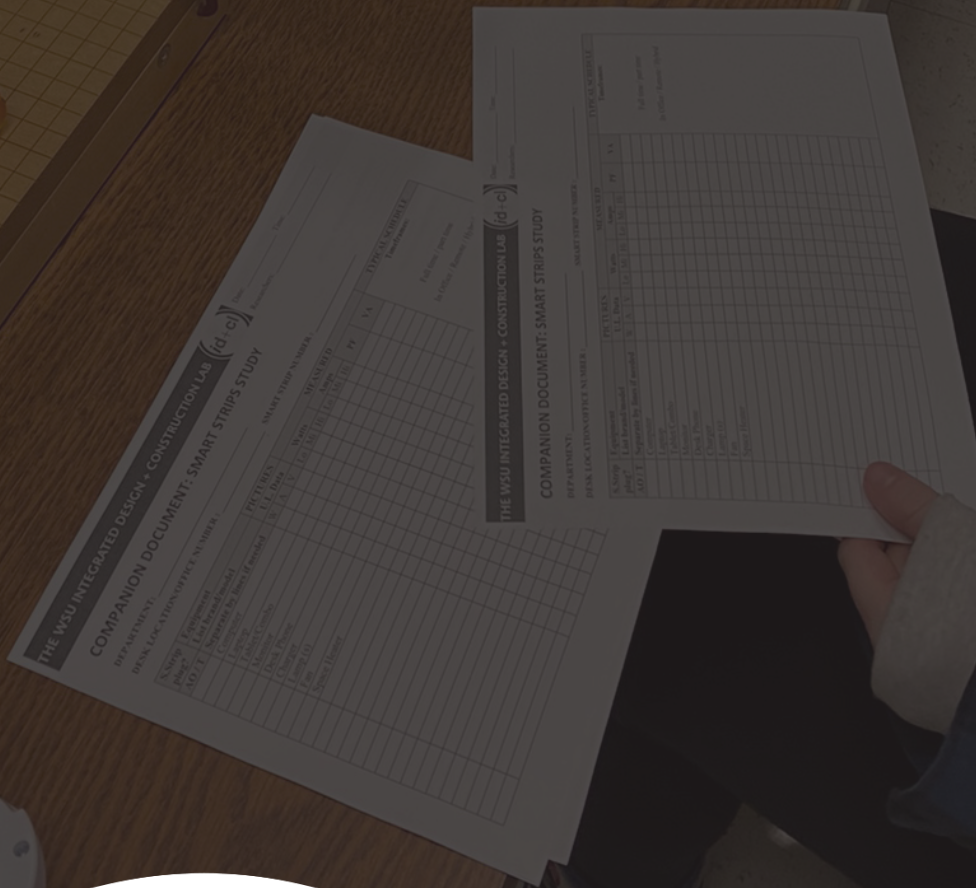




WASHINGTON STATE
UNIVERSITY

INTEGRATED DESIGN + CONSTRUCTION LABORATORY



2021

Annual Report

id+cl

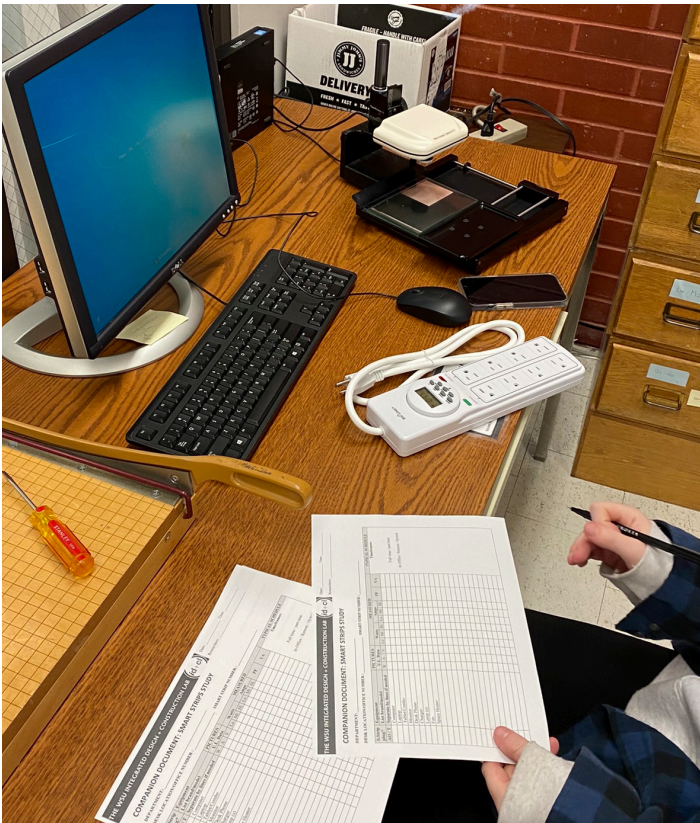
WSU Integrated Design + Construction Laboratory

