WASHINGTON STATE UNIVERSITY

INTEGRATED DESIGN + CONSTRUCTION LABORATORY

2020 Annual Report

id+cl

WSU Integrated Design + Construction Laboratory

idcl.wsu.edu
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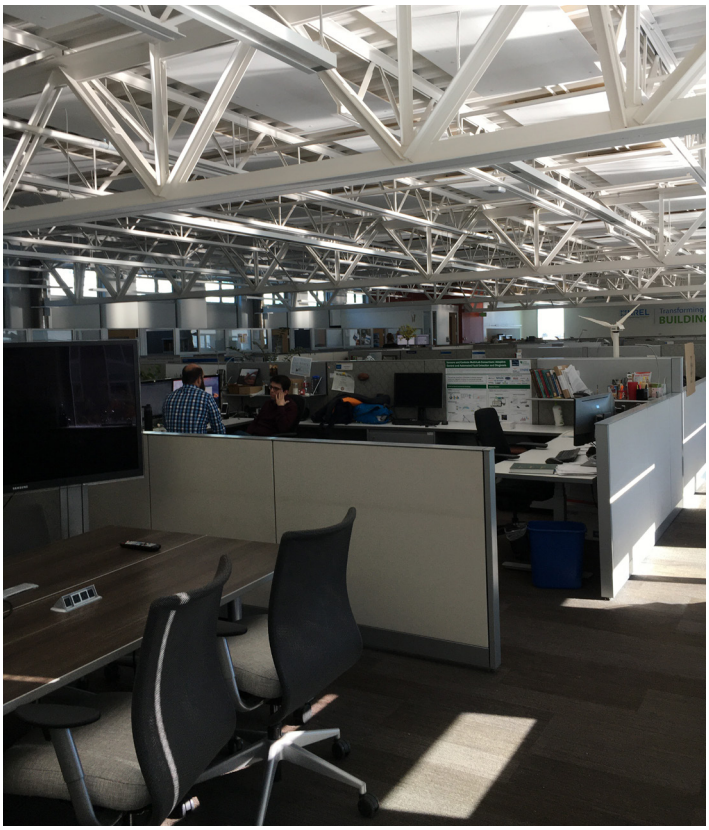

Story on page 3: On a tour of the NREL facilities, we learned about how office spaces within NREL were thoughtfully designed to improve visual comfort of employees.

Story on page 3: While awaiting return to Pullman, the ID+CL team stayed at a hotel with a wonderful outdoor space, and enjoyed s'mores together by the fire.

LETTER FROM THE DIRECTOR

JULIA K. DAY, PHD.

Dear Friends of the WSU Integrated Design + Construction Laboratory,

Wow, 2020 was a bumpy ride to say the least. First and foremost, our hearts go out to all of you who have been impacted by recent global events, including COVID-19. Twenty years ago, it seemed unlikely that we would face a global pandemic, one that has turned our lives upside down. The way in which we live has changed (and will likely still further change). Many of us currently live fairly isolated existences in our own bubbles, staying away from humans and the invisible germs that accompany them. However, at some point, we will need to enter back into the world, and back into public buildings and the homes of family and friends to seek some kind of normalcy.

One important issue this past year has highlighted is that the way in which our buildings are designed, built, operated, and occupied *must* change. We cannot continue to think and build in the same way. How can we join one another in a global fight to regain our collective health, reimagine our buildings for resilience, while simultaneously tackling the significant issues we were already facing such as climate change, dwindling resources, and rapidly decreasing fresh water supplies? There is much to do.

This past year has sparked some serious reflection about the ID+CL: *who we are, what we do, and why we do it*. After re-visiting our core values, our mission, and thinking about the types of projects we pursue, I am more convinced than ever that our efforts can truly make a difference. 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. Research topics include, but are not limited to, occupant comfort (thermal and visual), adaptive behaviors, energy efficiency, high-performance buildings, human-building interfaces and controls, and management of human satisfaction and behaviors. At the lab, we pursue research, education, and outreach activities that help create **healthy people + healthy buildings + a healthy planet.**

On a less serious note, I'll quickly recap some of our happier moments of 2020. Our last trip in 2020 was to Golden, Colorado, where we visited our friends at McKinstry Co., LLC and NREL (the National Renewable Energy Laboratory).

