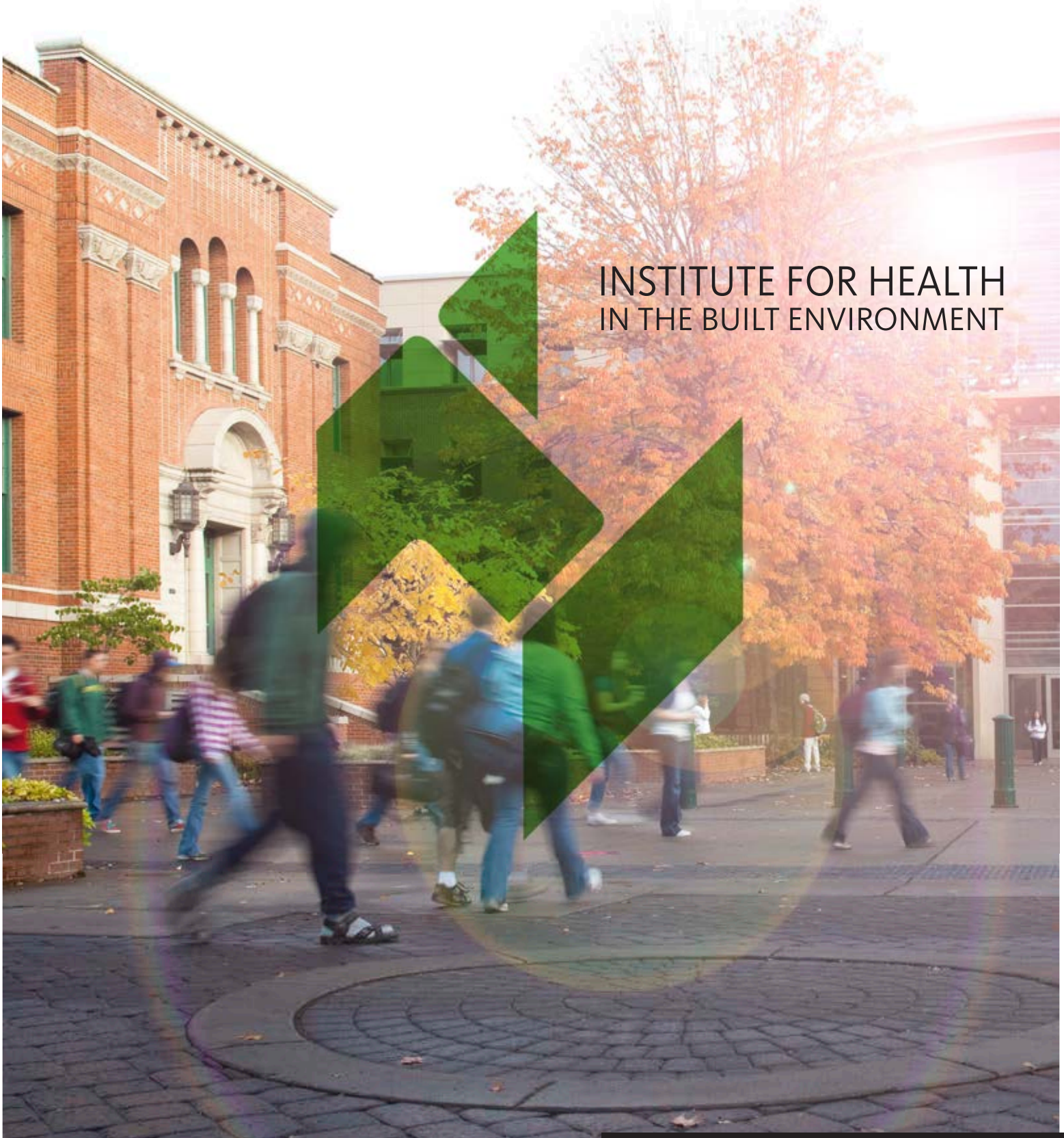
design the unseen

INSTITUTE FOR HEALTH
IN THE BUILT ENVIRONMENT

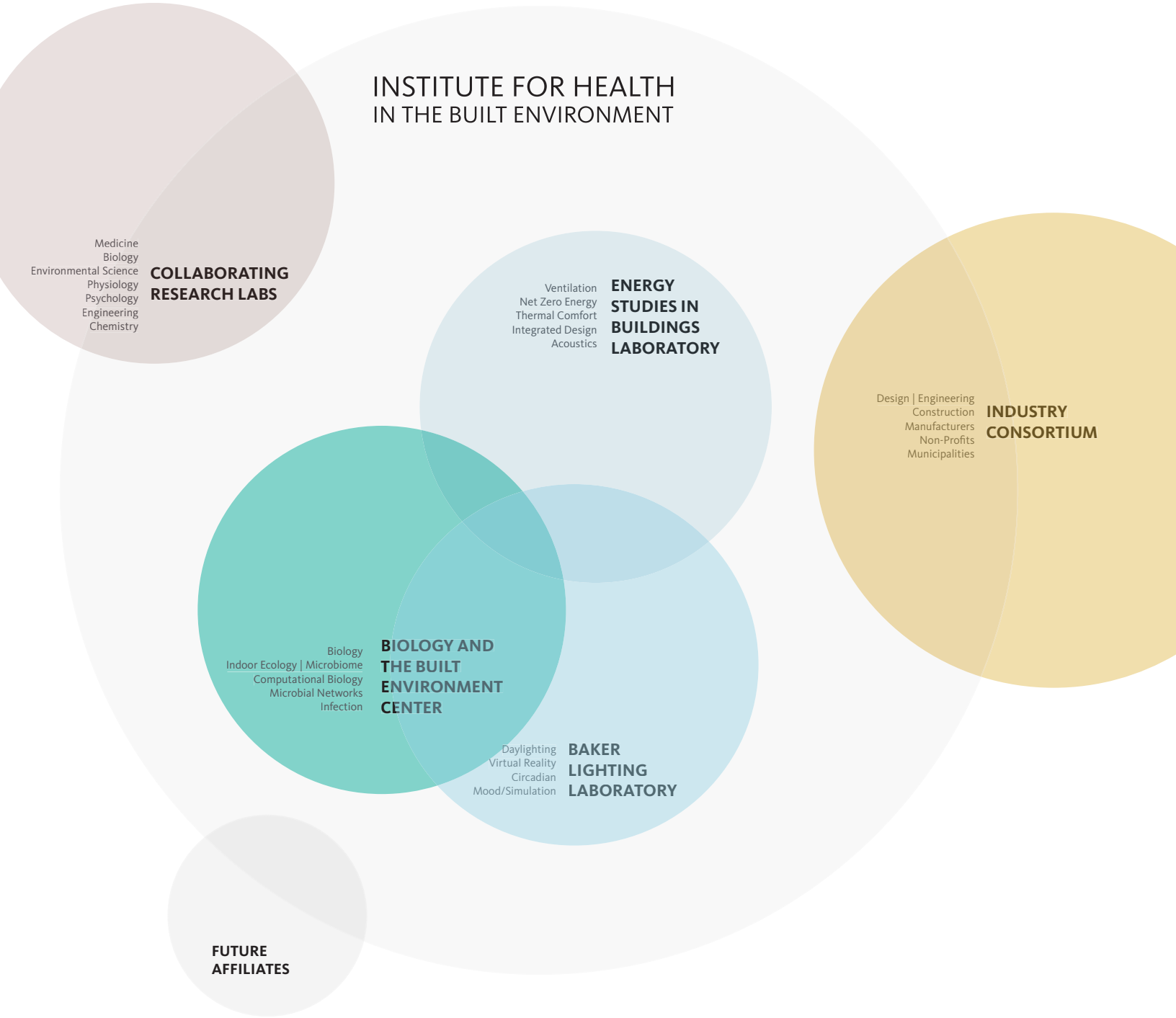


2018-2019 Build Health Quarter 2 Research Report

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.



Industry Consortium - Founding Members

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Q2 Report Directory

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IN THE BUILT ENVIRONMENT

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Overview Q2

Executive Summary

Dear Industry Consortium,

Greetings from Portland, Oregon and the University of Oregon Institute for Health in the Built Environment! Fall has been a time of teaching, learning, collaborating and moving in many directions as we continue to expand an ecology of innovation in the College of Design. We also continue to advance multiple research projects that interrogate scales from the micro to the macro in our built environment, synthesizing energy, health and poetic experience and are excited to share these updates with you in this Q2 report!

The second quarter of the 2018-2019 IHBE Industry Consortium has been very eventful as we advance projects, write new proposals and close the loop on research through peer-reviewed publication. *Current projects include*: healthcare-associated infections (HAI's) and architecture; building materials surface topology, air chemistry and the microbiome; mass timber wall and floor acoustic design for high-performance; on-going building commissioning studies. *New projects include*: literature review and paper on indoor environmental cleaning and chemistry; literature review on probiotic cleaning; literature review on lighting and healthy aging; use of iRobot to map space and layer environmental data with building user wearable data. *Student projects include*: using virtual reality for thermal comfort studies; examining the physiologic, comfort and energy differences between radiant and convective heating; testing effect of variable thermal conditions on cognition; Studio project: Center for Mental Health - Light, Health and Energy with collaboration from researchers at OHSU and ZRZ Realty Co. *New research proposals include*: Memory, metrics and mobility: universal design for an aging population - a collaboration with Departments of Sports Product Design, Architecture, Art and industry that seeks to use data and metrics to design integrated products and architecture for this population in the spirit of Bauhaus; Lightbox 2.0 to advance understanding of lighting on microbes indoors; Luminaire Level Lighting Controls, HVAC + Humans that seeks to investigate the energy and non-energy benefits of integrating luminaire level sensors into building control and automation. *Recent publications include:* "Antimicrobial chemicals associate with microbial function and antibiotic resistance indoors," "Daylight exposure modulates bacterial communities associated with household dust," "Developing a Process for Continuous Commissioning" and "A Human Factors Study Update a Recently Proposed Manual Blind Use Algorithm for Energy and Daylight Simulations"

Warm regards and happy new year!