idcl.wsu.edu

PACCAR Building, Room 107
2001 Grimes Way, PO Box 645815
Pullman, WA. 99164-5815

TABLE OF CONTENTS

Table of Contents	2
Letter from the Director	3
About The ID+CL + Contact Information	4
Outcome 1: Discovery Through Research	6
Outcome 2: Education + Outreach Beyond Academia	7
Outcome 3: Supporting People Through the Built Environment	8
Selected ID+CL Publications + Press	9
Support Us	10



Story on page 6: For the smart-strips study, research assistants collected metered data for each device plugged into the strip, and this data was analyzed to determine total energy use.



Meet the newest member of the ID+CL, Marcella Rose! Director Julia Day and her husband Kyle welcomed their first child on December 30, 2021, and will be on family leave until summer 2022.



LETTER FROM THE RESEARCH PROJECT MANAGER

SHELBY N. RUIZ, M.A.

Dear Friends of the WSU Integrated Design + Construction Laboratory,

After the bumpy road that was 2020, the last year has been fruitful, busy, and overwhelmingly abundant for us at the Integrated Design and Construction Lab (ID+CL). We have bounced back and forth through COVID-19 restrictions and navigated what may be the new normal for some time. We are moving with the changes as they come, but overall, are very eager to get back to the operating speed and capacity of work, number of staff, and research projects as we were prior to the impacts of this global pandemic.

As we find ourselves back on campus, and more importantly, back to daily interactions with people and the communities we are a part of, we are considering the role of buildings; how they are designed, built, operated, and how they help or hinder our wellbeing. How can we come together for the global fight to regain our collective health and reimagine our buildings for resilience, while simultaneously tackling the impending issues of climate change, dwindling resources, and rapidly decreasing fresh water supplies?

Many of the projects we take on at the ID+CL serve to answer or provide context for these questions. The work we do has shifted over the years to reflect our unique interests in serving building occupants; training end-users to manage their comfort, teaching about energy efficiency and building interfaces, as well as working with building designers, operators, and engineers to include the occupant in their considerations for a building, as they are ultimately the people who live or work within them. In short, the ID+CL seeks to transform design, construction and building operational practices to advance high-performance buildings that are more comfortable for people, require less carbon and energy to construct and maintain, and enhance the health and productivity of occupants. ID+CL research topics include, but are not limited to, occupant comfort (thermal and visual) and adaptive behaviors, energy efficiency, high-performance buildings, human-building interfaces and controls, and management for human satisfaction and behaviors. At the lab, we pursue research, education, and outreach activities that help create healthy people + healthy buildings + a healthy planet.

This year we reflect on the growth, transitions, and big changes that have at times been overwhelming since the beginning of the pandemic. We have gained members of our team (say hello to Maddy, Sierra, Robin, and Ailee), welcomed new and innovative projects in the senior living and lighting control sectors, partnered with WSU Facilities Services to transform on-campus energy use, created a podcast series, and further advanced health and energy in the built environment in ways that that we believe truly matters. Without the opportunity to travel, seek networking opportunities in traditional ways, or invite collaborators to Pullman, we have adapted in highly efficient ways. Between seemingly endless Zoom calls, shifting to exclusively online file and data management systems, and transitioning back to in-person research activities, we feel we are at a height of productivity and impact as 2021 comes to a close. There is always more to do.

