (heart rot, checks, and distortion) and logs with minimum diameters less than 4.1 inches (typically tree tops) were segregated from saw logs and chipped as whole logs. Saw logs were then processed through the HewSaw (Veisto Ltd., Mäntyharju, Finland) at PVF. Residual chips produced from the sawing operation were collected separately. Both whole-log chips and residual chips were shipped to PNC for pulping trials.

Preliminary results based on visual inspection by PVF indicated that lumber produced from thinned trees meets their product specifications. This is a critical component to the success of future thinning operations.

"If products can be obtained from the thinnings that have structural and quality characteristics that make them attractive in markets, the national forests could extend their treatments over much larger areas," says Dykstra. "Currently, the national forests have very limited budgets to undertake this type of work, so hazardous fuels are slowly increasing in forests throughout the West."

Dykstra says producing lumber from thinnings would be beneficial to the health of the forests, the safety of people who live in and around forests, and the economies of local communities where wood-processing facilities are located.

Paper produced from non-sawable logs and sawable log residuals

Two separate pulping trials were then conducted at PNC. The first trial was an evaluation of pulping characteristics of whole-log chips when added to the mill's conventional blend. This portion of the study was of particular interest to PNC and the paper industry because, although a large quantity of this material is available, only a small fraction (about 20%) is typically used due to problems with chip quality (such as species, color, moisture, degradation). For these trials, a 44% whole-log blend (30% from thinnings) was used without a noticeable loss of pulp quality, and the blend required less energy to refine.

For the residual chip trial, up to 50% of the chip blend evaluated was from thinning residuals. FPL researchers were mainly interested in studying pulp properties, such as fiber length and freeness, and how they changed as the ratio of thinned chips to traditional pulp mill chips was altered. Again, no loss of pulp quality was apparent, and refining energy requirements were similar.

Chips generated from forest thinnings as either whole logs or sawmill residuals produced commercial-quality TMP for newsprint, and the newsprint produced meets market specifications. Researchers continue to analyze the data but predict that mills may be more willing to use thinning materials in the future as a result of this study.

"Wood chips are getting harder and harder to come by these days," says Robert Grace, pulping manager at Ponderay Newsprint Company. "If there is an opportunity out there for us to improve our raw fiber supply, we need to look at it, and if further trials prove to be successful, we will consider consuming more of this type of wood chips in the future."

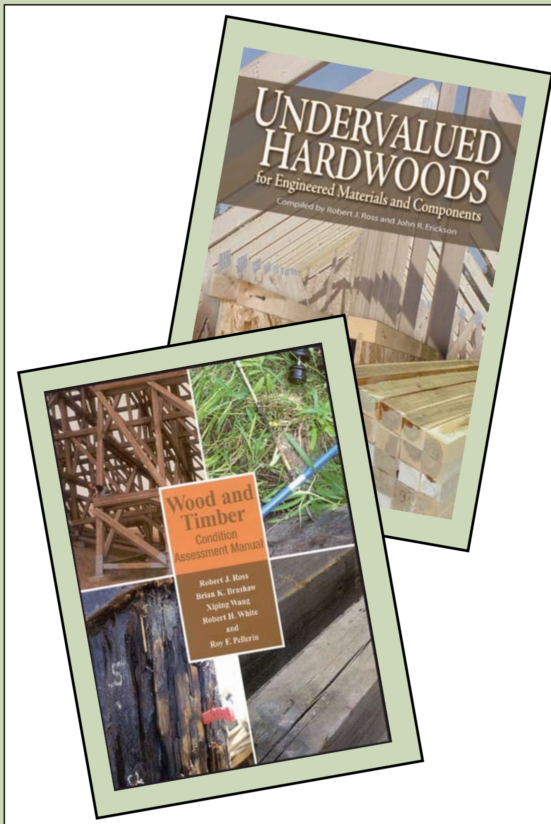
Forest Products Laboratory

NewsLine

Published Quarterly by

USDA Forest Service
Forest Products Laboratory
One Gifford Pinchot Drive
Madison, WI 53726-2398

Chris Risbrudt
Director



FPL Research is Basis for Two New Books

Two new publications authored by FPL researchers are available from the Forest Products Society:

Undervalued Hardwoods for Engineered Materials and Components, by FPL Research General Engineer Robert J. Ross and retired FPL Director John R. Erickson, serves as a reference for using lower grade hardwoods in engineered materials and components, an area of FPL research for the past decade.

Wood and Timber Condition Assessment Manual, by FPL researchers Robert J. Ross, Xiping Wang, and Robert H. White, along with Brian K. Brashaw of the University of Minnesota Duluth and Roy F. Pellerin of Washington State University, is intended for inspection professionals and stems from numerous research studies, inspections, and lectures dealing with assessing the condition of in-service wood and timber. The manual provides clear explanations of various aspects of inspecting in-service wood and timber, including several photographs and drawings of actual inspections.

More information on these publications is available online at http://www.forestprod.org