design the unseen

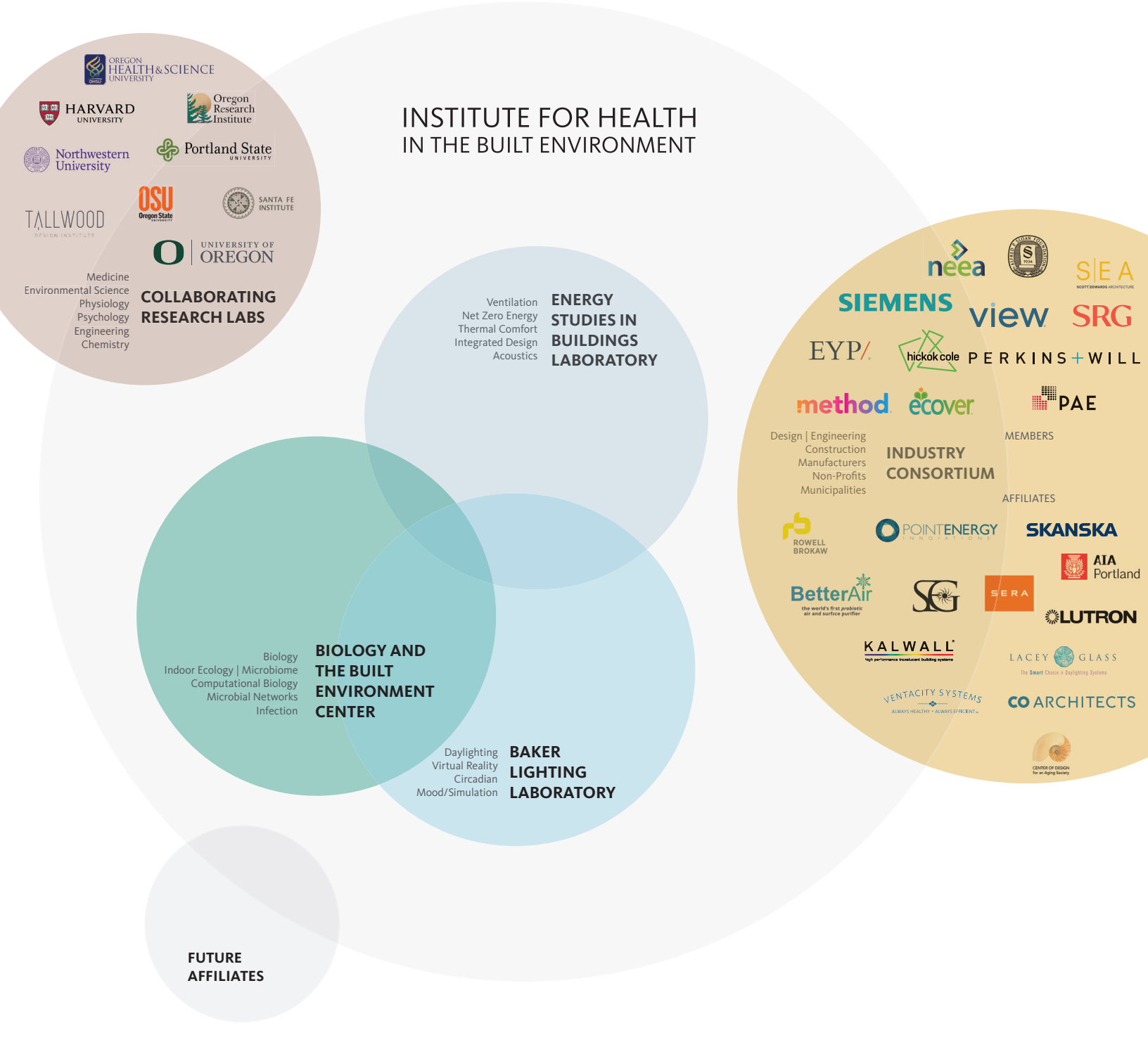
INSTITUTE FOR HEALTH
IN THE BUILT ENVIRONMENT

2018-2019 Build Health Quarter 3 Research Report

UNIVERSITY OF OREGON | INSTITUTE FOR HEALTH IN THE BUILT ENVIRONMENT

Our Vision + Mission

Decisions we make about how buildings and cities are designed, constructed and managed have significant implications for our own health, and for the health of our planet. The Institute for Health in the Built Environment advances, integrates, and applies new knowledge from diverse scientific disciplines to support a healthy, thriving community and planet. Our mission is to develop new design concepts for the realization of healthy and sustainable inhabited space. We do this by forming unconventional collaborations that conduct research where architecture, biology, medicine, chemistry and engineering intersect and translate it into design practice through a consortium of invested industry partners with applied impact.



Q3 Report Directory

INSTITUTE FOR HEALTH
IN THE BUILT ENVIRONMENT

Staff

Dr. Kevin Van Den Wymelenberg, Director - IHBE, Director - ESBL, Co-Director - BioBE
Dr. Jessica Green, Co-Director - Biology and the Built Environment Center
Dr. Siobhan Rockcastle, Director - Baker Lighting Laboratory
G.Z. (Charlie) Brown, Founding Director - ESBL, BioBE
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Dr. Sue Ishaq, Research Assistant Professor, Microbial Ecology - BioBE
Dr. Ashkaan Fahimipour, Research Assistant Professor, Computational Biology - BioBE
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Willem Griffiths, Research Associate - BioBE
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Collaborators

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Dr. Laszlo Kiraly, Associate Professor of Surgery, Division of Trauma, Critical Care and Acute Care Surgery, OHSU
Dr. Matthew Butler, Assistant Professor, Butler Clock Physiology Lab, OHSU
Dr. Andrew McHill, Assistant Research Professor, Shea Lab, OHSU
Dr. Christopher Minson, Kenneth and Kenda Singer Professor of Human Physiology, Department of Physiology, University of Oregon
Dr. Elliott Gall, Assistant Professor, Maseeh College of Engineering & Computer Science, Portland State University
Dr. Erica Hartmann, Professor of Civil/Environmental Engineering, Northwestern University
Dr. Curtis Huttenhower, Professor of Computational Biology, Harvard University
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David Ward, Campus Planning and Facilities Managment, University of Oregon
Kynthia Chamilothori - University of Michigan/EPFL
Chris Chatto - ZGF Portland
David Gull - Outer Realm VR, Los Angeles
Dr. Nathaniel Jones - ARUP San Francisco
Naomi Miller - PNNL
Vladimir Pajkic - ZGF Portland
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Zach Suchara - Luma Lighting
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Dr. Junhak Lee - UO College of Design
Jake Searcy - UO Data Science
Chris Retzler - Siemens
Corey Jones - Siemens
Joe Levesque - Siemens
Shan Rimmey - Siemens

Students

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Samantha Velazquez, Undergraduate Student, Biology
Mira Zimmerman, Web Designer, Blogger

1

Overview
Q3

Executive Summary

Dear Industry Consortium,

Greetings from Portland, Oregon and the University of Oregon Institute for Health in the Built Environment! On the waterfront outside our lab window, the cherry blossoms are bursting in a riot of color and bicyclists are shedding rain gear as spring takes hold. Inside the lab, students have returned from spring break and are continuing their work with faculty to investigate projects, write new proposals and innovate in design. We are excited to share this update on select projects, proposals and student work with you!

The third quarter of the 2018-2019 IHBE Industry Consortium has been focused on developing current projects, proposal writing, new research collaborations, collaboration with Consortium members on daylighting and senior living projects, and preparing for our Build Health 2019 event (May 16-17). We are also excited to announce the addition of two new Consortium members: dynamic glass producer, View, and architecture firm, Hickok Cole. View and Hickok Cole will broaden and deepen our Consortium expertise and we look forward to welcoming them at our Build Health 2019 event.

Current project updates in this issue include: mass timber wall and floor lab acoustic testing, building materials and the microbiome, light and healthy aging, luminaire level lighting control (LLLC) lab testing, on-going building commissioning and healthcare-associated infections and architecture.

Initiated projects include: a residential shade/blind operation pilot study and two white papers that will be released soon: circadian lighting and the workplace of the future.

Student projects include: a novel use of virtual reality for lighting design. This was a class taught by Siobhan Rockcastle, supported by the Nuckolls Fund and multiple industry and academic collaborators.

New research proposals include: NIH R1 proposal on the built environment's role in C. difficile healthcare-associated infections; "Fuzzy Wrenches," an NSF proposal bridging the gap between architecture, data science and STEM workforce; Building Immune Systems – the use of probiotics for HVAC biofilm reduction and increased energy savings.

Best regards and happy reading!

Mark Fretz, Associate Director of Outreach

2

Research Updates

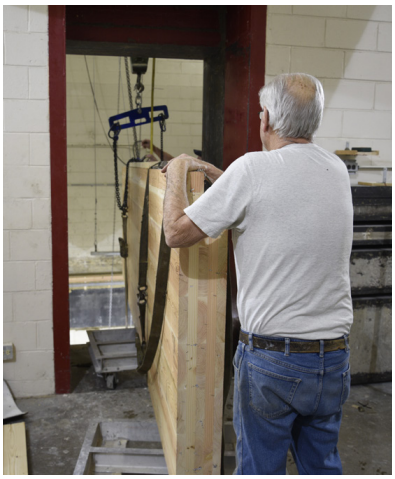
Mass Timber Acoustic Testing

Funded by USDA with TallWood Design Institute

Mark Fretz - Energy Studies in Buildings Laboratory
Dale Northcutt - Energy Studies in Buildings Laboratory
Jason Stenson - Energy Studies in Buildings Laboratory
Ethan Zagorec-Marks - IHBE, Student Researcher
Kevin Van Den Wymelenberg (PI) - Energy Studies in Buildings Laboratory

The use of mass timber panels is becoming a popular choice for construction due to concerns about climate change, resource sustainability, the need for construction efficiencies and the human biophilic affinity for wood. Panelized mass timber products have been used in Europe for some time but are now gaining market traction across North America and represent an opportunity for designers, developers, engineers and contractors. The Energy Studies in Buildings Laboratory is interested in researching the acoustic properties of this new product to ensure not only compliance with code but also occupant health and well-being. Furthermore, the acoustic performance of Cross-Laminated Timber (CLT) also needs to meet market expectations for high quality, sound separated living spaces to ensure occupant satisfaction.

Image
Calibrated impact sound generator used for IIC testing. Image Credit: Evan Schmidt, OSU TallWood Design Institute

Images
Images depict the process of moving CLT panels into testing chamber and securing joint. Note the size of door opening and the need for a joint in the mass timber base floor.
Credit for all images on this page: Evan Schmidt, OSU TallWood Design Institute


The acoustic performance of mass timber panels is measured by two metrics: STC (sound transmission class) and IIC (impact insulation class). STC, for example, is how well an assembly acoustically separates two spatial volumes. IIC is a measurement of how well a floor dampens the sound transmission of an impact between two adjacent spatial volumes, be that a dropped object or footstep.