Lastly and perhaps the most exciting announcement to share is that we welcomed an unofficial member of the ID+CL team in 2021, Miss Marcella Rose (pictured on page 2). The ID+CL director Julia and her husband Kyle welcomed their first child in the waning days of December, who was a much-anticipated blessing in such a strange time. Congratulations to their family!

In conclusion, as we start planning for the coming year, we are filled with hope and excitement for the future, as well as gratitude for all members and supporters of the Lab. The last few years have shown us how significantly research and creative thinking can have grand impacts in the world, and we are honored to contribute through the journey.

Sincerely,
Shelby N. Ruiz, ID+CL Research Project Manager



Julia K. Day, Ph.D.
Director | ID+CL
Associate Prof. | Construction Mgmt.
e. julia_day@wsu.edu



Shelby Ruiz, M.A.
Research Project Manager
e. shelby.ruiz@wsu.edu



ABOUT THE ID+CL + CONTACT INFORMATION

Background

The [WSU Integrated Design + Construction Lab \(ID+CL\)](#) conducts sponsored design and construction research activities under WSU's Institute for Sustainable Design + Construction, the School of Design + Construction, and is administered under the [WSU Composite Materials and Engineering Center](#). The ID+CL advances innovation in practice as part of an allied regional network of university labs (UO, UW, WSU, UI, MSU) that provide technical assistance and market diffusion services to A/E/C/O building teams. The network seeks to transform design, construction, and building operational practices to advance high-performance building designs that are more comfortable for people, require less carbon and energy to construct, maintain, and enhance the health and productivity of occupants.

Goals of the ID+CL

- employ students in cutting edge research activities,
- work on projects that support the WSU's mission as a land-grant university and Drive to 25 campaign,
- advance energy savings and occupant comfort in high-performance buildings,
- educate building occupants and building operators, and
- engage with the community and industry.



You can find us @ PACCAR!

2001 Grimes Way, Room 107
PO Box 645815
Pullman, WA. 99164
509-335-8722 | www.idcl.wsu.edu



ID+CL Staff + Student Team



Shelby Ruiz, M.A.
Research Project Manager
e. shelby.ruiz@wsu.edu



Maddy Vance
Research Assistant
B.S. in Architecture (22)



Sierra Rothlisberger
Research Assistant
B.A. in Interior Design (23)



Daniel Wolcott, B.S.
Research Assistant
M.A. in Interior Design (22)



Grace McGowan
Research Assistant
B.S. in Architecture (22)



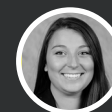
Ailee Simpson
Research Assistant
B.S. in Human Development (23)



Danica Miller
Research Assistant
B.S. in Architecture (21)
Auvil Scholar



Zakora Moore
Research Assistant
B.S. in Bio-Engineering (23)
LSAMP Scholar



Robin Olson
Research Scholar
M.A. in Interior Design (22)



What We Do:

The School of Design + Construction has recognized the ID+CL as a key player in the school-wide research initiative for the following activities:

- engagement of building occupants, building operators, designers, and contractors through research opportunities, training and education;
- engagement of undergraduate & graduate students in research opportunities and scholarly activities through mentorship;
- dissemination of cutting-edge research to the architecture, interior design, & construction communities;
- education and resource development for safe and efficient energy management; and
- facilitation of occupant-centric research in emerging tech, building case studies, innovative training for energy codes, standards and more.

The ID+CL hires a team of diversely talented students in the disciplines of Construction Management, Architecture, Interior Design, and Civil Engineering. We also aspire to seek additional expertise by hiring students in the Mechanical Engineering, Electrical Engineering, Computer Sciences, Environmental Sciences & design fields in the coming years.

