

CINTRAFOR and Innovation within the Wood Products Sector

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Over the last few years the wood products sector has experienced a significant shift in its momentum, especially in the US. Increased understanding of the environmental sustainability associated with wood products due to the renewability and lower carbon footprint of wood has propelled research and development on both the public and private fronts. In recent years the wood products industry has gotten a significant boost from research and development in several areas:

- i) mass timber, including glue-laminated timber and cross laminated timber,
- ii) thermal modification of lesser used wood species,
- iii) conversion of woody biomass into solid and liquid bioenergy products,
- iv) carbon nanomaterials with diverse applications, and
- v) social and cultural significance of traditional woodwork.

Traditionally, the relationship between societal environmental goals and industrial competitiveness is seen as a tradeoff between social benefits and private costs. The primary issue centers around balancing a society's desire for environmental protection with the economic burden imposed on industry. US industries, especially the forest products industry, have long argued that environmental regulations impose significant costs that slow growth in productivity, hindering their ability to compete. However, recent research suggests that well designed environmental regulations can be a net positive force driving private firms, and the economy as a whole, to become more competitive in both domestic and international markets.

New product development and innovation are integral for an industry to establish and maintain

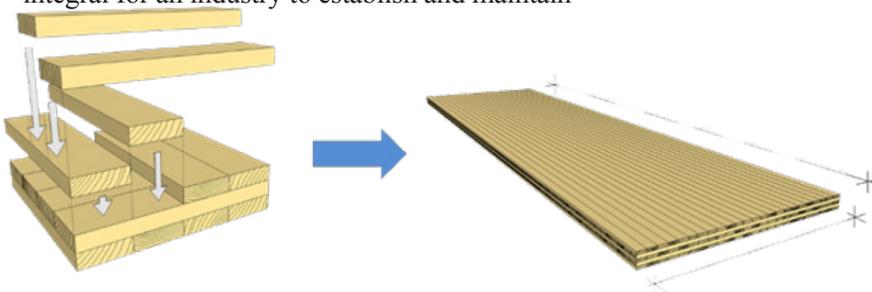


Figure 1. CLT Panels (Source: Gavin White, Ramboll UK, 2015)

its competitive advantage. Given the higher labor and operating costs in the US, this is especially true for the US wood products industry. Recent innovations promise enhanced global competitiveness of US wood products with favorable environmental performance that are likely to point towards a new direction in the wood products industry. Over the past decade the well-established environmental benefits of using wood have prompted governments and industry groups to invest in the research and development of innovative wood based solutions and in developing wood based alternatives to carbon/mineral intensive materials. Researchers at CINTRAFOR have been exploring a wide variety of innovative wood products including **1)** conducting a demand projection and an environmental assessment of cross laminated timber in Washington State, **2)** evaluating the potential to produce thermally modified lumber from lower quality western hemlock timber, **3)** assessing the potential for using woody biomass to produce solid and liquid bio-energy products, and **4)** exploring the potential for branding to help market Native American wood products.

1. Innovations and environmental assessments of mass timber products

Mass timber refers to a group of innovative wood products that include cross-laminated timber (CLT) and glue-laminated lumber. Cross-laminated timber (CLT) is a new-generation innovative engineered wood product that has been gaining popularity in low to mid-rise residential and non-residential construction in several countries, including Europe and Canada. CLT is a cost competitive wood based panel that is a suitable substitute for construction applications that currently use concrete, masonry and steel. Cross laminated timber is a panel product that is composed of an uneven number of layers (generally three, five, seven or more) of kiln-dried lumber arranged in perpendicular layers and quasi rigidly connected by structural adhesive (Figure 1). Glue-laminated lumber, also referred to as

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The Center for International Trade in Forest Products addresses opportunities and problems related to the international trade of wood and fiber products. Emphasizing forest economics and policy impacts, international marketing, technology developments, and value-added forest products, CINTRAFOR's work results in a variety of publications, professional gatherings, and consultations with public policy makers, industry representatives, and community members.