Using industry standards as a starting point for designing a series of floor and wall assemblies, we hope to find high performing cost-effective acoustic solutions for mass timber assemblies that can be readily adopted by design teams and jurisdictional authorities. In addition, this study aims to provide more third-party verified data on CLT + mass plywood panels (MPP) acoustic performance and disseminate it into the public sphere.

Five CLT and MPP floor construction details were designed and constructed for testing of sound transmission at Riverbank Acoustical Laboratories (Alion Science + Technology) in Geneva, Illinois. CLT and MPP samples were shipped to the lab wrapped and covered during transport. There were also three CLT and MPP wall assemblies that were designed and built and sent to USG Testing Services, Corporate Innovation Center in Libertyville, Illinois. Testing results will be shared at Build Health 2019, May 16 in Portland.

Images - Clockwise from upper left
1. Floor chamber testing opening. 2. The process of sealing perimeter of floor CLT using sand and acoustic putty. 3. IIC testing of bare CLT
Credit for all images on this page: Evan Schmidt, OSU TallWood Design Institute

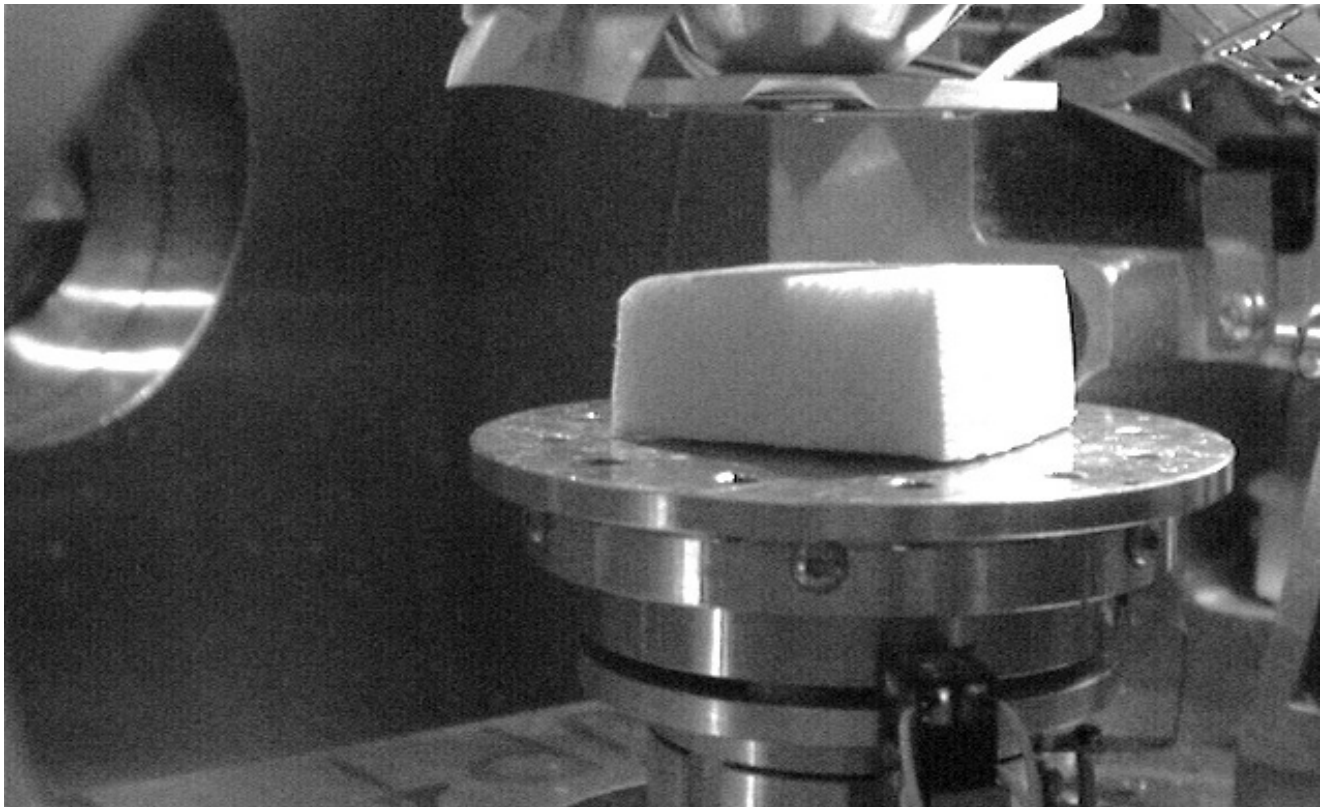
Images
Images this page: the process of receiving the CLT at testing lab, sealing in test opening and assembly build up.
Opposite Page Image: Workers lifting CLT panel into the USG wall test facility opening.
Credit for all images on this and next page: Dale Northcutt, ESBL

Building Materials and the Microbiome

Funded by USDA with TallWood Design Institute and Alfred P. Sloan Foundation

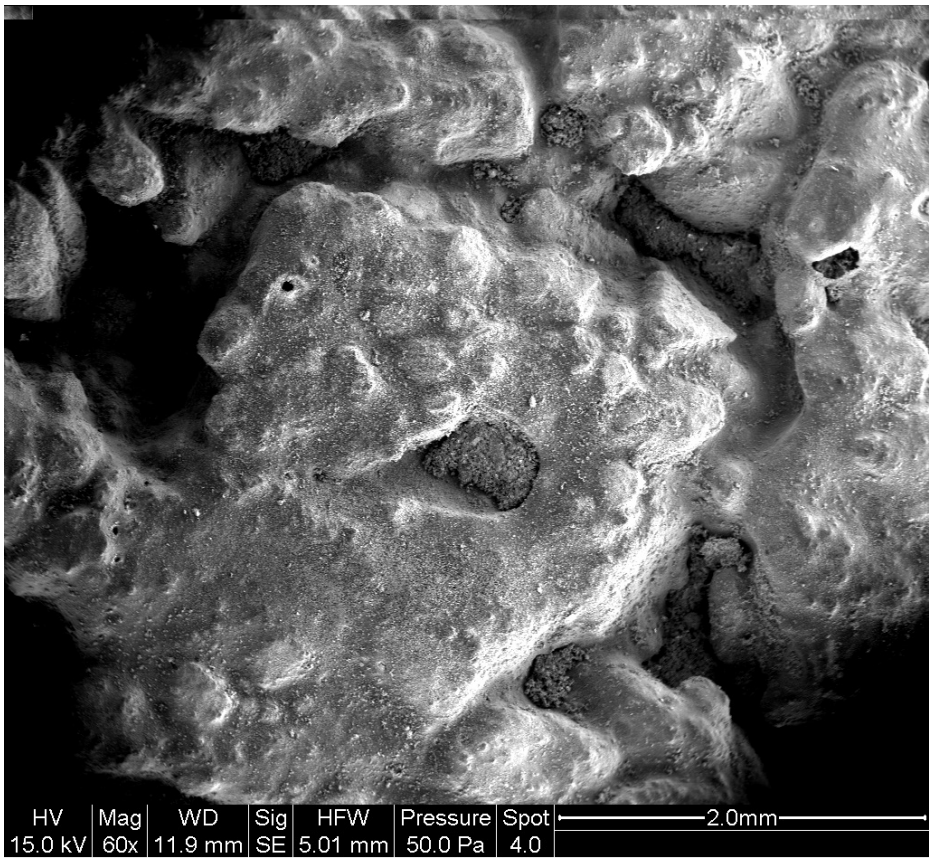
Elliott Gall, PhD - Portland State University
Jessica Green, PhD (PI) - Biology and the Built Environment Center
Willem Griffiths - Biology and the Built Environment Center
Aurelie Laguerre - Portland State University
Roo Vandegrift, PhD - Biology and the Built Environment Center
Kevin Van Den Wymelenberg, PhD (PI) - Biology and the Built Environment Center

Substrate is a substantial determinant of microbial community composition (e.g. soil vs. ocean vs. human skin). We suspect building material type influences microorganisms in the built environment. We inoculated building materials in an occupied office space, and then isolated them in individual microcosms, sampling the changing microbial communities at numerous time points over a 40 day period. We sampled resident microbes on cross-laminated timber, earthen plaster over straw bale, concrete, and painted drywall.

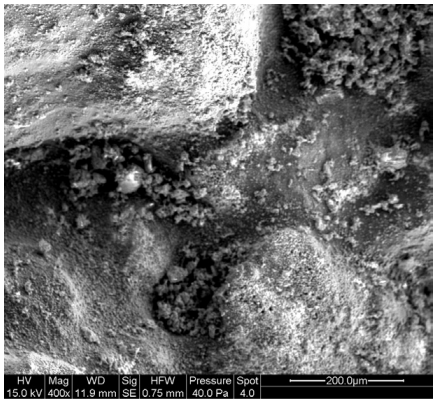


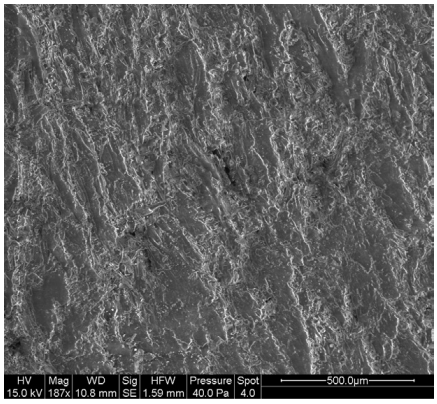
Images
Above: Mounted CLT in the scanning electron microscope at the University of Oregon's CAMCOR

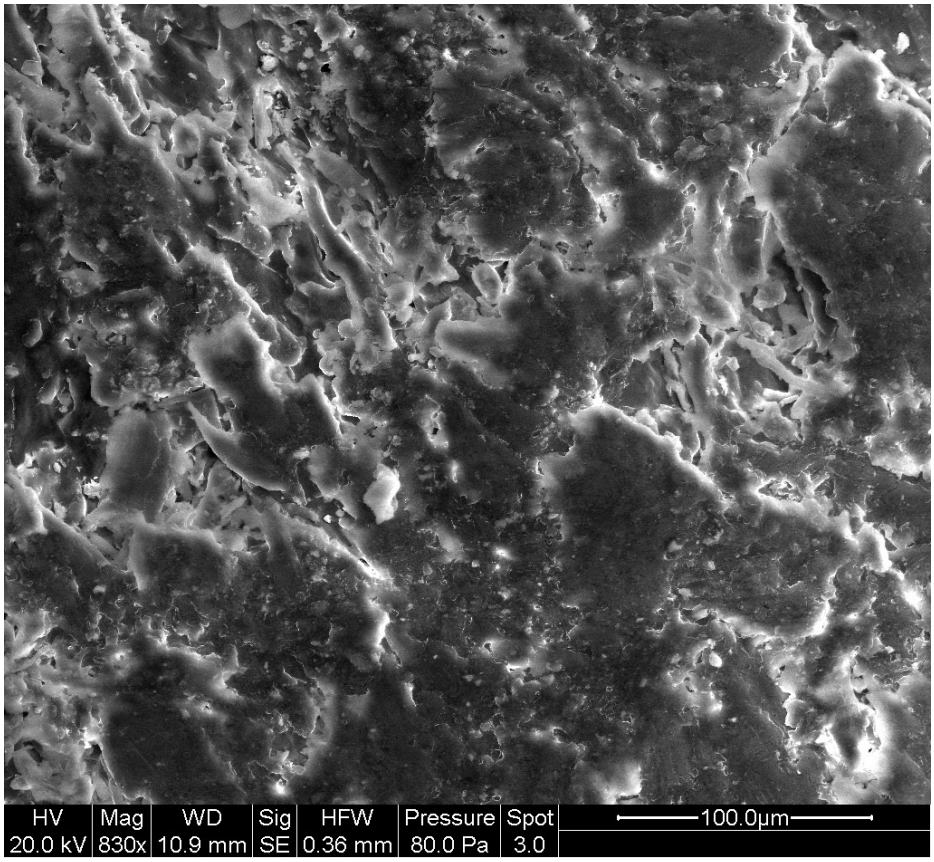
We've now completed three of our five experimental analysis pipelines. We sequestered, measured, and identified volatile organic compounds emitted by sample building materials and their resident microbes. Quantitative PCR experiments determined microbial biomass on each material block over multiple time points. We captured high magnification images of material surfaces using scanning electron microscopy -- revealing detailed surface micro-topography and microbial colonies. We are currently preparing sample DNA for next-generation Illumina sequencing to elucidate the bacterial strains residing on each material type. Lastly, metagenomic shotgun sequencing will allow us to identify discrete metabolic genes responsible for releasing volatiles into the surrounding environment.