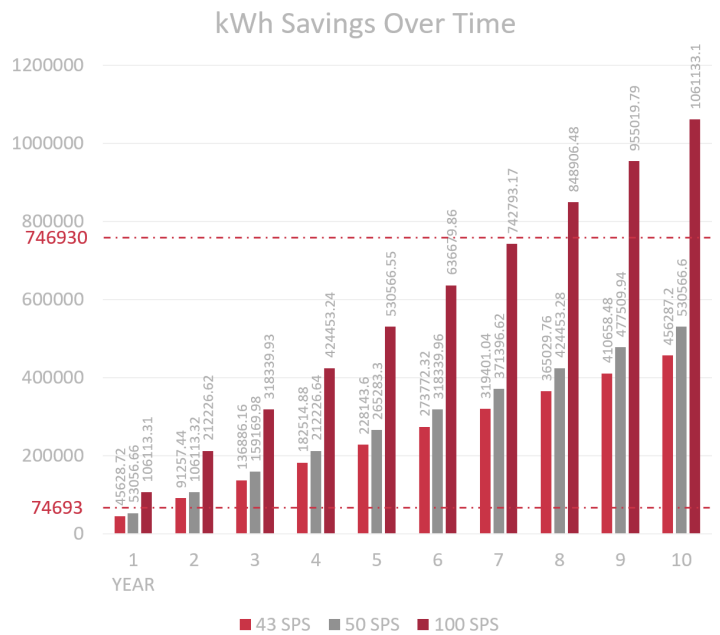
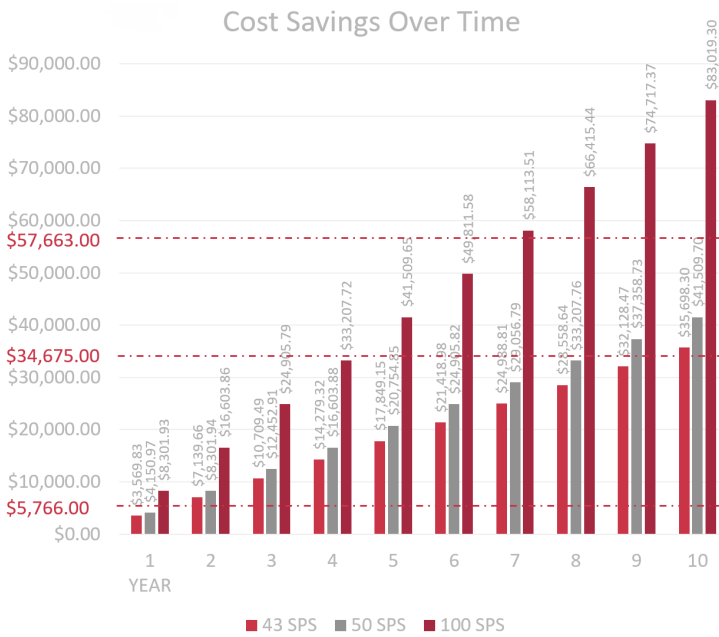
Since our re-establishment in 2017, the IDCL has hired 22 students

Disciplines employed:



- Architecture
- Interior Design
- Construction Management
- Civil Engineering
- Bio-Engineering
- Human Development



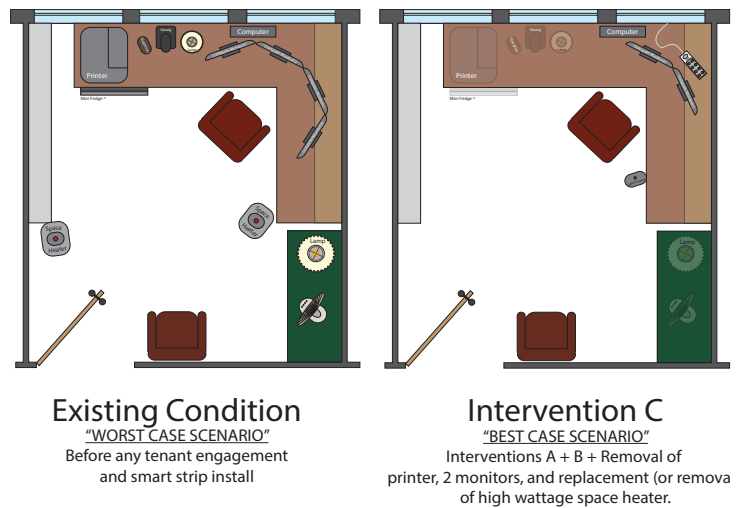


Cost and kWh savings potential from the smart strips study project.