This was the last ID+CL travel adventure of 2020, and a fantastic trip to go out on – we saw beautiful mountains, met new friends, made s'mores, and had an unexpectedly canceled flight that led to an unanticipated Sunday Funday in Denver, CO. This trip allowed us to work with McKinstry on our Tenant Engagement Project for the Catalyst Building in Spokane, WA. In addition, great research connections were made with NREL, which eventually led to my new joint appointment with NREL! In addition, our two ID+CL Construction Management students who joined – Dylan Sterling and Lewis Watson – made quite the impression on McKinstry, and they have both recently accepted full time positions (Spokane and Seattle offices, respectively), after graduation in May 2021.

Throughout 2020, we were able to work-from-home as a team and apply for several more grants, write and send out publications, virtually present at conferences, and we also received several more research grants. Another generous gift from NEEA enabled us to re-hire our full-time project manager (Shelby Ruiz), and we were also able to hire another 8 student employees, who gained research and professional experience.

Overall, 2020 has been a year full of challenges, lessons learned, creativity, and resilience. We, at the ID+CL, have fortunately been able to stay on our path to pursue projects that support **healthy people + healthy buildings + and a healthy planet**. I'm full of gratitude, hope, and excitement for what comes next.

Sincerely,
Director, Julia K. Day, PhD

Julia K. Day, PhD
Assistant Prof. | Construction Mgmt.
e. julia_day@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 provides technical assistance and market diffusion services to AECO 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 and 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 grand challenges,
- advance energy savings and occupant comfort in high-performance buildings,
- educate building occupants and building operators, and
- engage with the community and industry.

When we get back from working at home, you can find us @ PACCAR!

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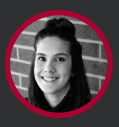
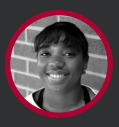
ID+CL Staff + Student Team



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

Dylan Sterling
B.S. Construction Mgmt. (2021)



Zakora Moore
B.S. Bio-Engineering (2023)
LSAMP Undergraduate Research

Daniel Wolcott, B.S.
Teaching and Research Assistant
M.A in Interior Design (2022)

Lewis Watson
B.S. Construction Mgmt. (2021)

Maddy Vance
B.S. Architecture (2022)

Modupe Akinnuoye, M.Arch
M.S Civil Engineering (2022)

Danica Miller
B.S. Architecture (2021)
Auvil Scholar, Undergraduate Research

Grace McGowan
B.S. Architecture (2022)

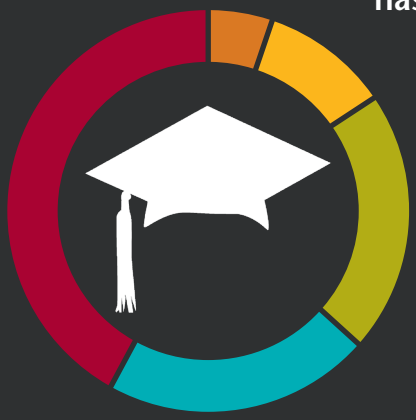
What We Do:

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 19 students



Diciplines employed:

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

Credit WSU Libraries Digital Collections

OUTCOME 1:
DISCOVERY THROUGH RESEARCH

The list below provides an abbreviated summary of some of our key research project topics in 2020.

Occupant Behavior

The ID+CL specializes in developing post-occupancy surveys that capture useful information about occupants' self-reported behaviors, access to control, and overall satisfaction. These survey results often reveal opportunities to for improving occupant experiences while also providing meaningful data for building operators and owners. In 2020, the ID+CL designed and delivered two large scale surveys to learn more about occupant behaviors, building interface interactions, and comfort. Follow up interviews have also revealed important information.

