INTEGRATED DESIGN LAB

Annual Report 2017–2018

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Cover Image: Austin Central Library, Austin, TX,, Lake|Flato Architects
IDL daylighting technical assistance project completed in 2017.
Photo credit: Nic Lehoux

LETTER FROM THE DIRECTORS

This year we are reflecting on significant progress on many fronts. We are thrilled to have the opportunity to serve the region and thank you for taking the time to reflect on our progress in 2018.

The UW Integrated Design Lab (UW IDL) advances our mission through interconnected research, technical assistance, and professional educational programs; working through multiple market-channels and underpinned by long-term strategic relationships with influential professionals in the building and energy efficiency industries. As a self-sustaining arm of the University of Washington's College of Built Environments (UW CBE), the UW IDL leverages the teaching, research, and public service missions of the UW to disseminate knowledge that serves the region's future.

The UW IDL has become a nationally recognized model for connecting leading practices with research and demonstration, focused on bringing solutions to rapidly emerging challenges specific to the Puget Sound Region. In this report we detail activities that have made these critical relationships possible including:

- Launching innovative new programs and policies at the municipal scale.
- Delivering educational programs and experiences that form the next generation of leaders in the building industry.
- Providing technical assistance to projects that have generated significant utility conservation incentives.
- Being recognized with national awards for building projects that achieve exceptional energy performance targets and serve as a model for future buildings and practices.
- Working to build a bridge between the AEC industry and academia to foster research-informed practice and practice-informed research.

Often when presenting the Lab's work at conferences or in meetings away from our home in the Pacific Northwest, people remark on the innovative work that is happening in our region. All of this is possible through the support of the robust energy efficiency ecosystem in the Pacific Northwest. We would like to take a moment to thank those individuals and organizations that make our work possible including the Northwest Energy Efficiency Alliance (NEEA), the U.S. Department of Energy (US DOE), the City of Seattle, our Puget Sound-regional utility partners, the AEC teams that bring us into their process, and our Advisory Board, which is helping us expand beyond our traditional boundaries.

We look forward to a bright future of expanded collaboration, innovation, and an ever-better built environment for our region.

-Christopher Meek and Heather Burpee

IDL AT A GLANCE

WHO WE ARE

The IDL is operated by the **Department of Architecture** in the **College of Built Environments** at the **University of Washington** in the **Center for Integrated Design**. We are a self-sustaining organization of interdisciplinary faculty, staff, students, professional collaborators, and partner organizations working together to push the boundary on what's possible in sustainable building design. Our shared mission is to discover solutions that overcome the most difficult building performance barriers, and to meet the building industry's goals of moving towards radically higher performing buildings and healthy urban environments.

OUR WORK

The Integrated Design Lab's mission is underpinned by three service streams that work in tandem to promote an energy efficient, healthy built environment:

Knowledge Transfer through Education and Outreach – We share technical knowledge and lessons learned with our commercial clients and industry partners through professional education programs and public tours of the Bullitt Center.

Discovery through Research – We perform targeted research projects on high performance buildings in order to discover new technologies and strategies for healthy, energy efficient buildings.

Guidance through Technical Assistance - We apply our research findings by providing technical design assistance that translates new strategies and technologies to building project teams and industry partners.

The outcomes of our work intersect with people, policies, cities and buildings, and markets. Work examples are highlighted throughout this report. **In the past decade the Integrated Design Lab has produced:**

65 PUBLISHED PAPERS, JOURNAL ARTICLES, AND 250 CONFERENCE PRESENTATIONS

DIRECT PROJECT INFLUENCE ON OVER 40,000,000 SQUARE FEET OF COMMERCIAL BUILDINGS

OVER 76,000 HOURS OF PAID GRADUATE STUDENT RESEARCH ENGAGEMENT AND MENTOR-SHIP

OVER 1,350 TOURS SERVING OVER 25,000 PEOPLE VISITING THE BULLITT CENTER

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OUTCOME I: ENERGY POLICY & PRACTICE RESEARCH

In the universal effort to address rising carbon emissions, increasing demand is placed on the building sector to reduce energy waste. The UW IDL's work supports ambitious code implementation, evaluates new technologies, and helps implement innovative projects deploying sustainable design strategies.