Located in the Pacific Northwest, CINTRAFOR is administered through the School of Environmental & Forest Sciences at the University of Washington under the guidance of an Executive Board representing both large and small companies, agencies, and academics. It is supported by state, federal, and private grants. The Center's interdisciplinary research is carried out by university faculty and graduate students, internal staff, and through cooperative arrangements with professional groups and individuals.

There might have been a time not long ago when folks would have been justified in considering the phrase "wood products innovation" to be an oxymoron; like army intelligence, jumbo shrimp, clever fool, precise estimate or airline food. However, on-going research in the forest products sector has resulted in the development of new innovative wood technologies such as cross laminated timber (CLT), thermally modified lumber, bioenergy products (e.g., torrefied wood pellets and biochar), biorefineries (e.g., bio-jetfuel) and nanomaterials (e.g., carbon nanotubes and nanocrystalline cellulose). Indeed, in a very real sense we are entering a wood renaissance that could have significant implications for the Pacific Northwest region.

During the past several years, this region has been devastated by catastrophic wildfires fueled largely by dead and dying woody biomass that has been left unmanaged in federal forests. Removing this woody biomass from the forest can be expensive while incurring significant transportation costs. Identifying appropriate markets and end-uses for woody biomass could help fuel the demand for this material while supporting rural economic development and the forest management activities required to restore healthy and fire-resilient forests in the region. Recognizing this need, for the past five years CINTRAFOR has been expanding its research portfolio to include a variety of projects focused on developing and marketing innovative wood products derived from woody biomass and low quality and lesser-used timber species. The following paragraphs provide a brief summary of some of the more noteworthy projects on which we are currently working.

CINTRAFOR is collaborating on a 5 year \$40 million biofuel grant awarded to Washington State University by the US Department of Agriculture. The goal of the project is to use woody biomass to produce a more environmentally friendly bio-jetfuel with a significantly lower environmental footprint. CINTRAFOR researchers are conducting a life cycle assessment of bio-jetfuel relative to

fossil-based jetfuel to determine how using bio-based jet fuel can reduce the greenhouse gas emissions of airplanes in flight. CINTRAFOR is also estimating the economic impacts of a potential biorefinery on local communities in the Pacific Northwest.

CINTRAFOR is collaborating with researchers at Humboldt State University to evaluate the feasibility of using in-woods mobile biomass conversion technologies to convert woody biomass into torrefied pellets, briquettes and biochar. In this project, CINTRAFOR is engaged in: 1) evaluating the market opportunities for these energy products, 2) estimating the economic benefits for rural timber-dependent communities and 3) using GIS spatial analysis linked to inventory data to evaluate the potential timber and biomass feedstock volumes available from selected forest types on forest lands in the western region under three sustainable management scenarios and relative to transportation distance, natural disturbance impacts and economic variables. The goal of this project is to demonstrate the feasibility of using mobile in-woods conversion technologies to produce competitive bioenergy products.

CINTRAFOR received funding to assess the potential for a tribal brand to expand the demand for Native American wood products. Opportunities exist to develop niche products in consumer markets that appreciate the unique values reflected by Native American forest and agricultural products. Export marketing can provide tribal forest managers with a new strategy to promote economic development and maintain cultural traditions within and between tribal communities while emphasizing the environmental sustainability of tribal wooden products. This project will assist Native American tribes develop strategies for marketing tribal wooden boxes produced from sustainably managed timber. The results of this project will be used to help develop a marketing strategy for Native-crafted wooden boxes based on design elements derived from traditional tribal cultural and environmental heritage.

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CINTRAFOR recently received funding from the USDA McIntire-Stennis program to investigate the market potential for cross-laminated timber (CLT). CLT, a new generation of engineered wood product, has been gaining popularity in low to mid-rise residential and non-residential construction in several countries in Europe as well as in Canada. CLT is a cost competitive innovative wood product that is a suitable substitute for construction applications that currently use concrete, masonry and steel. This research project aims to develop a comprehensive market feasibility assessment for manufacturing CLT on the Olympic Peninsula with a focus on the mid-rise nonresidential green building industry in the Pacific Northwest. The project aims to explore economic avenues for increasing forest resource utilization while reestablishing a regional wood manufacturing industry on the Olympic Peninsula.

