



THIRD ANNUAL REPORT

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Submitted by

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EXECUTIVE SUMMARY

The Wood Utilization + Design Institute had a productive year in 2017. We have continued to grow our membership, increased the number of faculty fellows in the Institute, added grants, and increased our visibility and activity level in the state, region and nation.

The Institute had a significant presence at the Mass Timber Conference in Portland, Oregon last March, four presentations were given, we had a booth, and Dr. Layton was on the program committee. This effort contributed to recruiting two new founding partners, three corporate memberships and 1 new individual membership. Dr. Layton is continuing on the program committee for 2018 and the Institute will have a booth.

Our research results were seen in numerous locations around the nation and world. Our RREA Extension grant was completed although we will continue to publicize the results. We have new grants that are beginning. Faculty fellows joined us from Chemical Engineering (Lignin and Bio-composites) and Automotive Engineering (nanocellulosics and Bio-composites) and submitted grants through the Institute. Given the level of our research and our need to have space that will handle the sizes and weights that work with, the Institute has partnered with four other departments to renovate space to expand at the Built Environment Laboratory. This space will allow us expanded research and large teaching spaces both indoor and outdoor. This will allow us to be more competitive in proposals, contract research, experiential learning for our students, and economic development activities. Additionally, there has been several key contract research opportunities that have supported our students and faculty. Some of these we hope will lead to new product development.

A key accomplishment for the state is that we have provided the information needed to eliminate a state engineer's office ban on Fire Retardant Treated Wood. We will work next year to get a similar prohibition in the K-12 public school building code removed. This was a collaborative effort working with many partners in the SC Wood Innovation Team, which formed under the development of one of our USFS grants.

Teaching activities have increased in the wood area, expanding to Italy and Charleston. Our studios that have been supported by John Blackburn, Clemson's Baruch Institute for Coastal Ecology and Forest Science, and others have fostered collaboration among our traditional partners and others.

REVIEW OF ACTIVITIES

Architecture Activities

A review of activities from the School of Architecture and its WU+D faculty fellows reveals a very productive year. The work from 2017 largely revolved around our innovative Sim[PLY] light framing system, as well as design-based studies of massive timber.

The Sim[PLY] system was developed in conjunction with Clemson's Indigo Pine House, our entry in the 2015 USDOE Solar Decathlon Competition. Sim[PLY] utilizes CNC-prefabricated framing components for rapid, intuitive assembly, optimal thermal performance, and easy disassembly and modification. Our work with Sim[PLY] was featured in multiple invited presentations and journal publications, including the Journal of Technology | Architecture + Design (TAD), which is circulated to all member schools within North America's Associated Collegiate Schools of Architecture. Additionally, a patent application was filed on the system with support from the Clemson University Research Foundation (CURF), and our team is awaiting the next steps in this process.

2017 presented new student and faculty projects designed to utilize the Sim[PLY] system and refine and advance its family of framing components. This included a student design/build project in Summerton, SC in the Spring. Directed by Dan Harding, the studio class was comprised of graduate students in our Architecture + Community Build program. Designed for a Summerton community arts center, the resulting structure supports an array of potential community events, ranging from theatrical performances and film screenings, to gallery exhibits. A time-lapse video of the structure's assembly can be found at:

<https://www.youtube.com/watch?v=hyw2v2y5PEo>



Over the summer, the Sim[PLY] system was used for a pop-up structure in Genoa, Italy, which was completed by students in the Architecture Minor program. The "Pop-up Piazza" was part of a collaborative effort between Clemson's Charles E. Daniel Center for Building Design and Urban Studies and Casa Gavoglio Civico.

<https://m.youtube.com/watch?v=GJtt-8quNPA>

The project paved the way for a currently active collaboration with The Giovani Orchestra Genovese, G.O.G. and the Teatro Carlo Felchi in Genoa, Italy to design fabricate and build an acoustical pop-up wood theater structure for classical chamber music performances. Design and prototypes versions will be implemented in 2017 and 2018.

In the Fall, Sim[PLY] was employed as a vehicle for outreach and children's education at our Clemson Design Center in Charleston (CDC.C). Throughout September and

October, the CDC.C hosted approximately 600 4th and 5th graders visiting from Richland County school system. The workshops, led by CDC.C faculty Dave Pastre and Ray Huff, provided hands-on learning opportunities and introduced a range of concepts relating to architecture and construction. More information, including a video from the workshops, can be found at: <http://newsstand.clemson.edu/mediarelations/600-elementary-students-build-to-learn/>

We continue to field interest in Sim[PLY] from around the country and the world, from the Florida Keys to British Columbia, and we look forward to assisting practitioners with applications to their specific projects. This will provide a critical information loop to inform future system developments. Along these lines we are also excited to have sold both Indigo Pine house prototypes to a developer from Greenville, SC. They are slated to be erected in the Taylors Mill neighborhood in the coming months.