Mark Fretz, Associate Director of Outreach

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Research Updates

Microbes
Molecules
Energy
People +

Healthcare-Associated Infections

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

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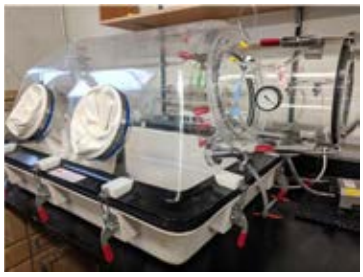
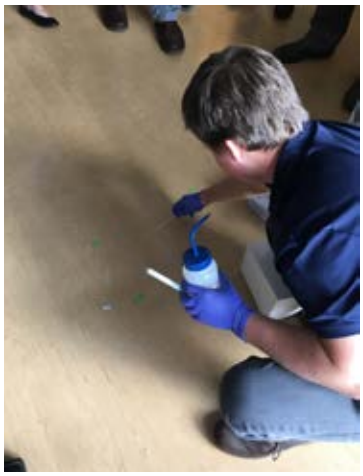
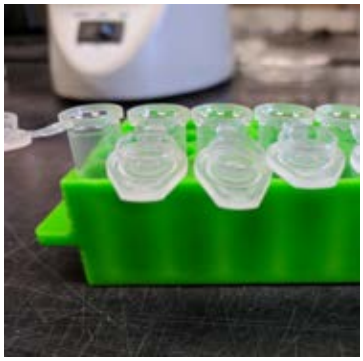
Patrick Horve - Biology and the Built Environment Center
Sue Ishaq, PhD - Biology and the Built Environment Center
Laszlo Kiraly, MD - Oregon Health Sciences University
Savanna Lloyd - Biology and the Built Environment Center
Robert Martindale, MD, PhD - **(PI)** Oregon Health Sciences University
Kyla Siemens - Oregon Health Sciences University
Kevin Van Den Wymelenberg, PhD - **(PI)** Biology and the Built Environment Center, ESBL

This highly collaborative and ambitious study of examining the architectural influences of healthcare-associated infections is underway! We have begun collecting samples from diagnosed patients and their rooms at the time of diagnosis, as well as before and after room cleaning post discharge. We are in the process of extracting DNA, as well as assembling the anaerobic chamber to culture and isolate any strains of Clostridioides difficile (C. diff) which are present in any of the samples. Since the chamber uses pressurized gases, including hydrogen, and C. difficile is a known pathogen, a number of safety requirements and special equipment was required before the chamber can be operational. We are just waiting for our pressure regulators to arrive, and then we'll be able to get culturing!







Images
Left: Clostridiodes difficile samples ready to transport from OHSU in Portland to biology lab in Eugene *Top:* Anaerobic chamber setup for culturing C.Diff *Middle:* Patrick demonstrating sampling technique *Below:* Lab work begins

Building Materials and the Microbiome

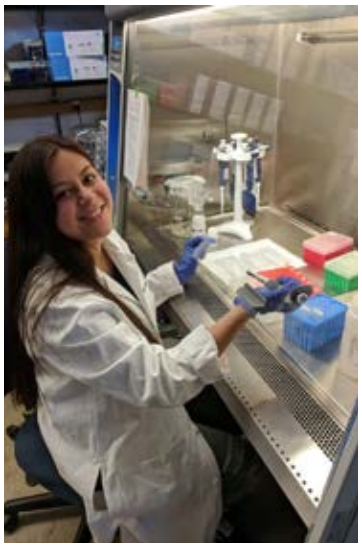
Funded by USDA with TallWood Design Institute and Alfred P. Sloan Foundation

Jessica Green, PhD - **(PI)** Biology and the Built Environment Center
Willem Griffiths - Biology and the Built Environment Center
Roo Vandegrift, PhD - Biology and the Built Environment Center
Kevin Van Den Wymelenberg, PhD - 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.

We are currently in the phase of analysis in which we are utilizing multiple channels to elucidate microbial community structure and its effect on the surrounding environment. qPCR (quantifies microbial biomass), 16S sequencing (identifies bacterial taxa), metagenomic analysis (reveals key functional genes from specific microbial taxa), volatile organic compound sequestration (detects VOCs exuded from materials and resident microbes), and scanning electron microscopy (illustrates material micro-topography). Employing this combination of analytical methods will provide a thorough characterization of the interaction between microbes and building materials, and reveal how those building materials shape the resulting indoor microbiome.

Images
Below: Swabbing material surface to collect microbes in specially constructed microcosms



Images
Top: Inoculated building material samples placed in microcosms in triplicate *Left:* Post-Doc Roo Vandegrift and Portland State University chemist, Aurelie Laguerre, sampling volatile organic compounds exuded by building materials and resident microbes *Above:* BioBE student research assistant, Susie Nunez, extracting DNA from sampled microbes

Mass Timber Acoustic Testing

Funded by Business Oregon (chambers); 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
Kevin Van Den Wymelenberg - **(PI)** Energy Studies in Buildings Laboratory
Ethan Zagorec-Marks - IHBE, Student Researcher*

Cross-laminated timber (CLT) and mass plywood panelized construction is gaining popularity in the United States as a building material with carbon sequestration, biophilic, environmental, and off-site construction benefits. Although this product and construction method has been available in Europe for decades, it is nascent in North America and emerging as production plants come on-line and structural and fire testing demonstrate code compliance.

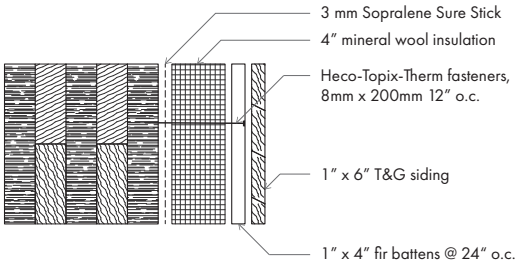
Images *Above* - Forest in Oregon
Opposite Page Right - Acoustic separation of spaces from foot fall and sound transmission promotes enjoyment and well-being in a space
Opposite Page Left - Diagrams of full assemblies to test. Components of each will also be tested.

In an effort to facilitate designers, engineers and contractors' use of mass timber construction, the Energy Studies in Buildings Lab is collaborating with TallWood Design Institute and Oregon State University to develop a research-grade, ASTM-certified acoustic testing facility. The facility design and development is underway and estimated to be up and running in 18-24 months; however, in the interim, the lab is working to identify gaps in publicly available lab testing data for CLT floor and wall assemblies. To arrive at which assemblies to test, the lab reached out to 24 building industry

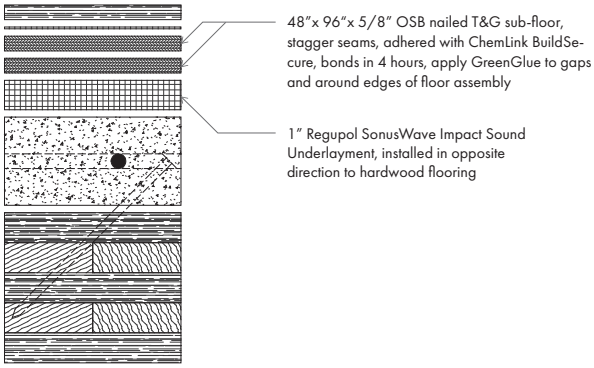
professionals, including: acousticians, architects, engineers, contractors and developers to gather feedback about performance, aesthetics, cost, and constructibility. The comments received indicated a desire to explore assemblies that eliminate wet trades, use generic materials and develop acoustic data for a structural composite assembly developed by OSU for high seismic areas.

The following wall and floor assemblies have been selected for testing (in addition to base case material). Lab bids have been received and labs selected, and we will begin testing in early 2019 .

