



WOOD UTILIZATION RESEARCH (WUR) IMPACTS AND SUCCESSES

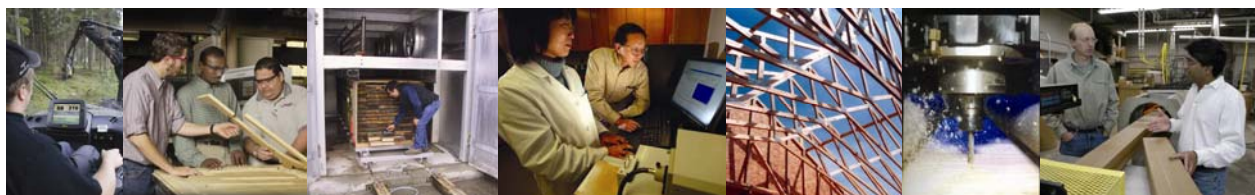
The Challenge: *To help the wood products sector develop new products, new technologies, and new business systems to position U.S. as a continued leader in wood products manufacturing, achieve energy independence and be a leader in sustainable use of forest biomaterials.*

WUR leverage leads to \$100 million cellulosic ethanol investment - The WUR program investment has allowed one WUR Center to become involved with national and university biofuels research. Investment in this effort by federal, state, and private partners exceeds \$100 million, promising accelerated development of the cellulosic ethanol industry in the Southeast U.S.

Wood Composite Panels Protect our Troops and Win Top National Awards - Modular Ballistic Protection System (MBPS), composite ballistic panels mounted to the inside of a standard army tent frame, received two of the composites' industry's highest awards from the American Composites Manufacturers Association (ACMA) in October 2007. The first award - The Best of Show Award - recognizes the finest composites product of the year; and the second ACMA award - the People's Choice Award - is selected by ACMA convention attendees for exhibiting the highest degree of design, innovation, creativity and the best use of composite materials. MBPS was developed by WUR researchers in partnership with the U.S. Army Natick Soldier RD&E Center.

Smart harvesting sensors for improved timber utilization - The total harvest of timber in the U.S. is currently about 15.5 billion cubic feet, with an estimated standing tree value of \$15 - \$20 billion. WUR funded research has shown that new harvesting-related sensor technologies, optimization systems, and equipment design can increase log value by 20% and reduce harvesting/transportation costs by 10%. Conservative estimates of the increased net returns to the forest sector nationally are \$2.5 billion per year, independent of the benefits of increased mill recovery from improved matching of log properties with market needs.

Wood machining speeds up productivity - WUR research efforts have resulted in dramatic productivity and wood utilization improvements for computer controlled routers used in the manufacture of upholstered furniture. The development of high speed spindles using smaller diameter tools has resulted in up to 5% wood yield improvements. High speed, high power spindles can also process multiple sheets which can easily double productivity. Application of these research results has had a dramatic effect on the global competitiveness of U.S. based manufacturers.





Future professors, scientists and wood science specialists are being developed through WUR - Over 50 future scientists and practitioners are trained each year through graduate degree programs supported by WUR research. The WUR program has supported the graduate education of over 30 young university professors who are the key to future workforce development and the next generation of scholars and practitioners.

Formaldehyde-free resin systems provide new opportunities - WUR research has identified and tested several formaldehyde-free binding systems that can be used in manufacture of wood-based composites such as plywood and particleboard. These new technologies enable U.S. manufacturers to produce competitive products without toxic formaldehyde emissions and reduce dependence on petroleum-based adhesives. WUR research laid the foundation for later competitive funding that resulted in newly commercialized technology.

Bio-oils find opportunities for use in petroleum refineries - Pyrolysis oils, also known as bio-oils, have been unable to be input to petroleum refineries. WUR researchers have developed a hydrotreating/hydrocracking process to deoxygenate raw bio-oil to a hydrocarbon rich biocrude that can be used by petroleum refineries for distillation. Petroleum companies are working to integrate this technology into the existing petroleum refinery infrastructure. One advantage is that no new capital investment in refinery structure is required.

WUR researchers provide key forest supply leadership as Minnesota mandates 25% clean energy by 2025 - WUR researchers are providing silvicultural and operations leadership as the State of Minnesota increases the use of wood resources for electrical and energy generation, in response to the 25 percent by 2025 renewable energy legislation passed in 2007. Approximately 1.3 million green tons of material potentially available for biomass energy projects has been identified in the state which can be used by the Laurentian Energy Authority project with a regional impact of \$1.2 billion over the twenty year project life.