OUTCOME 1: DISCOVERY THROUGH RESEARCH

Energy-Use Reduction Intervention

The ID+CL was hired by the Northwest Energy Efficiency Alliance’s BetterBricks Program to assess the energy and cost savings potential of Smart Power Strips implemented in commercial office settings. “Smart” Power Strips (SPS), are controlled power surge protectors that manage the on/off state of connected electronic devices. SPS’s use timers and automated scheduling to turn power off to select electronic devices eliminating energy consumption during non-business hours. With grant funding, 50 Smart Power Strips were purchased and installed in offices and workstations in select buildings on the WSU-Pullman campus. Through the SPS installation process, the data for each device plugged into the strip was metered, logged, and analyzed to determine total energy consumption in kilowatt hours (kWh) and utility cost per device. The goal metrics, established by WSU Facilities Services, were to save an estimated 74,693 kWh, or \$5,766 in utility costs, annually. Preliminary study results suggest that through the implementation of 100 smart strips those metrics could be exceeded by 42%. By eliminating the energy consumption of electronic devices during non-business hours, the university has the potential for a significant savings in energy use and utility costs across campus facilities.



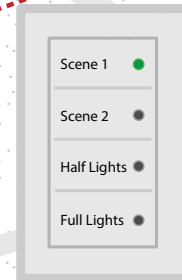
Office mockups of potential intervention strategies in WSU office spaces. The “Best Case Scenario” shown is the goal of all offices, to contribute to significant energy savings in the targeted buildings on the Pullman Campus.

Measuring Student Learning Outcomes

Lecture formats alone do not suffice when it comes to understanding the complexities of mechanical, electrical, and plumbing (MEP) systems in buildings. Oftentimes, students need hands-on experiences and projects to fully grasp these concepts. Utilizing the WSU Smith Teaching and Learning Grant, a robust research project was implemented into CstM Building Science 1 to create transformative learning and research experiences for undergraduate students (Architecture and Construction Management) and K-12 students to advance educational goals and course learning objectives in the School of Design + Construction (SDC). The goals of this project were to (1) develop a robust research experience for undergraduate students in the construction management and architecture disciplines, and (2) engage undergraduate students in community outreach and K-12 teaching. In short, there was a statistically significant difference between pre and post test results across all course topics; means and paired t-tests indicated an improvement in learning across all categories. Results and publication forthcoming in 2022.

LLLC Fixture/Luminaire

Integrated Sensors



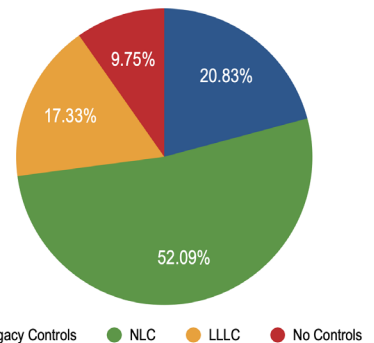
OUTCOME 2: EDUCATION + AND OUTREACH BEYOND ACADEMIA

Luminaire Level Lighting Controls Research and Introductory Training Materials

In collaboration with NEEA and Fernhill Shopworks LLC., the ID+CL team led a research effort to gain a better understanding of persistent barriers to Luminaire Level Lighting Controls (LLLC) and other Networked Lighting Control (NLC) adoption. Over the span of 2021, our team coordinated efforts with NEEA’s LLLC evaluation team to develop the research method, prepare and conduct surveys and interviews with selected lighting control specifiers, and analyzed the data to find significant market barriers and benefits to advanced lighting control technologies. Key findings include the desire for flexibility and “addressability” in lighting systems, as well as gaps in educational materials for specifiers and contractors. This effort helped contribute to the content provided in the Introduction of LLLC course shared below which is open to the public.

The introductory course was developed to demonstrate the importance of quality lighting controls, and to show the benefits and considerations to take when specifying a Luminaire Level Lighting Control (LLLC) system for a commercial building. Course learners will leave with a greater understanding of the benefits related to energy savings, occupant comfort, and the skills necessary to successfully commission and maintain these systems. You can find more information on this training at our website, under the [LLLC Curriculum tab](#).

Please estimate the overall percentage of products installed across the following lighting control categories for all of your projects over the last two years.