Images
Top Left: Concrete *Below:* Concrete
Bottom Left: CLT *Opposite Bottom Right:* CLT







Light and Healthy Aging

Funded by the IHBE Industry Consortium

Catherine Earley - Institute for Health in the Built Environment, M.S Student Researcher
Mark Fretz - Institute for Health in the Built Environment
Jeff Kline - Institute for Health in the Built Environment
Eunice Noell-Waggoner - Center of Design for an Aging Population
Alejandra Paniagua - Glumac
Siobhan Rockcastle - Baker Lighting Lab, IHBE
Jesse Smith - Glumac
Kevin Van Den Wymelenberg (PI) - Institute for Health in the Built Environment
Paul Ward - Institute for Health in the Built Environment
Ethan Zagorec-Marks - Institute for Health in the Built Environment, M.Arch Student Researcher

The rapidly aging population and the tremendous stress that dementia places on individuals, families and society is driving interest in healthy aging and care for individuals with dementia. An exciting thread in health research is uncovering the role that light plays in our health and issues associated with aging. We are especially keen on working in this area since the provision of light, especially daylight, dramatically affects energy consumption and therefore

Image *Below* - photo by Free Photos from Pixabay.com

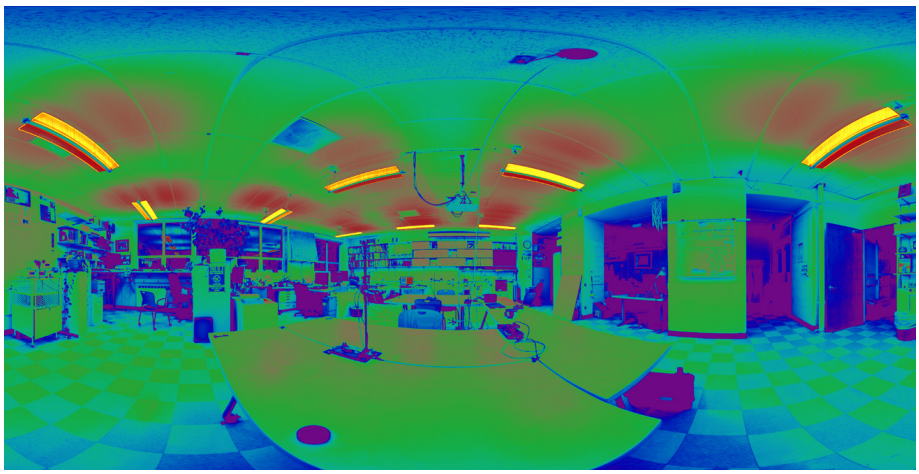
climate change, and is a fundamental concern of architectural design.
We are vigorously gathering strands of this complex fabric. We have been filling out our knowledge of the state of the art in research findings with a comprehensive literature review on light, aging, and dementia, as well as a white paper on circadian lighting. We have also initiated a small-scale project to collect preliminary data to bolster proposal writing – this will be described in more detail later. Finally, we are building relationships with owners and design teams of supportive living facilities for collaborative design and research projects.

Luminaire Level Lighting Control (LLLC), Lab Testing

Funded by Northwest Energy Efficiency Alliance (NEEA)

Carolina da Silva Correa Leite - Energy Studies in Buildings Laboratory
Jeff Kline - Energy Studies in Buildings Laboratory
Alen Mahic - Energy Studies in Buildings Laboratory
Dale Northcutt - Energy Studies in Buildings Laboratory
Kevin Van Den Wymelenberg (PI) - Energy Studies in Buildings Laboratory
Chris Wolgamott - NEEA program manager

ESBL continues exploring the energy and cost savings potential of Luminaire Level Lighting Controls (LLLC) technologies as a one-for-one lighting retrofit solution, which is a light-touch renovation strategy where existing lighting fixtures are swapped for LLLC equivalent fixtures. This means that existing wiring and spatial layouts can be preserved while more efficient lighting fixtures and controls are implemented, and also cuts down on installation time and cost.



Images
Below: Luminair Lighting Controls (LLLC) being tested in the Energy Studies in Building Laboratory *Bottom*: Energy Studies in Building Laboratory lighting levels

The study has completed two phases of testing so far. This includes establishing the baseline condition and evaluating the first one-for-one LLLC swap in the ESBL test space on the University of Oregon campus in Eugene. The data gathered for each phase includes per fixture energy consumption, occupancy state, and dimming level; human factors comfort questionnaire responses; and various light level measurements. The study will continue with testing of three remaining one-for-one LLLC swaps and one full lighting redesign retrofit, while developing data analysis pipelines using the data already collected.

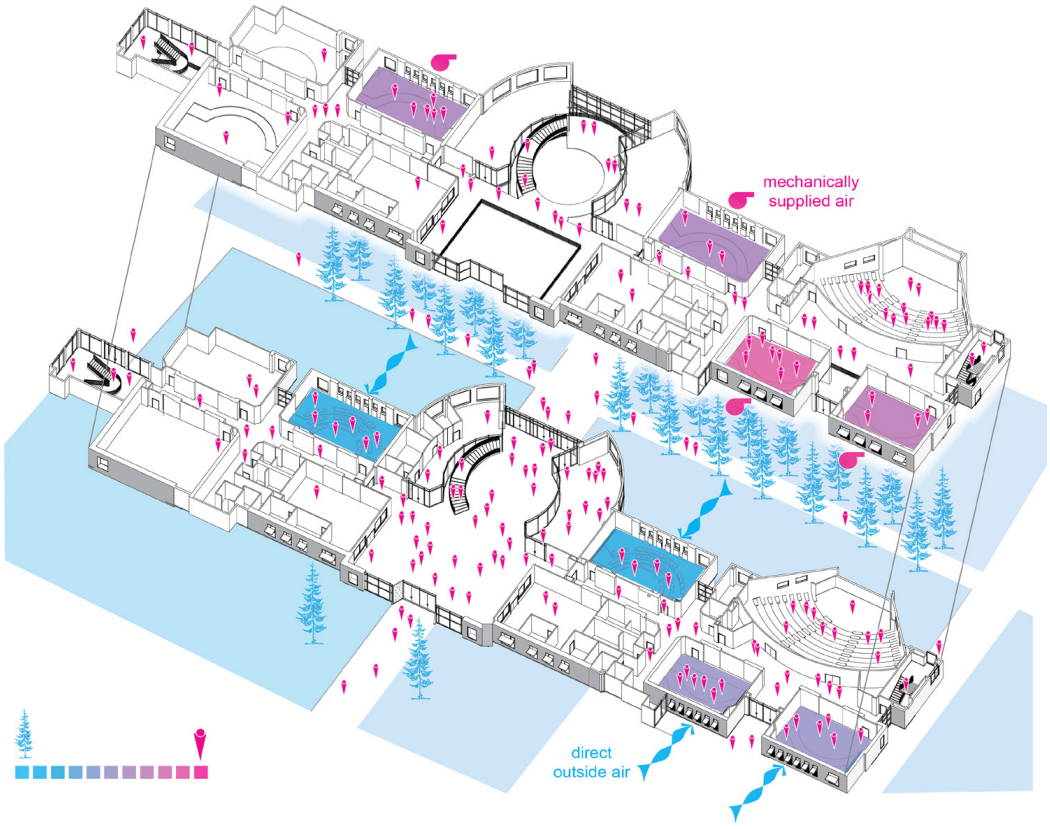
On-Going Building Commissioning

Funded by Northwest Energy Efficiency Alliance + UO Campus Planning and Facilities Management

Corey Jones - Siemens
Jeff Kline - Energy Studies in Buildings Laboratory
Joe Levesque - Siemens
Chris Retzler - Siemens
Shan Rimmey - Siemens
David Ward - UO Campus Planning and Facilities Management
Paul Ward - Energy Studies in Buildings Laboratory
Kevin Van Den Wymelenberg (PI) - Energy Studies in Buildings Laboratory

Campus Planning and Facilities Management (CPFM), Energy Studies in Building Laboratory (ESBL), and Siemens will be continuing our campus tune-up efforts in Lillis Hall. Siemens will recommission the air-handling equipment, while ESBL and CPFM work with occupants to develop new zone-level controls, setpoints, and schedules. ESBL will employ various approaches to performance measurement and verification in an effort to develop a cost-effective, validated method of estimating and tracking energy savings, so we can help UO continue in facility improvements.