Back in Clemson, professors Dustin Albright, Dan Harding and Paul Russell (of Landscape Architecture) have directed a funded Studio design project targeting new onsite housing prototypes and a new laboratory facility for the Belle Baruch Institute of Coastal Ecologies and Forest Science (BICEFS). This is a partnership with Clemson Public Service and Agriculture plus the Wallace F. Pate foundation. The housing prototypes are designed to utilize the Sim[PLY] system in service of coastal resiliency and energy efficiency. Moreover, the designs have expanded to consider multi-story applications of Sim[PLY] – a step that the system naturally anticipates. As a lead-in to this work, Dustin Albright directed a set of shear wall racking tests over the summer to analyze Sim[PLY] technical developments which stemmed from the Fall 2016 *Crop Stop Kitchen* project.



Regarding the BICEFS laboratory designs, students were challenged to explore the use of massive timber building systems, and, specifically, cross laminated timber. Through the process, students gained a deeper understanding of the structural capabilities, construction sequencing, and technical details pertaining to mass timber construction. Additionally, students were required to analyze and document the carbon footprint of the wood structural components in their designs and compare this with other material systems. The course was punctuated by a visiting lecture from Tom Chung, architect and mass timber design advocate. These laboratory designs, as well as the housing prototypes and associated site design work, will form the basis for a BICEF's capital campaign as it celebrates its 50th anniversary and looks ahead to expanded research capabilities in the future.

Engineering Activities

We have successfully graduated Ph.D. candidate Eric Gu and he has taken a position with Katerra. Additionally, we have recruited several new masters' students into the program (see below). We hope to recruit and fund several additional students this spring. Civil Engineering will offer Dr. Pang's course, CE 4070 Wood Design every spring semester instead of every three semesters. CE 4070 is an introduction to wood design and engineering; properties of wood and wood-based materials; design of beams, columns, walls, roofs, panel systems, and connections. This curriculum change will increase the

number and opportunity for CE students to learn about wood engineering. Additionally, the 2018 spring semester will include a graduate wood engineering seminar for students. Clemson University faculty will lead this seminar, which will feature as guest lecturers, engineers from other universities, government and industry to teach and interact with our students.

The following is an update of current grants and students in the program:

1. *Utilization of Cross Laminated Timber, CLT, in Low and Mid-rise Buildings for Enhanced Wind Performance*

Funding Agency: United States Department of Agriculture, Forest Service
PI: Weichiang Pang, Clemson University
Co-PI: Patricia Layton, Clemson University
Funding: \$244,956
Project Period: 2016-2019.

Abstract:

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 into efforts to gain

2. *Full-scale testing of cross-laminated timber diaphragm in-plane shear and development of a design guide for practitioners*

Funding Agency: United States Endowment for Forestry and Communities
PI: Weichiang Pang, Clemson University
Co-PIs: Patricia Layton, Clemson University; Douglas Rammer, Forest Products Laboratory; Maria Koliou, Texas A&M University
Funding: \$305,000
Project Period: 2017-2020.

Abstract and Project Objectives:

Cross-laminated timber (CLT) is an engineered wood panel made of layers of dimension lumber that are glued in such a way that the lumber of adjacent layers are oriented perpendicular to each other. There has been a great deal of research conducted in the past decade in Europe to improve the mechanical properties of CLT panels by optimizing the adhesive content, grade of individual lumber pieces, etc. The current solid CLT panel is a very promising system that has the potential to replace steel and concrete in the mid-rise construction market. While the design of CLT has recently been included in the 2015 NDS, lateral force transferring of CLT diaphragm for seismic loading is not included in the 2015 Special Design Provisions for Wind and Seismic (SDPWS).

The objectives of this research project are:

(1) test common self-tapping screws that can be used to connect CLT diaphragm panels and calibrate the design equation in building codes (e.g. NDS) for self-tapping screws to account for combined shear and withdrawal loads,

(2) build and test the in-plane stiffness and diaphragm performance of the CLT-Glulam composite system; and

(3) use the findings from (1) to (2) to develop design guides for engineers, and propose changes, if deemed necessary, to the provisions in the current US design standards for wood construction.

Panel + Connection = Diaphragm ?

- WSP Diaphragms based on **system testing**
- WSP Diaphragms capacities listed in AWC's Special Design Provisions for Wind and Seismic



Need for System Level Diaphragm Strength Verification

Table 4.2A Nominal Unit Shear Capacities for Wood-Frame Diaphragms

Blocked Wood Structural Panel Diaphragms^{1,2,3,4}

Sheathing Grade	Common Nail Size	Minimum Fastener Penetration in Framing Member or Blocking (in.)	Minimum Nominal Panel Thickness (in.)	Minimum Nominal Width of Nailed Face at Adjoining Panel Edges and Boundaries (in.)	A SEISMIC								B WIND			
					Nail Spacing (in.) at diaphragm boundaries (all cases), at continuous panel edges parallel to load (Cases 1 & 4), and at all panel edges (Cases 2 & 3)								Nail Spacing (in.) at diaphragm boundaries (all cases), at continuous panel edges parallel to load (Cases 2 & 3), and at all panel edges (Cases 1 & 4)			
					6				4				6			
					Nail Spacing (in.) at other panel edges (Cases 1, 2, 3, & 4)				Nail Spacing (in.) at other panel edges (Cases 1, 2, 3, & 4)				Nail Spacing (in.) at other panel edges (Cases 1, 2, 3, & 4)			
					v_n (psf)	G_n (kips/in.)	v_n (psf)	G_n (kips/in.)	v_n (psf)	G_n (kips/in.)	v_n (psf)	G_n (kips/in.)	v_n (psf)	G_n (kips/in.)	v_n (psf)	G_n (kips/in.)
Structural I	6d	1-1/4	5/16	2	370	18	12	500	8.5	7.5	750	12	10	840	20	15
				3	420	12	9.5	560	7.0	6.0	840	9.5	8.5	950	17	13
				2	540	14	11	720	9.0	7.5	1050	13	10	1200	21	15
				3	600	12	10	800	7.5	6.5	1200	10	9.0	1350	18	13
	8d	1-3/8	3/8	2	940	24	17	850	15	12	1280	20	15	1480	31	21
				3	720	20	15	850	12	9.5	1440	16	13	1580	26	18
	10d	1-1/2	15/32	2												
				3												