THE WSU INTEGRATED DESIGN + CONSTRUCTION LAB (id+cl)

BUILDING RELATIONSHIPS
 STEVE BROOKS, B.S., Mechanical Engineering
 PRESIDENT, UMC
 MARTIN CLINTON, M.S., Management and Leadership
 BUILDING PERFORMANCE SERVICES MANAGER, UMC

Find an Apple Podcast by searching "Building HEROes".

ABOUT STEVE BROOKS
 Steve Brooks, President of UMC has seen all the aspects to building automation and design. He gives us an inside look to UMC's capabilities as a company and what they focus on during a project.

ABOUT MARTIN CLINTON
 Martin Clinton, Building Performance Services Manager at UMC, specializes in building operations. He and his team perform building tune-ups, facility assessments, energy audits, monitoring based commissioning, training, and more.

BACKGROUND
 UMC, the University of Mechanical Contractors, has a long history of providing clients with unique, budget-sensitive systems, completed on time. They reduce energy and operational costs, help improve tenant and employee productivity, promote sustainable building environments, and remain accountable for the ongoing system performance of their clients' facilities. Throughout this podcast, we dive into the importance of communication in a building, both horizontal and vertical. It is essential to efficient operations and productive occupants. This podcast helps paint a picture for the potential of mindful design and long-term maintenance costs in regards to overall building efficiency.

WHERE TO LEARN MORE
 To learn more about what was discussed in this episode of the Building HEROes Podcast, please use these additional resources:
 • How Buildings are "Breathing our Coils"
 • Healthier Buildings, Healthier Futures
 • LEED-COVID-19 Mitigation for Air and Water
 • UMC Website
 • Powerful Energy Resources from BetterBricks

IMPORTANT TIMESTAMPS

- 7:00:00 How energy efficiency sits at the core of UMC's services and values.
- 11:00:00 Importance of an energy lens when specifying an addition to basic codes and requirements.
- 17:00:00 Challenges with a specific system, such as a new work, and the operation of networks.
- 23:00:00 Reasons between building from the field, the good, the bad, and the ugly.
- 28:00:00 The benefits of high-tech smart buildings vs. passive strategies to heat and cool.
- 34:00:00 Communicating to occupants on the building to enable to understand the operating intent and the history of energy saving (CO2) through and its potential for the future.
- 37:00:00 The history of energy saving (CO2) through and its potential for the future.

BUILDING HEROES

*Learning from the Greats" Podcast Chapter of Building Healthy, Energy-efficient, and Resilient Occupants' Educational Series

Building HEROes Podcast: Learning from the Greats Series

The Building HEROes, or Building Healthy, Energy-efficient, and Resilient building Occupants Podcast was created to feature voices in the architecture, engineering, construction, and building operation industries on topics relevant to our research at the ID+CL and hot topics in the A/E/C/O industry. In 2021, the ID+CL was contracted by the Northwest Energy Efficiency Alliance (NEEA) to record quarterly podcasts and publish companion documents from leading designers and engineers for the Podcast chapter titled “Learning from the Greats”. This chapter of the podcast features renowned professionals such as Lisa Heschong, Rick Danks, Barbara Erwine, as well as Steve Brooks and Martin Clinton of University Mechanical Contractors Inc. Topics discussed include the building industry culture, books published by the speakers, current design problems and trends, maintenance costs associated with energy efficiency, and sensory design for occupant comfort. You can [find the podcast series on our website](#) and [Apple Podcasts](#).





View of outdoor dining space, where senior living residents can enjoy fresh air, socialization, and a meal. Photo courtesy of Aljoya Mercer Island.



Photo for scale of a thermostat's small buttons and indicators, which are difficult for senior living residents to understand and interact with.