Images
Top: Lillis Hall Axonometric Room Air Diagram *Bottom:* Lillis Hall entrance, atrium and classroom spaces



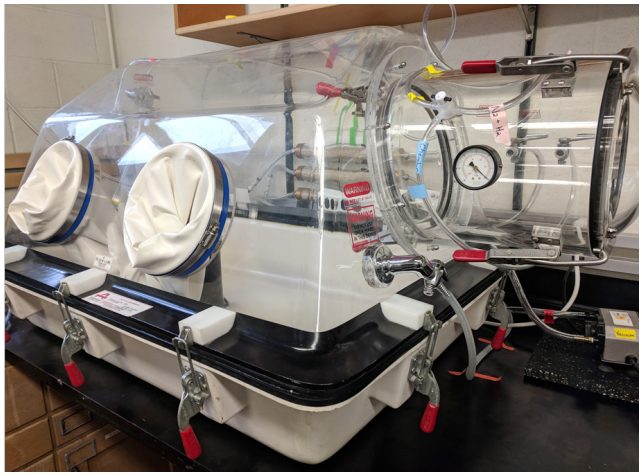
Healthcare-Associated Infections and Architecture

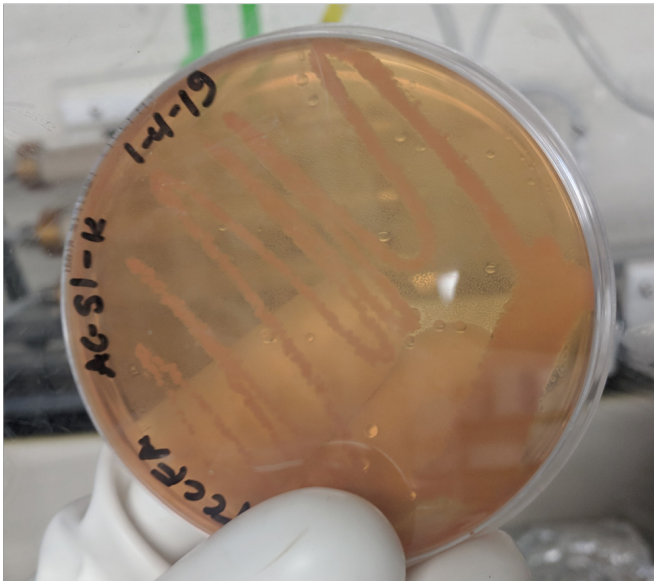
Funded by UO-OHSU Presidential Award and Alred P. Sloan Foundation

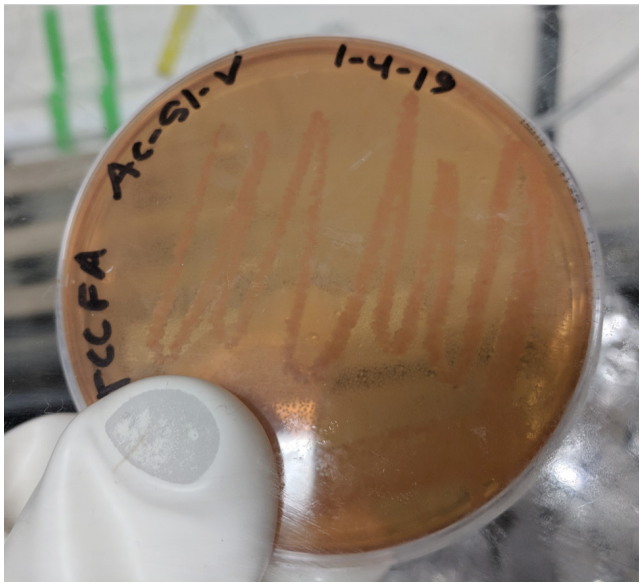
Charlie Borzy - Oregon Health Sciences University
Leslie Dietz - Biology and the Built Environment Center
Ashkaan Fahimipour, PhD - Biology and the Built Environment Center
Mark Fretz, DDS, MArch - Biology and the Built Environment Center, ESBL
Patrick Horve - Biology and the Built Environment Center
Sue Ishaq, PhD - Biology and the Built Environment Center
Laszio Kiraly, MD - Oregon Health Sciences University
Savanna Lloyd - Biology and the Built Environment Center
Kyla Siemens - Oregon Health Sciences University
Robert Martindale, MD, PhD (PI) - Oregon Health Sciences University
Kevin Van Den Wymelenberg, PhD (PI) - Energy Studies in Buildings Laboratory

The highly collaborative study for healthcare-associated infections and architecture is ongoing. We have just recruited our ninth patient to the study, and with our logistical team in place at OHSU, have been able to obtain swabs from the patients and their rooms even on short notice. The anaerobic chamber is up and running, and we have been fine-tuning the culture media using an in-house recipe, as the commercially-available media was not stringent enough for our needs. A preliminary analysis of DNA sequencing was run on a small number of the samples, and we were able to confirm the presence of C. difficile, as well as identify the other bacteria in the samples. We are hoping to recruit a total of 10 patients before beginning metagenomics samples in order to minimize potential batch effects during processing. Since we are already planning for the future, the team has submitted two funding proposals in the last few months looking to dramatically expand the scope of the current pilot project with two more planned for next Quarter.

Images
Below: anaerobic chamber *Bottom Left:* C. diff culture produced using anaerobic chamber of computer keyboard after patient room was cleaned post CDI patient *Below Right:* C. diff culture of air return grill after patient room was cleaned post CDI patient







3

Initiated Research Projects

Residential Shade Study

Funded by the IHBE Industry Consortium

Mark Fretz - Institute for Health in the Built Environment
Delaney Hetrick - IHBE, MArch Student Researcher
Jeff Kline - Institute for Health in the Built Environment
Carolina da Silva Correa Leite - IHBE, MArch Student Researcher
Kevin Van Den Wymelenberg (PI) - Energy Studies in Buildings Laboratory

Window coverings (blinds, curtains, shades) are key components of window systems. They are used to modulate comfort and views in and out of windows and have multiple and nuanced impacts on both health and energy. Yet, little is known about how people operate their window coverings, at least in residential settings, and we have not found research specific to supportive living facilities (commonly referred to as assisted living, nursing homes, and long-term care among other terms).

Images
Below: photo by Eduard Militaru on unsplash.com *Bottom:* photo by Alev Takil on unsplash.com

We want to know whether circadian health, especially for individuals with Alzheimers disease and related dementias, can be improved by changing the timing and duration of window covering deployment. We are performing a preliminary study of window covering position (how much of the window is obstructed) in supportive living facilities as well as comparison apartments for the general population. We have nearly finished collecting data from our "sidewalk shade census" which we'll use to develop health and energy rationales for research proposals.

4

Student Research and Design

Virtual Lighting Design

Funded by the UO Department of Architecture; Nuckolls Fund

Kynthia Chamilothori - University of Michigan/EPFL
Chris Chatto - ZGF Portland
David Gull - Outer Realm VR, Los Angeles
Nathaniel Jones - ARUP San Francisco
Alen Mahic - ESBL, University of Oregon
Naomi Miller - PNNL
Vladimir Pajkic - ZGF Portland
Azadeh Sawyer - University of Michigan/EPFL
Zach Suchara - Luma Lighting
Kevin Van Den Wymelenberg - ESBL, University of Oregon
Siobhan Rockcastle (PI) - Assistant Professor of Architecture, Class Instructor

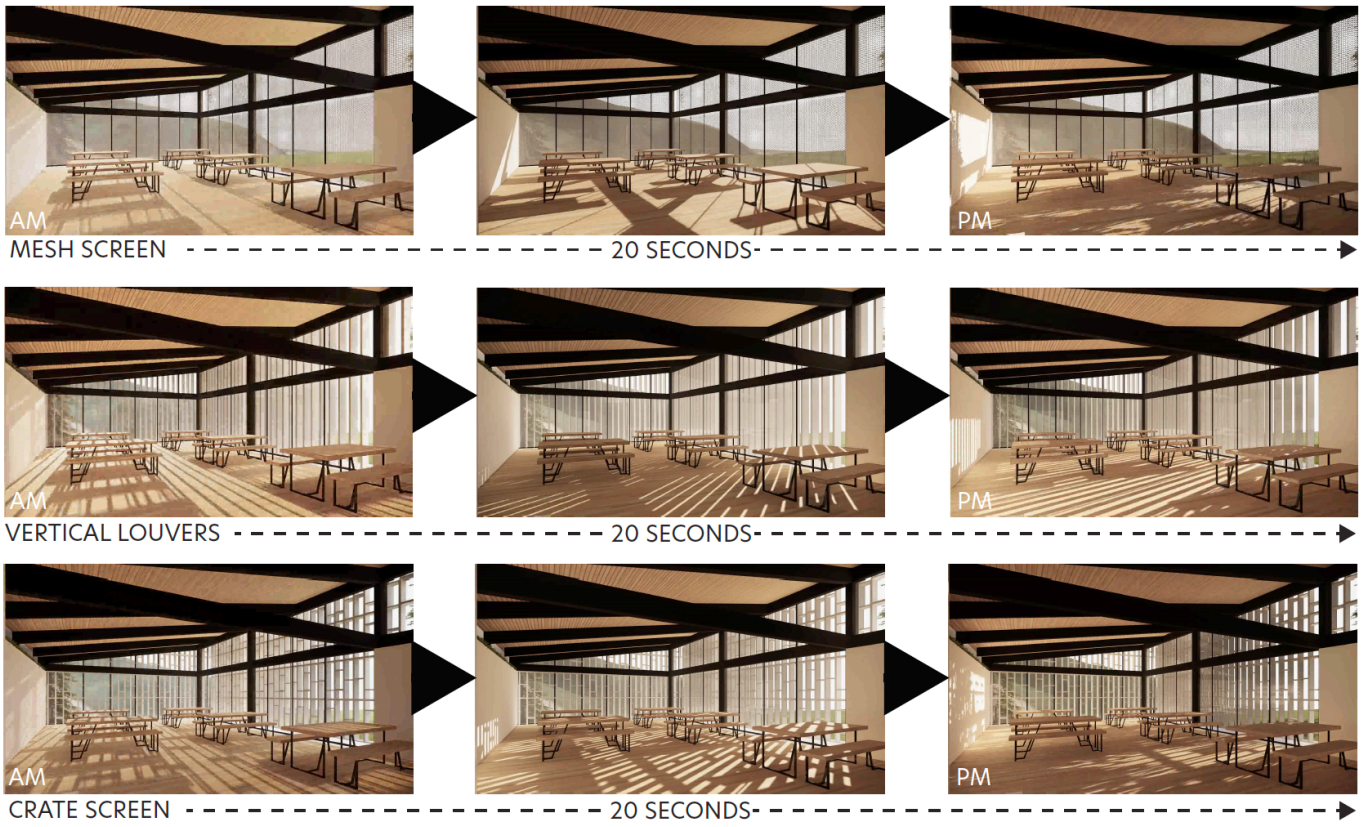
This course introduced students to the subject of next-generation lighting design and analysis through the use of performance simulation, real-time rendering and immersive virtual reality (VR). As our tools and methods move into the virtual realm, our design process, client engagement, and human-centered research methods are changing. With this transformation in software and hardware capabilities, we are now able to immerse ourselves, our clients, and our subjects within rendered scenes and visualize design changes and human responses in real-time. As these work-flows find their way into professional offices small and large, this course will prepare students with state-of-the-art skills in lighting visualization and analysis to generate and test immersive lighting design ideas.

Image
Students presenting their final projects with the use of Virtual Reality

Images
Depicting student work done by Luigi Ghersi & Esefania Valdiva, analyzing lighting interventions on Mies Van Der Rohe's Farnsworth House

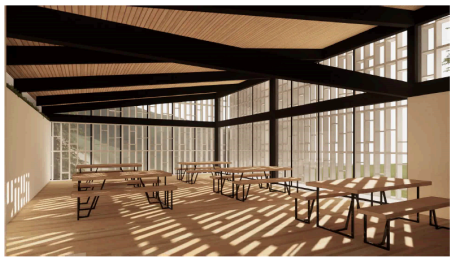
This course was funded through a grant from the Nuckolls Fund and included guest support from academic, research, and industry partners. Students learned through software workshops, guest lectures, and a term-long design project. In addition to simulation and rendering skills, students were expected to conduct an experiment on human responses to factors in the lit environment. Work was conducted in teams and design reviews used Virtual Reality to explore a reiterative design process.

