

CLEMSON[®]
WOOD UTILIZATION + DESIGN INSTITUTE

2018

Annual Report

Dr. Patricia Layton

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EXECUTIVE SUMMARY

The Wood Utilization + Design Institute recently celebrated its fifth-year anniversary at Clemson University! 2018 has been a productive year, building on the successes of the previous four years.

Early in 2018, WU+D had a significant presence at the Mass Timber Conference in Portland, OR where Dr. Layton, the Institute's fellows and students in various disciplines attended, exhibited and networked with key industry stakeholders. WU+D will continue to have a strong presence at this key event.

Several graduate students in engineering have expanded their work and research with Southern Yellow Pine CLT over the past year, making significant contributions to industry understanding (read more on pages 7-8). Clemson Research has elevated the work of student Michael Stoner by producing a video on his research which was distributed to media mid-year.

Updates proposed to the International Building Code this year have the potential to move the timber field forward by leaps and bounds. WU+D has already begun working with key industry members like Huber Engineered Wood and others in the Southeast to spread the news by teaching professionals, especially in the Carolinas, about the updates. An article written by Dr. Layton, *Mass timber comes of age: Code consideration, evolving supply chain promises new options for tall wood buildings*, was published in *Building Design + Construction* magazine in July, 2018.

The Institute continues to collaborate with the School of Architecture, Civil Engineering and the School of Construction Science and Management to bring timber learning to Clemson students, and drive collaboration with industry partners. Dr. Layton continues to play an integral role in connecting industry and academia for the betterment of this industry.



Mass Timber Conference 2018

REVIEW OF ACTIVITIES

ARCHITECTURE ACTIVITIES

In last year's report, we noted a wood and timber oriented design Studio focused on new laboratory space and researcher housing for the Baruch Institute for Coastal Ecology and Forest Science (BICEFS). This was co-taught by Dustin Albright (Architecture), Dan Harding (Architecture) and Paul Russell (Landscape Architecture). The project involved mass timber solutions for the laboratories and light frame solutions using the Sim[PLY] framing system for the housing. The subsequent outcomes from that Studio project include a presentation at BICEFS' 50th Anniversary celebration in January, 2018, attended by President Clements and Dean Askew, among other Clemson administrators and supporters. The designs that came out of the Studio are now serving as the basis for BICEFS' ongoing capital campaign. The laboratory portion of the project, which dealt with CLT construction and embodied carbon was also the subject of a research poster presented by student Emily Heezen at the 2018 Mass Timber Conference in Portland, as well as conference and symposium presentations by Dustin Albright in Philadelphia (ARCC / EAAE Conference, May 2018) and Augsburg, Germany (Design / Build Symposium, May 2018).

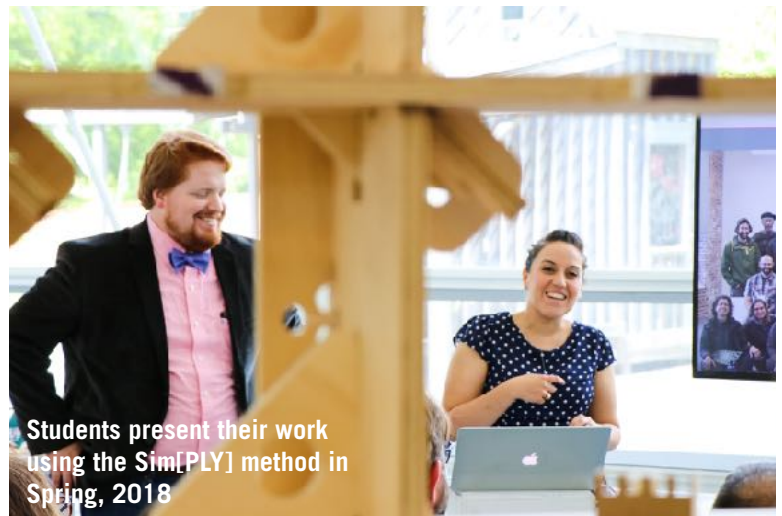


Student design work involving mass timber solutions continues to expand, even outside of such specific, topical courses as the one described above. To this point, in the Spring of 2018 the Graduate Comprehensive Studio took on design proposals for a hypothetical graduate student housing complex on Clemson's Campus. This marked the terminal project for the 2018 Masters of Architecture class and represents the highest level of technical development and materials and systems coordination. 8 out of the 16 design teams elected to utilize mass timber solutions for some significant portion of their projects, noting the environmental benefits, as well as ease and speed of construction.

