CU-iMSE

CLEMSON INSTITUTE FOR INTELLIGENT MATERIALS, SYSTEMS AND ENVIRONMENTS

School of Architecture
College of Architecture, Arts, and Humanities
CLEMSON University

DEC 2022

Applied Research in Built Environments

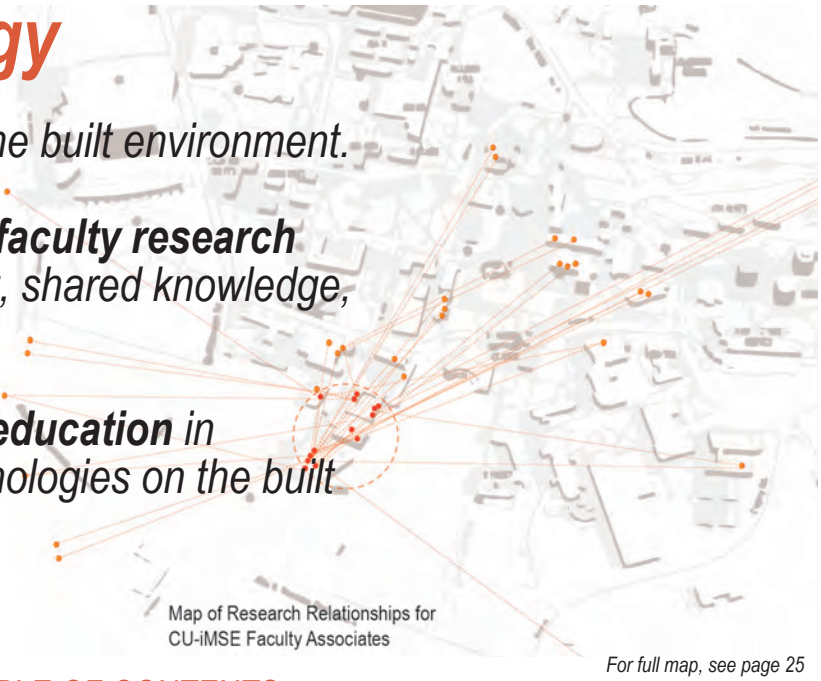
Institute for Intelligent Materials, Systems and Environments
Fostering research for a better built world

Institute Strategy

*To **increase research** on the built environment.*

*To **promote and facilitate faculty research** through public engagement, shared knowledge, and dissemination.*

*To **support research and education** in applied problems and technologies on the built environment.*



Map of Research Relationships for
CU-iMSE Faculty Associates

For full map, see page 25

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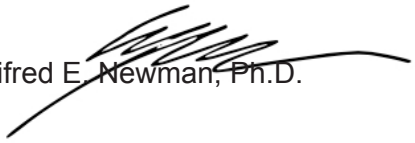
Cover image: Project by Yuting Lu, student in ARCH 6990-01 Smart Materials and Kinetic Structure F2020, faculty V. Blouin

The global pandemic impacted everyone: students, faculty and researchers. Our isolation from each other and our labs and workspaces meant less collaboration in the built environment and less research on the problems in the built environment. The faculty associated with the institute made the most of their time in the last two years to promote, develop and publish their work. Many completed ongoing projects and worked on submissions for future funding. Their research continues to range in focus and scale from self-healing structural systems to digitally out-sourced DIY construction, camouflage landscapes for drones to adaptive environments for aging. As the world emerges from the pandemic with new insight into the environment and our part in it's stewardship, it is an exciting time to engage the world as a designer where human interaction with our environment is being cataloged, measured and considered from the standpoint of the experiential to the mathematical. Virtual and real environments intersect; creating nuanced and subtle conditions in the built world previously impossible to imagine. Institute faculty push the boundary of what it means to be a designer in architecture and landscape architecture and allied fields.

CU-iMSE offers researchers an institutional structure to work across departments and college boundaries on shared problems of interest. Focusing on applied research in the built environment leverages the strengths of the School of Architecture and the university to engage faculty with expertise and knowledge in computational design, digital fabrication, smart materials and structures, adaptive and responsive environments, robotics and parametric and generative design. Working with faculty from engineering, art, computer science, industrial design, humanities, agriculture and other disciplines means we are able to contribute to a broad range of problems leveraging diverse knowledge and backgrounds.

As we start our next three-year plan in the context of the Clemson Elevate, CU-iMSE contributes to two significant areas: sustainable environments, health and artificial intelligence. The latter is a significant tool of inquiry in the allied disciplines of the built environment engaging human social structures, economic and institutional impacts and policy, codes, resource use and resilience in the broadest application. Institute faculty address research and education through funded grants, the graduate-level certificate program, Critical Inquiry courses, community service and service-learning projects, workshops, public lectures, poster presentations, and online and in-person courses.

Thanks to Jim Stevens, Director of the School of Architecture for his support of the mission of the Institute and the faculty and staff who make it possible. In addition, Brad Elliot and Diana Thrasher in the Office of Sponsored Research and Esther Kaufman, the financial director for the SoA all make a tremendous contribution to the ongoing programs and events at CU-iMSE. Thanks also to PhD student Tong Liu, PhD and most excellent webmaster and Arielle Spencer, PhD Student and support.



Winifred E. Newman, Ph.D.

Director, Institute for Intellgient Materials, Systems and Environments and Mickel Endowed Professor in Architecture

CU-iMSE Statements of Governance | 2

The Clemson University Institute for Intelligent Materials, Systems and Environments is an interdisciplinary research unit focused on applied research in the built environment.

CU-iMSE engages diverse knowledge areas including architecture, landscape architecture, planning and real estate development, construction science and management, civil engineering, mechanical engineering, electrical engineering and computer science, environmental engineering, materials science, law, business, marketing, psychology, and human factors. As such, the Institute comprises faculty from departments and colleges across the university. The *Institute's mission and objectives are built on the research and expertise of the faculty.*

Statements of Governance | 1.0 Mission

CU-iMSE is a transdisciplinary Design-Research Institute in Applied Research impacting the built environment. The Institute works across multiple scales from building and landscape materials to large scale urban communities and ecosystems. As an interdisciplinary research unit, the Institute works to advance research in applications of informatics in the design, management, development and construction of the built environment.

Statements of Governance | 2.0 Vision

Creative and aggressive ***COLLABORATION*** in the academic-industrial sectors of the built environment is critical to solving challenges facing us in the information age. Moving between informatics, systems, ecologies and physical outcomes enables us to make BETTER DESIGN DECISIONS, develop solutions faster and bring new products and processes to industry and manufacturing.

The Institute promotes systems thinking in design, development of architecture technology and digital and human-machine hybrid solutions as part of a paradigm shift in the design and occupation of the built environment. We participate in the design, research, and evaluation of intelligent environments, their materials and systems. CU-iMSE aligns the university with industry, manufacturing and government partners to develop sustainable and resilient solutions for tomorrow's problems in the built world.

Statements of Governance | 3.0 Values

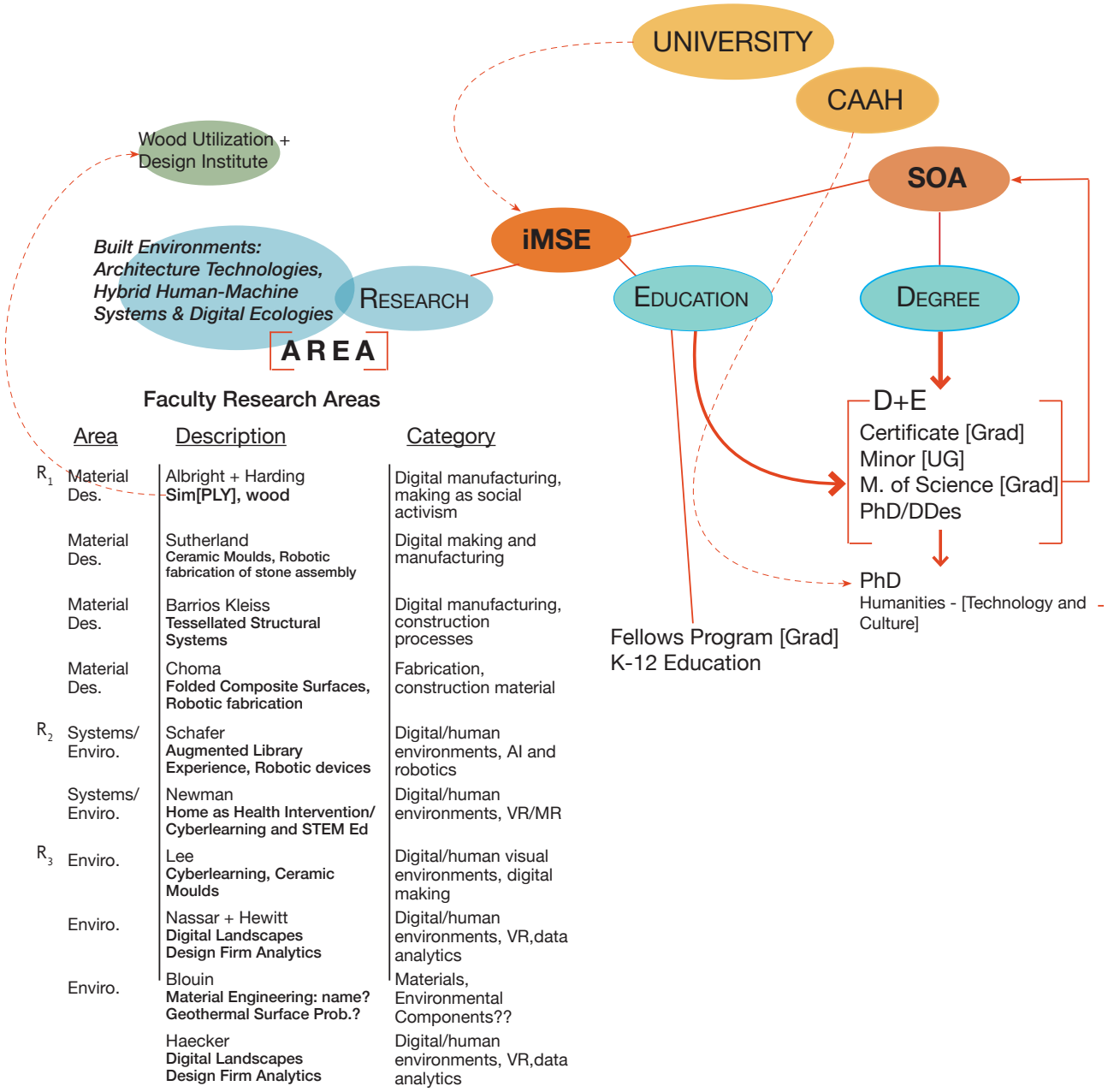
The digital ecology of the Institute includes design practices that promote ***SUSTAINABILITY*** and ***RESILIENCY***, manage and reduce the consumption of ***natural resources***, promote the use of ***DATA AND COMPUTATIONAL DESIGN*** for robust design decision spaces. We promote the development of human-machine hybrid solutions to address environmental, technological and social change while seeking to understand how these changes shape our world.