Seattle Building Tune-Up Accelerator.

The City of Seattle Office of Sustainability & Environment (OSE) in partnership with the UW IDL, Smart Buildings Center (SBC), Seattle City Light (SCL), and Pacific Northwest National Labs (PNNL) is engaging building owners, managers and vendors to develop market expertise and accelerate the voluntary implementation of energy efficiency improvements in Seattle's medium commercial building stock — buildings that will be subject to pending mandatory tune-ups beginning in 2020.

The UW IDL executed a recruitment plan for Building Renewal Path Projects in 2018. The intent is to cover the range of project typologies and vintages of buildings subject to the Seattle Tune-Up Ordinance. IDL is now actively engaged in technical assessment and measure package development. (SCL Territory)

Commercial Code Enhancement. The UW IDL, working in concert with NEEA, PNNL, and Duane Jonlin at the City of Seattle Department of Construction and Inspections, provided research and analysis support for a Washington State Energy code proposal entitled the Total System Performance Ratio (TSPR).The TSPR provides a method for evaluating the total HVAC system efficiency in lieu of a component-by-component efficiency criteria. The TSPR is the ratio of the sum of a building's annual heating and cooling load in thousands of BTUs to the sum of the annual carbon emissions in pounds from the energy consumption of the building HVAC systems. The purpose of the proposal is to incentivize energy-efficient HVAC system types and designs and to restrict the use of inefficient systems (even though the individual components meet code requirements), and therefore save energy. The proposal uses a simplified web-based software tool to simulate the HVAC system use and compares it to baseline buildings for 3 building types and sets a minimum allowable Total System Performance Ratio target for each building type based on its characteristics. The UW-IDL supported the TSPR proposal by performing the cost impact evaluation using the Life Cycle Cost Analysis Tool provided by WA State for code proposals and practices. (Region-wide activity)

> "IDL's work translates new approaches and technologies to building project teams, industry partners, and public agencies to address real-life challenges and raise the bar for building performance."

AIA Seattle Energy in Design Award.

The IDL provided technical support to the AIA Seattle COTE subcommittee toward a new honor award for energy innovation. This award required energy performance data submission for all project submissions. This program is being looked at by the American Institute of Architects (AIA) as a national model. (SCL, PSE, TPU, SnoPUD Territory)

OUTCOME II: EDUCATION & OUTREACH

One of the biggest barriers to the construction of high performance buildings is the unknown. The UW IDL works to advance research on the design, construction, and operations of high performance buildings, and educate the design community and broader public on the environmental and health benefits of living and working in a sustainable built environment.

Technical Education Series. The IDL partnered with Seattle City Light and SOLARC Energy Group to deliver a twelve-part education series focusing on the technical analysis of high-performance buildings. The three-part series focused on internal training for Seattle City Light's (SCL) Customer Energy Solutions (CES) Division as well as their customers such as building designers and other energy efficiency service providers. The UW IDL developed the curriculum for these series based on internal and external consensus, developed marketing materials, managed recruitment, registration and logistics, delivered the majority of the content (recruiting expert speakers where necessary), and followed up with an evaluation report. (SCL Territory)

Partnership Initiative. We launched a mechanism to unite leading design and construction firms around a shared research vision. Partners have worked toward three goals: establishing an Advisory Board to help guide the IDL's strategic direction; ensuring IDL's research and technical work is informed by and addresses the most pressing challenges faced by project teams; and developing a shared research agenda to be implemented by graduate research assistant students from UW's College of Built Environments. Participants support the lab in its role as a technical, research and educational resource for design practitioners. (SCL, PSE, TPU Territory)

> "Our education mission is a direct outgrowth of our research and is deeply informed by our technical engagement with building owners and designers."