In August of 2018, Dustin Albright presented an overview of the mass timber work coming out of Clemson's School of Architecture to the Forest Product Laboratory's Industry Needs Assessment held at Mississippi State University.

As part of a retooling of Clemson's 2nd Year Studio curriculum, Tim Brown and Dustin Albright have worked to introduce the basic tenets of wood construction to 80+ sophomores in the Fall of 2018. Topics for lectures and coordinated workshops included forest products (tree to lumber process), timber post and beam structures, and light framing methods. Building upon the skills and terminology acquired in the workshops, the students applied this knowledge while designing a timber-framed farmers market for downtown Asheville, NC and a light-framed arts center for Riverfront Park in North Charleston, SC. These students will further develop their understanding next semester when they engage in a full-scale wall framing exercise to be completed on Clemson's campus.

In August of 2018 we were notified that the U.S. Patent Office had accepted our patent application on the Sim[PLY] Building Framing System. This innovative light framing system utilizes prefabricated components cut from wood sheet goods, and was developed at Clemson in conjunction with its entry in the 2015 Solar Decathlon Competition. The patent application was supported by the Clemson University Research Foundation. **In December, 2018 the patent application was approved.**



Built applications, demonstrations, and research relating to the Sim[PLY] system continue to move forward. In September, a retrospective exhibit of the work was included in the Future Shock event held at the Discovery Place Museum in Charlotte. A “tiny house” prototype was refined over the summer and will be constructed in December as part of a Sim[PLY] framing workshop hosted at Clemson. This work is slated to be replicated in British Columbia in the coming months as part of partnership with a non-profit housing organization in Victoria. We look forward to using these demonstration structures as vehicles for further structural and envelope research, comparing notes between both climates.

Community Design + Build, WU+D Activities December 2017-18

Acoustical Scene - Design and Construction in Genoa, Italy
 Modified Sim[PLY] system for the purpose of a temporary pop-up chamber music. First public installation: Dec. 17, 2017. Continued use and installations with Clemson and Genoa, Italy community groups including 10 free classical music community concerts to-date. Faculty design and construction collaborator: Luca Rocco. Community Partner: GOG Giovine Orchestra Genovese.

- Albergo dei Poveri (4 concerts)
- Piazza Gavoglio (2 concerts)
- Cornigliano Mercato (3 concerts)
- Ospedale Psichiatrico Quarto dei Mille (1 concert)



POP-UP Piazza - Design and Construction in Genoa, Italy and Charleston, SC

Modified Sim[PLY] system for the purpose of public presentation and gallery space, workshop/educational outreach and wood system demonstration. Faculty design and construction collaborator: Luca Rocco. Community Partner: Cooperative Sociale-II Laboratorio-II Formicaio.

- Piazza Gavoglio, Genoa, Italy (20+ students and children)
- Piazza Cernia, Genoa, Italy (40+ students and children)
- Cigar Factory, Charleston (600+ students and children) POP-UP Piazza is the centerpiece and primary activity for the “AMAZING ARCHITECTURE” program for SC STEM programs in the Midlands and Low-country (Charleston workshops led by Dave Pastre and Ray Huff. POP-UP design and construction led by Dan Harding).

POP-UP Theater - Design and Construction in Clemson and Charleston, SC

Modified Sim[PLY] system for the purpose of public performances. Collaboration with Architecture and communityBUILD studio, Cedric Liqueur (performing artist) and Adam Schrimmer (visual artist-muralist). Designed and fabricated in concert with the National Community Build Association conference in Charleston, SC in March, 2018.



Picnic Table/People Power Transportation Follies – Design and Construction in Clemson and Charleston, SC

Wood public sculptures and structural follies in collaboration with Architecture, communityBUILD studio and Enough Pie. Designed and fabricated in collaboration with the National Community Build Association conference in Charleston, SC in March, 2018.