CU-iMSE Overview and Context | 3

The Institute is part of the University mission to promote Research, Engagement and the Academic Core. It is located in the College of Architecture Arts and Humanities associated with the School of Architecture. Director Newman is the Mickel Professor of Architecture in the faculty of architecture.

The Institute includes RESEARCH and EDUCATION in coordination with the degree programs offered by the SoA and engaged in service learning and K-12 education where possible [see Diagram 1: Organization Chart]. The primary role of the institute is to promote research in the built environment, but secondarily we prepare our professional workforce for challenges in technology, computational design and environmental and building systems.

Diagram 1: *Organization Chart*



The Institute overseas the Digital Ecologies Graduate Certificate in the SoA, a track in the Master of Science and the architecture technology area in the PDBE.

Associated faculty participate in developing curriculum and degree programs in their respective departments. The synergy between education and research represented by the faculty offers opportunities for program areas to respond to emerging areas of study.

CU-iMSE Strategy | 4

The Institute aspires to develop and foster robust funded research in the built environment. To do this, we are starting with a three-year plan to develop faculty awareness of opportunities for large-scale funded research in architecture and landscape architecture through federal, state and local grants. Creating a research infrastructure requires creating a research culture. Of the allied AEC, architecture, engineering and construction disciplines, architecture and construction are lag behind in producing and disseminating applied research products in both academia and the profession.

To achieve this aim, our strategy is to foster collaboration within School of Architecture departments and with departments in the college and university, promote faculty scholarship and research, and develop future researchers through education.

Institute Office, used for research and education, Lee 3-G07

Foster Research in the Built Environment through Collaboration

In our current funding context, being aggressive and creative about collaboration is the best way to address significant challenges in research. Building a culture of collaboration requires helping faculty recognize the benefits of multi-person teams in their personal and professional development. Government and industry large-scale funding is only possible with teaming.

Service facilities for the SoA with tools used by Institute researchers.

Promote Faculty

Faculty must already promote their work through publications and public presentations. The Institute additionally helps faculty disseminate their work through websites, newsletters, news articles, and online academic forums. Promoting affiliated faculty at the university, nationally and internationally is key to garnering attention and support for their work.

Develop Future Researchers

Education is the foundation of academic and professional competence. Developing, managing and getting funding for research is an acquired skill. The Institute hopes to develop educational opportunities for undergraduate, graduate and post-graduate education to grow future researchers in our disciplines.

Strategic Challenges

The faculty in the Institute met regularly during the AY 2018-19 and identified a series of strategic challenges outlined here.

Building Awareness

From 205-2017 there was a transition in directors for CU-iMSE. The previous and founding director built CU-iMSE into a robust unit focused on a narrow research area in architecture. During the transition, there was little to no activity and there is a need to build awareness of the new and somewhat broader scope of the institute.

Culture of Research

Creating a culture of research in the allied disciplines of architecture and landscape architecture requires time, support and belief in it's value to our professions. The current architecture education model is based on professional education culminating in licensure. Similar to challenges faced in medicine fifty years ago and law schools now, creating a culture of research where students and faculty participate in replicable studies that are shared as part of our knowledge is paramount to developing applied research in architecture and landscape architecture.

Research Infrastructure

Large-scale funding comes with infrastructure to support graduate and post-graduate education and fellowships. These students are the backbone of ongoing research projects. They enable researchers to produce high-quality articles, books, and book chapters, scientific posters, lectures and online documentation of results of studies. The support and growth of this infrastructure is a challenge in the context of the professional schools.

Diversifying Education Opportunities

Refining and developing successful pipelines to grow graduate student researchers and professional architects and landscape architects able to work in industry is one of the focuses of CU-iMSE. Diversifying education opportunities through certificates, post-professional education and Ph.D. degrees is one of the challenges facing the growth of a research population. Managing this responsibly is critical to make it possible in a cost-conscious educational environment where faculty time and commitments must be respected, and students must be prepared not only for research in academia but in industry and government.

Developing New Education Opportunities

Addressing growing areas of specialization in the profession through research is one of the links between industry and CU-iMSE. Contributing to this through research projects, links between courses and ongoing research and workshopping hepling students develop new skills along with knowledge in computational design challenges us to adapt faster than typically possible within the curricular structures of departments. The Institute helps fill the gap through collaborations between faculty, discussions, and rapid dissemination of information around innovation challenges in our allied disciplines.

CU-iMSE Goals | 6

Over the next three years, the Institute hopes to increase research applications for funding and grants received for associated faculty. But more importantly, the Institute should increase awareness within our professions and without about the relevance and importance of applied research in the built environment.

The following goals outline specific strategies. However, any good strategic plan should be considered a dynamic document able to respond to local and global conditions. These goals are a framework meant to act a sign posts for change, not signs of success. Achieving one or all of them does not guarantee success or the long-term sustainability of the institute. This must be an ongoing thoughtful and measured response to conditions as they emerge from the present and project us into an indeterminate playing field with multiple possible outcomes.

Goals | 1.0 Grow Identity and Relevance

Increasing the visibility of the Institute on campus and in the public realm. This will be through participation in research opportunities to promote faculty work, encouraging faculty to apply for fellowships, internal grants and seed funding. Participating in the Building and Environments Lab (BEL) by encouraging faculty to use the facility for grants and funded educational opportunities.

Goals | 2.0 Develop Industry Partnerships

Promote and develop at least two new industry partnerships over the next three years. Using a similar model as the Wood Institute, we hope to have an annual membership system for allied manufacturers and building components industry partners. This may also be in the form of funded Fluid studios for associated faculty in the SoA.

Goals | 3.0 Increase Support

Increase financial support for the Institute through
1.0 faculty-driven funded research and
2.0 a program grant, e.g. NSF-RCN, GERD or similar to create fellowships for students.

Goals | 4.0 Create Educational Content

Create educational content through
1.0 developing an online Digital Design Certificate or 36-credit Master program for digital-to-virtual design and fabrication.
2.0 participate in developing new doctoral degree in Technology and Ethics--this would be a joint effort with departments in CAAH.

Goals | 5.0 Extend Local Reach

Engage with Tri-County Technical College and the Anderson Innovation Academy to promote community college transfers and K-12 connections to the Institute.

Goals | 6.0 Extend National Presence

Extend national presence by
1.0 participating on national boards for journals and our collateral associations for the professional school to increase the national profile of the Institute.
2.0 hosting a national conference at Clemson.
3.0 continuing to organize departmental research talks, symposia and colloquia for the university community.

CU-iMSE Associated Faculty | 7

Faculty associated with the Institute represent multiple departments across two colleges, the College of Architecture, Arts and Humanities and the College of Engineering. Faculty maintain active research partnerships with other instututes and centers creating a broad network of collaboration at the university. Faculty work with the Watt Innovation Center, The Wood Institute, the Instiute for Engaged Aging and others. Researh partners include facutly from Computer Science and Human Centered Computing, Civil and Mechanical Engineering, Advanced Material Science, Psychology and Human Factors, Agricutlure, Electrical Engineering, GIS, Health and Behavioral Sciences, Education, Art, German Studies, History, English and Philosophy and Religious Studies, Material Science and Graphic Design.