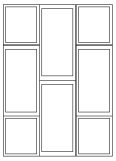
Images
Below: Student work - Facade Options
Click on image using Adobe Acrobat for video simulation.



CONTROL: Viewpoint, length of time, and interior layout INDEPENDENT VARIABLE: Facade Shading System

RESULTS // **CRATE SCREEN**



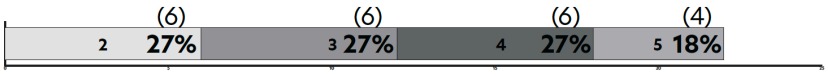


2,3,4,5
Mixed response

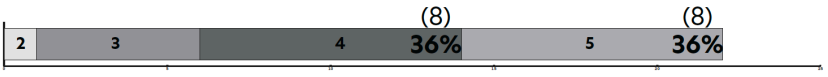
4,5
Very Comfortable

5
Very Interesting

Q.08 Please rate your connection to nature based on the view allowed:



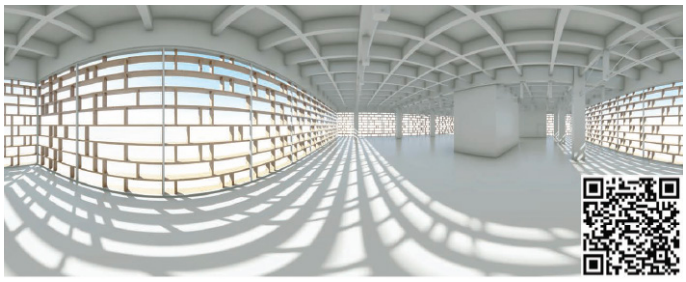
Q.09 Please rate your visual comfort with this environment:



Q.10 Please rate your visual interest with the shadow pattern displayed throughout the day:

Images and Figures
Above: Student work - Screen facade options throughout the day *Left:* Results of survey for Crate Screen Option

Wood Pattern 1



Wood Pattern 2

Wood Pattern 3

Images and Figures
Depicting wood facade patterns and experiment overview and design

Study Space

Experiment Overview

Research Questions

-Which of the facade patterns creates the most productive and appropriate lighting environment according to initial impressions of the space?

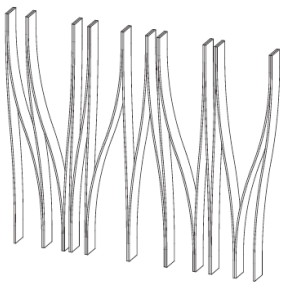
-How does the materiality of the facade design effect the perceived visual enjoyment of the space?

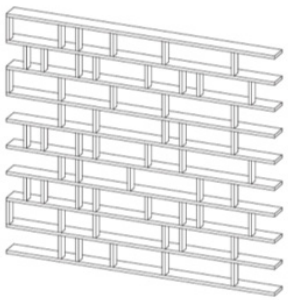
Research Goals

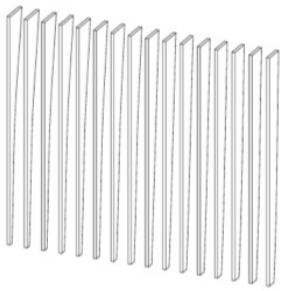
-Determine which design option is most appropriate to control daylight and privacy on the facade of an urban elementary school.

-Determine how materiality of the facade patterns effects occupant comfort, productivity and enjoyment of the interior space

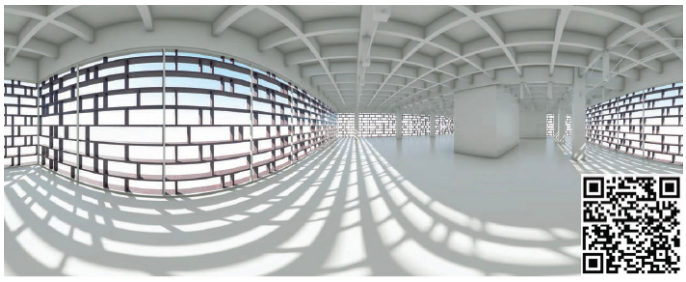
Design Options







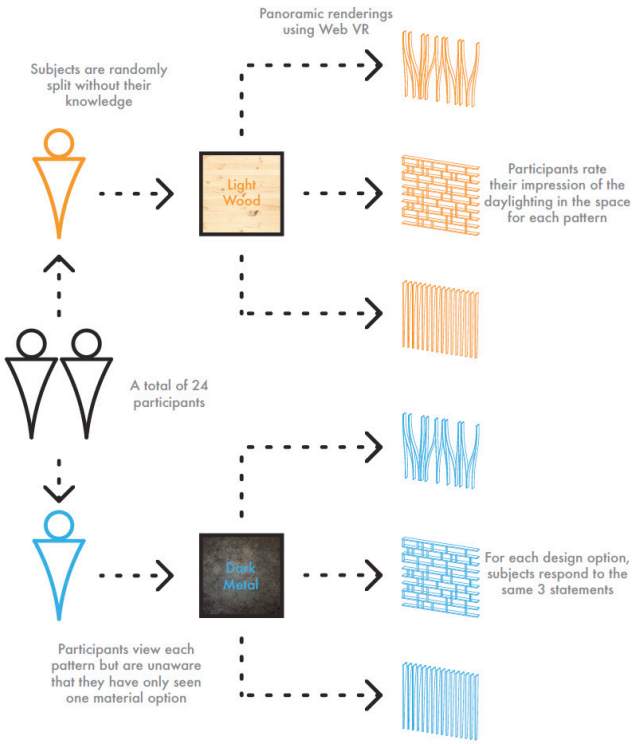
Metal Pattern 1



Metal Pattern 2

Metal Pattern 3

Experimental Design Diagram



Survey Questions

Each subject will agree or disagree with a series of statements about the lighting quality of the space on a scale from 1 to 5. Following the analysis of each design option, participants will be asked a couple questions regarding their overall design preferences.

Part 1:

Subjects view each design option one at a time and rate each space according to 3 different criteria.

-Please agree or disagree with the following statements on a scale from 1 to 5; 1 meaning that you completely disagree with the statement, and 5 meaning that you completely agree.

-I would describe the daylight in this space as distracting.

-I would describe the daylight in this space as energizing.

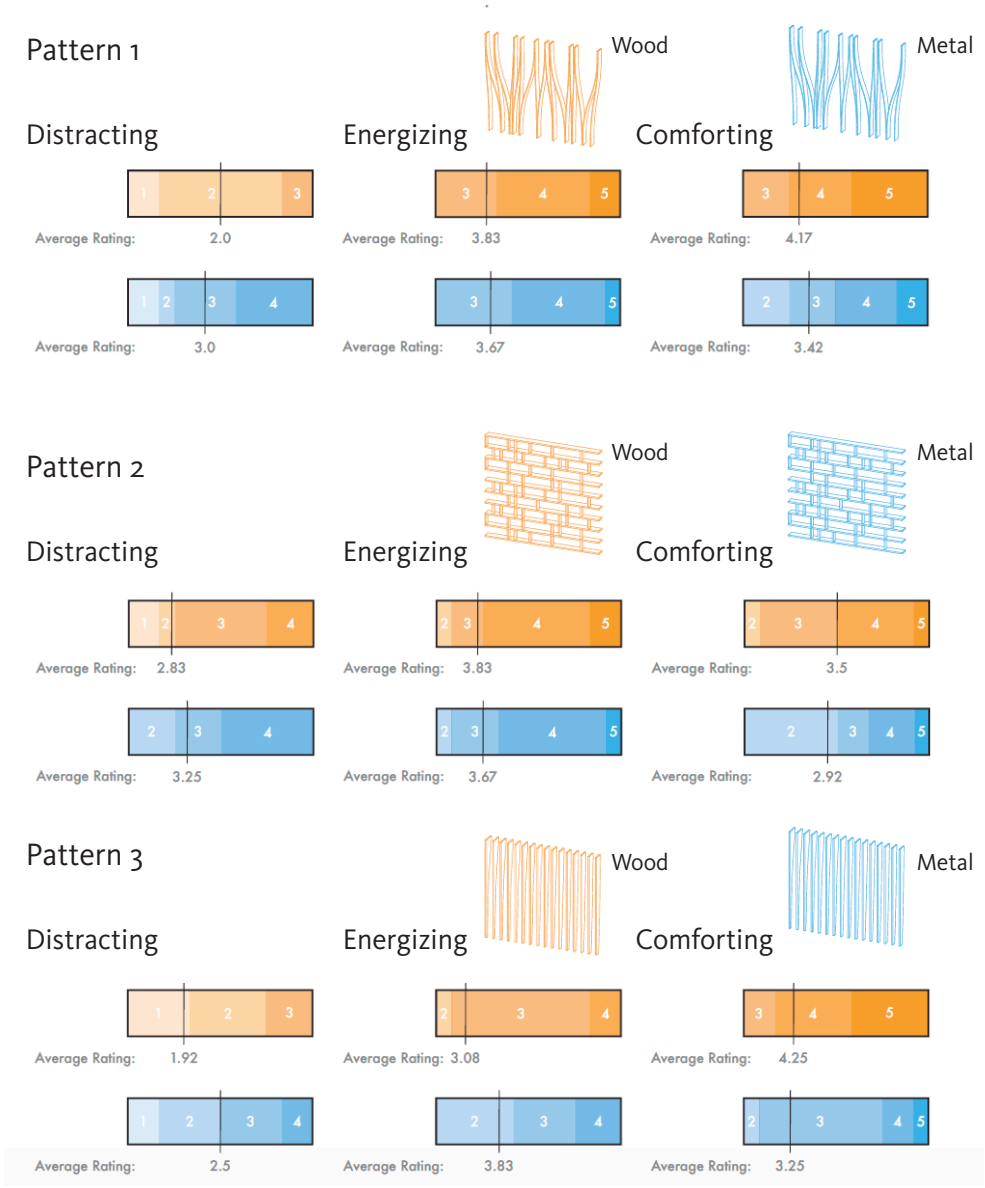
-I would describe the daylight in this space as comforting.