Comfort and Energy

Because comfort and energy are deeply tied to occupant behaviors, in many of our projects, we also seek to understand both residential and commercial office building inhabitants and their use of adaptive comfort opportunities, such as adding or removing clothing, as ways of maintaining comfort and reducing energy use from heating and cooling. In 2020, through the WSU Facilities project, the ID+CL interviewed over 65 WSU employees in two targeted buildings on campus. We also collected over 2800 survey responses system wide to better understand environmental and social barriers to energy conservation across the WSU community. Stories from building users revealed that more often than not, they lacked agency to control their spaces, and at times, they did not understand how to reduce their energy use. At the nexus of energy and comfort is the occupant, who may (or may not) be factored into high-performing energy profiles or have the ability to control their environments. In our work, we seek to find a balance between both building and occupant outcomes.

Environmental & energy use feedback combined with social interaction strategies create a gamified tenant engagement program. ID+CL Image.

Building Culture

One of the keys to effective tenant engagement strategies is the selection and implementation of strategies that are based on the qualities of the users, their space, and their needs. By using and applying concepts from the field the psychology such as competition, incentives, and social feedback, we can better foster a culture of efficiency in buildings. Ongoing projects at the ID+CL often use this approach to build building cultures that value and integrate these strategies. To see an example, see our work with McKinstry!

Credit Avista Utilities

OUTCOME 2:
EDUCATION + OUTREACH BEYOND ACADEMIA

Tenant Engagement for Higher Education

In 2020, the ID+CL was contracted by WSU Facilities Services to develop a tenant engagement program for two heavy energy-use buildings on the WSU Pullman Campus. This pilot study included preliminary interviews, surveys, and specific actionable advice for Facilities to prioritize campus building upgrades and occupant comfort. As part of the tenant engagement program, tenants will learn a variety of strategies to save energy within their respective buildings (e.g., guided human-building interface interactions and methods for saving energy through heating/cooling, plug loads, lighting, clothing decisions, etc.). Key findings from the research phase of the study guided the types of tenant engagement strategies we employed; research findings also provided guidance for how to best engage students vs faculty/staff the most effectively. In 2021, the ID+CL will implement the targeted tenant engagement program to two buildings in the Fall semester, expand and diffuse energy saving strategies to the remainder of the Pullman campus, and create a university-wide campaign to address sustainability and health initiatives.

Educational Content for Integrated Design and Education

With ongoing support from WSU Undergraduate education programs, the School of Design + Construction, and the Construction Management program, the ID+CL has conducted and produced multiple virtual MEP tours of high-performance buildings and construction sites. This collective project provides an innovative approach to enhancing and supplementing in-person field trips for the Building Science courses (CSTM 332 and 333), and the Industry-led Mechanical, Electrical and Plumbing elective course (CSTM 485). In addition, in 2020, Building Science 2 (CSTM 333) students were able to "learn through teaching" during a comprehensive interdisciplinary research project. After teams conducted research about high-performance building envelopes, HVAC, lighting, and controls, they selected one element to further explain in an interactive video for K-5 aged students.

International Outreach

The ID+CL frequently collaborates with international peers through several energy efficiency efforts. Currently, several research, education, and outreach activities are conducted through participation in the International Energy Agency (IEA) Energy and Buildings Communities Programme (EBC) Annex 79: Occupant behavior-centric building design and operation. Dr. Day (our ID+CL director) serves as a co-chair for Subtask 1: "Multi-aspect environmental exposure, building interfaces, and human behaviour." She is also involved in leadership roles in several American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Technical Committees, as well as the American Society of Mechanical Engineers (ASME) National Science Foundation Research Coordination Network for Sustainable Human-Building Ecosystems (SHBE).

Credit Avista Utilities and McKinstry

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 in 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 Avista, McKinstry and the Northwest Energy Efficiency Alliance (NEEA) is highlighted.