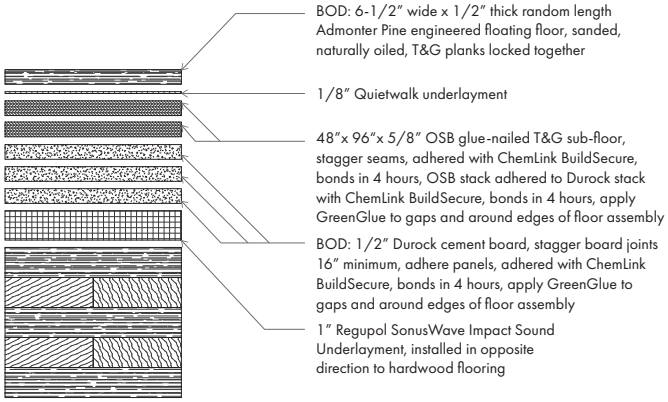
Wall Assembly - Exterior or Shaft Wall



Floor Assembly - Structural Composite



Floor Assembly - No Wet Trades



On-Going Building Commissioning

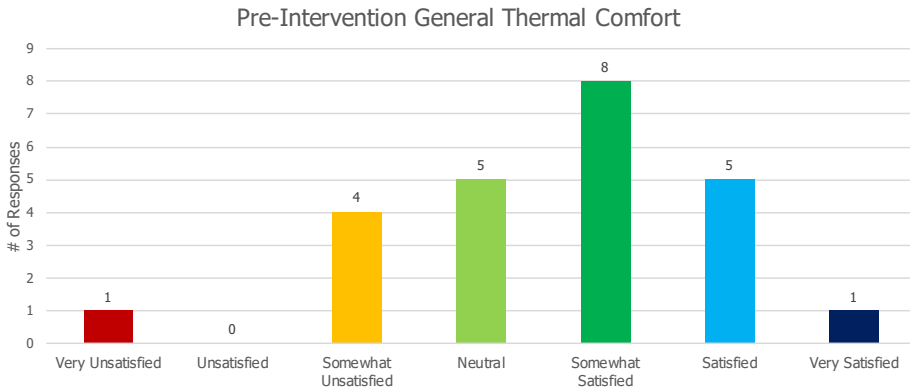
Funded by a Gift from NEEA and IHBE Members

Paul Ward - Energy Studies in Buildings Laboratory
Kevin Van Den Wymelenberg - Energy Studies in Buildings Laboratory

Image HEDCO Building, University of Oregon, Eugene

We've been busy using the University of Oregon campus as a living lab, monitoring performance and tuning controls at HEDCO since on-site work was largely finished in June. This project has taught our team a great deal about recommissioning in a campus environment and, while we are pleased with the initial results, we expect to be refining our approach for quite some time.

We know that we need to improve how we communicate the intent, process, and results of the work to the building occupants to reduce confusion and set appropriate expectations. We also realized that our initial, binary approach to occupancy was not sufficient and we developed a stand-by mode, with less aggressive temperature set-points, that governs unoccupied spaces during normal business hours. Initial comfort reports, informally collected by the building manager during the summer, were quite positive. Occupants reported favorable thermal conditions and drastically decreased fan noise. We recently administered our post-interventions survey and responses have been mixed. It seems that some occupants are more comfortable, while others are too cold now that outdoor temperatures are dropping. We're digging through the responses to draw out specific points of comparison, but it's clear we have more work to do to balance comfort and energy.



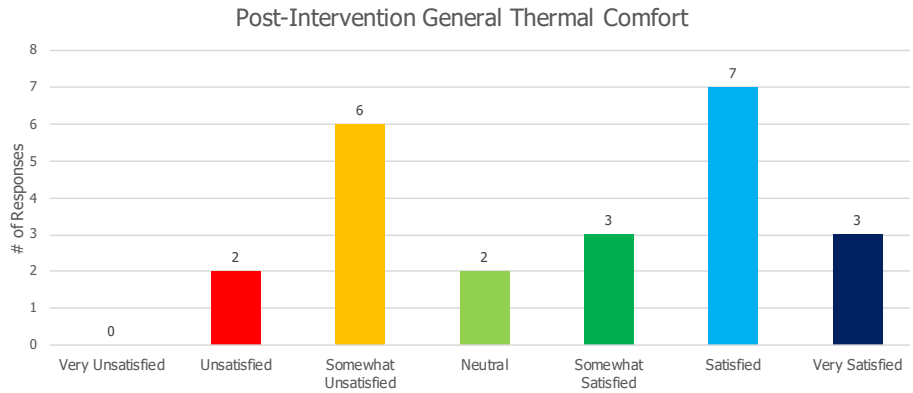
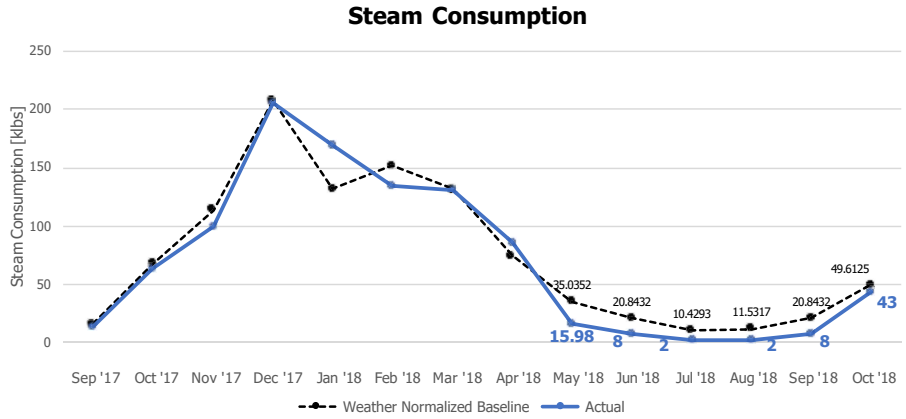
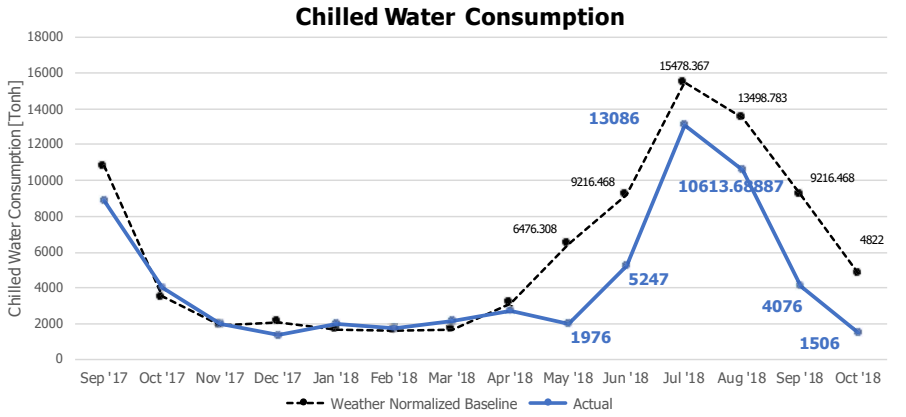


Figure *top* HEDCO Building comfort survey, pre-commissioning intervention *bottom* HEDCO Building comfort survey, post-commissioning intervention

Initial energy performance readings are also positive. A study of pre- and post-intervention AHU operation suggests that the VAV system will use ~66% less electricity and ~60% less district steam. We have also been analyzing the whole-





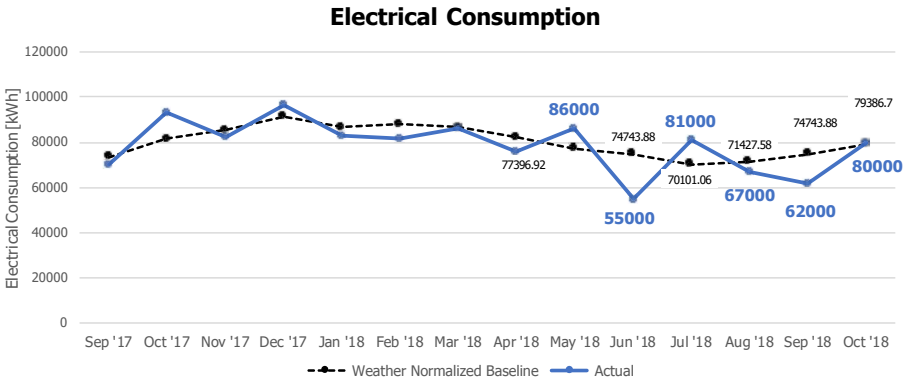


Figure HEDCO Building steam (*top*), chilled water (*middle*) and electricity consuption (*bottom*) post-intervention and compared to weather normalized baseline (WNB)

building utility consumption and, while a lack of comparable historic data and questions regarding meter calibration make precise calculations impossible, we appear to be on track for ~15-18% whole-building-energy savings.

Moving forward, we continue to improve our process for communicating with building managers and occupants. We're also in the midst of establishing guidelines for how we implement automated fault detection and other continuous performance monitoring via Navigator. We'll continue to update these protocols as we implement the next Siemens buildings on our list.

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Initiated Research Projects

Light and Healthy Aging

Funded by the IHBE Research 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
Ethan Zagorec-Marks - Institute for Health in the Built Environment, M.Arch Student Researcher

"Architecture is the masterly, correct, and magnificent play of masses brought together in light. Our eyes are made to see forms in light: light and shade reveal these forms." - Le Corbusier

"Light is as necessary to the perfect growth and nutrition of the human frame as are air and food; and, whenever it is deficient, health fails, and disease appears...A deficiency of light not only acts on the imperceptible processes of nutrition, rendering imperfect the gradual changes which take place in the minute structures of the animal economy, but it operates powerfully on the mind, depresses the spirits, and diminishes intellectual energy, and thus powerfully reacts, in another manner, on the nutrition." - The Duty on Glass. (February 22nd, 1845). The Lancet, 1, 214-215.