Timothy Shan Sutherland
Lecturer in Architecture
Director, DDS
Faculty Fellow CU-iMSE
https://www.clemson.edu/centers-institutes/cuimse/04people/Faculty_individuals%20/06_timothyshansutherland.html

Daniel Harding. RA
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Brygg Ullmer, HCC

Professor in Human Centered Computing
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Vincent Blouin, PhD

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Miriam Konkel, PhD
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Sida Dai, PhD
Post-Doc, Human Centered Computing
Fellow, CU-iMSE
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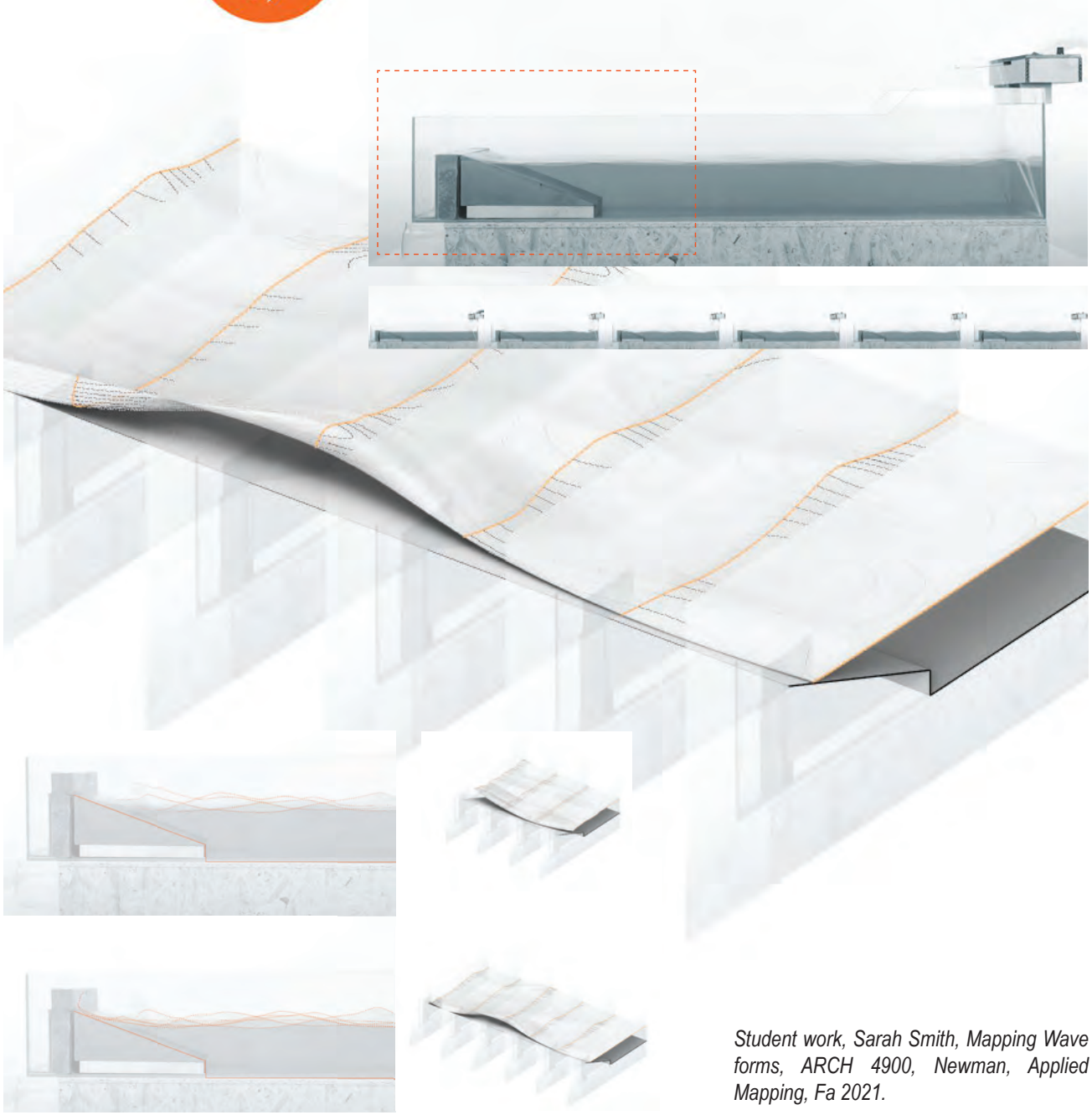
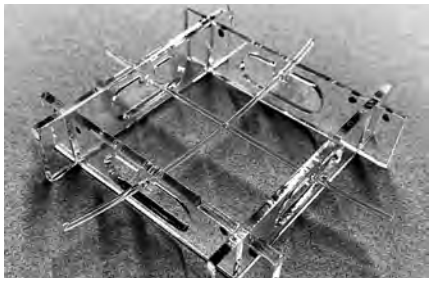
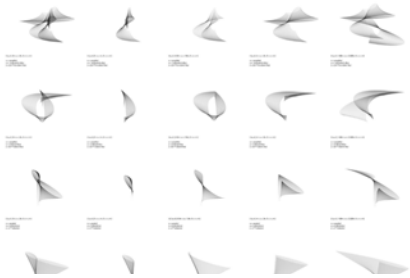
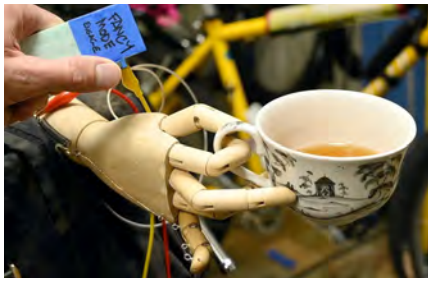


Student work, Sarah Smith, Mapping Wave forms, ARCH 4900, Newman, Applied Mapping, Fa 2021.







CU-iMSE Research | 8

https://www.clemson.edu/centers-institutes/cuimse/02research/index.html

The Institute fosters multi- and trans- disciplinary research in applied problems in the built environment. Faculty and students collaborate to develop new approaches for designing, fabricating, manufacturing and assembling landscape and building solutions across multiple scales. The work outlined below includes ongoing and proposed projects from AY 2018-2020. Funding sources for current and past work listed in Research, 4-2.0 Funding Support.

SimPLY; Patent #10,156,067: Team: Daniel Harding, Dustin Albright, Ulrike Heine, Vincent Blouin, Ufuk Ersoy, others. The Sim[PLY] system utilizes interlocking plywood components, each prefabricated using CNC routers and digital cut files. Assembly of the numbered components follows pictographic instructions and requires only manual tools, eliminating power tools and making construction safer and energy-efficient, ongoing

NSF-2012814 Project title: Collaborative Reserach: Tesselllated Structureal-Architectureal systems for Rapid Construciton, Repair, and Disassembly, PI: Michael Carlos Barrios Kleiss (Arch), Co-PI: Brandon Ross (Eng), $900,000, funded

Funded Conference, Organizer, the Campus Alliance for Advanced Visualization (CAAV) 5th Annual Conference, ONLINE at Clemson University, co-sponsored by the Watt Family Center for Innovation, collaborators: Barbara Spaziale, Tullen Burns, Nate Newsome. https://caavcon.com/

Prisma Health Transformative Seed Grant Program: Everyday Function Application, PI: Lesley Ross (Cog. Psy.) Co-PIs: W. Newman (Arch), Paige Rodeghero (Cog. Psy.), Alyssa Gamaldo (CS), Alain Litwin (MD), $10,000, ongoing

CU-SEED-Tier #2: Mapping Visual Stimulus Complexity & Spatial Navigation: Factors that Change with Age, PI: W. Newman, Co-PI: Kaileigh Bryne (Cog. Psy.), $10,000, ongoing

USDA, A9201 - Sustainable Agricultural Intensification (Land Stewardship), Identifying Conservation Priority Areas (icon) in the Southern United States to Ensure the Supply of Roundwood for New Market Opportunities & Safeguard Ecosystem Services, PI: P. Dwivedi, Co-PIs (Clemson): Pat Layton, W. Pan, P, Khanal, D. Albright, W. Newman, $14.6M, pending

ACCelerate Creativity and Innovation Festival 2022, Smithsonian Museum of American History, Washington, DC: selected to represent Clemson. The project, "Ferntor: Fargates between People, Places, and Events," in collaboration with Brygg Ullmer (CS) and Miriam Konkel (Microbiology), is an extension of the NSF MRI "Enodia" project, funded

CU FELLOWS: Strengthening the intersection of technology and successful aging: An application to hire an Associate Research Professor, PI: Lesley Ross, Co-PIs W. Newman, funded

NEA "Our Town": W.E. Newman (PI), Co-PIs: Brygg Ullmer (CS), Miriam Konkel (Microbiology), Sida Dai (CS), Shan Sutherland (Arch), $150,000, pending

NSF MRI: Enodia, Brygg Ullmer (CS) PI, Co-PIs: Miriam Konkel (Microbiology), W.E. Newman, $750,000, submittal in progress

NSF Research Concept Outline, C-Accel Pilot - Track A1 (Open Knowledge Network): CREATED: Coupling Research and Education to Accelerate Discovery of Open Knowledge Networks, Kuang-Ching Wang, D. Hudson Smith, Brygg Ullmer, Winifred E. Newman, Kapil Chalil Madathil, Nathan Newsome, Amy Apon, Cole Smith, Todd Marek, David White, Alex Feltus, Miriam Konkel, M.D., Venkat Krovi, Jerome McClendon, Ronald Gimbel, Khoa Truong., Scott Mason, Jeffrey Fine

Clemson Transformative Seed Grant. Experience, PIs Drs. W. E. Newman (Clem) and Suzanne Swedberg (Prisma), Co-PIs: Timothy Shan Sutherland (Clem), Dr. George Schafer (Clem), Dr. Kinsuk Maitra (GSU), $20,000

ACL Mental Health CHALLENGE, PaAT: Personal artificial AssisTant: An Online Personal Concierge, PI: W.E. Newman, Co-PIs, Cheryl Dye, Kelly Caine (CS), Ye Luo (Soc.), Kapil Mandathil (Eng), Kaileigh Byrne (Cog. Psy), Brodrick Stigall (CS), Phase 1, $150,000