Lean manufacturing improves industry competitiveness - World class manufacturers are increasing using continuous improvement programs to enhance competitiveness. WUR researchers have developed and implemented lean manufacturing strategies for loggers, sawmills, and secondary wood products manufacturers to enhance and improve their economic competitiveness. Over 250 companies and 1000 employees have received advanced training, with over \$1,000,000 of productivity enhancements reported.





Waste plastic and wood combine to improve bio-oil utilization and performance - Co-pyrolysis of wood and landfilled waste plastics has been shown to upgrade the properties of the bio-oil produced from the process. Bio-oil can be used as a source of value added fuels and chemicals with the potential for multi-billion dollar impacts. This process also provides a disposal stream for plastics in overburdened landfills.

Dry kiln monitoring costs can be reduced - WUR research demonstrated that volatile organic compound emissions from lumber dry kilns could be measured with \$25,000 less cost per kiln than proposed by environmental regulators. This followed earlier research on how kiln conditions impact emissions that eliminated the need for tests estimated at \$1.5 million per kiln.

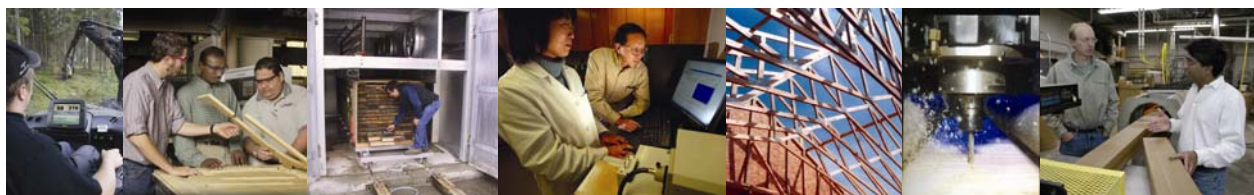
A gigajoule of energy savings can be achieved through improved lumber drying - 85% of western lumber processing energy requirements are found to come from the drying process. WUR researchers have conducted new assessments of the softwood lumber drying process, identifying new processing strategies that have the potential to save Oregon wood mills 0.7 gigajoules (GJ) of energy, which is equivalent to over 6 million therms of natural gas at approximately \$1 per therm.

Real time process control results save composites board mills over \$600,000 annually - Real-time process control has provided the forest products industry with essential methods needed for reducing wood waste, eliminating rework, improving production efficiency, and lowering manufacturing costs. Testing of this software system at two wood composite mills resulted in annual cost savings from raw material and wood waste reductions ranging from \$600,000 to \$900,000 at each mill.

Defect scanning systems provide opportunities for improved productivity - New technology to detect knots in softwood lumber and enable automated lumber grading or cutup has been successfully installed in window/door part cutup plants and sawmills. One manufacturer reports a yield increase of 4% worth \$2,000,000.

Paper bleaching research leads to company investment - A major forest product company invested \$600,000 to use WUR research to improve the environmental behavior of paper bleaching technology. As a result, the company was able to improve lignin removal from softwood pulp, reduce operating costs and lower pollution load, thus making the mill more economically competitive and able to retain jobs.

Dramatic market growth is occurring in wood thermoplastic composites - Wood-thermoplastic composite materials have grown into a \$1B industry in North America over the past 10 years. Formulations developed with WUR support provide opportunities to use low-value and small diameter trees.





Helping US Industries Grow and Withstand Foreign Competition - Support a \$150 million Industry Investment - This type of collaboration with industry is essential in ensuring that the research is industrially applicable, providing opportunities for commercial successes, especially in the rural areas of the U.S. where the wood-based industry is in a period of transition. A prime example is the conversion of a Louisiana Pacific's in a WUR state to OSL, a \$150 million dollar investment. LP's first boards are being tested by WUR researchers, and talks are underway to increase collaboration in terms of research related to oriented strand composites. These successes are due in great part to WUR funding, and future WUR projects will surely be leveraged in similar ways, allowing for excellent return on investment.