Light defines architecture. Our visual perception of space, form, material, excitement and calmness is shaped by light. Research is beginning to also reveal a multitude of non-visual aspects of our physiologic dependence on light in the built environment. Some of the effects of light include regulation of sleep, body temperature, alertness, memory and cognitive function, perception, mobility and circulation. For an aging population, these effects can become more acute. We are currently reviewing a broad swath of the scientific literature to better understand the visual and non-visual effects of light on this demographic and will publishing this review to consortium members in Q3 as well as moving forward with research initiatives and proposals that contribute to better understanding of bio-response and better design of senior living facilities.

Image *Below* - photo by Jon Marababol on unsplash.com

Probiotic Cleaning

Funded by the IHBE Research Consortium

Willem Griffiths - Biology and the Built Environment Center
Sue Ishaq, PhD - **(PI)** Biology and the Built Environment Center
Susie Nunez - Biology and the Built Environment Center
Semantha Velazquez - Biology and the Built Environment Center

The escalation of the antibiotic-resistant bacteria pandemic prompts a reassessment of our household and workplace cleaning paradigm. Contemporary indoor sanitation practices resemble a 'scorched-earth cleaning approach, where antimicrobial cleaning agents are used to eradicate microorganisms residing on indoor surfaces. However, the efficacy of this disinfection approach is under scrutiny due to its suspected link to the proliferation of antimicrobial-resistant bacteria. Additionally, the FDA stated that antimicrobial cleaning solutions are less effective at microbial removal and sterilization than they claim, and using the traditional soap and water cleaning method is often more effective (Office of the Commissioner). From a sustainability perspective, these harsh chemicals used for disinfection prematurely wear out finishes and furnishings often forcing designers to choose engineered materials that are less esthetic and do not readily degrade in the environment, creating a larger environmental footprint.

Image cleaning our indoor environments could one day be done by adding beneficial bacteria instead of a 'scorched earth' disinfection approach using strong oxidating chemicals - *rawpixel, unsplash.com*

Given BioBE's recent findings about antibiotic resistance from antimicrobial compounds in our built environment (Antimicrobial chemicals associate with microbial function and antibiotic resistance indoors), researchers at BioBE are interested in investigating the effectiveness of probiotic cleaning, which leverages microbe-microbe competition to eliminate pathogenic bacteria. Probiotic cleaning agents contain bacterial strains capable of degrading different organic compounds (i.e. protein, cellulose, starches), metabolizing odor-causing substances (i.e. ammonia and sulfides), and inhibiting the survival of undesired microorganisms residing on indoor surfaces.

Probiotic cleaning products are in the nascent stage of research and development. Additional research is required to address major questions/concerns regarding the safety and effectiveness of these cleaning products. BioBE is engaged in collaborative research efforts with cleaning industry leaders to assist with the development and optimization of probiotic cleaning solutions. These collaborative research endeavors will provide insight into critical questions concerning probiotic cleaning: How many bacterial taxa should be used in a mix? Do probiotic solutions emit an unpleasant odor? Can a scent be added without damaging bacteria? Are the solutions food safe? Can the probiotic cleaning products conform to current FDA regulations? Therefore, bacterial strains used in probiotic cleaning solutions must be properly identified and isolated to eliminate risk of deleterious human health consequences. Prolonged bacterial strain survival in solution and on indoor surfaces is imperative for product effectiveness.

Probiotic cleaning agents exhibit potential to eradicate undesirable microorganisms and prevent their recolonization via formation of a persistent surface biofilm. BioBE researchers intend on conducting meticulous experiments to assess the safety and optimize the effectiveness of probiotic cleaning solutions.

Robots and Wearables

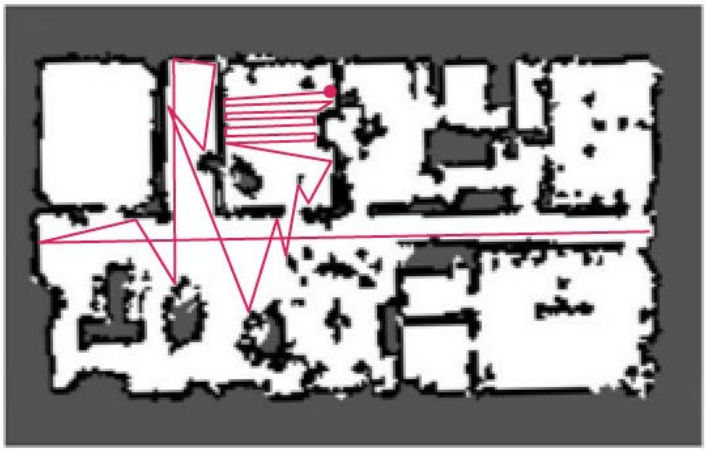
Funded by the IHBE Research Consortium; The Baker Fund

Siobhan Rockcastle - Baker Lighting Lab
Jason Stenson - Energy Studies in Buildings Laboratory
Lily Summers - IHBE, MArch Student Researcher

Here at the lab, we are gearing up to make good use of our new iRobot. The same folks who brought us the Roomba self-automated vacuum cleaner have released an iRobot that's sole purpose is to allow the user to hack into the system to customize added functions to the original interface.

The possibility for these hackable systems is enormous, and we're honing in on how the lab is going to use them. Others have adjusted these robots by adding 3D cameras, LED light painters and music systems to name a few. One person even created a robot that had a VR camera attached to the moving floor robot that could be controlled with a remote control, while the user wears VR glasses to feel as though they are in a given space in real time.

In terms of building health and energy, we see the potential to create maps of buildings and spaces in order to pair them with the work we're doing with wearable technology to see how factors like light, temperature and CO_2 levels correlate to the way people are moving through and inhabiting our buildings. We can also gather information from the main function Roomba was originally created to do, which is to collect dust samples to analyze the microbiome in a given space.



Images - *Left* iRobot Room Maps and example of robot travel – image credit: Ackerman, Evan, iRobot, November 2017, https://spectrum.ieee.org/automaton/robotics/home-robots/how *Right* testing setup in the lab

The next step is to figure out how to control these robots to move through space and follow a specific path the way we want them to. Currently, the Roomba is meant to go in a random direction and move around a room seemingly haphazardly. Built within all Roombas and iRobots is now the ability to map out a space and differentiate a wall, piece of furniture or a shoe from one another. These can create rough estimates of how a building is laid out and how that building is being occupied. Furthermore, the developers have created a function they call RoomSeg, so the robot can segment these rooms and their relationship to space in order for a robot to follow a more efficient route.

Images: *Above* - University of Oregon Energy Studies in Buildings Laboratory, Portland - new iRobot

As we learn to code and hack into this system, it is of course going to come with some trial and error. We've fondly named our new iRobot Erwin, after the repeated use of its proclamation of "Error 1" every time we tried to connect it to the internet. The actual first step will apparently be getting over the hurdle of connecting Erwin onto the University's WiFi. Next, we are excited to get add-ons like cameras and sensors hooked up, so we can begin gathering images and compiling big environmental data. Until then, we'll be pulling Erwin out of the nooks and crannies he's been getting himself jammed in.

Luminaire Level Lighting Control (LLLC), Lab Testing

Funded by NEEA

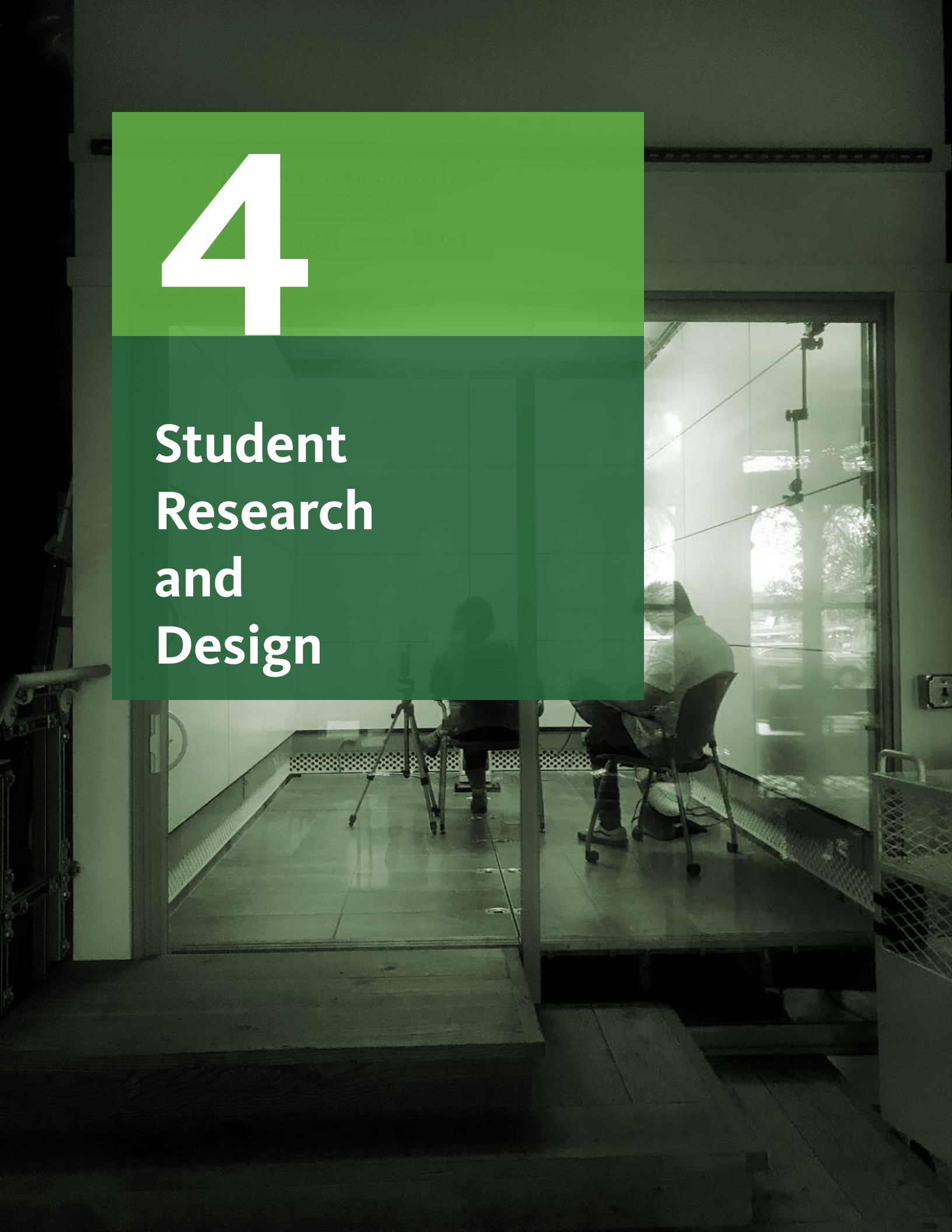
Carolina da Silva Correa Leite - Energy Studies in Buildings Laboratory
Alen Mahic - Energy Studies in Buildings Laboratory
Kevin Van Den Wymelenberg - **(PI)** Energy Studies in Buildings Laboratory