NSF - MyPATH: Harnessing Rich Data in the University for Goal-driven STEM Education and Accelerated Discovery, PI Dr. Kuang-Ching (KC), Co-PIs: Dr. Bridget Trogden, Dr. Marisa Orr, Dr. Winifred E. Newman, Dr. Marissa Shuffler, Dr. Barbara Speziale, Dr. Claire Dancz, Cora Allard, Dr. Carl Baum, Dr. Matthew Boyer, Troy Nunamaker, $3,800,000

NIH Par-45, Infrastructure Support for Research Optimizing Cognitive and Physical Functioning of Rural, Older Adults, PI: Dr. Cheryl Dye (Health Sci), Co-PIs: Drs. W. E. Newman (Arch), Kaileigh Byrne (Psy), Ye Luo (Soc), Kapil Madathil (Eng), $1,799,167.00, pending

Watt Fellow Project, South Carolina Health Stat-Map, a statistical profile aggregated from existing data describing South Carolinians and their unique health and wellness concerns using machine learning or AI and GIS software to create an interactive map of existing data as an analytical support tool to promote more efficient and effective health planning. Participants: W. E. Newman (Arch), Caitlin Torrence (Health Sci), D. Hudson Smith (Watt)

Watt Fellow Project, Developing a Technology-Enhanced Teamwork Training & Assessment Program for Higher Education. Improving team dynamics using play and technology. Participants: Michael Kleiss (Arch), Nathan McNeese, Jennifer Ogle, Johannes Schmidt, Marissa Shuffler.

PCI Foundation Research Grant ($100,000 Grant) Pre-Cast & Pre-Stressed Concrete Institute, PIs Dr. Carlos Michael Barrios Kleiss (Arch), ongoing.

NIST-PSIAP- PC2- Amended NOFO Hala Nassar, Co-PI: “Using LIDAR Technology for improving public safety.” $139.900

NSF Grant. PI: “Drones and the Design of Public Open Space.” Hala Nasaar, Co-PI, Robert Hewitt. In collaboration with Duke University Departments of Mechanical Engineering, Material Sciences and Human and Autonomy Lab, and Duke Robotics. $ 750,000, ongoing

NSF Grant, A Global Interdisciplinary Network for Pedestrian Safety Research, CoPI, Robert Hewitt, $750,000

World Design Studio, Combined grants from multiple sources for Charleston fieldwork, symposium, and MOU events – CAF SoA, LA Program, Dean of CAAH, Provost, Vice-Provost on International Engagement, Co-Pis Hala Nassar, Robert Hewitt, $25,000, funded.

NIST Grant, PSIAP Point Cloud City: Cataloging Critical Facilities in Upstate South Carolina, $138,000, Co-PI Robert Hewitt, not funded.

CU SEED-Tier 2: History in 3D A Three Dimensional Approach to Preservation and Archiving of Buildings of Historical Significance for Research and Learning in Architecture and the Humanities, PI: Michal Carlos Barrios Kleiss, Co-PI Ufuk Ersoy (Arch), not funded

NSF-Future of Manufacturing, Project title: Manufacturing in Extreme Environments: Digital Fabrication of Reconfigurable Habitats for Off-world Applications for On-World Innovation, PI: Michael Carlos Barrios Kleiss (Arch), Co-PI: W.E. Newman (Arch), pending

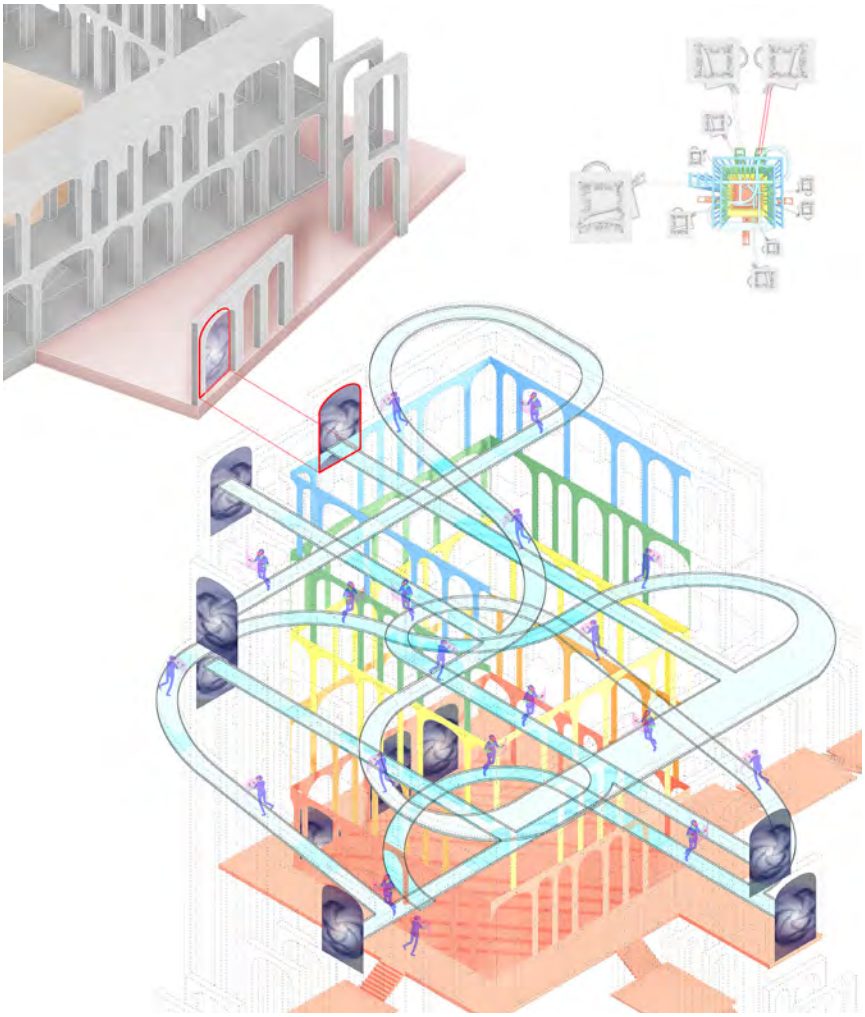
Transformative Seed Grant, DESIGN FOR USE: U-Rest PROOF of CONCEPT ASSESSMENT OF WHEELCHAIR IMPROVEMENTS APPLYING USERS' PSYCHO-SOCIAL EXPERIENCE AND HAPTIC MODELING, PIs Drs. W. E. Newman (Clem) and Suzanne Swedberg (Prisma), Co-PIs: Timothy Shan Sutherland (Clem), Dr. George Schafer (Clem), Dr. Kinsuk Maitra (GSU), Michelle Huskamp (Prisma), $20,0000, not funded

NIH Par-45, Infrastructure Support for Research Optimizing Cognitive and Physical Functioning of Rural, Older Adults, PI: Dr. Cheryl Dye (Health Sci), Co-PIs: Drs. W. E. Newman (Arch), Kaileigh Byrne (Psy), Ye Luo (Soc), Kapil Madathil (Eng), $1,799,167.00, pending

Watt Fellow Project, South Carolina Health Stat-Map, a statistical profile aggregated from existing data describing South Carolinians and their unique health and wellness concerns using machine learning or AI and GIS software to create an interactive map of existing data as an analytical support tool to promote more efficient and effective health planning. Participants: W. E. Newman (Arch), Caitlin Torrence (Health Sci), D. Hudson Smith (Watt)

Watt Fellow Project, South Carolina Health Stat-Map, a statistical profile aggregated from existing data describing South Carolinians and their unique health and wellness concerns using machine learning or AI and GIS software to create an interactive map of existing data as an analytical support tool to promote more efficient and effective health planning. Participants: W. E. Newman (Arch), Caitlin Torrence (Health Sci), D. Hudson Smith (Watt)

Clemson University & Prisma Health - Upstate Innovation Maturation Fund U-Rest Proof of Concept Assessment of Wheelchair Improvements Applying Users' Psycho-social Experience, PIs Drs. W. E. Newman (Clem) and Suzanne Swedberg (Prisma), Co-PIs: Timothy Shan Sutherland (Clem), Dr. George Schafer (Clem), Dr. Kinsuk Maitra (GSU), Michelle Huskamp (Prisma), $25,000



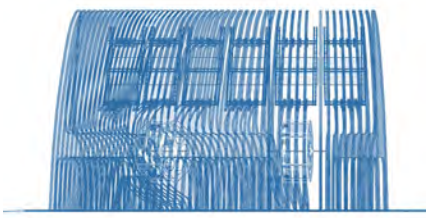
The CAAV Conference virtual reality platform created in Mozilla Hubs with AWS included a general meeting space and separate 'rooms' for talks and industry presentations. The project was jointly developed by iMSE and the Watt Family Center for Innovation. Archived in Tiger Prints, Clemson Univ.