OUTCOME 3: SUPPORTING PEOPLE THROUGH THE BUILT ENVIRONMENT

The ID+CL has built relationships with many strong companies and collaborators in the A/E/C/O industry in the Spokane, Seattle, and Portland areas. Through both industry and internally sponsored research, the ID+CL team has experience working in residential, commercial, educational, and institutional settings through all phases of design, construction and post-occupancy. Assisting our partners with technical innovations, equipment recommendations, market research, program design, and post occupancy evaluations further supports our goals of advancing energy savings and occupant comfort in high performance buildings. In many projects with industry partners, our contributions include advocating for the occupant in ways that will help owners and the design team meet their goals (e.g., energy efficiency) while also ensuring occupants are happy, healthy and productive. We hope to influence the design, construction, and operation of buildings so all parties involved are satisfied. In this section, some of our work with [WSU's Facilities Services](#) and [Granger Cobb Institute for Senior Living](#) is highlighted.

Energy + Comfort at WSU: Tenant Education, Energy Interventions, and Behavior Change

As a part of ongoing energy use reductions and resource conservation efforts happening on the WSU Pullman campus in preparation of [Washington State's House Bill 1257](#), the ID+CL has continued our partnership with WSU [Facilities Services](#) to implement the tenant engagement program developed in 2020. Some of the activities contributing to these efforts include the deployment of an online training for staff and faculty hosted on Skillssoft, engagement materials such as posters and energy newsletters, as well as direct interventions like the smart power strips study, space heater replacements or removal, and replacing desk lamp lightbulbs with energy efficient LED bulbs. You can find more information about this ongoing program at our [Tenant Engagement website](#).



Granger Cobb Institute of Senior Living: Learning about buildings from Older Adults

Due to advances and automation in building controls since the silent and baby boomer generations were born, people today use buildings differently; people formerly relied on passive or adaptive comfort strategies to manage interior environments: e.g., opening windows, changing clothing, and using their physical building interfaces to improve their spaces. To learn from these generations, such as how they lived in buildings, what strategies they used to make themselves more comfortable in the absence of technology, as well as how buildings have changed to automate the occupant out of the equation, the ID+CL worked with WSU's [Granger Cobb Institute for Senior Living](#) to conduct a study in senior living communities in western Washington over the summer of 2021. This pilot study implemented qualitative and narrative methods through interviews and observations of older adults in buildings (homes and senior living facilities) to better understand how the passing of time has changed their relationship with and their interactions within the built environment. This approach has garnered meaningful stories, lessons learned, habits, lifestyle changes, and more, that will inform future senior living developments.

SELECTED ID+CL PUBLICATIONS + PRESS

Journal Articles + Conference Proceedings

- Kane, M., Govertsen, K., Winston, C., Afroz, Z., Agee, P., Andre, M. A., Bandurski, K., Bandyopadhyay, A., Bavaresco, M., Becchio, C., Buonocore, C., De Castro, L., Corgnati, S. P., Day, J. K., Bing Dong, H., Gunay, B., Hahn, J., Heiler, S., Hobson, B. W., Lingua, C., Miller, C., Nagy, Z., O'Neill, Z., Peng, Y., Pioppi, B., Piselli, C., Reith, A., Sharma, K., Spigliantini, G., Zelovich, L. (2022) Improving Occupant-Centric Building Controls: Opportunities from an International Interview Study of Operators. *Energy Research and Social Science*. Submitted, awaiting review.
- Day, J. K., Meek, C., Berdiel, A. Occupant Preferences for Lighting System Interfaces in Commercial Buildings: Wall Station Design, Usability, and Capabilities. *Leukos*. Submitted, awaiting review.
- Ruiz, S., Day, J. K., Govertsen, K., Kane, M. (2022) Communication Breakdown: The Disconnect between Building Operators and Occupants. *Energy Research and Social Science*. Submitted, awaiting review.
- Agee, P., O'Brien, W., Day, J., & Brackley, B. (2020). Toward a user-centered built environment. *Science and Technology for the Built Environment*, 26:9, 1163-1164, DOI: 10.1080/23744731.2020.1810380.
- Day, J., McIlvennie, C., Brackley, C., Tarantini, M., Piselli, C., Hahn, J., O'Brien, W., Schweiker, M., Subashini Rajus, V., De Simone, M., Baun Kjærgaard, M., Schlüter, A., Peng, Y., Fajilla, G., Becchio, C., Fabi, V., Spigliantini, G., Derbas, G., Marco Pritoni, M., Pisello, A.L. (2020). A comprehensive review of human-building interface interactions and occupant engagement: Behavior, energy use impacts and occupant comfort. *Building and Environment*, 178. <https://doi.org/10.1016/j.buildenv.2020.106920>.
- Day, J., Moore, Z., Ruiz, S. (2020). Snuggies at work: Case study examples of thermal [dis]comfort, behaviors, and environmental satisfaction in the workplace. Windsor Conference on Resilient Comfort in a Heating World 2020. Windsor Park, Berkshire UK. (Full paper published in proceedings + presentation canceled due to COVID-19).

