# TABLE OF CONTENTS

EXECUTIVE SUMMARY .................................................................................................................. 3

REVIEW OF ACTIVITIES ............................................................................................................... 4
   Architecture Activities ............................................................................................................... 4
   Engineering Activities ............................................................................................................... 5
   Outreach Activities (Wood Promotion) ...................................................................................... 8

GRANTS AND CONTRACTS ........................................................................................................ 11

MEMBERSHIP ............................................................................................................................ 13

FINANCIAL OVERVIEW ............................................................................................................. 15

BUILT ENVIRONMENT LABORATORY PLANS ............................................................................ 16

PUBLICATIONS AND PRESENTATIONS FOR 2017 ............................................................... 19

FUTURE PLANS .......................................................................................................................... 22
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-8guNPA

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  

   **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 layups (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  

   **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

### Recent WUD Research Fellow Graduate


### 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. Addition 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
- 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.

---

**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 Retarded 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 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 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.