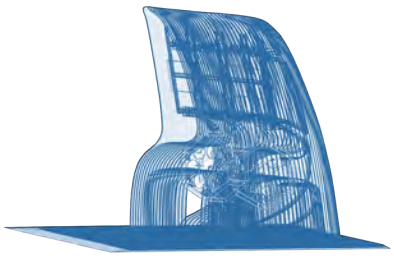
https://news.clemson.edu/two-clemson-exhibits-put-on-display-at-smithsonians-national-museum-of-american-history/

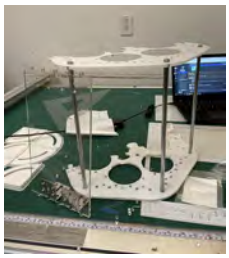
Clemson team selected to represent the university at the Smithsonian Museum ACCelerate Innovation, April 7-9, 2022. Our entry was an interactive interactive telecommunication and telepresence environment where you sense other people as they interact with the same information. The applications of this tangible user interface include communication in extreme environments, workplace collaborations, and adaptive home environments. *Selected to participate in Artisphere 2022 in Greenville, SC.*

Clemson Team

Dr. Brygg Ullmer, computer science
Dr. Winifred E Newman, architecture
Dr. Miriam Konkel, biology
Prof. Timothy Shan Sutherland, architecture
Dr. Sida Dai, architecture
Mitali S. Bhosekar, computer science
Joshua Graham, architecture
Kyle Kane, architecture
Laila Shafiee, computer science
Aika Washington, computer science
Dr. John Griffin, Senior Associate Provost,
Provost and VP Academic Affairs







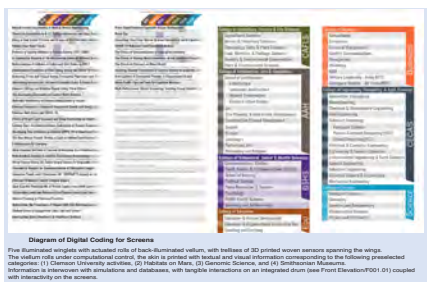


Diagram of Digital Coding for Screens

Five illuminated winglets with actuated rolls of back-illuminated vellum, with trellises of 3D printed woven sensors spanning the wings. The vellum rolls under computational control, the skin is printed with textual and visual information corresponding to the following preselected categories: (1) Clemson University activities, (2) Habitats on Mars, (3) Genomic Science, and (4) Smithsonian Museums. Information is interwoven with simulations and databases, with tangible interactions on an integrated drum (see Front Elevation/F001.01) coupled with interactivity on the screens.

RESEARCH | 1.0 Partner Institutions

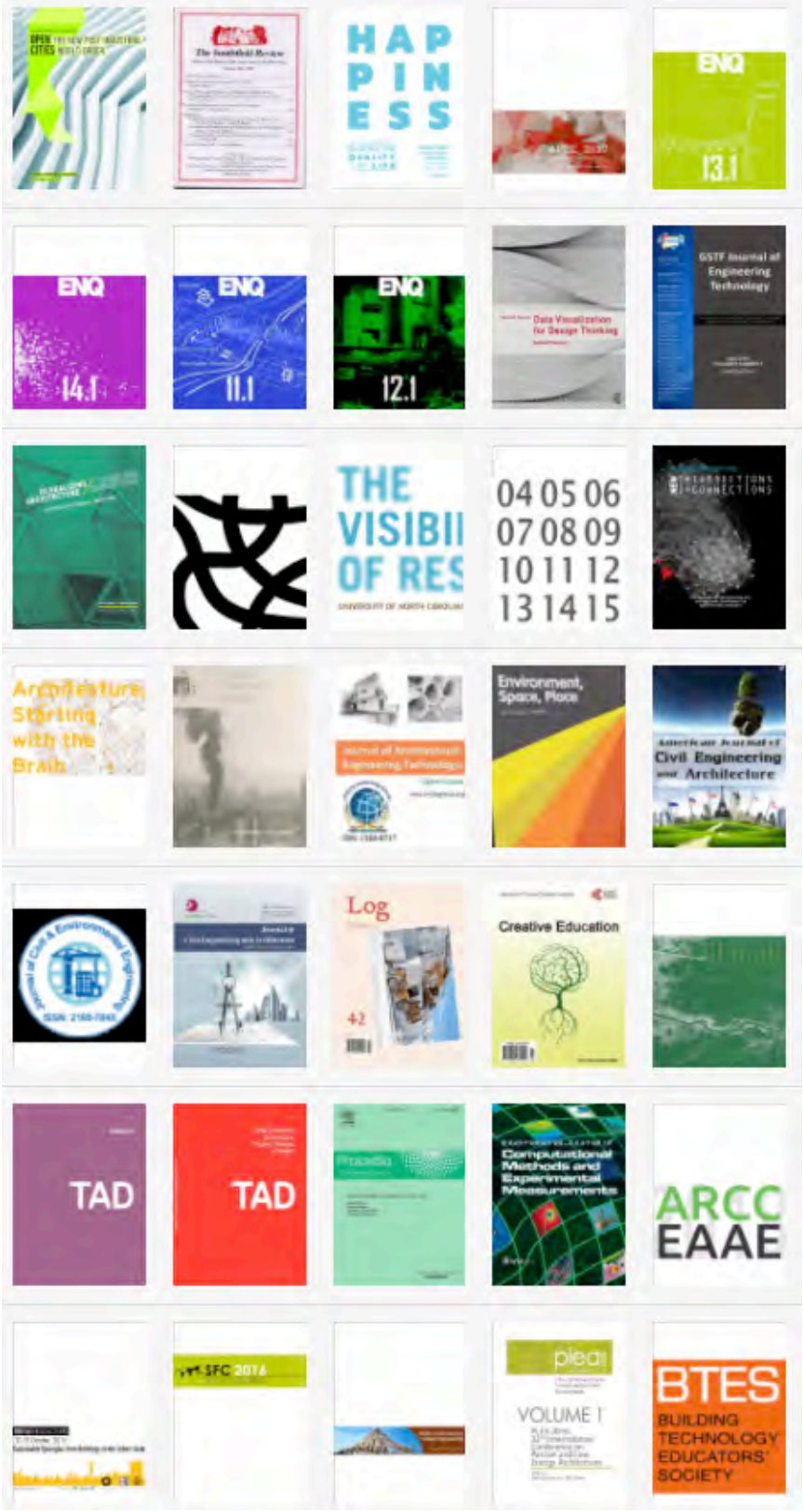
*Over **12** institutions, including **state**, **private**, **national** and **international** universities partner with CU-iMSE faculty.*

RESEARCH | 2.0 Funding Support

*Over **32** funding agencies supported research by CU-iMSE faculty. This includes **federal**, **state,** and **local government** and **industry** funding.*

1 *CU-Fellow successfully awarded with IEA for the Postdoctoral Fellowships in ADRD Research Dissemination.*

36 *is the* ***number*** *of journals and conference proceedings with faculty articles. In AY 2020--22 faculty published an average* **2** *articles per year.*



EDUCATION | 1.0 Digital Ecologies Certificate

https://www.clemson.edu/caah/departments/architecture/programs/graduate/certificates/a+de.html

***a - c** Student work, Yuting Lu 4D Printing + Shape Memory Polymers (SMP)*
***d - f** Student work Anastasia Maurina, Deployable Structures, Vincent Blouin, PhD Advisor.*

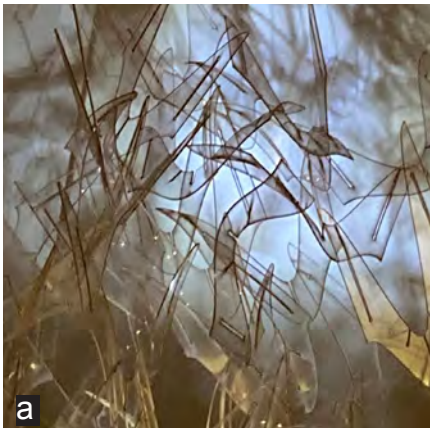
CU-iMSE faculty associates oversee the Graduate Certificate in Digital Ecologies.* Revisions to the certificate requirements added a studio option and Ph.D. time in fall 2019. The certificate cultivates knowledge through research and design practices responding to our increasingly digital society. The DE certificate cultivates theory, application and innovation in a number of areas related to computational design.

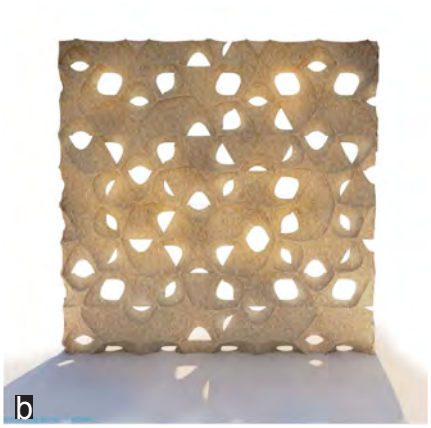
The Program requires 15 credit hours of design studios, research time* and courses at Clemson or one of the Clemson Fluid campuses.

