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Connecting People, Ideas, Resources

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Coming OWIC events:

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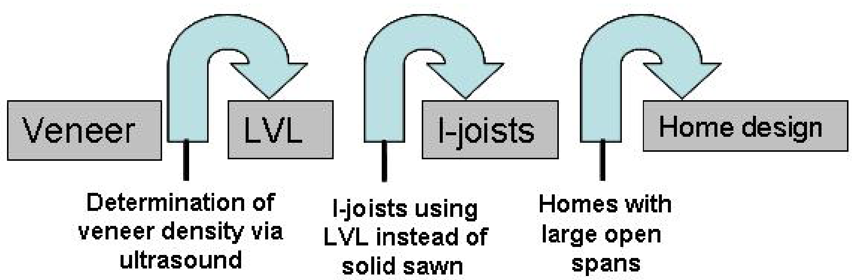
Product Innovation in the Forest Industry

There are numerous examples of product innovation in the forest products industry. Examples include wood-plastic composites, profile-wrapped products, and engineered wood composite products such as oriented strandboard (OSB), and laminated veneer lumber (LVL). Some of these are stand-alone products whereas others are creative combinations of existing products. Further, some product innovations come about as a result of process innovations. And of course, there is a 'ripple effect' to the innovation that goes beyond the product itself.

Engineered wood products provide a good example of the product combinations, linkages between product and process innovations, and the ripple effect. For example, the figure below represents the linkages and impacts related to wood I-joists. In the early 20th century, a series of product and process innovations resulted in the ability to produce wide, thin sheets of veneer from logs. Much later, ultrasonic technology enabled the sorting of this veneer into high-density, high-strength veneer suitable for LVL. LVL has largely replaced solid-sawn wood in the flanges of wood I-joists. Last but not least, I-joists have enabled changes in construction practices such as the design of homes with large open spans. The linkages of these product innovations is depicted in the figure below.



While there are many examples on new products in the forest products industry, it is important to remember that the majority of new products fail. There are many reasons for new products to fail including a lack of understanding of the end user, failure to assess competing products, lack of resources, availability of raw materials required to produce the product and many other reasons. The successful creation of a new product is a slow process and it can often take decades for a product to fully penetrate a market. This is particularly true with wood products where end users are dominated by builders, architects, and engineers. These professionals are bound by building codes and are often reluctant to adopt new products.

New Product Development

Modern new product development (NPD) practices typically have a specific structure and follow a common pattern starting with idea generation and ending with product launch and evaluation. Leading companies practice a formal NPD process that has key decision points for moving forward with development or killing the project. What most separates best and worst performers in NPD is how this process is implemented.

For the forest sector to move forward effectively it needs

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well-implemented innovation and NPD that is focused on customer needs. This is, in fact, one of the weakest NPD areas across industries as identified by Cooper et al. (2004). They also suggest that use of voice of the customer techniques are a characteristic of best NPD performing companies. In other words, the most successful companies are adept at gaining deep insights into customer needs and transferring those to the benefits offered by new products. However, the forest industry has often focused on wood as a raw material more than on the needs of customers.


OSB

Resource Push vs. Market Pull

Historically in the forest industry, many innovations have occurred via a resource push mechanism rather than market pull (Bull and Ferguson 2006). What this means is the creation of products is motivated primarily by resource issues without the marketplace in mind, a road that often leads to failure. Use of hybrid poplar in the U.S. Pacific Northwest is a good example of this. Originally planted for use in pulp mills, global surpluses of paper chips made hybrid poplar plantations for pulp chips unviable. Companies were then faced with a raw material with no home. Local economic development efforts have often resulted in products that effectively utilize local resources, but do not necessarily find a fit in the marketplace.

In contrast, market pull occurs where products originate with the motivation of filling unmet customer or consumer needs and raw material decisions are made based on what is required to meet the need rather than what new or cheaper raw material might be used.

In general, product innovation in the forest industry has been driven by a desire to improve physical properties, develop new ways to fully utilize wood fiber, and/or to utilize a changing wood resource. Because each product innovation is often motivated by and achieves more than one of these objectives, it is difficult to categorize products by a single motivation. For example, OSB made from poplar meets all 3 objectives – strand orientation improves physical properties, the production process enables fuller utilization of wood fiber than previous generation products, and the use of poplar allows for using a resource previously considered unusable for structural products.

This overlap of categories aside, we structure the information below by what we feel are the primary motivators for the product innovations being discussed.

Improving physical properties

There are many examples of product innovations that have been developed to improve the physical properties of the wood raw material. Grain orientation and knots are prime examples of natural characteristics of wood that impact physical properties. Grain orientation results in non-uniform shrink/swell behavior and knots affect both strength as well as appearance.

The advent of plywood enabled production of products that are much wider than the diameter of the tree from which they were produced. Further, the alternating orientation of the grain in the plies improves upon the natural properties of wood by providing much greater dimensional stability.