Recent WUD Research Fellow Graduate

- Mengzhe (Eric) Gu (PhD Civil), "Strength and Serviceability Performances of Southern Yellow Pine Cross-Laminated Timber (CLT) and CLT-Glulam Composite Beam", (Aug 2017).
Current Position: Mass Timber Engineer, Katerra, Spokane, Washington.

Existing WU+D Graduate Research Fellows

- Lancelot Reres, PhD Student, Civil Engineering
- Michael Stoner, PhD Student, Civil Engineering
- William Ashman, PhD Candidate, Civil Engineering

New WU+D Graduate Research Fellows

- Augusta Raymond, Degree - MS, Civil Engineering, Joined August-2017
- Bibek Bhardwaj, MS Student, Civil Engineering, Joined August-2017
- Jonathan Broyles, BS Student, Civil Engineering, to start MS program after Spring-2018

Outreach Activities (Wood Promotion)

WU+D outreach activities have been funded by grants from the USDA Forest Service and USDA RREA. Additional outreach efforts have been supported by funds within the Institute including salary savings from grants and the WU+D foundation account.

Our outreach efforts have included email marketing, informational meetings, news reports, letters to the editor, and other public relations tactics. WU+D has presented in SC, Atlanta, and beyond. In SC, progress is being seen as we now have a mass timber structure being planned at Clemson University, hotels will be built at Fort Jackson next year and a renovation at Florence Darlington Technical College. WU+D leverages Twitter, Facebook and e-newsletters to communicate these updates with various stakeholders and industry professionals. WU+D fellows have supported outreach efforts by connecting with extension agents located throughout the southeast and regional foresters to support the use of wood. Dr. Layton served as the program chair for the SC Division of SAF annual meeting and our program titled, *Why Not Wood – Just Ask for It*.

USDA Forest Service Project

Our USFS partners asked that we work with them to navigate wood markets for pine sawtimber that is being harvested during forest restoration projects from NC, SC, and GA mountains.

Identified issues include:

- Understanding the supply and demand for wood in the area and
- Lack of existing sawmills in the area.

Meeting attendees identified that there is a need to understand political actions needed and especially those, which concern harvesting/restoration on federal forests. Interested parties should get on mailing lists for actions on national forests and sales on federal and state forests. A Good Neighbor Program exists where federal land harvests/restorations are handled by the state forest agency. Attendees wondered if this would work in SC or other states?

<http://www.fs.fed.us/managing-land/farm-bill/gna>



A significant discussion was held about purchasing from federal lands. There is a program to allow for use of partially constructed roads, if buyers ask for BT5.23 or B5.23. For Stewardship sales, it was recommended that USFS and others mix sales to "Bundle" hardwood and pine into one sale for dealer flexibility. The opportunity to meet and discuss wood supply and other issues was identified as a highlight.

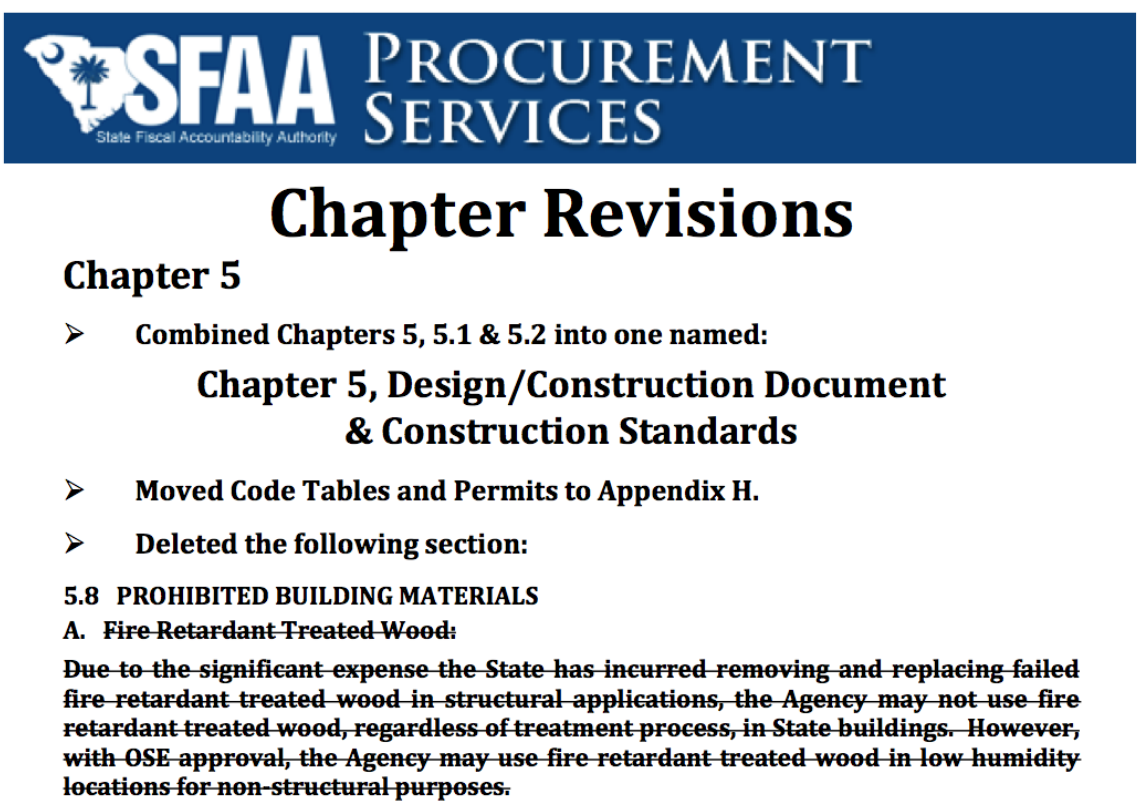
American Wood Council and WoodWorks/Wood Products Council