Full lighting redesigns often tend to be high-cost retrofit solutions that require more time investment during the design, specification, and installation phases of a project. The ESBL is conducting a study for the Northwest Energy Efficiency Alliance that is exploring the energy savings, cost, and lighting quality afforded by one-for-one replacement lighting strategies with LLLC technologies as a lower-cost alternative of similar performance.

This study will explore four different LLLC technologies applied as four separate one-for-one retrofit solutions and compare them to one typical full lighting redesign. These five solutions will be installed in the ESBL lab space on the University of Oregon campus in Eugene, OR over the course of a six-month testing and data collection period.

Image - *Left* - LLLC sensor mounted on lab bench *Upper* - lab testing

Image - Luminaire level lighting controls (LLLC) bench setup testing stations in Energy Studies in Buildings Lab.



4

Student Research and Design

Virtual Reality and Thermal Comfort

Funded by the UO Department of Architecture; IHBE Research Consortium

Zachariah Petett - The Living Building class, BArch Student
Josh Rosenthal - The Living Building class, BArch Student
Camila Salazar - The Living Building class, BArch Student

Mark Fretz - The Living Building, Class Instructor
Siobhan Rockcastle - Baker Lighting Chair, provided technical and research support

This student group investigated the effect of design and visual perception on thermal comfort. They were specifically interested with the use of nature views and biophilic materials as an influencing factor in the adaptive thermal comfort model, thereby allowing a wider range of ambient building temperatures to afford occupant comfort.

To test their hypothesis that "a strong connection to nature will increase the tolerance one has to thermal extremes," the group chose two highly biophilic reading spaces at John Yeon's Watzek House and a reading space in the basement of the UO Portland Library & Learning Commons. The spaces were digitized using

Image: *Below* - Climate chamber testing comfort and perception using virtual methods - University of Oregon Energy Studies in Buildings Laboratory, Portland

a Spheron camera and HDR radiance processing into a spherical image for use in the Oculis VR headset. 20 of their classmates were divided into a cohort that experienced the scenes in a 60 degree environment and a cohort that experienced the scenes in an 80 degree environment. A comfort survey with randomized scene selection was delivered orally and results analyzed for deviation from comfort.

The group found that in both temperatures, the participants had less discomfort in the Watzek spaces with a strong connection to nature than they did in the windowless, white-walled reading space. While this was a small pilot and more study is needed to understand the particular elements or combination of elements in the space yielding a thermal perception benefit, it begins to test the value of using VR and controlled environmental chambers together for human subject experiments.

Images: *Left Top* - VR scan of Watzek House living room *Left Mid* - VR scan of Watzek House reading room *Left Bottom* - VR scan of White Stag reading room *Right Mid* - Camila and Josh set up Spheron camera *Right Bottom* - Zacharia viewing spaces in VR in thermal chamber

Radiant versus Convective

Funded by the UO Department of Architecture; IHBE Research Consortium

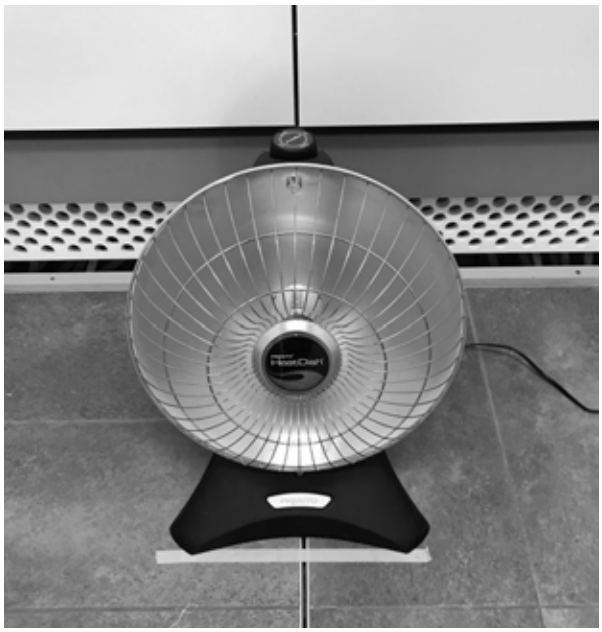
Chelsea Clark - MArch Student
Angelo DeBlase - MArch Student
Catherine Earley - *IHBE, MArch Student Researcher**
Rachel Lozeau - MArch Student

Mark Fretz - The Living Building, Class Instructor
Jason Stenson - ESBL, provided technical and research support

This student group wanted to better understand the difference between radiant heat, the primary way in which humans exchange heat and central to human evolution (sun, fire) and convective heat transfer, using comfort survey, blood pressure and energy use as metrics. To do this, they established a case study pilot using the climate chamber at the Energy Studies in Buildings Lab in Portland and 14 of their classmates as participants. They set the ambient air temperature to 62 degrees Fahrenheit and placed either a radiant parabolic heater or convective space heater 3 feet from the subject. Both heaters were set to the same wattage output using a "Kill-a-Watt" monitor and subjects were randomly assigned to either a radiant or convective space heating treatment. Subjects were acclimated to the ambient air temperature for 5 minutes at which time space heating was applied for 10 minutes. During the total 15 minute period, blood pressure and

Image: *Bottom* - Radiant heat transfer of a campfire evokes memories of comfort and relaxation - yet, there are underlying physiologic mechanisms / *Sandis Helvigs, unsplash.com Opposite Page* - radiant/convective climate chamber setup

comfort surveys were recorded every 5 minutes. Preliminary results indicated that the radiant treatment group had higher thermal comfort with a more rapid warming response to temperature change than the convective group. In addition, the radiant group generally experienced an overall decrease in systolic blood pressure at the end of the 15 minute period. Further study is warranted to better understand these effects within a larger population as well as with lower radiant temperatures seen in high-performance systems.



Thermal Variability Indoors and Cognition

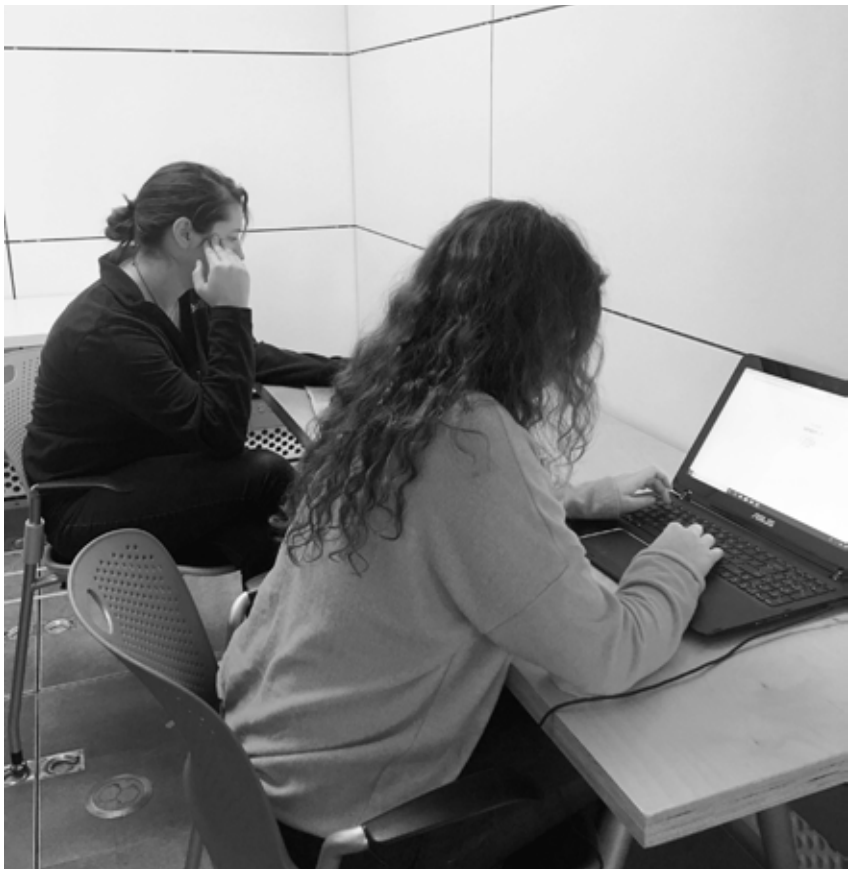
Funded by the UO Department of Architecture; IHBE Research Consortium