CINTRAFOR was invited to submit a proposal on adapting the thermal modification process for use with underutilized hemlock on the Olympic peninsula. Thermally modified (TM) lumber is a relatively new technology in the US that could substantially increase the value of low quality hemlock lumber. The TM process uses high temperatures (~170C) to permanently modify the physical and mechanical properties of the wood so that it has lower water absorption, greater dimensional stability, and increased resistance to insect attack and fungal degradation. Thermally modified wood is therefore well suited to the manufacture of a wide variety of outdoor products. If successful, this project could provide the foundation for the development of a cluster of small and medium-sized manufacturers of a variety of innovative outdoor wood products.

The goal of most of these projects is to use lower quality woody biomass in the production of value-added innovative wood products, with the key concepts being value-added and innovation. The spotted owl decision and the closure of federal forests combined with the housing crisis caused the closure of many sawmills in the Pacific Northwest and the loss of thousands of jobs in rural timber-dependent communities. Identifying new innovative wood products and processes could help to provide new economic opportunities for some of these rural communities and provide a basis for the sustainable management practices that contribute to healthier, more resilient forests in the region. **Q**

glulam, is a structural lumber product comprised of layers of dimension lumber bonded together using structural adhesives. Though similar in concept, CLT is a panel product whereas glulam lumber is typically a timber or beam product.

The versatility of the product results from the continuous bonding and quasi rigid composite action between adjacent layers. As can be seen in Figure 2, the flexibility of the product allows for its use in walls, floors and other large-sized load-bearing structural components.



Figure 2. Cross Laminated Timber CLT used in building
(Source: forterra.org; photo credit: [atelierjones](http://atelierjones.com))

The advantage of using CLT and glulam over light-weight wooden construction systems (e.g. timber frame) is that modular dimensions can be ignored and window and door openings can be freely placed. The increased design flexibility associated with CLT construction has opened new areas within timber engineering and allowed architects and engineers to design monolithic buildings using wood. Previously, similar design flexibilities for mid-to-high rise buildings were only possible using reinforced concrete, brick or other mineral-based building materials. For example, developers in Vienna, Austria are scheduled to start construction on a 29 story CLT tower this summer.

The use of CLT is gaining popularity in particular within the green building sector. Since CLT is a wood product, it has a smaller carbon footprint than traditional concrete and steel construction. Replacing steel and concrete with CLT can be a great path to achieving environmental sustainability. CINTRAFOR is involved in multiple projects related to developing the market for mass timber products, ranging from developing a demand projection

for cross laminated timber to developing LCA's for glue-laminated lumber and cross laminated timber.

CINTRAFOR research initiative: In collaboration with the UW Department of Architecture and Washington State University, CINTRAFOR researchers are working on developing a series of viable architectural models for mid-rise non-residential buildings using varying levels of CLT, and developing comparative cradle-to-gate life cycle assessments (LCA) of similar structures using CLT and reinforced concrete. This project also aims to develop comparative cost assessments for similar mid-rise buildings using CLT and reinforced concrete. We will also be developing demand estimates for CLT panels in the PNW region as well as a regional timber demand estimate (lumber species and grade) based on the CLT demand estimate. Finally, we are completing an LCA study on glulam lumber based on industrial surveys conducted with the major glue-laminated lumber manufacturers in the US.