In February 2017, the WU+D Institute was delighted to partner with the American Wood Council and WoodWorks/Wood Products Council to once again have a meeting in Charleston. The meeting was entitled *Durable Design: Best Practices for Wind and Seismic in Today's Urban Construction*. We had about 90 people register and about 85 attended. A certificate

for continuing education credit was given to the attendees as we submitted this event to the appropriate groups to get approval for credits.

Fire Retardant Treated Wood (FRTW)

One major barrier to expanding the use of wood in SC was identified by the WU+D team -- the State Engineer and K-12 School building codes ban the use of Fire Retardant Treated Wood (FRTW). The team and others worked to educate the State Engineer on the changes in FRTW over the last 30 years, including chemistry, testing and standards changes. The information was originally presented in 2016 and then followed up later that same year with additional information. In the summer of 2017 the State Engineer met with team members and discussed the issue. On September 28, 2017, State Engineer John White informed the team that his office is removing the prohibition against FRTW in the State Engineer's Manual. The State Engineer is required to advertise this change for 60 days. The effective date of the change is January 1, 2018.



The image is a presentation slide with a blue header containing the SFAA Procurement Services logo and name. The main title is 'Chapter Revisions' in large black font. Below it is 'Chapter 5' in bold. A list of revisions follows: combining chapters 5, 5.1, and 5.2 into one named 'Chapter 5, Design/Construction Document & Construction Standards'; moving code tables and permits to Appendix H; and deleting a section on prohibited building materials. The deleted section is shown in a lighter blue box with the text crossed out. The deleted text states that the state has incurred significant expense removing and replacing failed fire retardant treated wood, and that the agency may not use fire retardant treated wood in structural applications, regardless of treatment process, in state buildings. However, with OSE approval, the agency may use fire retardant treated wood in low humidity locations for non-structural purposes.

SFAA PROCUREMENT SERVICES
State Fiscal Accountability Authority

Chapter Revisions

Chapter 5

- **Combined Chapters 5, 5.1 & 5.2 into one named:**
**Chapter 5, Design/Construction Document
& Construction Standards**
- **Moved Code Tables and Permits to Appendix H.**
- **Deleted the following section:**

5.8 PROHIBITED BUILDING MATERIALS
A. Fire Retardant Treated Wood:

~~Due to the significant expense the State has incurred removing and replacing failed fire retardant treated wood in structural applications, the Agency may not use fire retardant treated wood, regardless of treatment process, in State buildings. However, with OSE approval, the Agency may use fire retardant treated wood in low humidity locations for non-structural purposes.~~

Figure 1. SC OSE announced in a presentation slide to state engineers that the Fire Retardant Treated Wood Ban was being deleted from the state manual.

Wood Summit

The RREA project identified key issues facing the increased use of wood and subsequent action items for overcoming the issues identified throughout the SE during a "Wood Summit" on May 11-12, 2016 in Clemson, SC.

As a result of the Wood Summit, the project developed and delivered the tools necessary to increase wood as a non-residential building product. The project identified existing materials

and developed new materials for inclusion in the Extension Toolbox. A relationship with reThink Wood© was established to allow the researchers to incorporate many of their materials into the Ask For Wood website (<http://www.askforwood.com>). The e-learning platform was critiqued by Extension personnel for improvements and missing information vital to educating the public about building with wood. Dr. Pat Layton and a Clemson University student worker spent over 100 hours on the development of the website while Dr. Bill Hubbard and the Southern Regional Extension Forestry group spent approximately 110 hours on development. The current efforts of the research team are focused on visibility and availability of the toolbox for extension professionals throughout the country.

The website [ASKFORWOOD.COM](http://www.ASKFORWOOD.COM) creates a one-stop location for learning about the benefits of building with wood as well as information about building codes. The website also provides introductory information on building with wood, such as a glossary of terms, the history of building with wood and the current trends in building with wood. The website also houses a toolbox that can be utilized for Extension personnel to educate various audiences on the use of building with wood. In addition, the project team has delivered seven professional presentations and provided information on the website in several informal settings.