Technical Reports:

- Day, J., Ruiz, S. (2021). WSU Facilities and NEEA BetterBricks – Tenant Engagement at WSU: Phase 1 Implementation and Smart Strips Study Preliminary Findings Report, December 14, 2021. Integrated Design + Construction Lab, Washington State University, Pullman, WA.
- Day, J. (2021). WSU Smith Teaching and Learning Grant Outcomes Report, December 13, 2021. Integrated Design + Construction Lab, Washington State University, Pullman, WA.
- Day, J., Ruiz, S., Wilson, J. A., Simpson, A. (2021). NEEA LLLC Journal Research Project Summary Report, December 16, 2021. Integrated Design + Construction Lab, Washington State University, Pullman, WA.
- Day, J., Ruiz, S. (2020). WSU Facilities - Barriers to Comfort and Energy Efficiency: Preliminary Survey and Interview Findings, Phase 1 Report, Integrated Design + Construction Lab, Washington State University, Pullman, WA.

News/Press Releases:

- Hunter, A. (2021). Julia Day Pioneers Cutting-Edge Research for Healthy Buildings. <https://foundation.wsu.edu/2021/09/21/healthy-people-healthy-buildings-a-healthy-planet/>
- BetterBricks Blog, “Julia Day pioneers cutting-edge research for healthy buildings” (2021, November 2).
- Washington State University News, “Grant will help students learn how to build energy-efficient buildings” (2021, September 30).
- Hunt, K. (2021). WSU announces new joint appointment program with NREL. <https://news.wsu.edu/2021/05/12/wsu-announces-new-joint-appointment-program-nrel/>

Conference and Student Abstracts:

- Day, J., Ruiz, S. (2021) “Energy and comfort perceptions in university housing: A mixed-method approach to understanding the human-building interface.” WSU Academic Showcase. Pullman, WA. (Poster virtually presented March 22-24, 2021.)
- Ruiz, S., Day, J. (2021) “Discovery and Development of a multi-tenant engagement program for a net-zero building: Engaging high-performance building occupants in Spokane, WA.” WSU Academic Showcase. Pullman, WA. (Poster virtually presented March 22-24, 2021.)
- Moore, Z., Day, J., Ruiz, S. (2021) Exploration of Mixed Method Research Regarding Energy and Comfort in the Built Environment. WSU Showcase for Undergraduate Research and Creative Activities (SURCA). (Presented virtually)
- Miller, D., Day, J., Ruiz, S. (2021) Collecting Industry Perceptions of LLLC Technologies. WSU Showcase for Undergraduate Research and Creative Activities (SURCA). (Presented virtually).
- Watson, L., Sterling, D., Day, J., Ruiz, S. (2021) Discovery and development of a multi-tenant engagement program for a Net-Zero building in Spokane, WA. WSU Showcase for Undergraduate Research and Creative Activities (SURCA). (Presented virtually).
- Day, J., Ruiz, S. (2021). “Seeking Barriers to Comfort and Energy Efficiency on a University Campus” to the 6th International Symposium on Occupant Behavior Research (OB-21). Trondheim, Norway. Virtual/hybrid event.



SUPPORT US

Are you or your organization interested in sponsoring a study or pursuing new avenues of research?

Your support could help drive significant and timely change in the built environment. Our team targets cutting edge interdisciplinary research to advance building energy savings and occupant comfort through market transformation, education, and innovation.

To begin a partnership or discuss potential projects, please email the ID+CL Director at julia_day@wsu.edu.



Thank you to all of our generous ID+CL supporters:



WASHINGTON STATE UNIVERSITY
School of Design and Construction



WASHINGTON STATE
UNIVERSITY