2. Evaluating the potential to adapt the thermal modification process to lesser used timber species in the PNW

The forestry and wood products manufacturing sectors play an important role in the economy of Washington State, particularly in rural, timber-dependent communities providing over 25,000 jobs, generating \$14.5 billion in gross business revenue and paying over \$1.5 billion in wages. However, weak domestic demand during the housing crisis was devastating to the forest products industry on the Olympic Peninsula where the number of sawmills declined by 27.7% between 2005 and 2014 while sawmill employment fell by 23.3%, with three more sawmill closures in the past year. Identifying new innovative value-added wood products that can be produced locally from lower valued, underutilized western hemlock would provide an important economic opportunity for rural, timber-dependent communities and support new business opportunities for local entrepreneurs. The volume of western hemlock growing on the Olympic Peninsula represents over 40% of the growing stock and recent research suggests that western hemlock could be used in the production of thermally modified lumber and cross laminated timber panels. However, markets for hemlock lumber are extremely underdeveloped, partly because kiln drying hemlock lumber is challenging due to the presence of wet pockets and growth stresses in the wood which result in excessive product degrade (e.g., warping and twisting) during kiln drying. However, when hemlock is not commercially harvestable, ecological options, such as managing for other species dependent on early seral openings like neotropical songbirds, ungulates, and insects providing for productive aquatic food chains, are no longer available. The poor hemlock market also limits the use of thinning-

from-below management strategies that are needed to speed late-seral habitat development.

The thermal modification of wood involves the controlled heating of lumber (~170C) in a low- or no-oxygen environment that permanently alters the physical and mechanical properties of the wood and imparts a range of advantageous properties, including an attractive dark color, drastically reduced water absorption, improved dimensional stability, degradation of water-binding hemicelluloses, increased durability against rot and insect attack and the elimination of many volatile organic compounds, Figure 3. Thermal modification is not the same as traditional wood drying because the thermal modification process permanently alters the physical and chemical composition of the wood. These beneficial changes in the structure of TM wood make it particularly well suited for use in exterior applications including decking, fencing, siding and outdoor furniture. The thermal modification process can increase the value of lower quality timber species by improving their physical and mechanical properties in such a way that they can be used across a broader range of end-use applications that could support the development of a manufacturing cluster of small entrepreneurs focused on the utilization of TM lumber in the production of a variety of value-added wood products.



Figure 3: Thermal modification improves several characteristics of wood and imparts an attractive dark color to wood
(www.popularwoodworking.com/projects/thermally-modified-wood)

CINTRAFOR's research initiative: The overall goal of this project is to assess the potential of thermal modification (TM) to increase the value of western hemlock lumber by enhancing its physical, mechanical and fire resistance properties. If successful, this project would result in the development of a series of innovative engineered/value added wood products that could provide the foundation for the development of wood manufacturing clusters within rural timber-dependent communities focused on the manufacture of value-added wood products derived from low valued western hemlock lumber. This project could also increase the pace and scale of restoration efforts

within the Olympic National Forest and support forest restoration activities.

3. Using woody biomass for innovative bioenergy products.

Woody biomass based energy is emerging as one of the most important sources of renewable energy globally. In its various forms, wood accounts for about half of Europe’s renewable-energy consumption, representing up to over 80% in countries like Poland and Finland. In the US, overall renewable energy use has been in single digits although it has increased from 5.4% in 2001 to 9.8% in 2014. As seen in Figure 4, total biomass based energy consumption represents around 50% of the total renewable energy portfolio in the US. Over the last 10 years, the increase in consumption of renewable energy in the US was primarily driven by increases in the consumption of biomass and wind energy. The other sources of renewable energy consumption, including geothermal, solar and hydroelectric, have remained relatively flat in the US over the last couple of decades.

Within the biomass-based energy sector, wood based renewable energy represents 96% of the overall supply. Until 2001, the contribution of wood had been reported to be around 46%. As can be seen in Figure 5, the increase in the overall contribution in biomass based bioenergy from 2001 to 2014 can be solely attributed to a surge in the use of biofuels. Currently, most of this biofuel is comprised of first generation biofuels produced from agricultural products such as corn and soybeans. However, in recent years the US government and private research organizations have made significant investments in the research and development of advanced types of wood based bioenergy, including the development of various forms of kerosene/diesel-based biofuels derived from a broad range of cellulosic feedstock sources, including plantation-grown timber and woody biomass derived from timber harvest operations.