High temperature drying leads to 20% energy savings - Sawmills adopting WUR research on high-temperature drying of grand fir lumber have realized a 200 billion Btu annual savings in natural gas and wood energy. This is a savings of approximately 20% of all energy used at those plants and is equivalent to 5.5 million cubic meters of natural gas, or enough energy to heat over 2,500 homes in Idaho each year.

Blast-Resistant Wood Structures developed for military force protection, homeland security applications and strengthening residential and commercial structures in natural disasters – WUR researchers, in partnership with the US Army Corps of Engineers has developed blast-resistant wood structures with coated wood framing members, panels and subassemblies. The coating unlocks energy that exists in wood in a novel manner which allows otherwise brittle wood to become ductile. These structures have undergone both laboratory and field-testing during FY 2008.

Sales and job creation from applied wood utilization research - WUR researchers partnered with five small and medium-sized wood products companies in the midwest to create new and innovative wood products. WUR supported assistance and research enabled the companies to add new product lines and expand production as a result of their improved competitive market position. As a result, annual sales have increased by \$15 million and over 250 new jobs have been created since 2000.

Innovative composite development serves the western U.S. furniture industry - New high performance strand-based furniture substrates have been developed for use by western US furniture manufacturers, a \$5.9 billion industry.

Value-added market opportunities enhance hazardous fuel reductions - WUR economics researchers have provided key information during U.S. Forest Service Mechanical Fuels Treatment training for timber managers, describing the value of harvesting traditional timber products as a component of fuel reduction treatments.





Scientists develop new opportunities for underutilized lignin - Novel lignin-based resins were developed to utilize lignin, the largest byproduct of the forest products industry. These resins can be converted into resins, generating added revenues for pulp and paper plants and to cellulosic ethanol plants.

Electronic information system provides opportunities for industry growth - A comprehensive and readily-accessible electronic information system on the Inland Empire region's primary and secondary wood processors allows firms to reach new markets and suppliers, locate potential research and business cooperators, and analyze the condition and outlook of other regional manufacturers.

New Alaska grade stamps increase lumber value by 15% - Many mills closed or were severely stressed due to the harvest restrictions in the Tongass National Forest. With WUR assistance, the Ketchikan Wood Technology Center helped create new grade stamps for three Alaska tree species, resulting in increased value for wood products. These grade stamps for Alaska species have created new interest in using Alaska timber for construction, increasing its value by 15-20%.

Making Nanotechnology More Affordable - Carbon nanotubes have unique properties which include: strength 100 times greater than steel, the ability to conduct electricity 1,000 times better than copper or silver, and a unique ability to function as a vessel for targeted drug delivery in the body. The global carbon nanotube market has been estimated to exceed **\$1.9 Billion** by 2010. One problem though is their very high cost of about \$100 per gram. A new method to produce carbon nanotubes from wood fiber promises to produce lower cost carbon nanotubes than is possible using other methods.

Town hall presentations provide key information on the Inland Empire's forest industry - Educational presentations on the Inland Empire region's forest products industry condition and outlook and periodic evaluation of competitiveness are helping keep elected officials and industry leaders informed of the industry's needs and abilities to respond to new opportunities. This information helps overcome a lack of public and political understanding of the region's forest products industry, which employs over 30,000 rural residents.

Innovative system reduces lumber warp in southern yellow pine - A restraint device has been designed, constructed and tested to reduce or eliminate warp in southern yellow pine during the drying process, resulting in increased revenue of up to \$500,000 for a sawmill.





Dry ice research improves sanding belt cleaning saving \$100,000/sander - Wood machining research has resulted in an automated belt cleaning system utilizing process monitoring sensors for detection and a dry ice blasting system for cleaning. This translates to a cost savings of over \$100,000 for a single wide belt sanding machine. This process also results in improved productivity, reduced downtime and improved sanding performance.

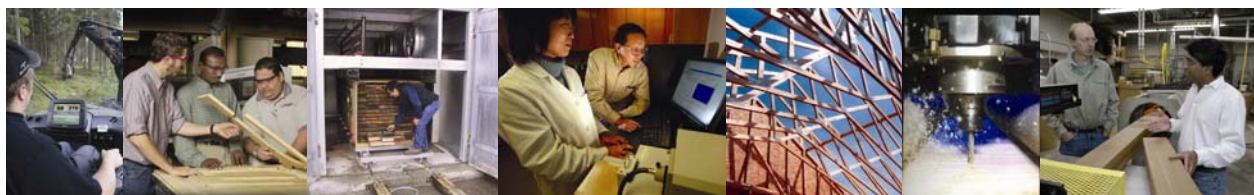
Utilization of geographic information systems provide new economic opportunities for forest harvesting - WUR researchers have developed a geographic information system collect mark-up maps of daily logging production, which can be used to develop a logging production forecasting tool. This system would enhance supply chain management decision support systems. The total forest harvest value in one pacific northwest state was approximately US\$ 1.1 billion on 3,752 million board feet, so a 5% improvement in sales could yield companies an additional US\$ 55 million.