Catalyst Building Tenant Engagement Development, South Landing Spokane, WA

The WSU ID+CL partnered with McKinstry to research, develop, and implement a multi-tenant engagement program to help achieve net-zero and strict energy budgets in tenant contracts. We were unable to implement the tenant engagement program in 2020 due to swift and unexpected work from home orders (we didn't have any occupants to engage). However, we did successfully develop a tenant engagement playbook, which we can use once everyone has safely returned to work. *The finished Catalyst building is pictured above.*

> "We set out to bring together smart grids, smart cities and smart buildings in a way that's never been done before. This is our opportunity to create a new energy future for the 21st century."
>
> — Scott Morris

In addition to our work with McKinstry, we were also able to work with Avista, Emerald Initiative, and BetterBricks to tell the story of South Landing. We developed a series of six case studies (with much help from both Avista and McKinstry) to document the energy saving features of the South Landing development from a macro (i.e., community/grid) to micro (i.e., building system/interface/occupant) perspective.
You can check out the completed case studies here!

SELECTED ID+CL PUBLICATIONS + PRESS

Journal Articles + Conference Proceedings

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).

O'Brien, W., Wagner, A., Schweiker, M., Mahdavi, A., Day, J. Baun Kjærgaard, M., Carlucci, S., Dong, B., Tahmasebi, F., Yan, D., Hong, T., Gunay, B, Nagy, Z., Miller, C., & Berger, C. (2019). Introducing IEA EBC Annex 79: Key challenges and opportunities in the field of occupant-centric building design and operation. *Building and Environment, 178*. https://doi.org/10.1016/j.buildenv.2020.106738.

O'Brien, W., & Schweiker, M., Day, J. (2019). Get the picture? Lessons learned from a smartphone-based post-occupancy evaluation. *Energy Research & Social Science, 56*.

Day, J., Futrell, B., Cox, R., & Ruiz, S. (2019). Blinded by the light: Occupant perceptions and visual comfort assessments of three dynamic daylight control systems and shading strategies. *Building and Environment, 154*, 107–121.

Technical Reports:

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.

Day, J., Ruiz, S., Sterling, D., Watson, L, & Colf, H. (2019). McKinstry Summary Report 2019-12-20, Integrated Design + Construction Lab, Washington State University, Pullman, WA.

Wagner, A., & O'Brien, (and subtask leaders including Day, J.) (2019, May) Annex 79 ExCo Report.

Wagner, A., & O'Brien, (and subtask leaders including Day, J.) (2019, October) Annex 79 ExCo Report.

News/Press Releases:

UX for Architects, "Occupant Experience Design: Call to abandon 'Architecture as an Object'" (2019, October 16). Retrieved from https://uxforarchitects.com/2019/10/16/occupant-experience-design-call-to-abandon-architecture-as-an-object/

Washington State University News, "Making energy-efficient buildings healthier" (2019, November 13). Retrieved from https://news.wsu.edu/2019/11/13/making-energy-efficient-buildings-healthy-people/

Conference and Student Abstracts:

Day, J., Schwabe, A.; and Ruiz, S. (presented virtually, 2020). "How Does a Net-Zero Energy Building Tenant Behave?" to the 5th International Symposium on Occupant Behavior (OB-20). Southampton, UK. Presented virtually due to COVID-19 travel restrictions.

Watson, L., Sterling, D., Day, J., Ruiz, S. 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).

Moore, Z., Day, J., Ruiz, S. Snuggies at work: Case study examples of thermal [dis]comfort, behaviors, and environmental satisfaction in the workplace. WSU Showcase for Undergraduate Research and Creative Activities (SURCA).

Colf, H., Day, J., Ruiz, S. Utilization of Videos in the Building Science Education Classroom. WSU Showcase for Undergraduate Research and Creative Activities (SURCA).

Miller, D., Day, J., Ruiz, S. Bridging the Gap, Embracing Technology in the Classroom. WSU Showcase for Undergraduate Research and Creative Activities (SURCA).

SUPPORT US

Are you or your company 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.

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ID+CL Annual report prepared by Shelby Ruiz