AIA Design and Health Research Consortium. The IDL is part of a UW team selected to join a partnership that will further research and recognition of how design impacts public health. Over a three-year period, the American Institute of Architects (AIA) and the Architects Foundation will provide institutional support for the new members of the Consortium, promoting local and national partnerships, practice engagement, and knowledge-sharing. The IDL was invited to present its work at the AIA's Research Summit in Minneapolis in July of 2018.

Bullitt Center Tour Program. In 2013, the Bullitt Center became the first large scale 'living' commercial building, and has achieved net-positive energy during its past two years of operation. The IDL hosted over 120 tours and 20 events in 2017-2018, serving over 6,000 visitors to the Bullitt Center, promoting education and awareness of the building's design.

Performance Based Design Studio. Faculty from the IDL led a seminar and studio with Perkins + Will focused on designing a mixed-use building in Belltown, Seattle that would meet the Living Building Pilot Ordinance and the Housing and Livability Agenda (HALA). UW students explored evidence- and performance-based design processes underpinned by research and case studies through workshops on energy efficiency, facade design, building economics, water, and renewables.

Image: Austin Central Library (Atrium under construction). Photo: Lake|Flato

OUTCOME III: TECHNICAL INFLUENCE ON DESIGN & CONSTRUCTION

In the past decade, IDL's interdisciplinary faculty and students have influenced over 40 million square feet of new construction and major renovation of buildings. Providing technical consultation to leading architecture firms during early design phases, we apply evidence-based strategies gleaned from our research to ensure our technical support is ever-evolving and targeted to optimize energy savings.

> "Technical assistance is the engine that drives our research focus and connects us with the day-to-day challenges of the design community."

Harrison Medical Center. The UW IDL, in collaboration with SOLARC, was engaged to provide technical design assistance on Harrison Medical Center, a new 135 bed (524,000 ft^2) hospital in Silverdale, Washington. NBBJ is the architect, and AEI is the mechanical engineer. The UW IDL's scope is energy evaluation and goal setting, strategy development, and energy modeling. The project is currently under construction and on target to meet deep energy goals, with a stated goal of 135 kBtu/ft^2-yr in the RFP, and a current performance is estimated at 94 kBtu/ft^2-yr. PSE is evaluating the project and we estimate that it will garner over $1,000,000 incentive for over 5 million kWh/yr electricity savings compared to a Washington State Energy Code 2015 baseline. (PSE Territory)

Annie Wright School. Mithun. The IDL is working with Mithun on the Annie Wright Schools (Tacoma, WA) new construction project, specifically the design of a new Boys Upper School and a pool and gym building. The UW IDL has focused daylighting assistance on the educational spaces (classrooms, shared learning, and seminar rooms), the multipurpose room, and the central hallway for the boys' upper school. This included an evaluation of the performance of a clerestory window and other top-lighting alternatives. For the gym and pool building, IDL has analyzed daylight availability and possibility of glare. (TPU/PSE Territory)

Georgia Tech Engineered Biosystems Building wins AIA National Top Ten Green Building Award. The AIA's Top-Ten is the highest award given for green buildings in the US. The UW IDL partnered with Lake|Flato and Cooper Carry to provide daylighting design assistance and simulation support on the new 200,000 ft^2 LEED Platinum research facility on the Georgia Tech campus in Atlanta, Georgia. Jury comments were that the "design team managed to show that vast improvements can be achieved through ingenuity and integrated design" and that the "project reports significant measured energy savings of 58 percent for the building type and an impressive 90 percent of floor area with direct view of the outside. Thoughtful organization allows for an abundance of daylight to reach the laboratory spaces as well as the offices."

Overlake Medical Center. The UW IDL in collaboration with SOLARC, was engaged to provide technical design assistance on Overlake Medical Center, a new 196,000 ft^2 hospital in Bellevue, Washington. Its current performance is estimated to be significantly below 100 kBtu/ft^2-yr. The project will be evaluated for incentives by PSE and we expect a significant conservation incentive for electricity savings. (PSE Territory)

Image: Cherry Blossoms on the Quad Photo: Katherine B. Turner/UW

SELECTED PUBLICATIONS

We transfer our research findings directly to design teams and professional partners to strengthen the industry's technical capability. Our recent research includes analyzing building data and examining important design factors, such as climate's role in design and building energy use, the impact of occupant behavior on energy use, and the health impact of green buildings.