Cultural Megaphone – Modified Sim[PLY] Exhibit, Workshop and Installation in Bozeman, MT

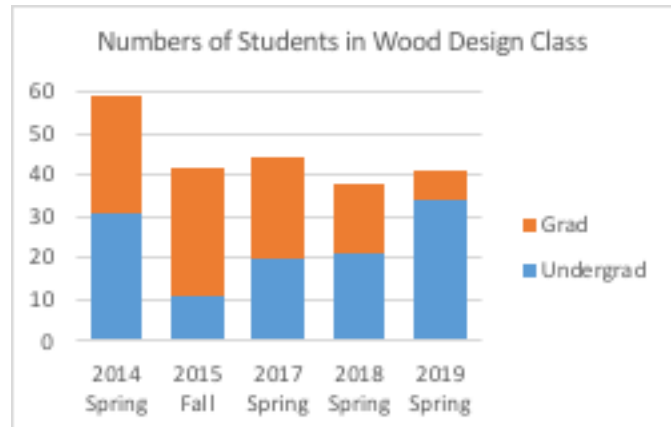
Collaborative academic seminar course based on Sim[PLY] and wood fabrication with Bradford Watson (faculty) and graduate students at Montana State University School of Architecture.



ENGINEERING ACTIVITIES

Wood Design Class – Civil Engineering

The Wood Design class is a dual-level (undergraduate/graduate) course in the Civil Engineering Department. The course teaches engineering students how to design wood buildings and other structures following the National Design Specifications for Wood Construction, (commonly known as the NDS code). Prior to 2016, the wood design course was offered every 3 semesters, as opposite to reinforced concrete and steel design courses, which were offered every other semester. Starting from Spring of 2017, the wood design course is being offered every other semester or every year. This resulted in more engineering students received former training in wood design annual.



In order to encourage students to take the wood design course, I always reached out to the industry (American Wood Council) to solicit sponsor for my class. Over the past several three years, Charles Ingram Lumber was kind enough to sponsor the wood design class at Clemson. The retail price for the latest version of NDS is \$150. While students can get 50% discount, the sponsorship helped reduce the financial burden. Without the sponsorship, I suspect many students would not purchase the NDS code or would elect to take other design courses such as steel or reinforced concrete design.

Structural Engineering Seminar on Wood Design

In Spring 2018, a structural engineering seminar course was offered with a focus on timber engineering. Ten external speakers were invited to the campus to give seminars with seven of them focused on issues relevant to timber engineering. More than 30 students attended each of the seminar. Our students love to hear from the current engineers and practitioners about the industry. Students commented that they enjoyed learning and hearing the different perspectives from the speakers.

The following shows the select speakers invited to the campus. Note that two of the speakers were from Europe, namely Mr. Hannes Blass and Mr. David Barber. One of the female speakers, Kelly Cobeen, is a co-author of the textbook used in the Wood Design class. Having regular invited speakers ensure that our students stay abreast of the latest development in the industry. In addition, it also create networking opportunities for our students for future job prospects.

Bibek Bhardwaj: Full-scale testing of cross-laminated timber diaphragm in-plane shear and development of a design guide for practitioners

The test configuration for diaphragm assembly has been decided upon. All equipment and materials required for conducting the test have been procured. The required steel fixtures are currently being fabricated at WISER, Clemson and is expected to be completed by first week of December. Following its completion, actual setup of testing configuration will be carried out, which includes diaphragm assembly and instrumentation setup. The test matrix for various small-scale connection tests has also been tabulated and agreed upon. Some of tests will be carried out in Clemson following the full-scale diaphragm test while Texas A&M, one of the collaborators for this project, will be conducting remaining tests in the test matrix.

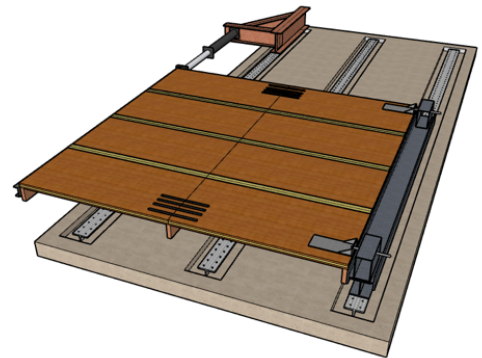
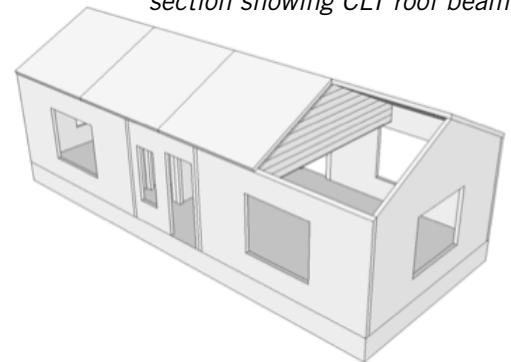