Anna Arscott - MArch Student
Jasmeen Ezat-Agha - MArch Student
Lily Summers - *IHBE, MArch Student Researcher**

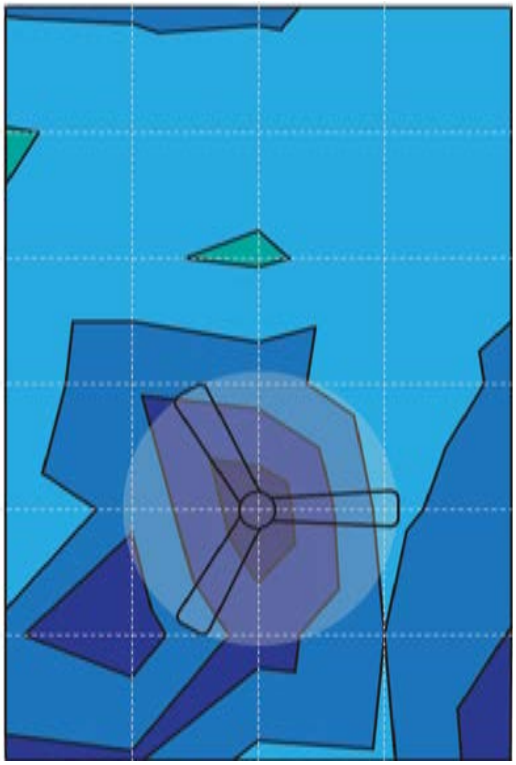
Mark Fretz - The Living Building, Class Instructor
Jason Stenson - ESBL, provided technical and research support

This student group was interested in better understanding our human evolutionary relationship to thermal environments and how being indoors with highly controlled, comfortable but static thermal environments affects our alertness and, therefore, mental processing compared to the variable and random outdoor sensory patterns in which humans evolved. To investigate this, the group devised a climate chamber study in which temperature and humidity were maintained constant within the comfort zone and a cohort of 20 classmates were placed four at a time in the chamber for 15 minutes. During this time, groups were randomly assigned either static thermal environments or randomized air movement via a ceiling fan. The participants responded to laptop-based cognition tests to determine which environment produced improved cognition and alertness. The results of this study are still being analyzed; however, preliminary results indicate that further study is warranted and we will continue to pursue this as a future project.

Image: *Bottom* - Natural + random thermal variability / *Alistair Macrobert, unsplash.com*



Images: *Left* - Students taking cognitive test in climate chamber *Right* - Fan air distribution in climate chamber *Bottom* - Mechancial thermal variability / Radu Florin, unsplash.com



Studio: Light, Health and Energy
Center to Support Mental Health

Funded by the UO Department of Architecture

Matt Bunza - Studio Instructor
Kevin Van Den Wymelenberg, PhD - Studio Instructor

G.Z. Brown - Provided studio support
Siobhan Rockcastle - Provided studio support

CONCEPT:
The Oregon Health Sciences University's "...singular focus on improving health starts with Oregonians and has global impact." OHSU is the only academic health center in Oregon, and is dedicated to conducting research to cure disease, to teaching the future generation of health care providers, and to incorporating emerging knowledge and best practices into patient care. Given the cost pressures and inequity in the health care delivery system, OHSU leadership acknowledges a sense of urgency to translate its research into practice and transform health care delivery.

Image - Annelies Gielstra, Erik Wolowitz, ARCH 683, Fall 2018

** Projects will be submitted to AIA COTE in January 2019*

Doctors Bradley and Taylor write in the American Healthcare Paradox, (p109) that "The vast majority of health gains in the last century have been due to environmental, economic, and social circumstances...". Their book emphasizes the need to shift attention of the health care community to the broader determinants of health in order to make more rapid progress for human health.

The life expectancy in the USA is falling behind other developed countries despite the fact that the healthcare spent per person in the USA far exceeds that of any other country. We posit that architects, and the built environments that they design, and social interactions these designs support, play an essential and uniquely influential role in achieving the desired transformations in human health, and ultimately to health care delivery.

Designers influence human health directly by providing shelter, creating space for positive social interactions, supporting safety and security, inducing the rhythms of light and dark, managing glare, regulating thermal environments, providing access to fresh outdoor air, and detailing indoor material selections that minimize human exposure to carcinogens. Architects also influence human health indirectly by designing buildings that harvest and utilize renewable natural resources (e.g. energy, water), improve deteriorated sites, capture and treat all waste streams such that each building improves the quality of air and water, and increases the resiliency of energy and water infrastructure.

In this hypothetical design problem, OHSU has joined forces with researchers at all Oregon universities (including OSU, PSU, and UO), the Zidell Family Legacy Vision, and the Oregon Museum of Science and Industry (OMSI) to jointly address key environmental and social determinants of health in combination with the deep medical expertise available among OSHU researchers. To kickstart an innovative approach to transform global health, these organizations have established a new public-private partnership within the Portland Innovation Quadrant to construct an experimental translational research and treatment center focused on mental health and depression. The proposed center is envisaged as an opportunity to connect leading experts from the state research institutions in Oregon with one another and with the general public in a way never before conceived through this site and building program.

SITE:
The site represents the threshold between the two largest undeveloped sites in downtown Portland, the OHSU South Waterfront district and the Zidell Yard redevelopment. Both developments have recently completed detailed master plans and both have extensive brown field remediation requirements caused

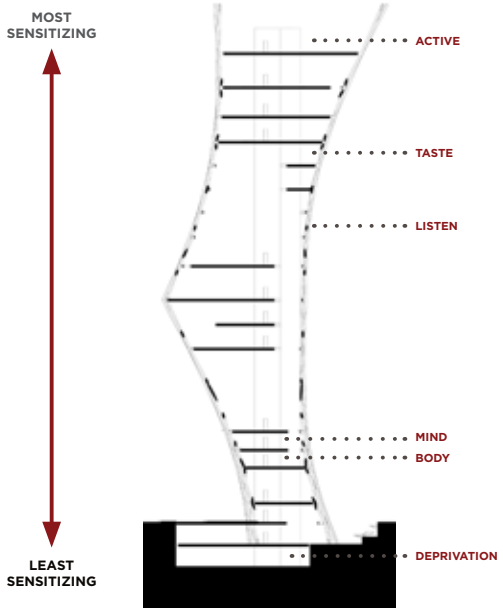
by historic industrial processes. The specific site is approximately 70' wide and runs the 750' length of the north edge of the OHSU's South Waterfront district and the south edge of Zidell Yards redevelopment. The site serves as the connective tissue between OHSU's public development and Zidell Yard's private redevelopment. It is directly parallel with and abuts the South Waterfront to Marquam Hill Aerial Tram. It connects to the Willamette River's west bank, the Greenway and the City of Portland's Green Loop, and is a short walk to the Tilikum Crossing and OMSI. It is a brownfield site with remediation requirements.

SPACE PROGRAM:
The program for the building emerged from the goal to transform human health and health care delivery by examining the medical, social and environmental determinants of health in an integrative manner and includes the following:

» Flexible office and meeting space to support dynamic and evolving research teams, including OHSU researchers and visiting scholars from Oregon, national and international locations
» A modest amount of housing space for visiting scholars
» Mental health counseling space and treatment spaces to support populations including seniors with Alzheimers, Dementia, and Parkinson and diverse populations with Seasonal Affective Disorder, postpartum depression, veterans with post-traumatic stress disorder.
» A modest amount of housing space for in-patient diagnostics and treatment
» Public education and outreach space
» (optional) intergenerational daytime living and care space (integrated senior and child care)

Images - Annelies Gielstra, Erik Wolowitz, ARCH 683, Fall 2018

SOL TURRIM: BRINGING MENTAL HEALTH AWARENESS TO THE PUBLIC
PROGRAM RELATIONSHIPS: SENSORY EXPERIMENTAL TREATMENT SPACES

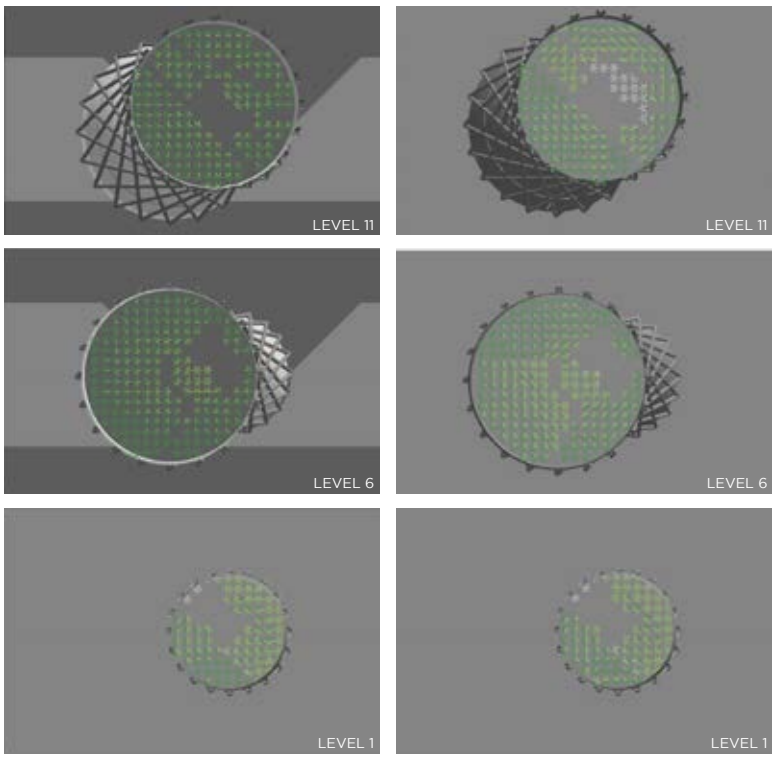


UNIVERSITY OF OREGON ARCH 683: LIGHT, HEALTH, & ENERGY (FALL 2018)
INSTRUCTORS: KEVIN VAN DEN WYMELENBERG / MATTHEW BUNZA