Part 2:

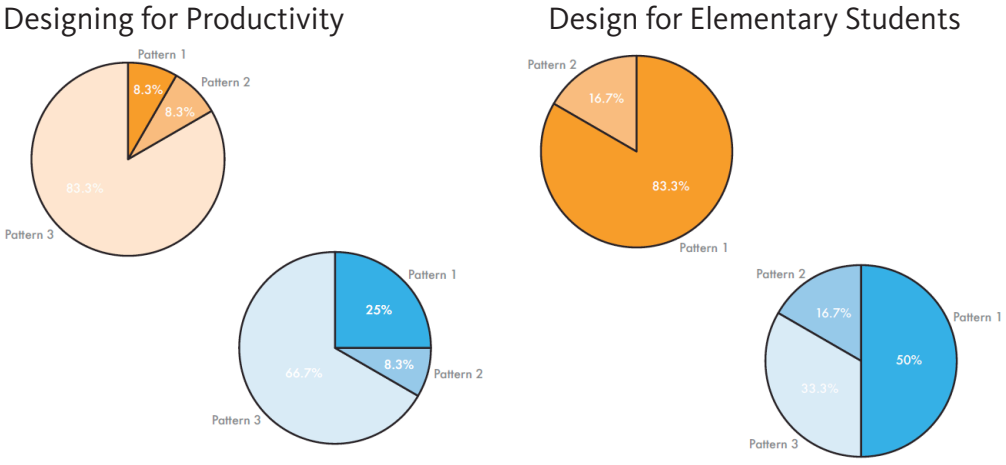
Subjects are asked to choose between the three design options based on their lighting preference for certain program criteria.

-In which of the three spaces would you imagine yourself being the most productive?

-If you were an elementary school student, which of the facade patterns would you prefer for your learning environment?



Figures
Different wood versus metal facade patterns and human perception study results



5

New Research Proposals

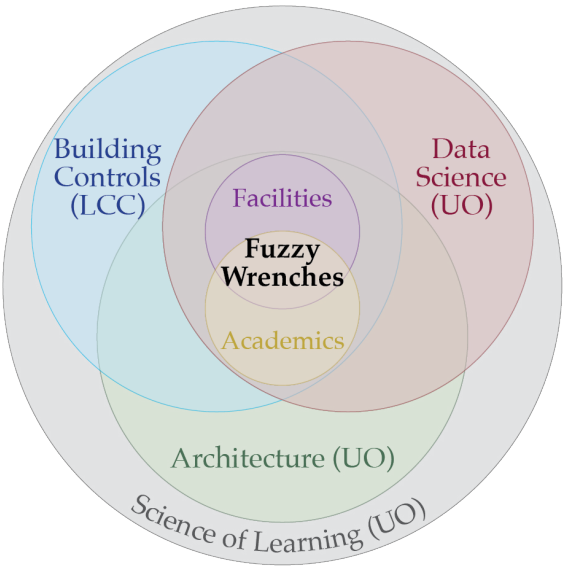
Fuzzy Wrenches

Submitted to the National Science Foundation

Daniel Anderson (Co-PI) - University of Oregon (UO) College of Education
Roger Ebbage (Co-PI) - Lane Community College, Northwest Water and Energy Education Institute
Ken Kato - UO Campus GIS
Junhak Lee - UO College of Design
Gwynne Mhuireach - Energy Studies in Buildings Laboratory
Siobhan Rockcastle (Co-PI) - Energy Studies in Buildings Laboratory
Jake Searcy (Co-PI) - UO Data Science
Paul Ward - Energy Studies in Buildings Laboratory
Kevin Van Den Wymelenberg (PI) - Energy Studies in Buildings Laboratory

Summary and Vision:
While STEM-qualified workers are increasingly needed to fill new technology-oriented jobs and maintain US competitiveness in the global marketplace, our educational system has fallen short of producing enough industry-ready STEM graduates. The field of smart building controls and energy management, in particular, faces a severe shortage of professionals trained to both interpret massive amounts of data from embedded devices using advanced techniques, like fuzzy logic, and to implement changes to equipment operation. The Fuzzy Wrenches Project will work toward rectifying this shortage by forming a "living laboratory" of campus facilities and academic programs within a unique university--community college--industry partnership. This innovative approach will use hands-on project-based learning within a design studio framework to inspire students to pursue STEM training focused on smart buildings and big energy data analytics. We will recruit new learners from underrepresented groups reduce disparity in STEM academic achievement. The project builds on the top-ranked Building Controls and Energy Management programs at Lane Community College and Architecture and Data Science programs at the University of Oregon. Mentoring and internship opportunities with our industry partners will nurture student attainment and career prospects.

Figure
Reshaping disciplinary boundaries



Intellectual Merit: The Fuzzy Wrenches Project will achieve these goals by

- Designing and piloting three new university courses that integrate traditional building energy assessments and cutting-edge big data analysis using an experiential and work-integrated learning approach. The courses will train university and community college students from diverse disciplines and backgrounds, as well as upskilling incumbent workers through professional certifications.
- Attracting and inspiring new students from underrepresented and non-traditional groups by providing mentoring and internship opportunities through connections with industry, professional organizations, and public utilities within a field experiencing rapid deployment of new technologies.

» Leveraging existing relationships with industry and professional organization collaborators who are at the forefront of knowledge and technology development in this area. Collaborators will co-create the new curricula, enhancing the relevance of our teachings to industry employers.
» Generating new knowledge about how learners respond to the living laboratory approach to STEM education within a design studio framework by rigorously evaluating student feeling and learning, outcomes. We will address a substantial gap in our understanding of how students engage with dialogic feedback to become lifelong learners.

Broader Impacts: The Fuzzy Wrenches Project will impact education, society, and science by

» Increasing diversity of learners engaged in STEM training by connecting with underrepresented youth, strengthening community college--university bonds, and building connections with professional organizations to upskill individuals already in the workforce.

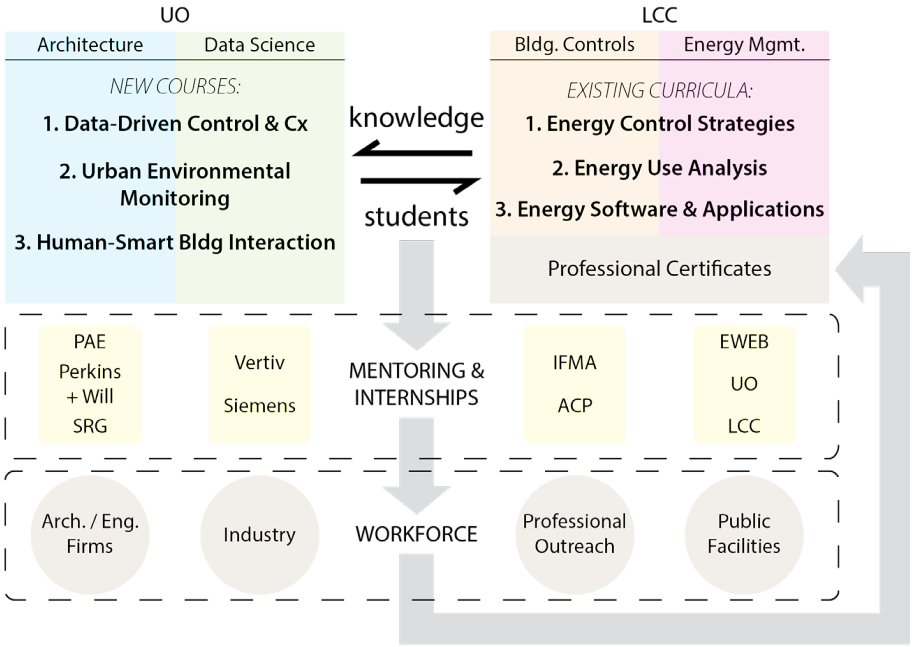


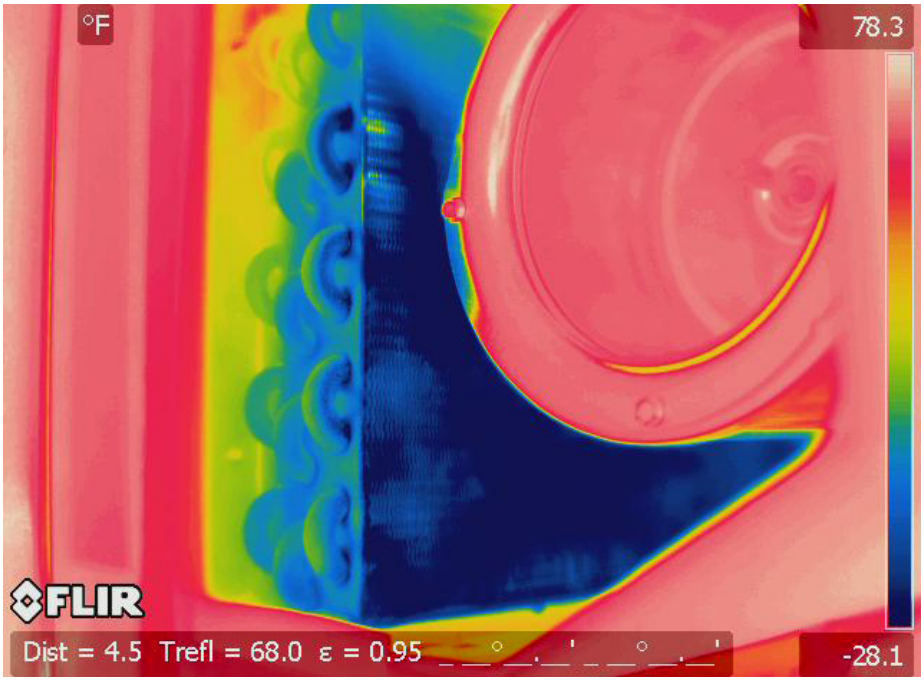
Figure
Relationships between UO and LCC, and student pathways through the program

» Reducing energy use and improving operational efficiency through building re-tuning in academic campus buildings, as well as creating transferable methods for other large institutional buildings and campuses.
» Improving the health and productivity of occupants and ensuring public safety in buildings. Advancing technologies, such as luminaire-level sensors and intelligent building automation systems, continue to increase the amount and granularity of information available to building operators, allowing them to fine-tune room environmental conditions to suit individual occupants and dynamically adapt to changing occupancy loads and characteristics.

Probiotics + HVAC for Energy Conservation

Mark Fretz - Institute for Health in the Built Environment
Willem Griffiths - Biology and the Built Environment Center
Jason Stenson - Energy Studies in Buildings Laboratory
Paul Ward - Energy Studies in Buildings Laboratory
Kevin Van Den Wymelenberg (PI) - Energy Studies in Buildings Laboratory

Bacteria create biofilms - persistent extracellular matrices that adhere firmly to surfaces and allow microbes to survive for long periods of time in variable environmental conditions. Biofilms are omnipresent on HVAC coils due to constant microbial influx through our ventilation systems and condensation water source from cold coils. Biofilm build-up effectively reduces the available opening area of a duct, thereby increasing resistance in the system, which results in more fan pressure and a decrease in energy efficiency in HVAC systems. Furthermore, maximum heat transfer, system longevity, and indoor air quality is dependent on having clean coils. Conventional HVAC coil cleaning techniques (detergent application, power washing, compressed air, physical scrubbing) prove ineffective for biofilm removal and are expensive maintenance procedures.