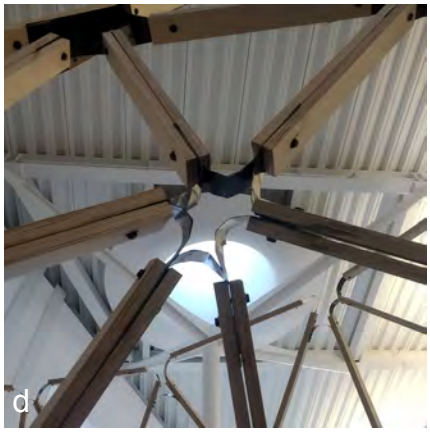
SAMPLE COURSES

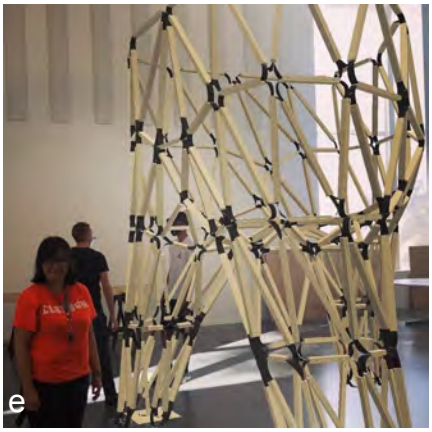
- **Computation Design Methods** ARCH 8120, Spring
- **Smart Materials & Kinetic Structures** ARCH 8760, Fall
- **Digital Manufacturing Processes** ARCH 8780, Fall
- **Interactive, Responsive and Assistive Artifacts and Environments** ARCH 8790 Special Topics in Architectural Technology, Spring
- **Directed Studies in Landscape Architecture** LARC 8900, Fall and Spring
- **Directed Studies in Architecture** ARCH 8900, Fall and Spring
- **Selected Topics in Architectural Technology** ARCH 8790, Fall and Spring

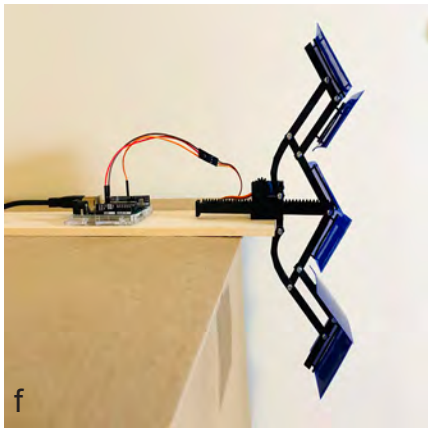
** Not all faculty that administrate the certificate associated with iMSE.*

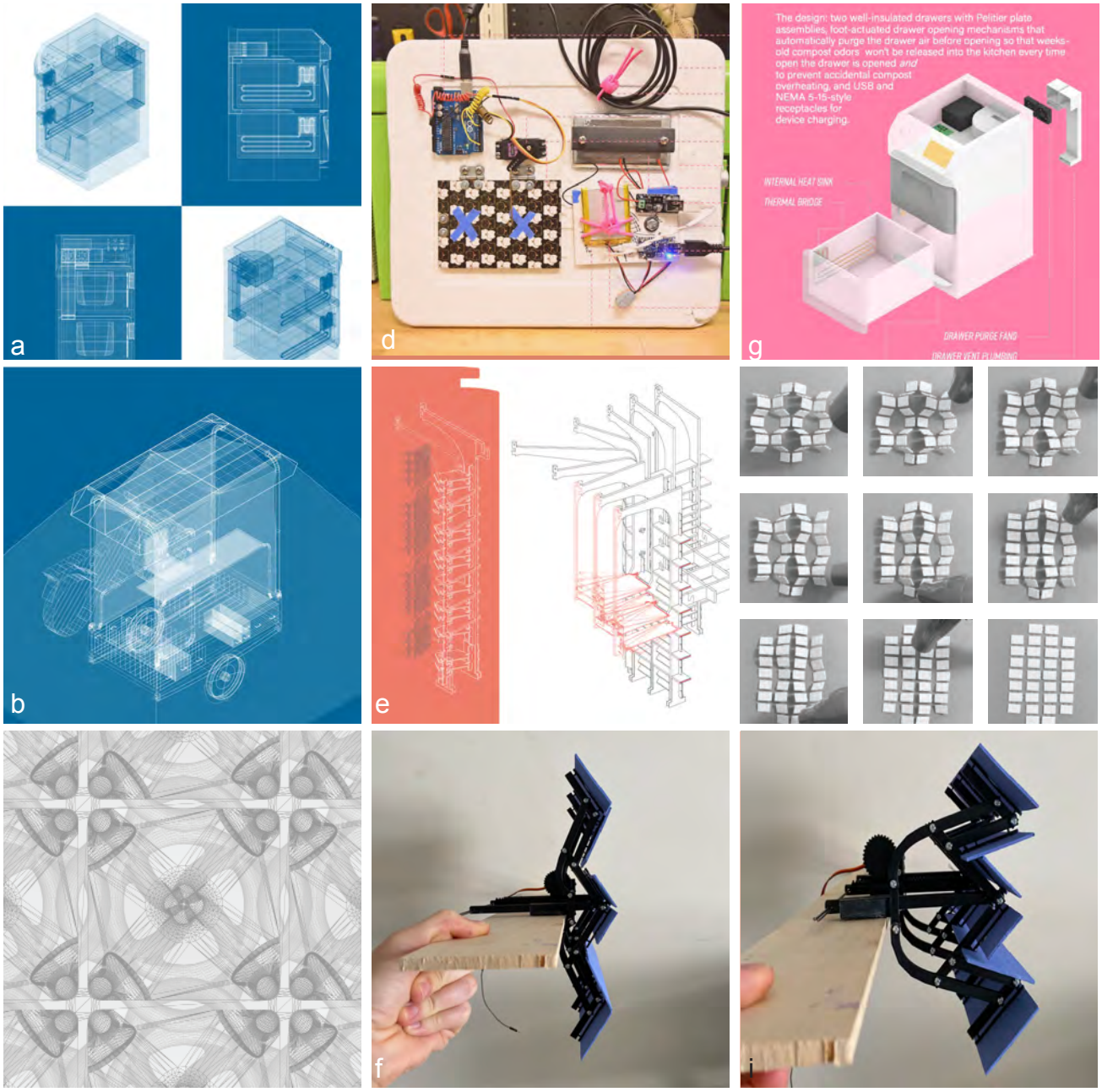












a, d and ***g*** *Student work, H. Floyd, COM | Port Post, Energy - Harvesting Smart Composting System ARCH8760 + ARCH8570, Instructor: V. Blouin*

b and e *Student work, H. Floyd, ARCH 8570 (Studio), Vessel: Mind and Matter, Instructor: D. Harding*

c *and* ***h*** *Student work, Sarah Smith, DMP +Kinetic Stuctures using memoery shapy polymers*

f *and* ***g*** *Student work, Marissa Cutry, ARCH 8760 | SMART MATERIALS + KINETIC STRUCTURES, Instructor: V. Blouin*

EDUCATION | 2.0 Master of Science in Architecture - Technology Track

Starting in AY 2018 and continuing to AY2022 faculty in Digital Ecologies reviewed the current technology track in the Master of Science in Architecture. Based on this analysis, it was determined to 1) develop better marketing and promotion for this area, 2) evaluate whether to include tracks, themes or faculty projects as part of the program description and 3) revise the current website text and images. We anticipate making a recommendation Spring 2021-22

EDUCATION | 3.0 Students

Students engage at all levels with iMSE facutly; from PhD students in the CAAH PDBE program to graduates in our Digital Ecologies Certificate Program. Undergraduates take Critical Inquiry courses, Fluid studios and seminars. They are able to engage direclty with iMSE faculty research through the Critical Inquiry courses offered through the Honors College.

Post-doctoral Students

Mevlut Tascan Materials Sci. and Eng., graduated > academia
Sida Dai Architecture, current

Doctoral Students

Chin Ho Ko Architecture, current
Henrique Houayek Architecture, graduated > academia
Apoorva Kapadia Elect. and Comp., Eng., graduated > academia
Nathan Klein Psychology/Human Factors, graduated > industry
Stan Healy Healthcare Administration/MUSC
Joe Manganelli Architecture/PDBE, graduated >
Tarek Mokhtar Architecture/PDBE, graduated > academia
George Shafer Architecture/PDBE, graduated > academia
Arash Soleimani Architecture/PDBE
Arielle Spencer Architecture/PDB
Anthony Threatt Architecture, graduated > U.Vanderbilt Post-Doc
Yixiao Wang Architecture, graduated > Ph.D. PDBE
Paul Yanik Electrical and Comp. Eng., graduated > academia
Nyoman Dewi Pebryani Architectural Design, Technology + Construction Processes, graduated >Ph.D. PDBE
Qingqing Sun Architecture. Architectural Design, Technology + Construction Processes
Goulwendin Alexia Nikyema Architecture. Architectural Design, Technology + Construction Processes
Niraj Poudel Architecture/PDBE, graduated
Maryam Hamidpour Architecture/PDBE, graduated
Nixon Wonoto Architecture/PDBE, graduated
Anastasia Maurina, deployable structures
Fawaz Alshatti, environmental sustainability of Kuwait and the United Arab Emirates, Architecture, graduated > academia

Master Students

Rachael Daniels Psychology/Human Factors, graduated > industry
Isaiah Dunlap Architecture (graduated) > architectural intern
Nick Kuntzi Architecture, graduated
Manas Tonapi Elec. and Comp. Engineering
Jennifer Turchi Sociology (graduated) > PhD Sociology at Ohio State Univ
Linnea Smolentzov Psychology, graduated Microsoft Research
Amith Mysore Vijaykumar Elec. and Comp. Engineering
Ksenia Krasnova Architecture, graduated > architecture intern
Seth Lauderdale Architecture, graduated
Martha Kwoka Elec. and Comp. Eng., graduated > industry
Jessica Merino Elec. and Comp. Eng., graduated > Disney
James Rubenstein Psychology/Human Factors

Undergraduate Students

Akshit Bhandari Elec. and Comp. Eng.
Tyler Berkey EUREKA Honors Program/ECE
Maggie Boyd EUREKA Honors Program/ECE
Zack Hewitt EUREKA Honors Program/ECE
Katelyn Fry Elec. and Comp. Eng., graduated
Joseph Johnson Mech. Eng., graduated > grad studies Stanford/