Images - *Sol Turrim*, Megan Danell, Alex McCord, ARCH 683
Left - Tower verticality prioritizes sensitivity to stimulation *Bottom* - simulation of recommended daily light dose using 'Ocuvis' simulation software by OCULIGHT

SOL TURRIM: BRINGING MENTAL HEALTH AWARENESS TO THE PUBLIC
INFORMED BY DAYLIGHT: OCULIGHT VITALITY SIMULATION

WITHOUT WALLS



WITH WALLS

UNIVERSITY OF OREGON ARCH 683: LIGHT, HEALTH, & ENERGY (FALL 2018)
INSTRUCTORS: KEVIN VAN DEN WYMELENBERG / MATTHEW BUNZA

SOL TURRIM: BRINGING MENTAL HEALTH AWARENESS TO THE PUBLIC
MEGAN DANELL AND ALEX MCCORD

Images - *Right - Sol Turrim*, Megan Danell, Alex McCord, ARCH 683, Fall 2018 *Left and Bottom* - Austin Gutierrez, Jose Silva Penaherrera, ARCH 683, Fall 2018

5

Proposals
+
Pre-prosals

Memory, Metrics and Mobility: Universal Design for an Aging Population

Funded by the Tinker Hatfield Award for Innovation in Design

Susan Sokolowski, PhD - Associate Professor, Director, Sports Product Design Program
Esther Hagenlocher - Associate Professor, Architecture, Interior Architecture
Mark Fretz - Assistant Research Professor, Institute for Health in the Built Environment
Michael Salter - Professor of Art

Innovation Objective

The innovation for this Tinker Hatfield Award for Innovation in Design is to revolutionize the integration of design thinking, making, aesthetics and data/digital metrics to derive form, function and improved healthy aging through a synergistic interaction of University of Oregon College of Design students and faculty in product design, architecture, interior architecture and art.

Image - Color, light and spatial perception in architecture / *Robert Katzki, Dockville Festival Hamburg, unsplash.com*

Description

Our population is aging. Thirteen percent of the U.S. population is over 65, and the National Institute on Aging predicts this demographic will double over the next ten years[1,2]. We propose to augment the health of this population by deconstructing siloed design thinking and synthesizing a synergistic interaction of product, architecture, interior architecture and art to innovatively address the concept of "mobility, memory and metrics" through a Universal Design lens and cross-disciplinary perspective.

Historically, products and spaces were designed to be most suitable for elite or average users. When a Universal approach is applied, they are created to be usable by everyone, without the need for adaptation or specialized design[3]. Universal design considers individual preferences and abilities; communicating necessary information effectively (regardless of ambient conditions or the user's sensory abilities); and can be approached, reached, manipulated, and used regardless of the individual's body size, posture, health or mobility.

This collaborative project engages a framework that is designed to bring together a range of interdisciplinary ideas and original works of design, architecture, interior architecture and art. The project team: Sokolowski, Fretz, Hagenlocher and Salter are leaders in their respective fields (Product Design, Architecture, Interior Architecture and Art) and have shared interests in the advancement of health, cognitive behavior and safety of the aging population. Their work also aligns to the goals of Universal Design, where consideration of: body fit, comfort, awareness, understanding, wellness, social integration, signage, personalization and cultural appropriateness are evaluated to enable healthy lifestyles and performance.

Image - Metrics to better design for mobility and memory in an aging population / *Serhat Beyazkaya, unsplash.com*

The main objective of the project through the Tinker Hatfield funding would be to generate strategic partnerships between College of Design students, faculty, national and international industry experts in product, architecture, interior architecture and art to synergistically innovate and address the concept of “mobility, memory and metrics”. The project work will be executed through a unique course, where twenty UO College of Design seniors and graduate students from Eugene and Portland will learn together from faculty in Product Design, Architecture, Interior Architecture and Art to address the design needs of the aging population. Students will work between the three themes of mobility, memory and metrics, and as the course

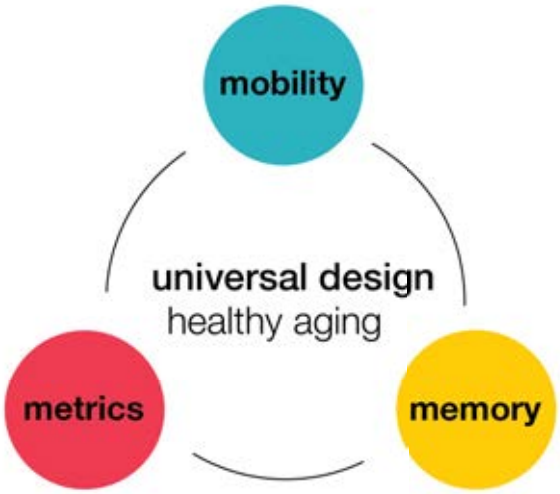
develops, they will individually develop a healthy aging design opportunity, including a prototype/model; based upon field work, research, industry feedback and iteration. The work created form the course will then be reviewed by a jury of industry experts and faculty to curate the best work into two design exhibits. Experts will involve professionals from the fields of Product Design, Architecture, Interior Architecture and Art. They also all work in the healthy aging and/or universal design fields. An initial list includes: Scott Edwards | Architecture: Melisse Kuhn - Associate, Modo: Bob Marchant - President, Ziba: Rachel Volker – Industrial Design Lead, Markgraph Frankfurt am Main: Lars Uwe Bleher - CEO, Nike | Universal Ease: Swan Paik – Senior Director, and the UO Accessible Education Center: Hilary Gerdes - Director. Tinker Hatfield, the grant sponsor and Christoph Linder, Dean of the College of Design, would be invited to be a part of the jury pending availability. Since the initial submission of the original project proposal, the team has also connected with other College of Design faculty that are interested with the effort. They include: Colin Ives (Art), Alex Xu (Product Design) and Landry Smith (Architecture).

Image - Universal design through better body metrics as well as metrics on how we actually use built environments as we age - *credit: rawpixel, unsplash.com*

The project aims to address three themes of concern for the aging population: mobility, memory and metrics. Mobility includes the practices of promoting, continuing or intervening to change behavior to live well to maximize health performance, including fall prevention and safety. This includes understanding the aging body, footwear/apparel, neural, sensation, flooring surfaces, proprioception, and equipment like walking devices. Memory connects us to a sense of place and informs coherent navigation. Research indicates that designed elements in the environment such as lighting and architectural organizations can improve outcomes for aging populations with memory care needs. Metrics include all of the data that does not exist for the aging demographic. Metrics inform current patterns, predict behavior or inform future health outcomes, especially in the age of algorithmic design. There is a lot we do not know about the aging built environment user population, including their anthropometrics, building use patterns and how their biomarkers respond to indoor environmental conditions. The potential of this project opportunity could be transformative, generating future opportunities to develop strong cross-disciplinary research, outreach and applied design.

Dissemination

The outcomes of the work funded through the Tinker Hatfield grant will be disseminated visually and experientially through a juried exhibition at the White Box in Portland, organized similarly to the Josef Albers Exhibition at the Wallace and Grace Hayden Gallery, University of Oregon or "Dialog with Time" Exhibition at Dialoghaus in Hamburg, Germany. The exhibit will last for two weeks and be promoted through social media, web promotion and postcards. Students, scholars, industry professionals and the general public will be invited to attend the design exhibition in April 2019. Corollary to the exhibition, a symposium will be organized with invited industry professionals and a keynote speaker. All symposium presentations would be published digitally on the UO Universal Design For Healthy Aging: Mobility, Metrics And Memory website. A similar exhibit to the one in Portland will be shown at ICFF or Wanted Design in the New York metro area. Funding will help refine the work, so the exhibit is world-class. Both of the New York venues will have opportunities for international press, lectures and published interviews with curators. Because there is an increased interest from College of Design faculty to participate in the project, the team believes the work can also be shared broadly at the University through lunch and learn sessions, with students and other faculty across campus.