The website provides information on why and when building with wood is appropriate, the building codes that are related specifically to building with wood and additional learning resources for building with wood. The website also provides educational tools for promoting the use of wood in buildings. Additionally, informational videos have been created and added to the Clemson University Wood Utilization + Design Institute's website (www.clemson.edu/wud). These videos outline topics such as an introduction to building codes, building trends, history and examples of non-residential wood buildings. The intent is for Extension agents to utilize the website for educational tools to promote the use of building with wood. The Extension agents will hopefully provide feedback on gaps in available information for promoting the use of wood in non-residential buildings. The website [Askforwood.com](http://www.Askforwood.com) will continue to be advertised to land grant universities throughout the country. A card was also developed for distribution to Extension Directors, ANR Program Leaders and Middle Manager at their PLN annual meeting in Fort Worth, TX.



In October, the WU+D partnered with ULI SC, Britt, Peters & Associates and Clemson University's College of Business to for a Beer and Brainstorming Event at Clemson One. The agenda and other information are found at [this website](#). About 90 people attended the event. We are in discussions to consider similar events in other cities including Columbia, Charleston, and Atlanta.

Other media and news events are found in the *Publications and Presentations* section of this report. Our Twitter account is

[@wudclemson](#) and our Facebook page is [Clemson University Wood Utilization + Design Institute](#) -[@wudclemson](#)

Figure 2. Attendees at the Beer & Brainstorming: Mass Timber – Strategy for Sustainability enjoy networking before presentations begin.

GRANTS AND CONTRACTS

FY2017 – 2018 Proposals Submitted to Date

Project Title	Sponsor Name	Total Requested	Status	Total Awarded
An Interdisciplinary Approach to Building the Bioproducts Workforce	USDA/NIFA	\$2,983,427.00	Denied	\$0.00
Fuels Management and Cultural Landscape Restoration Project at Kings Mountain National Military Park and Other Parks within Southeast Region of the National Park Service	US DOI	\$12,900.00	Approved	\$12,900.00
Full-scale Testing of Cross-laminated Timber `Diaphragm In-plane Shear and Development of a Design Guide for Practitioners	US Endowment for Forests and Communities/USDA Forest Products Lab	\$304,999.00	Approved	\$305,000.00
Development and Implementation of a Timber Bridge System	USDA FS	\$250,000.00	Denied	\$0.00

FY 2017 – 2018 Grants in Progress

Project Title	Sponsor Name	Total Awarded	End Date	Balance
Expanding the Use of Wood Building Products in SC	USDA FS	\$271,014	6/30/2018 will request no cost extension due to late start	\$49,903
Fuels Management and Cultural Landscape Restoration Project at Kings Mountain National Military Park and Other Parks within Southeast Region of the National Park Service/increase to existing grant	US DOI	\$12,500 Incremental funding added	12/31/2018	\$87,536
Full-scale Testing of Cross-laminated Timber Diaphragm In-plane Shear and Development of a Design Guide for Practitioners	US Endowment for Forests and Communities/USDA Forest Products Lab	\$305,000	9/30/2020	\$305,000
Utilization of Cross Laminated Timber (CLT) in Low and Mid-rise Buildings for Enhanced Wind Performance	USDA FS	\$244,956	5/31/2019	\$ 124,850
Wood Utilization: Pathway to Healthy Forests and Sustainable Communities	USDA RREA	\$60,000	6/30/2017	\$0

MEMBERSHIP

Membership increased throughout 2017. There were increases in founding partners, corporate memberships and individual members. A list of members is found below.

Membership Type	Name
Founding Partners	
	Collum's Lumber Products, LLC.
	Huber Engineered Woods
	Katerra
	Lendlease
	W. McLeod Rhodes Co. Inc.
	Smartlam
	Simpson Strong-Tie
	Weyerhaeuser
Corporate Partners	
	Britt, Peters and Associates, Inc.
	IB X-LAM USA
	Franklin Adhesives
	Sherman Construction
	Lord Aeck Sargent
Individual Members	
	Scott May, LS3P
	Jared Coffin, Hanbury
	Allen Wood, retired
	Bo Shaw, retired

FINANCIAL OVERVIEW

Wood Utilization + Design Institute Expenditure Summary for FY 2017 and first Quarter FY 2018

Expense Category	Foundation 2017	Foundation 2018	Grant ¹ 2017	Grant ¹ 2018	University 2017	University 2018	PSA 2017	PSA 2018	Totals 2017	Totals 2018	Grand Total
Salary	12,510	4,186	33,672	12,847	63,137	19,888	82,617	18,894	191,936	55,815	247,751
Fringe	1,070	561	10,230	4,385	23,898	7,718	30,024	7,028	38,222	22,818	84,914
Travel	2,571	79	4,102	1,536	1,542	769	5,381		13,596	2,384	15,980
Other	4,509		8,818	20,066	1,104	1,659	1,104	433	15,535	22,158	37,693
Subcontract			1,584								1,584
F&A			23,789	13,111					23,789	13,111	36,900
Total Expenses	20,660	4,826	82,195	51,945	89,681	30,034	119,126	26,355	311,662	113,160	424,822