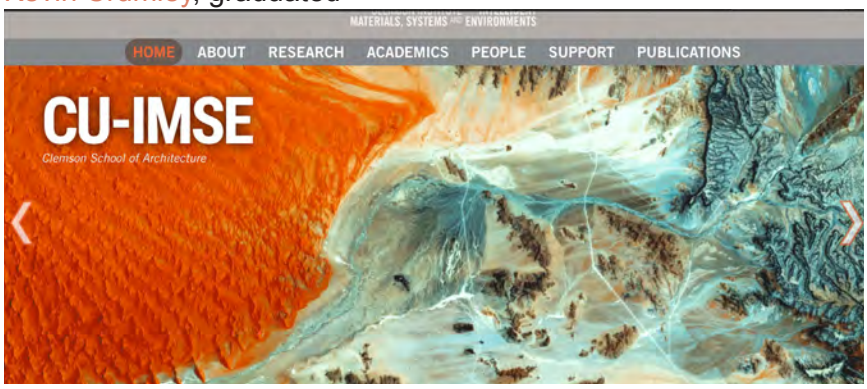
Robotics
Dominic Leali EUREKA Honors Program/Engineering
Lyndsey Mayweather Psychology/Human Factors (BS Psych)
Sam McKee EUREKA Engineer
Mary Rutland EUREKA Honors Program/Engineering
Alyssa Simpson EUREKA Honors Program/Digital Arts Production
Andrew Ries Honors Thesis Student/ECE
Jessica Merino Honors Thesis Student/ECE

18 ***new students since 2018*** *in the PhD and Digital Ecologies Certificate Program*

Gradaute Digital Ecologies Certificate Students
Ksenia Krasnova Architecture, graduated > graduate school (PhD)
Seth Lauderdale Architecture, graduated

Sarah Smith, graduated
Harrison Floyd, graduated
Marissa Cutry, graduated
Rachel Baca, graduated
Hunter Harwell, graduated
Joseph Scherer, graduated
Kevin Crumley, graduated

CU-iMSE Promotion and Events | 4



In AY 2019 the iMSE website was revised and re-started with the incoming new Director. In addition to the website, the institute has a new logo and new look. Web analytics are unavailable, but a Clemson iMSE search on Google results in the website coming up first in the search results, generally an indication of frequency of access through public searches.

CU-iMSE has a web presence on Academia.edu, ResearchGate.net, and Pinterest, the latter through the Digital Ecologies Certificate and Fluid Studio boards. Analytics indicate strong response to the Digital Ecologies boards and the DE Fluid studio work shown with over 4,000 views per month.

1 ***fully online conference in 2020*** *for the CAAV Conference 5th year Anniversary.*

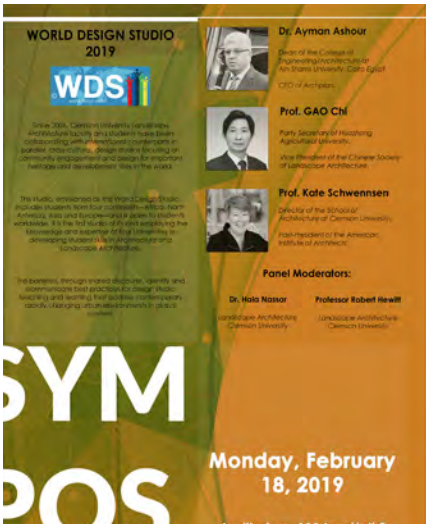
THE 5th Annual International Conference
OCTOBER 14-17, 2020 | CLEMSON SC ONLINE2020
CAAV

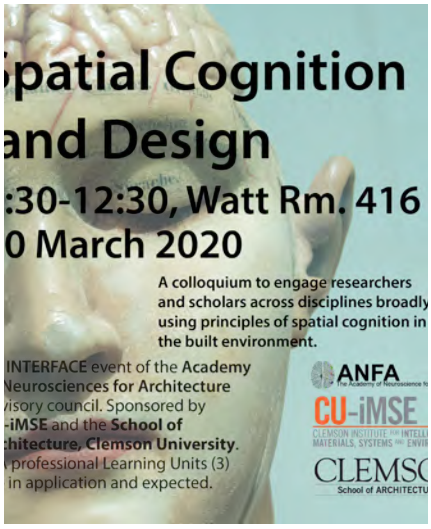
https://www.clemson.edu/centers-institutes/cuimse/index.html

10x ***increase*** *in graduate students in the Digital Ecologies Certificate Program since 2019.*

https://www.clemson.edu/caah/departments/architecture/programs/graduate/certificates/a+de.html

5,875 ***views on Pineterest*** *of our Digital Ecologies and CU-SoA Fluid Studio boards.*





CU-iMSE Promotion and Events | 10

Events are shared though iMSE News on the website.

Ongoing work to improve the website includes addition of publication texts where possible, improved descriptions of faculty research, more images and videos, and better analytics to gauge change.

The Digital Ecologies web presence on the SoA site was improved with a revised format that includes video files, information for Digital Ecologies courses per semester, and updated information. The following pages are a sample of range of projects and research included over the past academic year on the CU-iMSE website.

10 BIG Research Ideas in the Built Environment
Symposium 2020
Thursday, April 30, 2020
9:00AM – 4:30PM
Snow Center
Clemson University
Clemson, South Carolina
The symposium brings together academics, government and industry partners to understand what the next big challenges in the built environment are. The invited speakers include Ron Ott, Dir. Building Technologies Program at Oak Ridge National Laboratory and Rainer Strauch, CTO of international design and building company CREE Rhomberg.

This was a coordinated and jointly funded effort of CU-iMSE and the Clemson Wood Utilization + Design Institute (CUWU+DI), Patricia Layton, Director.

Postponed due to COVID-19

Spatial Cognition and Design Colloquium

A colloquium to engage researchers and scholars across disciplines broadly using principles of spatial cognition in the built environment. An INTERFACE event of the Academy of Neurosciences for Architecture advisory council. Sponsored by CU-iMSE and the School of Architecture, Clemson University, AIA.

30 March 2020

A colloquium to engage researchers and scholars across disciplines broadly using principles of spatial cognition in the built environment.

An **INTERFACE** event of the **Academy of Neurosciences for Architecture** advisory council. Sponsored by **CU-iMSE** and the **School of Architecture, Clemson University**. AIA professional Learning Units (3) are in application and expected.

The symposium is free and open to all. For more information and to r.s.v.p., please visit: spacecogdesign.eventbrite.com

ANFA
The Academy of Neuroscience for Architecture

CU-iMSE
CLEMSON INSTITUTE FOR INTELLIGENT MATERIALS, SYSTEMS AND ENVIRONMENTS

CLEMSON
School of ARCHITECTURE

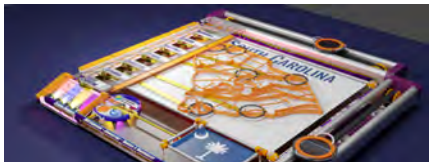
Agenda

8:00AM	Coffee in Watt Center for Innovation
8:30AM	"John Eberhard, ANFA and Early Efforts at Framing a New Discipline", *Prof. David Allison, Clemson University*
9:00AM	"Impact of Age-Related Cognitive Changes on Human-Spatial Environment Interaction", *Dr. Kaileigh Byrne, Clemson University*
9:45AM	"Feeling-for-Space", *Dr. Harry Francis Mallgrave, IIT (Emeritus)*
10:30AM	Coffee Break
10:50AM	"Direct Perception and Its Implications for Design", *Dr. Christopher Pagano, Clemson University*
11:45AM	Discussion, moderated by *Dr. Winifred Newman, Clemson University* and *Prof. Robert Condia, Kansas State University*
12:30PM	Closing remarks and adjournment