Figure 1: CLT Diaphragm Assembly

Augustus Raymond: Tornado resilient buildings utilizing CLT

Since last year, the subject of this research has shifted from a CLT (Cross-Laminated Timber) manufactured home to a CLT site-built home, given that CLT is both heavy and expensive, contradicting the two main principles behind manufactured housing. In addition, a site-built home is more preliminary in scope, which is the purpose of this research. However, the geometry (16' x 40') is still being used in the design, but there are plans to increase the dimensions to two larger sizes once the preliminary design is finished.

Figure 2: Rendering of a cut section showing CLT roof beam



ASCE 7-16 has become more mainstream in the last year and being the first ASCE code to include tornado procedures, this provides official design loads as opposed to speculating loads with unofficial assumptions.

A major development for the research this year has been a MathCAD sheet that will allow the current and future researcher to change all variables on the first few pages and then see the results on the last few pages with a step-by-step process for checking and understanding the calculations. This could be used in the future in case a tornado-CLT specific software is developed.

Member capacities and connection loads are nearly complete thanks to the MathCAD sheet, and it appears the structure will work in resisting an upper bound EF 3 tornado. Unfortunately, the roof is not strong enough on its own to resist the uplift forces from the tornado, meaning a roof structure is needed. After months of design concepts and analysis, the research will include four alternative designs: three triangular roof beams spanning the short direction (CLT, a tapered glulam and a curved tapered glulam) and a flat glulam roof beam spanning the long direction with a column supporting the middle. Because these roof beams are in edgewise bending, there are many assumptions as for the edgewise CLT properties, as they are not provided in PRG-320 currently.

There are plans to use software to simulate how accurate the analysis is or if there is something missing. The software of choice currently is Dlubal FEM, a leading software in CLT applications. Not much progress has been made currently.

Fanfu Fan: Tornado hazard for residential structures

Unlike other nature hazards, tornado induced fatalities are more likely to occur within the residential structures. In order to compare the performance of traditional light-frame wood and CLT construction subject to tornado wind, statistical methodology for developing tornado hazard curves at any given study domain have been proposed in this project. These derived hazard curves could be applied to determine the survival probability of a structure under a given hazard level, and also could be used to predict the structure losses or damages.



Figure 1: Tornado induced damage for residential light-frame wood structures (Adopt from Dao et al., 2014).

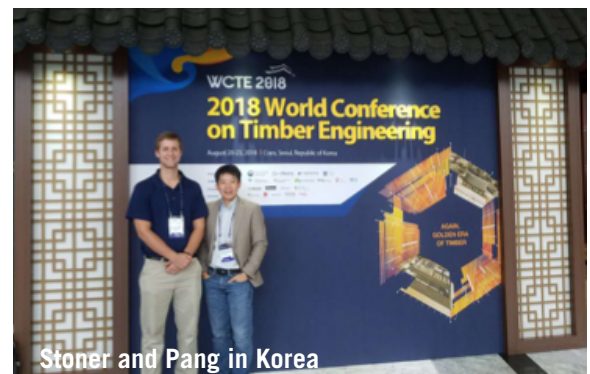
References

Dao, T. N., Asce, A. M., Graettinger, A. J., Asce, M., & Alfano, C. (2014). Failure Progression Analysis of Observed Residential Structural Damage within a Tornado Wind Field Abstract: Introduction:, 1448–1459.