Over the past five years CINTRAFOR researchers have been heavily involved in the research and development of wood based bioenergy. Typical forest harvest operations in the Pacific Northwest leave a considerable volume of unused woody biomass in the forest in the

form of tree tops and branches. Despite the environmental benefits, the economic feasibility of extracting these residuals from the forest has been limited by low market demand and the high collection and

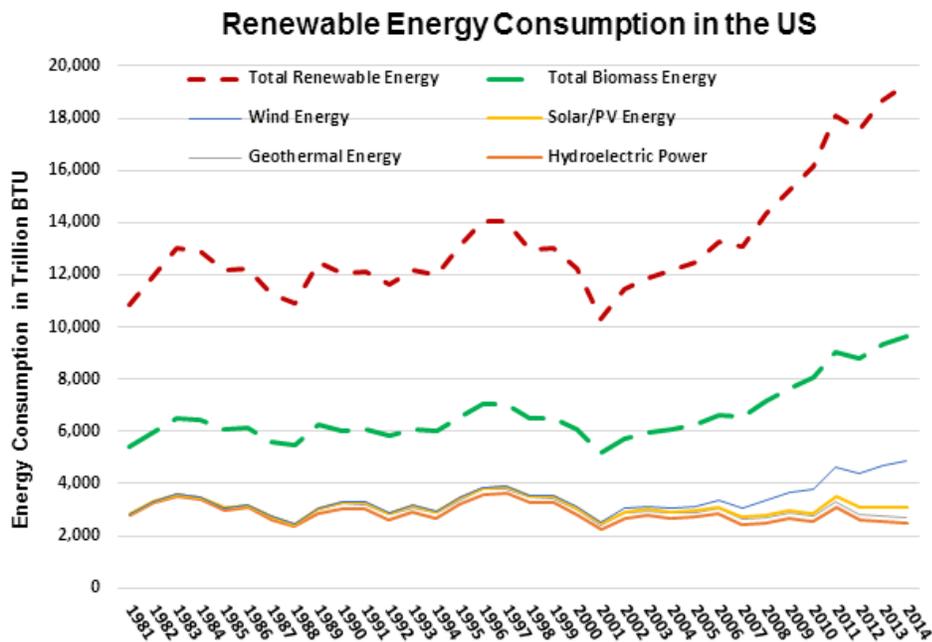


Figure 4. Renewable Energy Consumption in the US, by sources of energy (Source: www.eia.gov, 2015)

transportation costs. Currently, most of the unused woody biomass is collected, piled, and burned in the forest or it is simply left on the forest floor to decompose. To address the market failure of more fully utilizing woody residues, new technologies are being developed to utilize forest residuals for

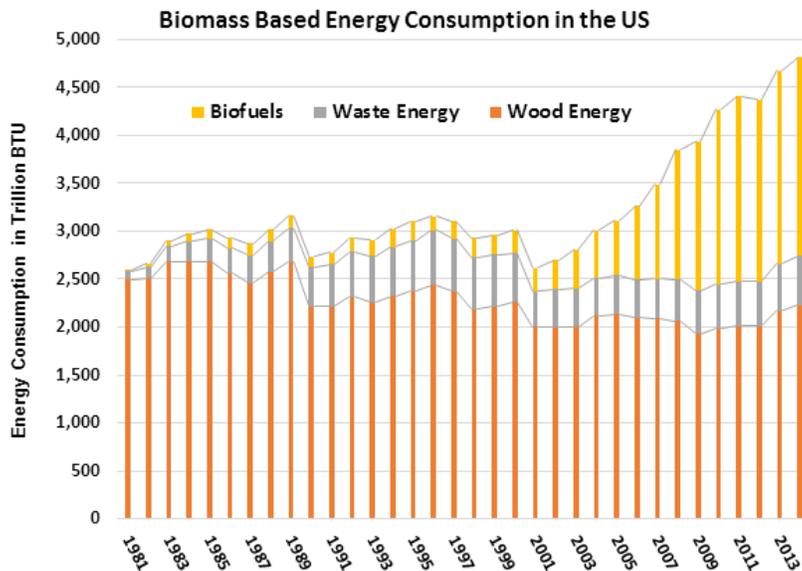


Figure 5: Biomass Based Renewable Energy Consumption in the US, by sources of energy (Source: www.eia.gov, 2015)