Knots can significantly reduce the strength properties of large, solid-sawn beams – or at least, make it so that it is very difficult to accurately predict the mechanical properties of a specific beam. Glulam beams are designed such that the knots are positioned within the beam to minimize their impact on strength. In addition, finger-jointing is often used to produce long, knot-free lumber for use in glulams.

Ultrasound can be used to sort veneer by density and thus strength. As with glulam production, LVL is designed to ensure the stronger wood is placed where the greatest stresses are likely to occur in the finished product.

Other product innovations that have been developed to improve the physical properties of wood are actually combinations of other

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products. Wood I-beams provide a good example. The web (or vertical component of the 'I') of the I-beam is typically made with plywood or OSB and the flanges with LVL. I-beams can be made in very long lengths, are lighter weight, and more stable than a similar solid-sawn product.

Other products that involve combinations of materials include a patio door stile (vertical component of the door) that is an assembly of solid wood veneer, finger-jointed core material, LVL, and a thin layer of rigid plastic to provide stiffness.

Developing new ways to utilize wood fiber

A wide variety of composites have enabled new ways to utilize wood fiber that was previously considered waste material. Such product innovations include particleboard, hardboard, medium density fiberboard (MDF) and wood fiber-inorganic composites such as wood-plastic and wood-cement composites.

Particleboard, for example, is produced from the waste sawdust and planer shavings of sawmills and other wood products manufacturers. Hardboard and MDF are produced from chips. The chips are also generated as residues by other mills as well as from whole-tree chipping of low-grade logs or recycling of urban wood.

Utilizing a changing resource

Changes in the resource have occurred as the forest industry has shifted from one region to another, for example from the eastern white pine forests of New England to the Douglas-fir forests of the Pacific Northwest. However, the resource has also changed with respect to log size (i.e., the shift to using smaller logs) as well as species. In the latter category, product innovations have been created to be able to effectively use species previously considered unsuitable for a specific end use such as structural products.

OSB and other strand-based composites are examples of product innovations that enable the use of small logs and logs from 'non-traditional' species. Logs are flaked into

Ask the Expert

Have questions related to wood? The faculty of the Wood Science and Engineering Department at OSU can handle almost any question about wood. Simply submit your question using the Ask the Expert form (http://owic.oregonstate.edu/askexpert.php). In order to assure that your question is answered correctly, please be as specific as possible when submitting your questions.

The following is an example of a recent 'Ask the Expert' question:

Question: For a baseball bat made of ash, which is better for bat strength, tightly spaced growth rings, or widely spaced growth rings? I have two bats of the same brand and type; one has growth rings around 1 mm wide, the other has growth rings more like 2+ mm wide.

Answer: Ash is a ring porous hardwood which means that in the early part of the growing season, a narrow band of very porous (and low density) wood is added first, followed by more dense wood throughout the remainder of the growing season. As a result, the faster the wood grows, the more dense it will be. This is the opposite of what most people expect for wood - faster growth is usually assumed to result in less dense and hence, weaker wood. On the other hand, faster grown ash will also result in a heavier bat.

Terry Conners at the University of Kentucky was able to shed more light on the subject. The bat factories set aside bat billets with specific ring-per-inch (growth rate) ranges for specific players. Thus, not surprisingly, players specify their preference for either heavier or lighter-weight bats. Pro ball players prefer 6-14 rings per inch.

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strands or wafers, resin is applied, followed by heat and pressure to set the resin and densify the finished product. Altering the grain orientation of the strands results in a product with enhanced dimensional stability properties (similar to plywood) and densification enables the use of low-density species like poplar and aspen to produce a product with structural properties much greater than would be possible from the species without densification.

Profile wrapping involves covering a low-value or non-wood substrate with a very thin piece of high-value, fleece-backed veneer. The result is a finished product such as a piece of moulding that looks like a solid piece of the species used for the veneer. Finger-jointed radiata pine from plantations in the southern hemisphere is a common substrate; vinyl or aluminum are often used as well. The face veneer can be any number of high-value species. As stated above this is an innovation that meets multiple objectives – a use for a changing resource as well as 'stretching' the utilization of a high-value resource like decorative hardwoods.

The Future of Product Innovation in the Forest Industry

What sort of product innovations might we see in the coming years? While any attempts to predict the future must be taken with a grain of salt, ongoing research is one indication of what the future may hold. In this regard, we can expect to see improved wood-plastic composites and new bio-based composites such as wood and nylon.

Researchers in the Department of Wood Science and Engineering at OSU are on the forefront of product innovation. Examples include using heat and pressure to increase density and strength of veneer from low density species, using extractives to create non-toxic insect repellants, creating more people-friendly wood preservatives, using nano-technology to create cellulose-based membranes for kidney dialysis, creation of new composites using wood and other materials such as plastic or recycled carpet fibers, and growing trees with low-lignin content to increase suitability for paper production.

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