Michael Stoner: Utilization of CLT in low and mid-rise buildings for enhanced wind performance

The overall goal of this project is to foster the use of Cross-Laminated Timber (CLT) to construct wind resistant buildings. The specific objectives of this project are to (1) build and test the windborne debris impact performance of standard PRG-320 qualified CLT panels; (2) build and test the out-of-plane strength of CLT panels under positive (pressure) and negative (suction) wind loads; (3) based on the findings from (1) and (2), build and test new CLT panel layouts (i.e. non PRG-320 panels) to meet both debris impact resistant and wind pressure/suction requirements under hurricane and tornado winds; and (4) provide new wind performance data and propose changes, if deemed necessary, to the CLT product standards. The performance data of CLT generated in this project will feed continued efforts.

Experimental debris impact testing of 3-ply CLT was completed proving the capability CLT to resist debris associated with high level wind events. Vulnerabilities in the panel's corners underscored the need to develop connections that allow for the dissipation of energy in the event of windborne debris. Additional mass timber products, namely Massive Plywood Panels, were tested in similar fashion to determine their debris impact resistance and potential as a material that can withstand significant wind events. In 2019, a suction chamber will be used to test the out-of-plane strength of these materials under reverse cyclic load expected in high wind events. The preliminary findings of this study were presented at the 2018 World Conference on Timber Engineering in Seoul, South Korea.



OUTREACH ACTIVITIES (WOOD PROMOTION)

Clemson University is now an official provider of AIA continuing education credits. The School of Architecture, WU+D and Dr. Brandon Ross in Civil Engineering joined forces and funds to become a provider. We have used this to offer credits at numerous events, many of which are listed below. If any member is interested in developing course work with us to offer to architects, please contact Pay Layton.

Wood Conferences

WU+D attended and exhibited at the Mass Timber Conference in Portland, Oregon in 2018. Dr. Layton served for the second year as a member of the Technical Program Committee. Emily Heezen, architecture student, displayed a project poster at the event. The booth was well-attended and showcased Clemson's new Snow Family Outdoor Fitness and Wellness Center, a hybrid CLT building designed by Cooper Carry. Brian Campa of Cooper Carry helped promote and answer questions at the booth. During the conference, our team met several software providers that work in the design and manufacturing arena. We were visited by Laurent Decosterd of Cadwork who demonstrated their software. We hope to get a trial package to determine if it might be useful for our programs.

Dr. Layton agreed to join the Forest Economic Advisors' (FEA) program committee to put on the Industrialized Wood Based Construction Conference (IWBC 2018). She served as a moderator for three sessions and was asked by FEA to continue working on the program committee for next year's conference.

Mass Timber Code Coalition

Pat worked on a committee to support the mass timber code coalition. Her responsibility included reaching out to forestry program chairs and deans to gain their efforts to reach their building code officials and encourage these officials to register to vote in the votes on 2021 code changes. She was the lead presenter for a seminar to demonstrate agencies could register to become voters in the ICC process. In the summer she worked with the team at APCO to write an editorial for Building Construction & Design to inform their readers about the Tall Wood proposals.

Extension Programs

Dr. Layton presented mass timber talks at the Sumter and Anderson County landowner associations. She also set up a wood identification workshop for SC county agents, WU+D graduate students and others at the University. In April, Layton led a tour of wood research facilities on campus. The agents loved seeing the air cannon and wind tunnel.

Working with Lendlease, Britt Peters and WoodWorks the Institute reached out to ULI members in Columbia and Charleston to repeat the Mass Timber story and opportunities to ULI members. (insert photos etc)

After working on a wood innovation proposal about LVL markets with several APA LVL members and Weyerhaeuser, the APA Markets Committee invited Dr. Layton to attend their meeting in Atlanta and to discuss WU+D and the many projects that we have worked with APA over the years.



Layton speaking in Columbia, SC

Dr. Layton was invited to the Southern Lumber Markets Association to present on mass timber products with Steve Lieberman from IB X-Lam. While in Atlanta for this meeting, Layton and Lieberman met with several architecture firms including Cooper Carry. As a result of that meeting, we later held a Lunch and Learn event in Atlanta with Bruce Lindsey of Woodworks and Britt, Peters and Associates for institute clients and other partners of Cooper Carry.

In April, Dr. Layton presented information about mass timber and increasing the use of wood products to the Pee Dee Land Trust field day event. This is a new audience and one to consider for future outreach focus.