conversion into high value advanced bio-fuels. CINTRAFOR is involved in two such efforts: (i) as a member of the Washington State University led and USDA funded Northwest Advanced Renewables Alliance (NARA), CINTRAFOR is conducting a life cycle assessment designed to evaluate the environmental footprint of producing aviation biofuels from unused residual biomass and estimate the net environmental benefit associated with displacing petroleum based jet fuel. (ii) CINTRAFOR researchers are also members of the Department of Energy Funded Woods to Wisdom (W2W) project where we are evaluating the social acceptability, community economic impacts and the local air quality impacts associated with the collection and conversion of residual harvest slash into densified forms of solid biofuel (pellets and briquettes) and soil amendments (biochar).

Conversion of Residual Woody Biomass into bio-Based Jet-Fuel (NARA):

The Washington State University (WSU) led Northwest Advanced Renewables Alliance (NARA) is exploring the production of an advanced drop-in aviation biofuel from forest residuals. The woody biomass to bioconversion process adopted by NARA utilizes a mild bisulfite pre-treatment process designed to liberate the C6 sugars, which then go through enzymatic hydrolysis, saccharification and fermentation to produce isobutanol (iBuOH). The isobutanol is then converted to bio-jet fuel (iso-paraffinic kerosene, IPK) using a proprietary biocatalytic fermentation and oligomerization process. The 'Woods-to-Wake' (WoTW) environmental impacts of woody biomass jet-fuel, which takes into account all the environmental impacts associated with the in-woods biomass collection through to the burning of the biojet fuel in an aircraft engine, are then compared to the 'Well-to-Wake' (WTW) impacts associated with the production and use of fossil based jet-fuel. In converting from woody biomass to liquid biofuels, two bio-based co-products are also produced, activated carbon, which can displace fossil based activated carbon and lignosulphonate, a bio-based cement additive.

CINTRAFOR research initiative: As one of the collaborators on the WSU-led NARA research grant, CINTRAFOR is conducting a 'Woods-to-Wake' (WoTW) Life Cycle Assessment (LCA) to develop the environmental burdens associated with the collection of harvest residues, the production of woody biomass based bio-jet fuel, and finally the burning of the bio-jet fuel in an aircraft engine. The LCA based environmental

analysis undertaken by CINTRAFOR revealed that the net climate change impact of substituting wood-based bio-jet fuel for fossil-based jet fuel represents an 80% or greater reduction depending on the environmental impact being considered.

Utilizing forest residues for the production of bioenergy and bio-products: Waste to Wisdom (W2W):

The Waste to Wisdom (W2W) project, funded by the US Department of Energy (US DoE) and led by Humboldt State University, explores the conversion of forest residues into bioenergy and other valuable bio-based products. Specifically, the W2W research project explores the conversion of forest residues into high quality biomass feedstocks that meet the specification requirements (e.g., size, moisture content, and contaminants) for three in-woods biomass conversion technologies, (i) a biochar production system, (ii) a wood torrefaction system and (iii) a wood briquette system. This project's focus is developing cost effective residual woody biomass collection processes, in-woods processing and conversion into valuable bioenergy and bio-based products. This project emphasizes the evaluation and implementation of low cost decentralized in-woods production technologies for biomass conversion that reduce the costly transportation of woody biomass to a centralized processing facility.

CINTRAFOR research initiative: As one of the collaborators in the W2W project, CINTRAFOR is primarily responsible for three major components of the project: (1) developing the cradle-to-gate LCA for the forest collection processes as well as one of the biomass conversion processes (the LCA's for the remaining biomass conversion technologies are being performed by the USDA Forest Products laboratory), (2) conducting an economic analysis of the proposed technologies and a marketing analysis of the associated bioenergy products to determine the potential short- and long-term economic viabilities of the technologies, and (3) modeling the local air quality impacts associated with collection and conversion of residual woody biomass into solid bioenergy products, including the environmental and health benefits associated with the elimination of slash pile burns by collecting and using the woody biomass from the forest.