The Application of Occupant Behavior Modeling in an Ultra-Low Energy Building[1] - This journal article published in a special edition of *Building Simulation* (publication of the International Building Performance Simulation Association (IBPSA)) examines the methods of modeling occupant behavior for energy analysis. The impact of user behavior becomes significantly more pronounced in ultra-efficient buildings, where system loads such as heating, cooling, lighting, and ventilation are reduced or eliminated through high-performance building design and where occupant behavior impacts the persistence of performance gains and possible improvements. It describes methods and application of building occupant behavior modeling using simulation methods developed by the Building Energy Research Center (BERC) at Tsinghua University and measured energy consumption data collected by the UW IDL.

Partner Initiative with Leading Architecture Firms to Spark Research Innovation in Practice[2] - This paper, presented at the American Council for an Energy Efficient Economy 2018 Summer Study on Buildings, shares the UW IDL Partnership Initiative, a new academic-practitioner engagement model aimed at accelerating the industry's adoption of energy efficient design and construction practices. Leveraging a long-term investment by utilities and others in a university-based market transformation effort, and existing market relationships between leading practitioners and the UW IDL; this Partnership seeks to drive research-informed change in regional practice to increase high performance building design that realizes energy savings and non-energy benefits.

Energy Performance Evaluation of a Whole-Building Electrochromic Window Retrofit in a Commercial Office Building[3] - IDL has published a paper documenting whole-building energy savings from the retrofit of existing single-pane glazing with new double-pane switchable electrochromic glazing in a seven-story leased commercial office building in the Seattle. We estimate that energy savings attributable to the dynamic glazing system during the study period are approximately 17.7% or 351,604 kWh.

Adopting Parametric Design and Construction Analyses in Integrated Design Teams[4] - This paper reports on an industry-academia collaboration for integrating construction and engineering analyses into a graduate-level architecture design studio, including the developed work-flow and curriculum, and lessons learned from the students' and instructors' experiences. The results of this paper are useful for students and new professionals in the AEC field who want to take advantage of the emerging data-driven built environments and adopt a new mindset that supports the integration of construction information into the design process.

How US Hospitals Can Realize Net-Zero Energy[5] - IDL has created new road-maps for zero-net energy hospitals for the Federation of European Heating, Ventilation, and Air Conditioning Associations (REHVA). This paper reports findings from our study and recommendations to researchers and practitioners who are interested in this emerging topic.

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PUBLICATION CITATIONS

[1]Meek, C., Curry, R., Norwood, W., "Energy Performance Evaluation of A Whole-Building Electrochromic Window Retrofit in a Commercial Office Building," Proceedings of the Conference on Advanced Building Skins. Bern, Switzerland. October 2018.

[2]Zhu, P., Gilbride, M., Yan, D., Meek, C.; The Application of Occupant Behavior Modeling in an Ultra-Low Energy Building; Journal of Building Performance Simulation: Applications of Occupant Behavior Modeling; Joint Submission of University of Washington Integrated Design Lab and Tsinghua University Building Energy Research Center, August 2017

[3]Burpee, H., Meek, C., Valtman, B., Schopf, A., "Partnership Initiative with Leading Architectural Firms to Spark Research Innovation in Practice," Proceedings of the American Council for an Energy Efficient Economy (ACEEE) Summer Study on Energy Efficiency in Buildings. Asilomar CA. August 2018.

[4]Borhani, A., Dossick, C., Meek, C., Kleiner, D., Haymaker, J., "Adopting Parametric Design and Construction Analyses in Integrated Design Teams," International Council for Research and Innovation in Building and Construction Conference, Chicago, IL, October 2018.

[5]Burpee, H., "How U.S. Hospitals Can Realize Net-Zero Energy," The REHVA European HVAC Journal. Special Issue "HVAC in Health Sector; NZEB Hospitals Case Studies," Federation of European Heating, Ventilation and Air Conditioning Associations (REHVA), October 2017, 54(5) 31-35.

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