Other Outreach

In previous years, Dr. Layton has reported on the Rural Renewables Resource Act Grant that she and others received. To conclude this grant, she and co-PI Bill Hubbard hosted a webinar for extension agents across the country to discuss the project and the Ask for Wood website. In addition, Dr. Layton attended and gave a similar presentation to the Agricultural and Natural Resources Extension Professionals meeting in Gulfport, Mississippi.

Dr. Layton was contacted by the Roper Mountain Science Center to meet with their architects about constructing a new building using mass timber (including glulam beams). She presented about mass timber, conducted a site visit and discussed siting and forestry with the team.

Dr. Layton, working with Britt Peters, has helped organize one LS3P Lunch and Learn in Charlotte, NC about mass timber. At least one more is planned for next year in Charleston, SC.

In September, Dr. Layton attended the National Association of State Foresters (NASF) meeting in White Fish, Montana. Dr. Layton had assisted a joint meeting of the Forest Markets and Forest Management Committees in Greenville SC in June 2018. She arranged for Bruce Lindsey to do a presentation. As a result of that meeting, the committees drafted a policy statement emphasizing the importance of Forest Markets in Forest Management. Dr. Layton was able to contribute a mass timber section to that document. At the NASF meeting in Montana, this policy was submitted to the State Foresters where it was approved and is now part of their policy issues.

While in western Montana, Dr. Layton was able to visit with SmartLam and explore their current manufacturing plant as well as their new plant which was being outfitted with equipment.



Dr. Layton was asked by Clemson University's Construction Science and Management Foundation to develop a panel focused on glulam and mass timber for their Annual Symposium. With assistance from APA's Warren Hamrick and Canfor SYP's Jeff Stefani our panel discussed the basics of glulam and the possibility of using mass timber for new projects, including the Snow Family Outdoor Recreation and Wellness Center at Clemson University. Even with Tropical Storm Michael in the area at that time, about 200 individuals attended the panel meeting and were very engaged.

While in Atlanta in the spring, Kattera and WU+D discussed meeting with the Georgia Structural Engineers Association. With Matt Kantner's efforts we became scheduled for the October dinner in Atlanta. The meeting was attended by about 30 people despite a tropical storm bearing down on the area. While in Atlanta, Lord Aeck Sargent, a Kattera company, set up a site visit for the Kendeda living challenge building at Georgia Tech.

Another effort to support the Tall Wood codes change included partnering with Huber Engineered Wood Products and the American Wood Council to host four consecutive events about the 2018 Building Code changes as they concern wood, and to highlight the Tall Wood proposed code changes. Three events scheduled in September were postponed to October because of Hurricane Florence. We held events in Commerce, GA, Cayce, SC, Concord, NC and Raleigh, NC. Between 30 and 70 building code officials attended each event.

Dr. Layton presented at the forestry committee of the Georgia Farm Bureau in December about mass timber. Due to their interest in mass timber, they have discussed highway sound barriers among other products and buildings.

Dr. Layton has continued to work with companies who are interested in learning more about Southern Yellow Pine (SYP) cross-laminated timber. She has provided information about work at Clemson, facts about SYP in general and set up meetings for some companies with the SC Department of Commerce.



GRANTS & CONTRACTS

AWARDS

FY'18

Patricia A. Layton. Full-scale Testing of Cross-Laminated Timber Diaphragm In-Plane Shear and Development of a Design Guide for Practitioners

20% - \$61,000.00

Weichi Pang. NSF Graduate Fellowship - Michael Stoner

100% - \$46,000.00

Weichi Pang. Full-scale Testing of Cross-Laminated Timber Diaphragm In-Plane Shear and Development of a Design Guide for Practitioners

80% - \$244,000.00

Mark C. Thies. AIR-TT: Ultrapure Lignins Recovered from Paper-Mill Black Liquors as Renewable Biopolymers

100% - \$200,000.00

Mark C. Thies. MRI: Acquisition of a 500 MHz NMR Spectrometer with Cryoprobe

11% - \$52,598.59

FY'19

Brandon E. Ross. Collaborative Research: Tessellated Structural-Architectural Systems for Rapid Construction, Repair, and Disassembly

50% - \$129,952.50

Weichi Pang. NSF Graduate Fellowship - Michael Stoner

100% - \$46,000.00

Weichi Pang. Enhancement of Advanced Blast Analytics and Development of Performance-Based Blast Damage Assessment of Buildings