4. Promoting the role of branding to expand economic opportunities for timber dependent Native American communities

Despite the developments in the wood products sector, Native American forest income is still heavily dependent on timber production. Native

American communities were one of the worst hit by the recent economic downturn and it is estimated that timber revenues for forest-dependent tribes declined to approximately \$6.8 million, a loss of approximately \$38 million or 86%. Low lumber prices continue to challenge tribal sawmilling and forest operations, reduce stumpage revenues and the funding necessary to support forestry and forest management activities, and further jeopardize tribal employment. For timber-dependent Native American tribes, the community suffers as jobs and revenues decline and the capacity to maintain healthy forests is compromised. The combination of low stumpage prices, high unemployment and the closure of tribally managed sawmills continues to undermine tribal economies and the ability of tribal foresters to manage their forests.

Tribal resource management is often based upon a unique integration of cultural, social, environmental, and economic values that contribute many public benefits and ecosystem services. However, these values are generally not recognized or rewarded in the marketplace. Previous research by CINTRAFOR revealed that tribal forest products are often sold as commodities in the domestic market with little effort to distinguish or differentiate them from similar non-native products. To address this market failure, CINTRAFOR researchers have been working on a number of tribal branding projects with the Intertribal Timber Council to explore niche market opportunities within the US and abroad. One of those research areas involves exploring the domestic and international marketing opportunities for co-marketing tribal agricultural products packaged in wooden tribal gift boxes.

Assessing Domestic and Export Opportunities for Tribal Wooden Gift Boxes

CINTRAFOR worked with the Intertribal Timber Council (ITC) to conduct a survey of their membership designed to assess tribal managers attitudes towards the development of a tribal brand and willingness to work collaboratively to market branded tribal wood products, both in the US and off-shore. The results of a survey of tribes with forests on their reservations showed that approximately three-quarters of tribes support the idea of developing a tribal brand that would allow them to differentiate their products in the marketplace, Figure 6. When asked to evaluate a range of attributes upon which a tribal brand might be built, the highest rated attributes included: 1) the cultural and spiritual respect that tribes have for their forestlands, 2) the traditional forest steward-

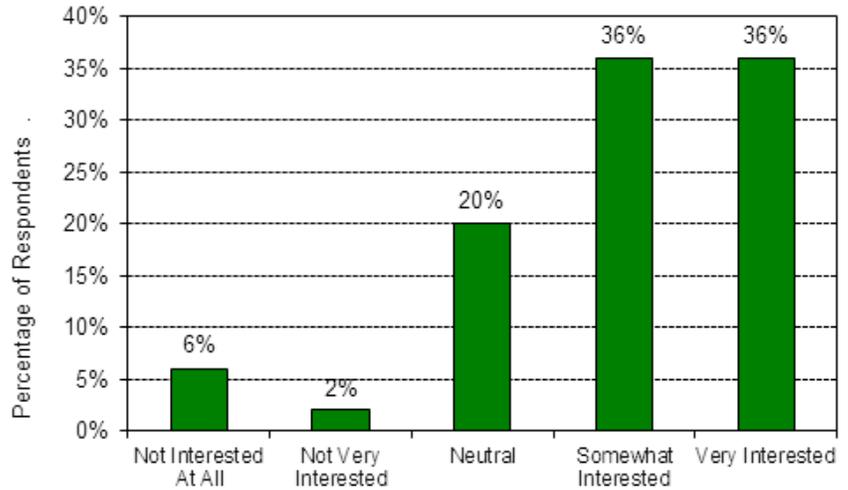


Figure 6. Native American tribes have expressed strong interest in developing a tribal brand for wood products harvested from tribal forests.
(Source: Ganguly et al., 2011).

ship values of tribes, and 3) the high quality wood growing in tribal forests.

Motivated by these results, CINTRAFOR researchers developed a plan for evaluating the potential value of the tribal brand for both the domestic and the international market. A series of studies were developed to carefully evaluate the various aspects of the tribal brand that would create an image to differentiate a tribal product in the marketplace and provide an experience/customer satisfaction over and above product utility. The innovative tribal gift box concept was developed to evaluate various aspects of the value-cost proposition associated with a tribal brand.