Wood Utilization + Design Institute Funds Available

Source	FY 2017	FY 2018
Foundation	\$126,851	\$273,700
Public Service & Agriculture	\$479.94	\$116,879
University	\$ 31,375	\$ 43,932
Total	\$158,707	\$434,510

¹ Does not include Grants in Civil Engineering

BUILT ENVIRONMENT LABORATORY PLANS

In the spring of 2017, our Institute along with Civil Engineering, Architecture, Construction Science and Management, and Forestry and Environmental Conservation were presented an opportunity to share space in Pendleton. Following a series of meetings among participants, we developed plans for collaboration and partnership. This space was seen as a significant improvement for many of us. VP Askew was able to submit the following information to the state of South Carolina in the hopes that they might fund a significant amount of the renovation. We would still need to find funds for equipment. After the renovation we would hope to seek recurring funding for a facility manager and lead researcher in subsequent asks in the state legislature.

Request to the Legislature submitted by the WU+D to the VP PSA \$1.3 million

The Wood Utilization + Design Institute (WU+D) develops sustainable new wood products from our abundant forests. The WU+D along with Clemson's Department of Forestry and Environmental Conservation, the School of Architecture, the Department of Construction Science and Management, and the Glenn Department of Civil Engineering have been assigned 12,000 square feet of space in an existing "High Bay" building in Pendleton, SC. This facility allows our programs an opportunity to create a collaborative research and instructional space for addressing the many challenges facing construction, operation and maintenance of South Carolina's Built Environment.

Our goal is to increase the use of wood products in our state, which will increase the value of forests to the state's 200,000+ forest landowners. South Carolina's forest products industry has a \$21 billion economic impact; increasing wood manufacturing and growing more wood can increase the impact significantly. Both are critical to the health of rural communities where most of the trees are grown, harvested and transported to manufacturing. South Carolina is blessed with abundant, sustainable forests to support this growth.

Over the past year, South Carolina had the 10th-fastest growing population nationally, likely to top 5 million citizens in 2017 (Census Bureau statistics). In the face of this growth, South Carolina faces significant building challenges. For example, the state's schools have an estimated capital expenditure gap of \$90 million. Success in a 21st century economy requires serious, sustained leadership in housing and structures research, instruction and development to overcome these challenges.

The Built Environment Lab will focus on the design and construction needs of South Carolina's expanding housing and building/structure needs. These needs fall into two overlapping categories – materials and structures. For materials we will focus on improvements to our existing building materials as well as developing new materials. . We also will investigate new and improved methods for working with these materials. With regard to structures, we are designing and adapting structural systems to take advantage of these material developments. An important part in of our success will be utilizing the "high bay" facility as collaborative implementation space. This space will be renovated into a well-designed and equipped facility for multi-disciplinary approaches to research, development, instruction and implementation. It also will support the state's competitiveness in built environments and healthier forests and rural economies.

The BEL facility will be the hub for built environment undergraduate and graduate research on campus. Renovation Expenditures \$1.3 million:

- Strong Floor and Wall - \$500,000
- Overhead crane system - \$250,000
- Reconfiguration of Electrical Systems, Insulation and Deconstruction - \$100,000
- HVAC system, shop facility construction and exterior access - \$140,000
- A&E Expenses - \$50,000
- Outdoor Concrete Pad with tie downs for temporary building projects - \$100,000
- Other Miscellaneous Expenses including bathrooms, safety and ADA compliance upgrades that may be needed - \$160,000

Equipment Needs \$1 million:

- Major pieces of shop equipment, including CLT ¹Press, CNC,² Dust Collection, material and structural testing machines.

For more information on this process and the ask please see the following Clemson University PSA government affairs sites.

<https://www.clemson.edu/public/budget-priorities/>

<https://www.clemson.edu/public/budget-priorities/nonrecurring/built-environment-lab.html>

<https://www.clemson.edu/public/budget-priorities/advocacy-resources.html>

We encourage all of those interested to become an advocate for the PSA budget request

<https://www.clemson.edu/public/budget-priorities/advocacy-resources.html>

¹ Cross Laminated Timber - CLT

² Computer Numeric Control – CNC

- Built Environment Laboratory (BEL)
Recurring request: \$310,000 plus fringe⁴



The BEL requests the following positions for support of the facility.

- Research Scientist (12-month FTE) \$85,000 + fringe
- Technician (12month FTE) \$45,000 + fringe

While wood products have been an integral part of construction for centuries, most wood buildings do not exceed three to four stories in height. However, with recent developments in wood products engineering alongside other new technologies, it is now possible to expand the use of wood into larger construction projects. Adrian Blocker, Weyerhaeuser senior vice president of wood products states "While wood is one of the oldest building materials around, new technology utilizing engineered mass timber panels and wood-based building systems creates new possibilities for wood construction." These new wood products will support better rural economies and forest health while maintaining our forested land base. Collin O'Mara, president and CEO of the National Wildlife Federation stated, "Healthy, well-managed forests can provide important habitat for wildlife, restore watershed health, and help store carbon. By supporting the development of new markets for saw timber, we will help landowners keep their forests as forests, while avoiding global warming pollution from conventional building materials."

To support the development of new sustainable wood products and the industry that provides those products, the Department of Forestry and Environmental Conservation requests two new faculty positions.