100% - \$129,755.00

Mark C. Thies. REU: AIR-TT: Ultrapure Lignins Recovered from Paper-Mill Black Liquors as Renewable Biopolymers

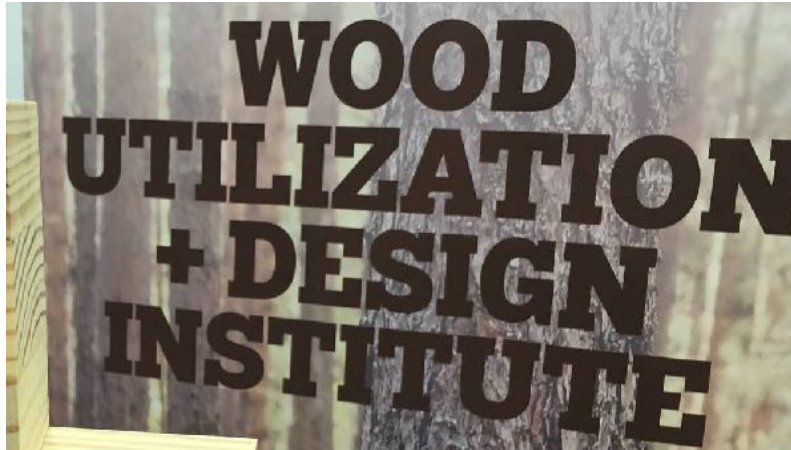
100% - \$8,000.00

PROPOSALS SUBMITTED

Project Title	Sponsor Name	Total Requested	Status	Total Awarded	End Date	Balance
Expand the use of LVL through Training and Education	Department of Agriculture	249,157	Denied	0	7/31/2021	0
Wood Product Supply Chain Marketing Study	SC Forestry Commission	54,743	Denied	0	9/30/2019	0
Southcentral Atlantic State Supply Chain Alliance (SASSCA): Sustainable Production of Wood-Derived Aviation Biofuels and Co-Products	AFRI Sustainable Agricultural Systems	\$9.9M	Pending	0	TBD	0

MEMBERSHIP

FOUNDING MEMBERS



CORPORATE MEMBERS



INDIVIDUAL MEMBERS

PUBLICATIONS & PRESENTATIONS



Scott May, LS3P - Jared Coffin, Hanbury - Allen Wood, Retired - Bo Shaw, Retired

FY'18

Blaney, C., Cobeen, K., Filiatrault, A., Welch, D., Stoner, M., Pang, W. and Vincent, T. September, 2017. "Prestandard for Seismic Assessment and Retrofit of One- and Two-family Dwellings (ATC-110 Project)," 2017 Structural Engineers Association of California (SEAOC) Convention, San Diego, California.

Pang, W. and Albright, D. November, 2017. "Looking Forward: Leading Edge Solutions through Applied Research in Wood Building Systems," 2017 Southeast Wood Solutions Fair, Charlotte, NC.

Layton, P. and Hubbard, W. March, 2018. Sustainable Wood Products Tools for State, District & County Extension Professions: ASKFORWOOD.COM. An Extension National Webinar <http://www.forestrywebinars.net/webinars/sustainable-wood-products-tools/>

Harding, D. March, 2018. Empathy and Wood: Hands, Lines, and the CNC router. Invited lecturer/presenter at the RCID Research Forum-Clemson University.

Wang, J., Pang, W. and Cao, S. March, 2018. "Fragility analysis of the roof structure of low-rise buildings subjected to tornado vortices," International Workshop on Wind-Related Disasters and Mitigation (WRDM), Tohoku University, Sendai, Japan.

Heezen, E., Anderson, C. and Chan, A. March, 2018. "BICEFS Research Support Building: Mass Timber Coastal Research Lab." Project Poster at the 2018 International Mass Timber Conference. Portland, Oregon.

Layton, P. and Hubbard, W. April, 2018. Sustainable Wood Products Tools for State, District & County Extension Professions: ASKFORWOOD.COM. Presented to the ANREP 2018 Conference. Biloxi MS.

Layton, P. and Pang, W. April, 2018. Clemson's Wood Utilization + Design Institute Where Innovation and Education Meet. An invited talk to the APA Engineered Wood Association's Forest Markets committee meetings Atlanta GA.