New bridge testing techniques will improve public safety - In-place testing techniques for assessing the structural health of timber bridges using forced vibration testing have been developed and implemented on two Great Lakes region bridges. The implementation and use of these automated inspection techniques will enhance the safety of our rural bridge system and be cost-effective.

Rapidly deployed housing structures can provide immediate assistance in disaster events - Internal connection systems being used to quickly assemble panelized wood frame walls. These systems have application in disaster relief housing, rapid deployment military and traditional residential construction. Several demonstration units have been constructed and are being adapted for future use.

Low-value hardwood finds new products opportunities in OSB - Higher density wood species such as oak, which are widely available in the eastern U.S., have not been used in the manufacture of oriented strand board (OSB). WUR research is overcoming the quality and engineering challenges to use oak, thus allowing for new or expanded plant facilities to manufacture OSB, increased utilization of low-value materials, and increased employment.

Promising antiviral and anti-cancer drugs from birch bark - Researchers have expanding native people's use of birch bark, medicine for use in treating modern illnesses. Promising antiviral drugs are being developed from birch's triterpenes to treat HIV, herpes and melanoma cancer by a partner company. Studies of these bioactive compounds continue to identify pharmaceutical and nutraceutical applications for birch from Alaska and the lower 48 States.





3D bucking systems can improve log value increases by over 26% - Merchandising, bucking, and sawing of hardwood logs were assessed throughout West Virginia and a 3D optimal bucking system was developed to generate log bucking decisions and increase the value of the tree stem. This system could result in increases in value for Appalachian hardwood species 26 to 43% per tree stem with a rate of return for merchandising pulpwood logs sawn at 25, 30, 35, and 40 dollars/ton ranging from 10 to 39%.

\$4.5 Million Leveraged State Funding - One large impact of WUR research funding was the use of research results to approve a State bond. This allowed for an expansion of a large WUR laboratory to include an Oriented Strand Composites Pilot Line. In addition to \$1.5 million to expand the building, close to \$2 million has been secured and spent on equipping the facility with a log tank, strander, screener, dryer, resin blender and forming line. Such capabilities, along with published results from work conducted on the pilot line, are wholly responsible for a major increase in industrial contract work related to strand-based composites, totaling more than \$340,000 since April 2005.

Research Helps Protect the Health of Northern Sawmill Workers - Particulate measurements from sawmills show that the 40,000-50,000 workers in the Northern states exposed are not at risk. The first-ever measurements in Northern sawmills have shown levels of particulates well below levels considered hazardous.

Environmental Clean-up and Adhesives from Forest Bioproducts - A new patent has been awarded to WUR researchers, *Oxidation using a non-enzymatic free radical system mediated by redox cycling chelators*. This work permits new ways of generating oxygen radicals that can be used to clean up organic pollutants. The same oxygen radicals have been used to activate lignin and to make new adhesives and bond together composite products. It has been conservatively estimated that the global market for hazardous waste remediation technologies was worth about **\$11.4 billion** in 2006 and **\$16.6 billion** by 2011. Chemical treatment's share of the remediation market is around 18%. The oxidation process developed in this patent is one of the most effective technologies in the chemical treatment segment.

Bird Flu Treatments to Save Lives- WUR researchers have developed methods to extract shikimic acid, the key ingredient for synthesis of Tamiflu[®], from conifer waste materials. Tamiflu is being stockpiled worldwide for treatment of bird flu and the price of shikimic acid has risen from \$45 to \$700 per kilogram due to its shortage and demand.

Purchasing decision software enhances new capital investment - Development of a wood machining economic simulation program provides an opportunity for the wood products manufacturers to make informed purchasing decisions for new moulding and sanding equipment, resulting in potential for substantial cost savings.