- Associate Professor (12 month FTE) \$95,000 + fringe
- Assistant Professor (12 month FTE) \$85,000 + fringe

These positions will be allocated across teaching, research and Extension to provide support and assistance to our existing and new industries that will develop in South Carolina because of the Research and Development that will be produced in the BEL.

⁴ At 37.2% fringe this amount would total \$425,320

PUBLICATIONS AND PRESENTATIONS FOR 2017

- Albright, D., Harding, D., Pastre, D.** 2017. "Hands and Things: Leveraging Technology to Incite Constructive Participation". Invited Presentation at the 2017 BTES Conference, Des Moines, Iowa, June 8-10, 2017.
- Albright, D., Harding, D., Pastre, D., Heine, U., Blouin, V.** 2017. Assembling the Digital House by Hand: Lessons from deep Engagement and Guiding the Experimental Impulse. Technology|Architecture + Design Vol. 1 , Iss. 1, 2017 pp. 92-106.
<http://tandfonline.com/doi/full/10.1080/24751448.2017.1292798>
- Albright, D., Blouin, V., Harding, D., Heine, U., Pastre, D.** 2017. "Indigo Pine: Net Zero Performance in a Unique Package," Procedia Environmental Sciences, volume 38 (2017): 60-67. ISSN _ 1878-0296
- Albright, D., Blouin, V., Harding, D., Heine, U., Pastre, D.** 2017. "Sim[PLY]: Rapid Structural Assemblies Using CNC-Fabricated Plywood Components," International Journal of Computational Methods and Experimental Measures (CMEM), volume 5, issue 4 (2017): 532-538. ISSN _ 2046-0554
- Albright, D., Harding, D.** 2017. "Assembling the Digital House by Hand: Lessons from Deep Engagement and Guiding the Experimental Impulse". Invited Presentation at 2017 ACSA Conference, Detroit, Michigan, March 23-25, 2017.
- Albright, D.** 2017. "Assembling the Digital House by Hand: Designing and Building an Idea". Invited Presentation at Augsburg University Design/Build Symposium, Augsburg, Germany, March 21, 2017.
- Albright, D.** 2017. "Wood Renaissance: Wood Design + Building in North America". Invited Presentation at Augsburg University, Augsburg, Germany, March 20, 2017.
- Ashman, W. Pang, W.** Impact of projections on balcony pressure coefficients. Presented at 2017 Mass Timber Conference, Portland, Oregon, March 29-30, 2017.
- Gu, M.** 2017. "Strength and Serviceability Performances of Southern Yellow Pine Cross-Laminated Timber (CLT) and CLT-Glulam Composite Beam".
http://tigerprints.clemson.edu/all_dissertations/2014
- Gu, M. Pang, W.** Hollow Mass Timber & Vibration Serviceability Studies. Presented at 2017 Mass Timber Conference, Portland, Oregon, March 29-30, 2017.
- Joy, J., Jose, C., Yu, X., Mathew, L., Thomas, S., Pilla, S.** 2017. "The Influence of Nanocellulosic Fiber, Extracted From *Helicteres isora*, on Thermal, Wetting And Viscoelastic Properties of Poly(Butylene Succinate) Composites," Cellulose, (DOI 10.1007/s10570-017-1439-y)
- Layton, P.** 2017. Update on our RREA project and presentation of the AskForWood website. SREF Retreat. Oct 10-11, 2017, Cheaha State Park, Delta, Alabama.
- Layton, P.** 2017. AskForWood.com. State Wood Innovation Grants Webinar presented on July 13, 2017.

- Layton, Patricia A.** 2017 How Big is the Market and How Do We Convert it to Wood. Presented to the SC Society of American Foresters Annual Meeting. Florence, SC June 15, 2017.
- Layton, Patricia A.** 2017. SC Wood Innovation Team: Promoting Mass Timber. Invited Presentation to 2017 Mass Timber Conference, Portland, Oregon, March 29-30, 2017.
- Layton, Patricia A., Goetzl, A. and Guynn, S.** 2017 Building Sustainably with Wood. P. 2 Carolina Forestry Journal. Jan-Feb, 2017.
- Pang, W., Albright, D.** 2017. Looking Forward: Leading Edge Solutions through Applied Research in Wood Building Systems. Presented at SE Wood Solutions Fair, Charlotte, NC November 2, 2017
- Reres, L., Pang, W.** Parametric Study of Wind-Induced Vibrations in a Cross-Laminated Timber Building. Presented at the 13th Americas Conference on Wind Engineering, Gainesville, Florida, May 21-24, 2017
- Ross, B.** 2017. The Learning Buildings Framework for Quantifying Building Adaptability. AEI Conference, ASCE Architectural Engineering Institute, Oklahoma City, OK.
- Ross B, Rockow Z., Black AK.** 2017. "The International Database of Demolition and Adaptation" AEI Conference, ASCE Architectural Engineering Institute, Oklahoma City, OK.
- Ross B.** 2017 "Learning Buildings: How to Design and Build Them," Invited Lecture, University of Alabama Department of Civil, Construction and Environmental Engineering.
- Rodriguez, L., Pradeep, S.A., Brown, N., Orrego, C., Pilla, S.** 2016. "Effect of Wood Fiber on Foaming Behavior of Pine Oil based Bioepoxy," The 14th International Symposium on Bioplastics, Biocomposites and Biorefining, Guelph, ON, Canada.
- Schwennsen, K.** 2017. A Brief History of Wood in Buildings. Presented to the SC Society of American Foresters Annual Meeting. Florence, SC June 15, 2017.
- Stoner, M. Pang, W.** Cross-Laminated Timber as a Tornado Resilient Material. Presented at 2017 Mass Timber Conference, Portland, Oregon, March 29-30, 2017.