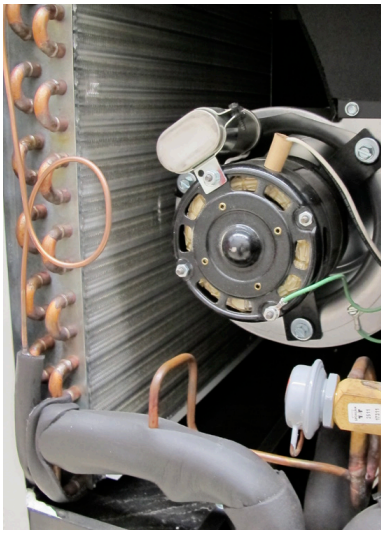
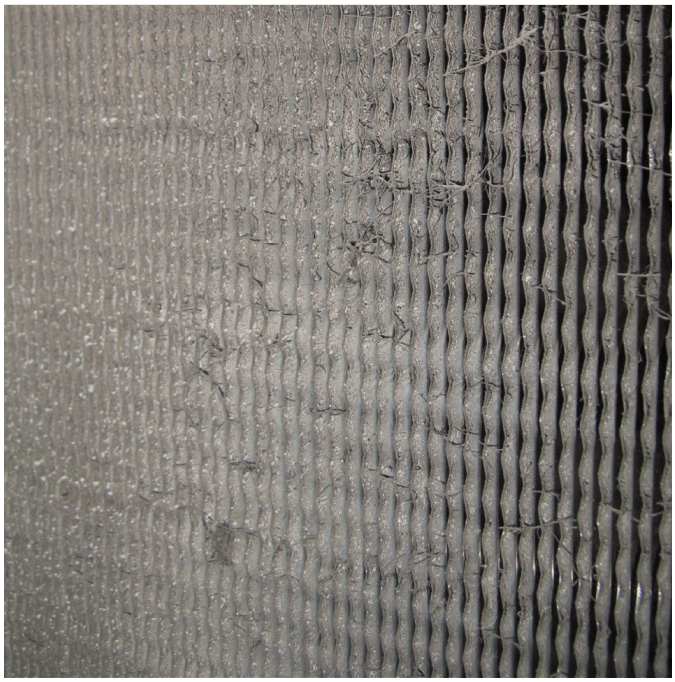


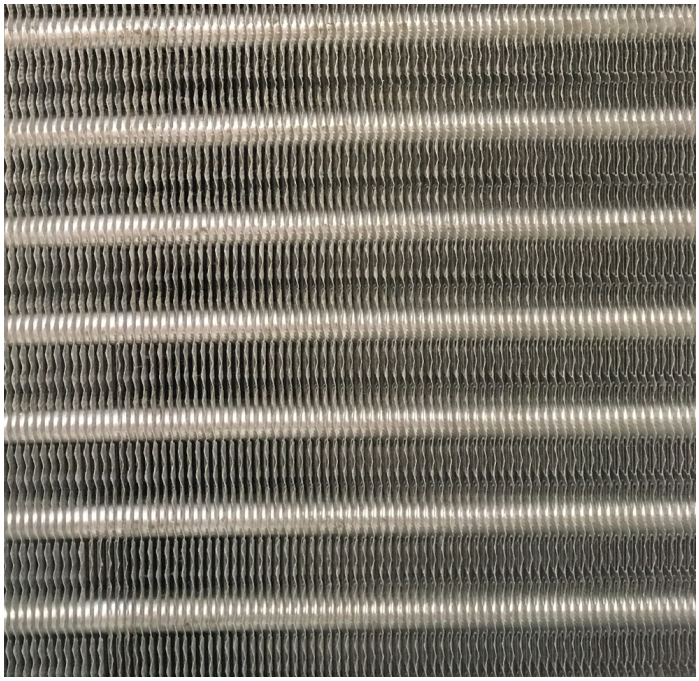
Image
Left: Cold coils (blue) cause condensation which represents a nutrient source for bacteria. *Right:* Fan energy is increased as the pressure in the system rises.

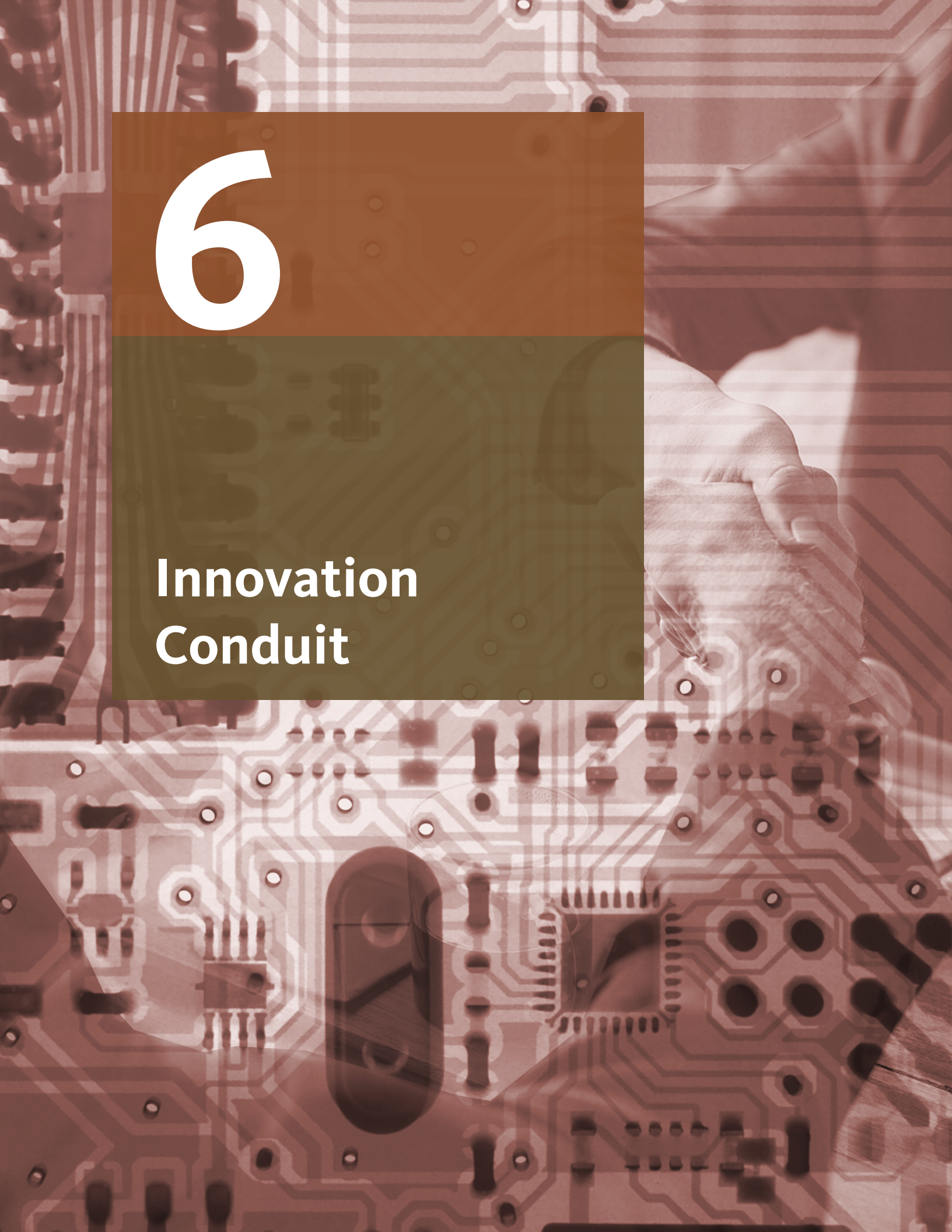
Recently developed probiotic cleaning solutions represent a potentially novel use of bacteria for biofilm elimination in HVAC systems. Probiotic bacteria, such as Bacillus species, produce bio-surfactants, which break down the extracellular polymeric matrix of the biofilm. The breakdown of biofilm releases additional nutrients that probiotic bacteria continually eat, helping them out-compete pathogenic bacteria.

The BioBE/ESBL team is interested in quantifying the effect of biofilm build-up on heat transfer reactions in HVAC coils. Additionally, we aim to test the efficacy of multiple probiotic cleaning formulations for eliminating biofilms on HVAC coils and associated energy savings.

Images
Top Left: example of kombucha biofilm - Image credit: Charles de Mille-Isles, Flickr *Top Right:* magnified biofilm - Image credit: CDC Public Health Image Library, Rodney M. Donlan, PhD - wiki commons *Bottom Left:* dirty coil in our lab, *Bottom Right:* relatively clean coil from our lab







6

Innovation Conduit

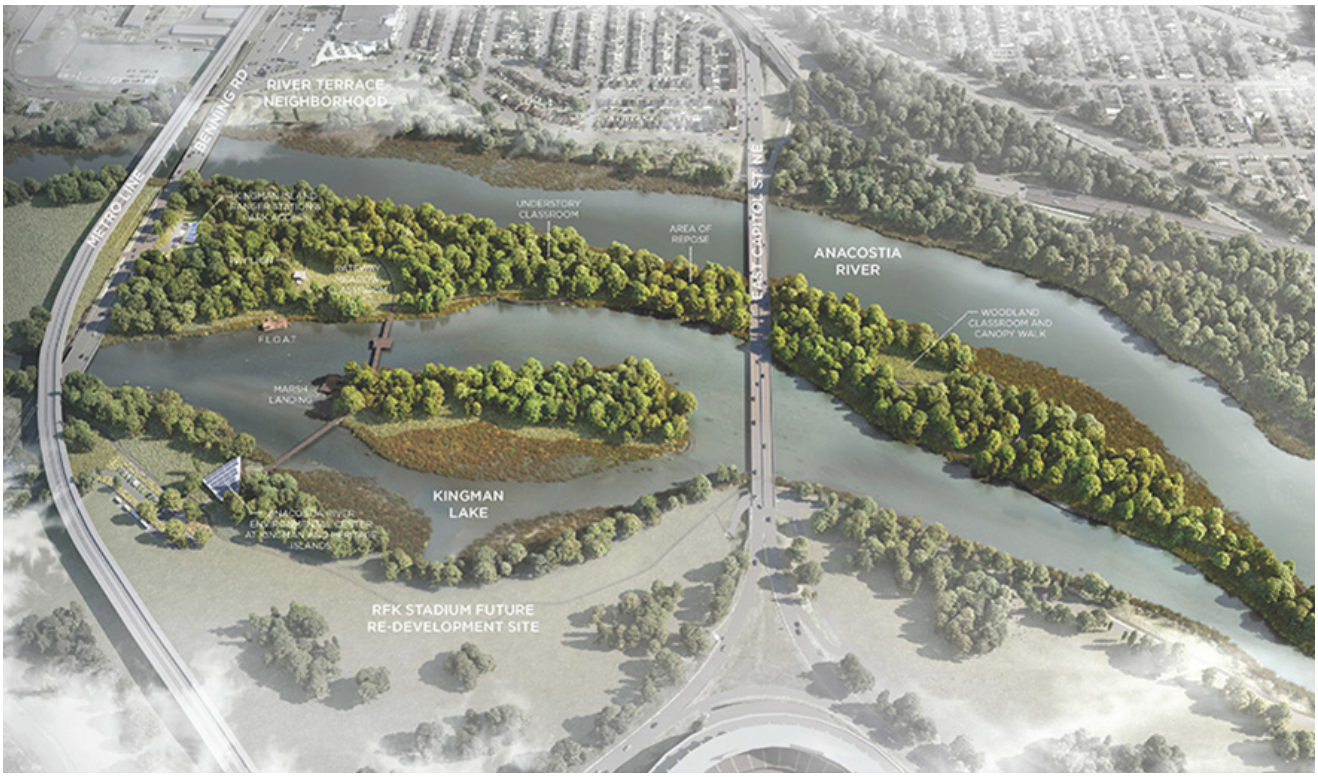
New Member Spotlight: Hickok Cole

Welcome to new Consortium Member, Hickok Cole! Hickok Cole is a forward-focused design practice that connects bold ideas, diverse expertise, and partners with vision to do work that matters. Founded in 1988 and employing 100+ people, Hickok Cole works on projects from Philadelphia to Richmond, but is focused on the Washington Metropolitan area and is a collaborative, multi-disciplinary firm, with specialties in Commercial Office, Residential, Commercial Interiors, Urban Build-to-Suit, Master Planning, Branding and High Performance Design. Hickok Cole currently has offices in both Washington, DC and Richmond, Virginia. We asked Melanie De Cola, senior designer, research and communications coordinator at Hickok Cole, to share a description of current work and the value that Hickok Cole sees partnering with the Industry Consortium at the University of Oregon.