FUTURE PLANS

Albright, D. May, 2018. “The Hobcaw Studio: Designing Service Learning”. Invited Presentation at Augsburg University of Applied Science Design/Build Symposium. Augsburg, Germany.

Albright, D. May, 2018. “Timber in North America: Innovations in Wood Design + Building”. Invited Presentation at Augsburg University of Applied Science. Augsburg, Germany.

Albright, D. May, 2018. “Architect Meet Ecologist: A Studio-Based Study of Massive Timber for an Ecological Research Laboratory.” Proc. of 2018 ARCC / EAAE International Conference, Philadelphia, Pennsylvania.

Kircher, C., Pang, W., Filiatrault, A. and Heintz, J. June, 2018. “Solutions to the Short-Period Building Performance Paradox,” 11th U.S. National Conference on Earthquake Engineering, Los Angeles, CA.

Blaney, C., Cobeen, K., Filiatrault, A., Welch, D., Stoner, M., Pang, W. and Vincent, T. June, 2018. “Prestandard for Seismic Assessment and Retrofit of One- and Two-family Dwellings,” 11th U.S. National Conference on Earthquake Engineering, Los Angeles, CA.

FY'19

Layton, P. July, 2018. Mass timber comes of age: Code consideration, evolving supply chain promises new options for tall wood buildings. Building Design + Construction. Op-ed. <https://www.bdcnetwork.com/mass-timber-comes-age-code-consideration-evolving-supply-chain-promise-new-options-tall-wood-7/2/2018>.

Albright, D. July, 2018. “Innovations in Wood and Timber Design: An Architect’s Perspective”. Presented at the Forest Products Laboratory Industry Needs Assessment. Starkville, MS.

Stoner, M. and Pang, W. August, 2018. “Experimental Testing and Numerical Validation of Cross-laminated Timber under Debris Impact Loading,” World Conference on Timber Engineering (WCTE), Seoul, Korea.

Albright, D. and Harding, D. September, 2018. “Sim[PLY] Building Framing System”. Invited exhibit at *Future Shock* event of the Discovery Place Museum. Charlotte, NC.

Harding, D. October, 2018. Design+Build and Research Initiatives-Clemson University. Invited lecturer/presenter at research centric design+build symposium at California Polytechnic School of Architecture.

Harding, D. November, 2018. At Hand: Leveraging Technology to Incite Participatory Construction. Invited lecturer/presenter at Montana State University School of Architecture Fall lecture Series.

Fan, F. and Pang, W. 2018. "Stochastic Track Model for Tornado Risk Assessment in the U.S.," *Frontiers Wind Engineering and Science*, in review.

Rockow Z., Ross B. and Black AK. 2018. "Review of methods for evaluating adaptability of buildings" *International Journal of Building Pathology and Adaptation*, <https://doi.org/10.1108/IJBPA-01-2018-0013>.

Black AK., Rockow Z. and Ross B. 2018. "Identifying Physical Features that Facilitate and Impede Building Adaptation," *Sustainability in Energy and Buildings*, Gold Coast, Australia.

Black AK. and Ross B. 2018. "A Methodology for Quantifying Adaptability of Buildings using Analytic Hierarchy Process," *Sustainability in Energy and Buildings*, Gold Coast, Australia.

Teaching:

Forestry, Architecture and Civil Engineering will be heavily involved in teaching this coming spring. Now that WU+D is eligible to offer AIA continuing education credits to architects, curriculum will be developed to further cater to this audience.

Research:

Institute fellows will continue to submit proposals for research grants as graduate students continue to perform research operations. As mass timber comes into more use industry-wide, we will be seeking out contracts with individual companies to perform product testing research.

Outreach:

Dr. Layton will once again serve on the Mass Timber Conference Program Committee and additionally serve on the Industrialized Wood-Based Construction Conference Program Committee in 2019.

Institute Operations:

The Institute will continue to work on its strategic plan for future development, to aid the University's administration in understanding how WU+D can grow and support the mission of PSA and Clemson University. This is especially important as University-level administration continues to evolve.

We are strategically seeking out new members and industry partners who will participate actively in our research, teaching and outreach initiatives so that all parties find significant value in the future.