Other Media and/or News Coverage

- Testing the wind: Clemson engineers work to make buildings stronger in face of storms
<http://newsstand.clemson.edu/mediarelations/testing-the-wind-clemson-engineers-work-to-make-buildings-stronger-in-face-of-storms/>
- \$100,000 donated to Clemson's Wood Utilization + Design Institute
<http://newsstand.clemson.edu/mediarelations/100000-donated-to-clemsons-wood-utilization-design-institute/>
- Clemson architect students designing innovative sustainable housing
<http://wsps.com/2017/02/14/clemson-architect-students-designing-innovative-sustainable-housing/>

- Clemson is in the house: Architecture team is developing a new way to build
<http://newsstand.clemson.edu/mediarelations/clemson-is-in-the-house-architecture-team-invents-a-new-way-to-build/>
- 600 elementary students build to learn
<http://newsstand.clemson.edu/mediarelations/600-elementary-students-build-to-learn/>
- Building a New Field
<http://newsstand.clemson.edu/building-a-new-field/>
- Canada's new UN ambassador designee to speak at Clemson University Friday
<http://newsstand.clemson.edu/mediarelations/canadas-new-un-ambassador-designee-to-speak-at-clemson-university-friday/>
- Letter to the Editor: Fire testing
https://www.postandcourier.com/opinion/letter-fire-testing/article_5e02bb7e-76e2-11e7-bd27-1fc7a0e29a0b.html
- Mount Pleasant hotel first South Carolina building to use lumber said to be strong as concrete
https://www.postandcourier.com/business/mount-pleasant-hotel-first-south-carolina-building-to-use-lumber/article_5708d6f8-581c-11e7-a0f2-9f72dae421c4.html
- Congress gears up for a fight over mass timber legislation
<https://archpaper.com/2017/11/congress-fight-mass-timber-legislation/>
- Clemson Engineers Studying Ways to Make Structures More Resilient Against Hurricanes.
<http://www.wrdw.com/content/news/Clemson-Engineers-Studying-Ways-To-Make-Structures-More-Resilient-Against-Hurricanes-446941693.html>
- www.AskForWood.com – A website developed as a direct result of this grant that is a toolkit for Extension personnel, public, architects and engineers to learn about the benefits of building with wood and how to go about it.
- Have used **#AskforWood** on Twitter 24 times and on Facebook 17 times.
- Building Sustainably videos on the Wood Utilization and Design Institute website.
<https://www.clemson.edu/centers-institutes/wud/sustainable.htmlv>
- [AskForWood.com](http://www.AskForWood.com) Push Cards delivered to Extension Directors, ANR Program Leaders and Middle Managers (2017). (See attached)

FUTURE PLANS

Teaching:

Forestry, Architecture and Civil Engineering will be heavily involved in teaching this spring. Additionally, under Dr. Brandon Ross's leadership we are seeking to become an AIA continuing education provider so that as we participate with others in "lunch and learn's", or other types of events for Architects we can offer credit.

Research:

Faculty Fellows will continue to develop research grants. Another call for USFS Wood Innovation Grants is out and we hope to have at least one proposal in that competition. Additionally we are revising our proposal to USDA NIFA for the Bioproducts Challenge Area in the education area. While we were not funded in 2017 we are addressing the comments and hope to submit in 2018 if this RFP is available. Dr. Layton has met with the program manager and there is some chance that this will be a funding area in FY 2018.

We are reaching out to several partners to try to replicate the out reach event with ULI in SC and possibly Atlanta, GA and NC. We believe that events of this type will allow more developers to learn about mass timber buildings.

Outreach:

Dr. Layton is once again serving on the Mass Timber Conference Program Committee. Plans for that conference are moving along. At Dr. Layton's suggestion, seconded by WoodWorks, a keynote session will be about passing the Tall Wood Building Code.

Additionally Dr. Layton has been asked to serve on a steering committee organized by AWC to help with increasing the number of positive votes for the addition to the 2021 IBC codes.

Built Environment Laboratory:

The legislative ask to the State legislature will require some time and effort this spring to support. If that passes then our team and the other partners in this joint effort will go into renovation mode as quickly as possible. If additional funding is needed to complete the renovation, we will seek funding from the US Department of Commerce. We have held initial discussions with Ms. Robin Cooley from this organization and it is believed that our laboratory renovation meets the criteria for funding. The state funding would provide the cost share for this.

Institute Operations

The Institute needs to develop a strategic plan this year for our future development. This will aid the University's administration in understanding our Institute and the opportunities for it to grow and support the mission of the PSA and the University. This is especially important, as there are some administrative changes at the University level that were not involved in the initial development of the Institute.

Additionally we would like to continue to grow our membership and have more active participation of our members in our Research, Teaching and Outreach so that the members find significant value in their investment in our Institute.