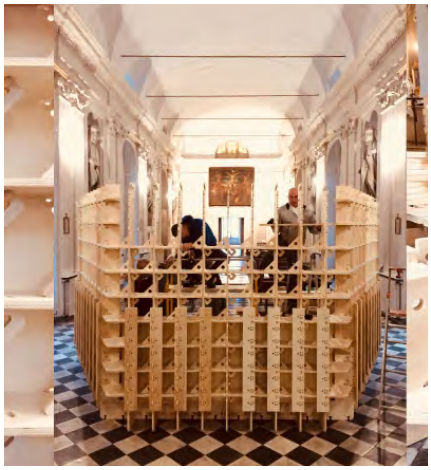
Postponed due to COVID-19

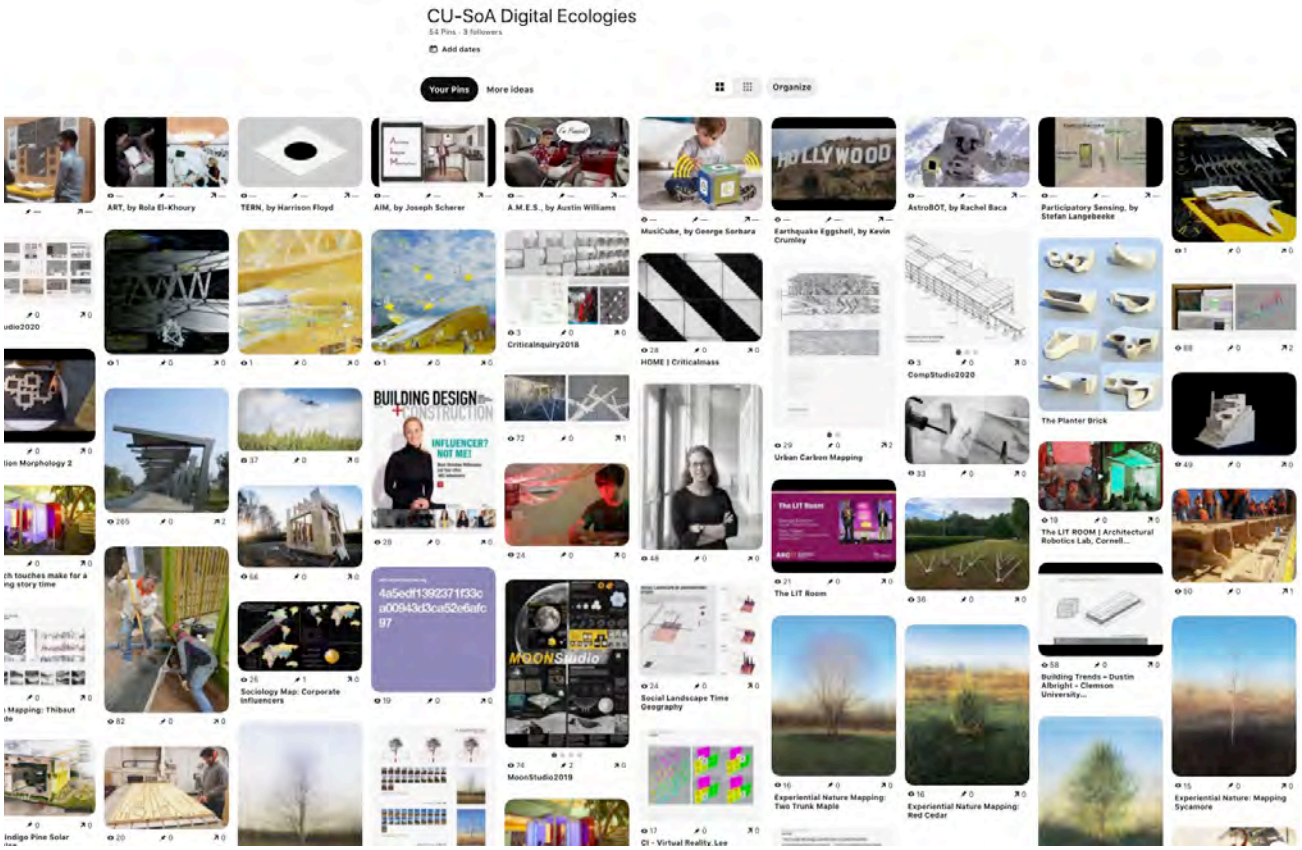
Brown-Bag Research Talks | Fall 2022 Spring 2023
Brown--Bag Research talks initiated to foster shared research culture across departments in the SoA and with colleagues in allied disciplines. Faculty presented past and ongoing work to faculty and PhD students in the PDBE program.

Clemson-designed technology and building solution: Sim[PLY] May 9, 2019
Habitat for Humanity understands the concept. So do weekend warriors and faithful DIY-ers: The value of a do-it-yourself construction project lies not only in its affordability, but also in its community focus and the pride that comes from creating something by hand, from scratch. Clemson University is taking the concept of DIY construction to the next level with a newly patented 3D building technology, developed by faculty and students at this R1 Research University and land-grant institution. Called Sim[PLY], the building system blends technological advancements with DIY sensibilities. And by finding better ways to build, Clemson also is leading the way in everything from affordable housing to disaster relief shelters, pop-up health care facilities and more.



Keynote Speaker, **Civil, Architectural, and Environmental Engineering Applied Science, Engineering, and Technology,** Oct. 2022, Webinar, https: // inovsctieconferences.com
Plenary Speaker, **CIVIL-MEET2022 International Meet on Civil, Structural and Environmental Engineering**. "Computational Thinking in Design and Construction," May 23-25, 2022 | Munich, GER
Plenary Speaker, **Global Webinar on Civil, Architectural, & Environmental Engineering**, "Intellgent Systems and Environments in Architecture Design and Construction," Dec. 18, 2021, Webinar, http://istconferences.com
Plenary Speaker, **Global Webinar on Civil, Architectural & Environmental Engineering** "Recent Outcomes of Digital Ecologies in AEC," December 18, 2021, Kolkata, India (online)
Keynote, **International Conference on Civil, Structural and Environmental Engineering**, "Intelligent Buidling Design and Systems," March 10-11, 2022, (online)
Invited Speaker, **2021 Rocky Mountain Advanced Computing Consortium (RMACC)**, "Digital Therapeutics and Responsive Design," May 19029, 2021
Invited Speaker, **2021 Carolina Center on Alzheimer's Disease and Minority Research (CCADMR)** Research Education Seminar, "Aging and Technology," March 5, 2021
Invited Speaker, 2021 Session moderator, **"Do not try to remember." Pedagogy in Transition**, University of Oklahoma (OU) Christopher C. Gibbs College of Architecture, "Schools of Thought: Rethinking Architectural Pedagogy," from March 5-7, 2020, Fred Jones Jr. Museum of Art, University of Oklahoma Campus, Norman, Oklahoma.
Session workshop presenter, "Defining your Research," Sponsored by TAD: Technology | Architecture + Design, ACSA 2020
Publicity Co-Chair and Technical Committee for the **2020 9th International Conference on Educational and Information Technology (ICEIT 2020)** Feb. 11-13, 2020, St. Anne's College, University of Oxford, United Kingdom





The CU-Soa Digital Ecologies Pinterest Boad - The board is a recent addition to our social media. This is in addition to current SoA social media on Facebook and Instagram. The Pinterest board is gaining followers (15 thus far) and pins (over 4,000/mo.).

Tessellated Structural-Architectural Systems: Concept for Efficient Construction, Repair, and Disassembly

Brandon E. Ross1; Cancan Yang, A.M.ASCE2; Michael Carlos Barrios Kleiss3; Pinar Okumus4; and Negar Elhami Khorasani, A.M.ASCE5

Abstract: This paper introduces a tessellated structural-architectural (TeSA) wall system concept with the potential for improving both re- silience and sustainability of the built environment. Resilience requires fast recovery and restoration of building functionality after an extreme event, while sustainability seeks designs that facilitate building adaptability and reuse for long-term occupancy. TeSA wall systems are com- prised of individual, interchangeable tile segments, which are arranged in tessellated (repetitive) patterns. TeSA walls provide a resilient and sustainable solution wherein tiles can be prefabricated, reconfigured, disassembled, and reused during the lifetime of a structure. This paper introduces the TeSA concept through preliminary physical and analytical studies. The physical test involved a beam made of interlocking tessellated acrylic tiles, which was loaded to failure. The analytical study featured two reinforced concrete TeSA shear walls under lateral loading. The physical test showed that damage can be localized within individual tiles that can be replaced to restore loadbearing capacity. The analyses showed that TeSA shear walls can provide ductility and localized damage in individual tiles. Recommendations for advancing the TeSA toward implementation are also discussed.

DOI: 10.1061/(ASCE)AE.1943-5568.0000418. © 2020 *American Society of Civil Engineer*s

Author keywords: *Tessellations; Structural-architectural wall systems; Topological interlocking; Noninterlocking; Shear wall; Localized damage.*

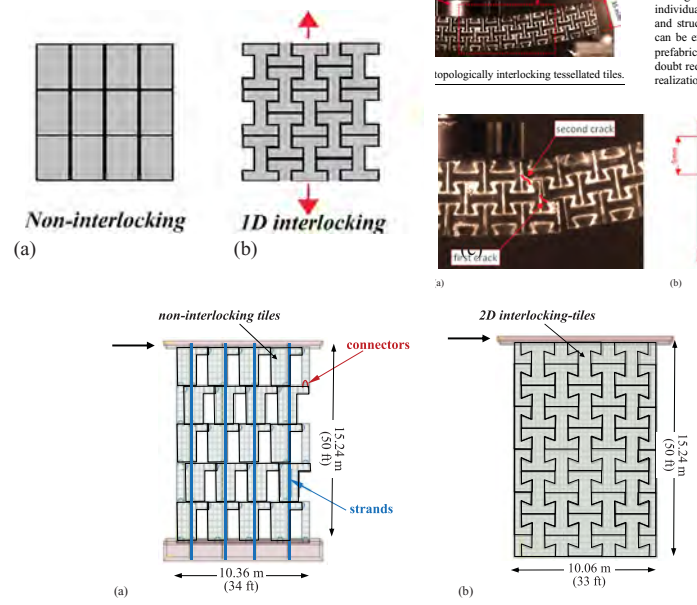


Fig. 7. (a) Noninterlocking; and (b) topologically interlocking walls studied using finite element analyses.

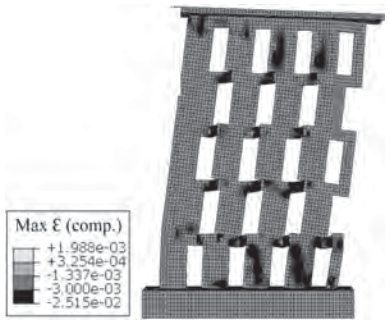


Fig. 9. Principal compression strains of the noninterlocking wall at 1.7% drift.

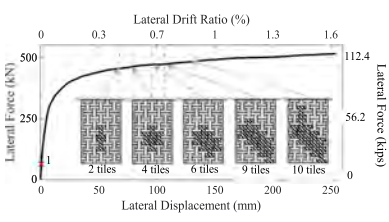


Fig. 10. Load-displacement behavior of the 2D interlocking wall highlighting failure progression.