1. Institute of Medicine (US) Food Forum. Providing Healthy and Safe Foods As We Age: Workshop Summary. Washington (DC): National Academies Press (US); 2010.
2. Size and Demographics of Aging Populations. Available from: https://www.ncbi.nlm.nih.gov/books/NBK51841/#
3. Principles of Universal Design. Available from: http://idea.ap.buffalo.edu/udny/Section3.htm

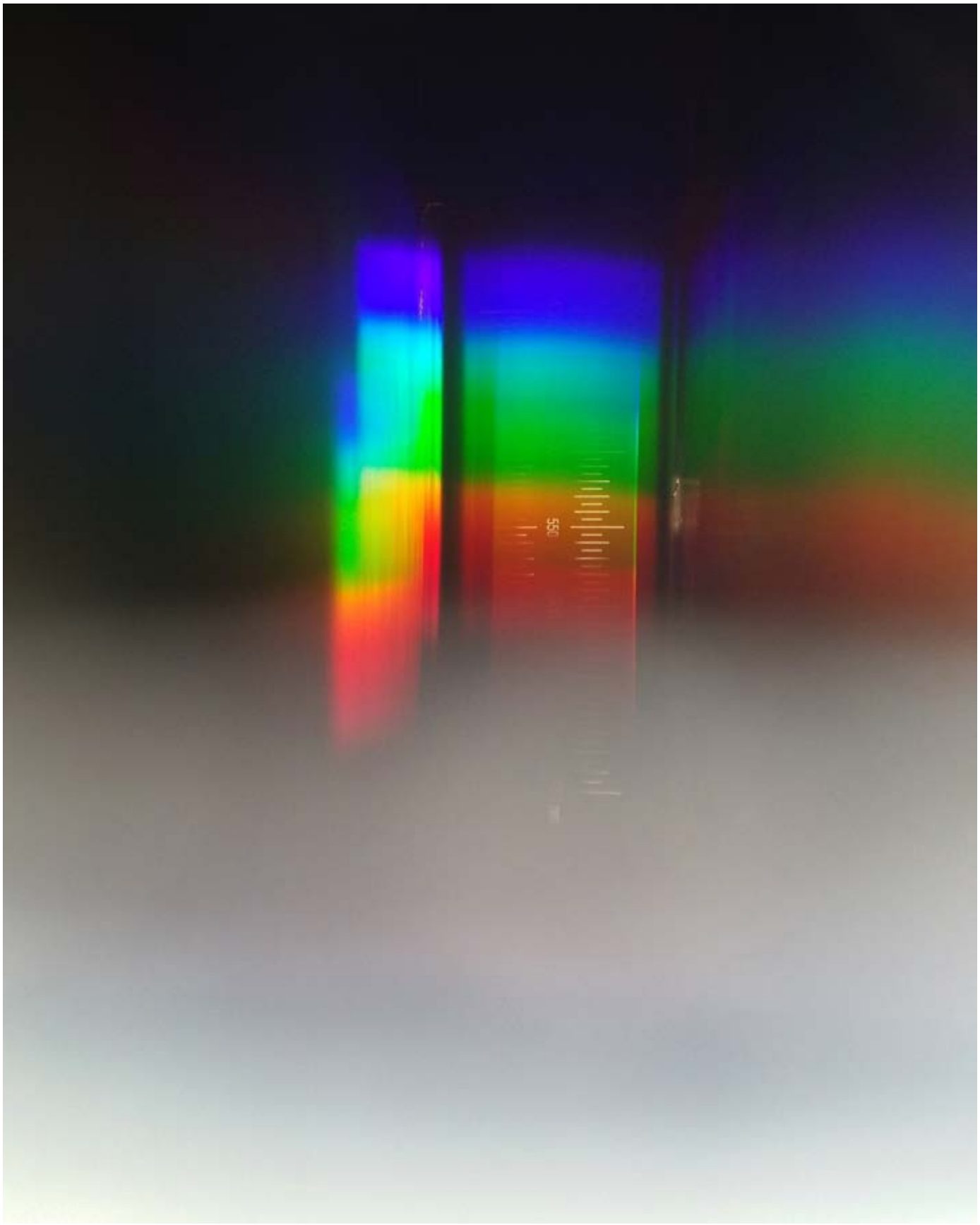
Lightbox 2.0

Planned with funding by the Alfred P. Sloan Foundation

The use of microcosms has become an effective research instrument to investigate architectural determinants on indoor microbial ecology in the built environment. In 'Lightbox 1.0,' we simulated office space lighting conditions with glazing that filters incoming daylight either in the visible or uv region of the electromagnetic spectrum and exposed household dust to these conditions, as well as a dark room (control), to determine the effect of daylight on bacterial composition and viability indoors. The findings implicate daylight as an architectural determinant in the composition of bacterial communities indoors and involved in reduction of the overall percentage of viable bacteria. Read the full paper here.

Image - *Above* Three lightbox microcosms, each with a different glazing treatment *Opposite page* Visible light spectra / *unsplash.com*

For the next iteration, 'Lightbox 2.0,' we intend to investigate the circadian effects of light on indoor bacteria, sampling throughout a 24-hour cycle with finer resolution. We also plan to outfit the 'dust dollhouse' microcosms with LED overhead lighting with a spectral output and distribution typical to office spaces and concentrate on this variable without daylight.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Luminaire Level Lighting Control (LLLC), HVAC + Human

Submitted to NEEA as a proposed project for funding

Mark Fretz - Energy Studies in Buildings Laboratory
Alen Mahic - Energy Studies in Buildings Laboratory
Jason Stenson - Energy Studies in Buildings Laboratory
Paul Ward - Energy Studies in Buildings Laboratory
Kevin Van Den Wymelenberg - **(PI)** Energy Studies in Buildings Laboratory

The IoT revolution, big data and the smart phone have the promise of improving building energy use while simultaneously enhancing human well-being and productivity in a space. Disseminated sensors at each luminaire can detect ambient air temperature, daylight illumination levels, adjacent plug-loads, fixture level metering and occupancy through PIR motion data and Bluetooth cell phone beaconing. This high resolution of data has the potential to manage physical assets as well as better understand human occupant behavior, thereby articulating with a building automation system to provide better space utiliztion, more responsive and energy-efficient HVAC and electric lighting.

Image - *Left / Upper Right*- cellphone Bluetooth beaconing possible with luminaire level sensors / *Photos by Huaihang Tang and Rawpixel, unsplash.com Bottom Right* - HVAC fanwall

The Energy Studies in Buildings Laboratory has been working with Industry Consortium member, Siemens, to identify an office research setting for a study evaluating the energy and non-energy benefits of luminaire level lighting controls. We have identified two possible study locations and are currently working with owner's representatives to develop a study design and secure permissions.

7

Innovation Conduit

Innovation Conduit

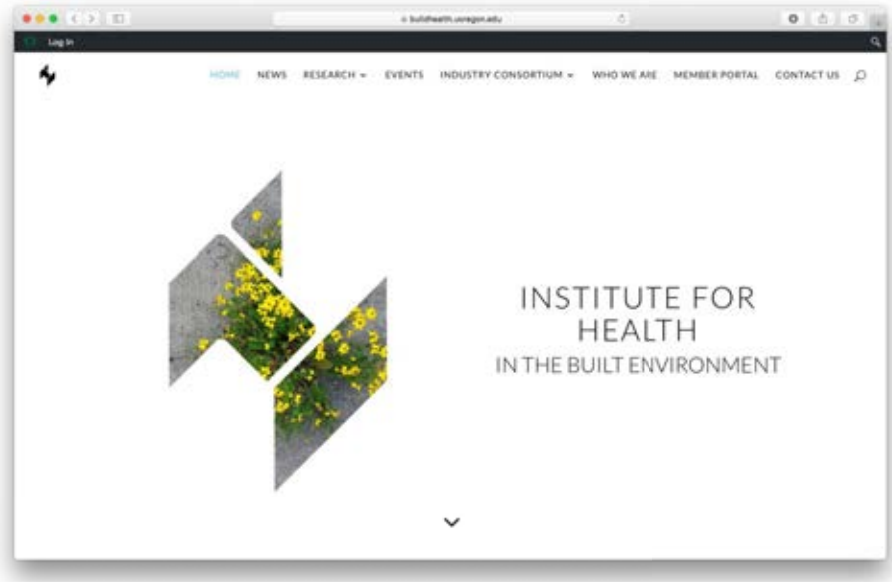
Let's stay connected!

Journal Publications

New highly collaborative studies recently published, including: "Antimicrobial chemicals associate with microbial function and antibiotic resistance indoors," in *mSystems*, "Daylight exposure modulates bacterial communities associated with household dust" in *Microbiome*, and study on exposure to chemicals in dust published in *The Journal of Hazardous Material*, "Developing a Process for Continuous Commissioning" by *IEEE*, and "A Human Factors Study Update a Recently Proposed Manual Blind Use Algorithm for Energy and Daylight Simulations" by *IEEE*!

Website

The Institute for Health in the Built Environment website is live and frequently updated with new content. Industry Consortium members now have an exclusive member portal on the Institute for Health in the Built Environment website. Through this portal, members can access on-demand webinars, past presentations, quarterly reports and additional content related to the research studies.



Slack Workspace

For Industry Consortium members, stay directly connected to researchers and the research through the Slack workspace and discussion channels. Please contact Mark Fretz (mfretz@uoregon.edu) if you have questions.

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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 15, 2019	Pre-Conference Workshop
May 16-17, 2019	**Build Health Event, Portland**
June, 2019	Q4 e-Blast Update (Will include Post-Conference Report)

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