Image
The Ranger Station Rendering at Kingman Island - *image by Hickok Cole, used with permission*

What is Hickok Cole passionate about?
We engage in proactive market research on demographic, technology and design trends. Our in-house research and microgrant programs, as well as sector-focused Think Tanks, are a rich substrate for forward-looking ideas. We aspire to design for what people not only need today, but for what they need before they know they need it.

Some of our more recent research investigations have focused on increasing employee and planetary vitality, from designing human-centered wellness spaces, urban planning for biodiversity and designing structures for a circular

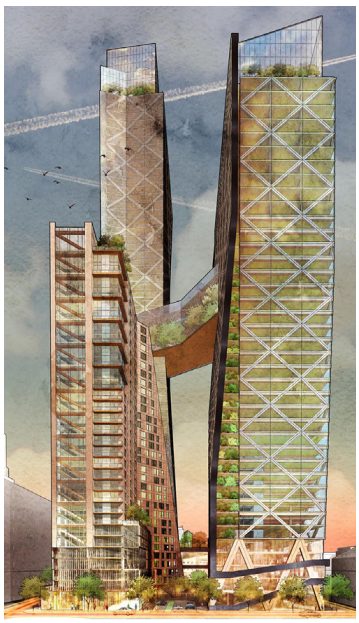


economy. With cities across the country setting ambitious energy goals, including Washington DC's goal of 100% renewable energy by 2032 (an agreement signed at our American Geophysical Union headquarters building, currently targeting net zero energy), we strive to be at the forefront of designing buildings and neighborhoods to the highest performance standards possible.

Images
Top: Kingman Island Masterplan *Bottom:* Timber Towers Rendering - *Images by Hickok Cole, used with permission*

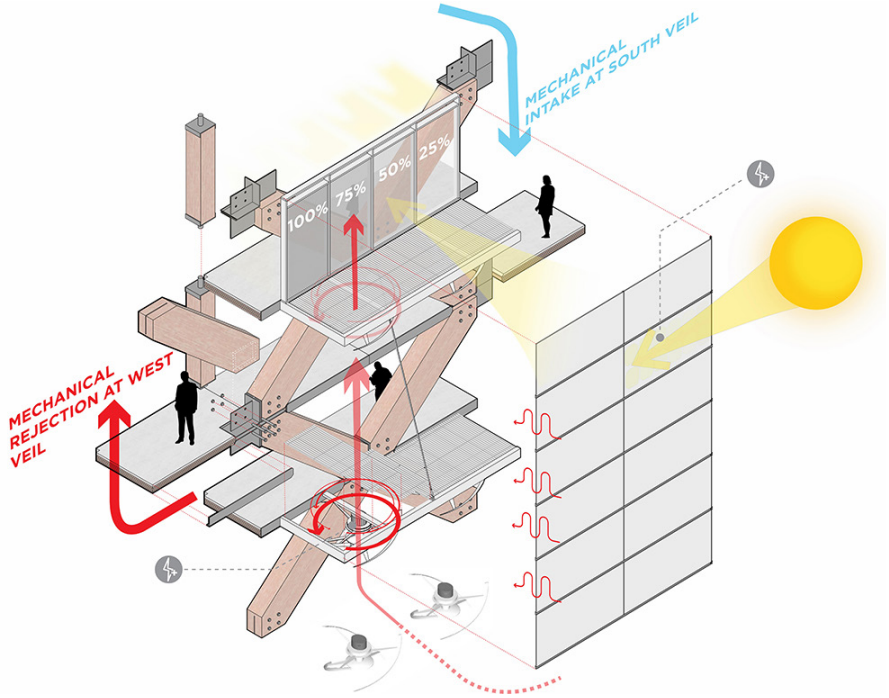
Various grants for DC government

Hickok Cole has completed multiple grants for DC's Department of Energy & Environment (DOEE) and Office of Planning, including a master plan for Kingman & Heritage Islands, multiple Sustainable Development & Planning grants, and a Green Building Case Study & Historic Preservation Guideline grant. All of these grants resulted in reports, many of which are available to the public, in support of DC's mission: creating "the healthiest, greenest, and most livable city in the United States."



Timber Towers

Originally designed for a competition, this mixed-use mass timber complex consists of two office towers—one 62 stories, the other 40 stories—and a 32-story residential building. These towers are anchored by a school, playing fields and street-level retail. This project was shortlisted in the Skyhive Skyscraper Challenge. Structural and fire safety engineering was provided through a partnership with Arup. Leading from DOEE's master planning grant for Kingman & Heritage Islands we also won a Wood Innovations grant to support design development of a ranger station made of CLT. This is a partnership with Integral Engineering, Oehme Van Sweden, Skanska and Arup.



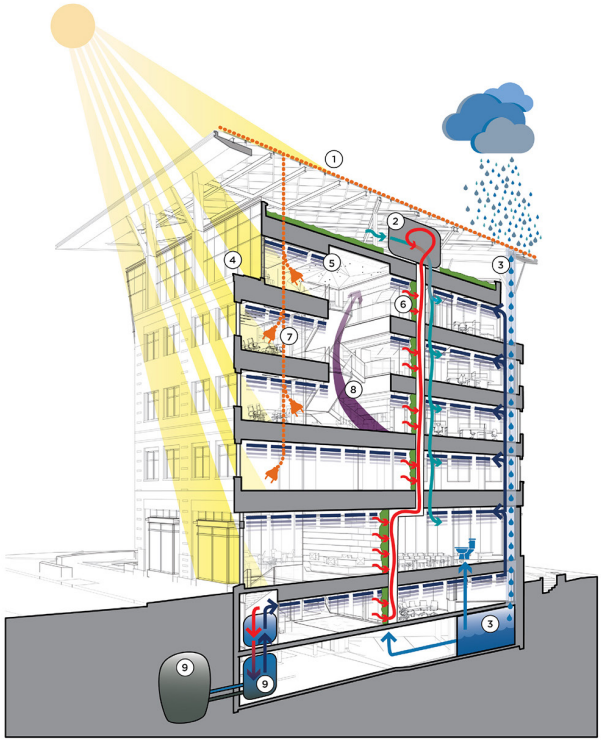
Images
Top: Timber Tower environmental control strategy *Below:* Bird's eye view rendering of AGU - *Images by Hickok Cole, used with permission*

American Geophysical Union headquarters
As part of its mission of "science for the benefit of humanity," AGU seeks to lead by example and is striving to create the first-ever "net zero energy" renovation of an existing commercial building in DC. This project includes such high performance features as a sewer-heat exchange system, a 250 kilowatt solar PV array, a hydroponic phytoremediation wall, electrochromic glazing, radiant ceiling cooling and a DC power network.

Mass timber penthouse structure
Design development is currently underway from a mass timber penthouse office structure to sit atop an existing concrete office building in SW DC. We have been successful for petitioning for a code modification in order to build this structure. At this time the client and exact location are confidential. Structural and fire safety engineering was provided through a partnership with Arup.

Contributions to health in the built environment
Hickok Cole has invested in indoor air quality sensors, from Awair, to monitor our own air quality, and has written grants seeking to study the influence of plants and air filtration systems on office air quality. We are also advising clients on air quality monitoring in an attempt to reduce sick building syndrome symptoms. Our AGU headquarters retrofit also includes a hydroponic phytoremediation (hy phy) wall, while this wall looks like a standard green wall or vertical garden, it actually works a little harder. It will be an active rather than passive wall, and function as part of the building's ventilation system. The wall will filter and improve indoor air quality, all while reducing the amount of outside air necessary. The plants, their roots, and the water filtration system will scrub air of unwanted toxins and VOCs before it recirculates throughout the building.

We have also funded an internal microgrant to design wellness spaces for far-ranging human needs, from supporting new mothers and employees with medical concerns and religious needs. In addition, we have WELL and ILFI certified staff and as well as those pursuing becoming RELi and Fitwel ambassadors.



1. Solar Photovoltaic (PV) Array
2. Dedicated Outdoor Air System (DOAS) with Exhaust Air Heat Recovery
3. Stormwater Collection and Reuse
4. Enhanced Dynamic Glazing System
5. Radiant Ceiling Cooling System
6. Hydroponic Phytoremediation (Hy Phy) Wall
7. DC Powered Workspace and Lighting
8. Central Active Stair
9. Municipal Sewer Heat Exchange System

What does Hickok Cole hope to achieve through research and industry/ academia collaboration?
We are very excited to have joined the consortium. As busy architects and designers we rely on partnerships with academia, as well as engineers and constructions trades, to bolster our knowledge base. In order to participate in primary research we have written multiple grants to support our investigations into flexible models of living for families and seniors in the city, to implementing improvements in indoor air quality. We often encounter clients who are seeking solutions to improve their spaces with low-cost interventions, if we can offer them a wide range of options, backed by scientific findings, we can all improve the built environment together, both inside and out, for humans and other living species.

Image
AGU Environmental Strategies Diagram *- Image by Hickok Cole, used with permission*

7

Calendar + Milestones

2018 - 2019 Calendar + Milestones

2018-2019 MILESTONES

May 17-18, 2018	Build Health Event
June 5, 2018	Launch Research Study #1
July 9, 2018	Post-Conference e-Blast
August 17, 2018	Q1 e-Blast Update
August 20, 2018	Launch Research Study #2
January 7, 2019	Q2 e-Blast Update
January 7, 2019	Launch Research Study #3
February 15, 2019	Q3 e-Blast Update
February 18, 2019	Launch Research Study #4
May 16-17, 2019	**Build Health Event, Portland**
June, 2019	Q4 e-Blast Update (Will include Post-Conference Report)

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