CINTRAFOR’s research initiative: In 2014, CINTRAFOR developed a comprehensive research plan for evaluating the market value of various aspects of a tribal brand using an innovative tribal gift box. This project, funded by the USDA Federal-State Market Improvement Program (FSMIP), was designed to evaluate the effectiveness of a hypothetical tribal brand in expanding the demand for tribal products through the co-marketing of tribal agricultural products packaged in a tribally produced wooden gift box within the US and Japanese markets. If found to be effective, the co-marketing strategy could be applied to several combinations of tribal agricultural/wood products, increase the demand for and profitability of, tribally produced agricultural products, and help to develop marketing and managerial capacity within Native American communities. The project objectives include: a) develop and implement consumer surveys in the US and Japan to identify the optimal mix of attributes for co-marketing tribal agricultural products packaged in traditional wood boxes using an optimal choice experimental design in conjunction



with perceptual mapping, b) conduct workshops to develop managerial expertise within tribes and support the establishment of networks for commerce between tribal communities, c) develop a strategic framework for co-marketing tribal agricultural and wood products in Japan and the US and d) provide graduate training of tribal students.

The study was undertaken in the US and Japan to evaluate customer willingness to pay a premium for tribal attributes, namely, tribal design, tribal forest certification and certificate of Native American origin. Preliminary results reveal a strong interest among the US and Japanese respondents in tribal culture, as well as tribal wooden gift boxes. The preliminary study results also suggest that respondents may be significantly more likely to purchase a wooden gift box bearing a tribal cultural design and that respondents showed a preference for tribal wooden boxes displaying a tribal forest certification logo. A vast majority of respondents agreed that tribal products made by the tribe should be differentiated from imitated tribal products made by non-tribal people, and believe that purchasing tribal products can improve the quality of life of tribal people. Interestingly, respondents associated tribal forest management with sustainable forest management and believed that wooden boxes made by tribes provides an assurance of its sustainable sourcing.

Concluding remarks

Current innovations in the US wood products industry range from 'radical innovations' which could potentially redefine the US wood products industry in the longer-term (e.g., using residual woody biomass to produce bio-jet fuel) to incremental innovations that have more with immediate (e.g., using woody

biomass to produce biochar as a soil amendment). The successful adoption of these innovations is associated with varying degrees of industry learning and adaptation. For example, using CLT for mid-to-high rise buildings, which has already been approved within US and international building design standards, would require some changes in regional building codes. It would also necessitate building professionals (e.g., architects, structural engineers and building contractors) to learn and adapt to new product/construction practices unique to the CLT construction technology. In the case of bio-jet fuel, the significant investment required to finance a bio-refinery can pose a major challenge, especially with the recent decline in oil prices. Simpler innovations (e.g., thermally modified lumber and branded tribal wood products) could be adopted sooner.

However, innovation is critical to the success and development of the US forest products industry which has been struggling with low prices and demand over the past decade. Increased competition from substitute materials (e.g., steel and plastic), growing competition from developing economies with a competitive advantage (e.g., lower labor costs and reduced environmental regulations), and more recently, a depressed domestic housing market, have resulted in continued mill closures and the loss of employment within the forest products sector. Increased use of CLT in non-residential and multifamily construction could provide a much needed boost to the US wood products industry. The successful adoption of innovative wood products will help to revitalize the forestry and wood products sectors in the Pacific Northwest. 

New Publications

Working Papers and Special Papers

WP126 Use and Awareness of Green Building Programs and Environmentally Certified Wood Products in the US Residential Construction Industry

Daisuke Sasatani, Indroneil Ganguly, Ivan Eastin, Cindy X. Chen and C.Tait Bowers. 2015. 48 pages. \$50.00

WP125 The Effects of the 2008 Lacey Act Amendment on International Trade in Forest Products

Patrick Bridegam, Ivan Eastin and Bruce Bare. 2015. 108 pages. \$50.00

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