



# UW

## **INTEGRATED DESIGN LAB**

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# **Annual Report 2016–2017**

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## LETTER FROM THE DIRECTORS

“ Today, more than ever, our world needs research and data-driven decision-making. We appreciate our work with you during this unprecedented time to help shape a healthy, productive built environment for current and future generations. ”

As a self-sustaining arm of the University of Washington’s (UW) College of Built Environments, the Integrated Design Lab (IDL) interconnects research, advocacy, and education to shape tomorrow’s design leaders, and help our stakeholders break new ground in sustainable design practice and accelerate long-term market transformation.

The past academic year marked a pivotal period for the IDL, as we worked to support an energy efficient, healthy built environment in the Pacific Northwest and beyond. As the building industry elevated its commitment to environmental stewardship, the IDL stayed busy engaging with the design community on high-performance building technical assistance projects; shaping educational and research initiatives; onboarding and training new research students and staff; traveling to share our recent building performance research; expanding knowledge through Bullitt Center tours; and teaching graduate and undergraduate courses at the UW’s Department of Architecture.

This period was also a time for reflection at the lab. We have evolved significantly from our time as a small technical assistance group in the early 90s – back when today’s sustainability standards were mere ambitious ideas. With each project, we learn more about buildings as interdependent systems and appreciate how each piece works in tandem to achieve better performance. As we continue to expand our knowledge and experience in high performance building design, our core

services have grown to address a broader range of building issues and components. We also continue to unpack questions and lessons learned through research projects and educational programs that help us translate our findings back to the design community.

In stride with the Northwest Energy Efficiency Alliance (NEEA), the building industry, and our technical and utility partners, the IDL seeks to bridge academia and the building industry in a mutually supportive role to promote sustainable design, but our work is far from done. We persistently ask ourselves and our stakeholders how we can work better together to meet the challenges and opportunities posed by a rapidly evolving, often complex energy efficiency and building performance space.

- Christopher Meek and Heather Burpee



*Chris Meek*



*Heather Burpee*

# IDL AT A GLANCE **W**

## WHO WE ARE

The IDL is operated by the **Department of Architecture** in the **College of Built Environments** at the **University of Washington**. We partner with the **Carbon Leadership Forum** at the **Center for Integrated Design**, 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:**



**55 PUBLISHED PAPERS,  
JOURNAL ARTICLES,  
AND 250 CONFERENCE  
PRESENTATIONS**



**DIRECT PROJECT  
INFLUENCE ON OVER  
20,000,000 SQUARE  
FEET OF COMMERCIAL  
BUILDINGS**



**OVER 70,000 HOURS  
OF PAID GRADUATE  
STUDENT RESEARCH  
ENGAGEMENT AND  
MENTORSHIP**



**OVER 1,100 TOURS  
SERVING OVER 22,000  
PEOPLE VISITING THE  
BULLITT CENTER**

## CONTACT

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Contact us to learn more or make a  
tax-deductible contribution to support  
the lab's mission or to create student  
research internships.



## 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 recognizes successful projects deploying sustainable design strategies.

**Building Tune-Ups Accelerator.** We headed into 2017 partnering with the City of Seattle to develop and implement a three-year program funded by the U.S. Department of Energy that supports Seattle's Building Tune-Ups ordinance, an initiative to roll out mandatory energy tune-ups for commercial buildings 50,000 square feet or larger, beginning in 2018.

**Commercial Code Enhancement.** We are developing technical briefs to support NEEA's Commercial Code Enhancement initiative, which aims to bridge the gap between market practices and state policies by identifying, assessing, and validating the feasibility and affordability of the next-generation technologies and practices.

**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 was the first time in the award's history that energy performance data was required for all project submissions. We delivered a draft Carbon Impact Calculator, updated from the Portland 2015 Awards.

“ 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. ”

**View Dynamic Glass A/V Light Control Study.** We examined the performance of View electrochromic windows implemented in The Lake Union Building to control daylight for audio/visual equipment. We assessed the 45-year-old building's annual energy savings, finding the upgrades saved 17.7% (351,604 kilowatt hours), worth nearly \$28,000 in energy cost reduction.

**Monitoring and Evaluating Bullitt Center Energy Performance.** As a net-positive-energy building, the Bullitt Center achieves performance goals through multiple integrated strategies incorporating technologies, systems, and human behavior considerations. We examine the building's energy performance and analyze energy use that is influenced by occupant decisions, as

well as integrated lighting and shading technologies. We share data and lessons learned from the Bullitt Center to shed light on what's possible in urban sustainability.

**Partnership with Beijing's Tsinghua University.** We're partnering with TU's Building Energy Research Center (BERC) to co-research building energy use and specific factors influencing consumption. Our collaborative research aims to provide an evidence-base for decision-makers and building professionals on what impacts a building's energy use and how. We've recently developed a methodology for building occupant behavior modeling using simulation methods developed by the at Tsinghua University using measured energy consumption data.





## 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.** We are working with Seattle City Light to deliver a four-part education series focused on the technical analysis of high-performance buildings. An outgrowth of IDL's work on AIA Getting to Zero, the series will be delivered in 2017 as professional development for the AEC industry.

**AIA Materials Matter.** We recently worked with AIA Seattle and AIA National to develop and deliver Materials Matter, a professional education series on sustainable building materials selection. Materials Matter comprises online and in-person courses focused on the environmental and health impacts of materials, and implementing materials transparency and optimization in practice.

**Partnership Initiative.** We launched a mechanism to unite leading design and construction firms around a shared research vision. Partners will work 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

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

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 will support the lab in its role as a technical, research, and educational resource for design practitioners.

**AIA Design and Health Research Consortium.** We are part of a UW team selected to join a partnership to 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 AIA Design & Health Research Consortium, promoting local and national partnerships and knowledge-sharing.

**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 2016, serving over 6,000 visitors to the Bullitt Center, promoting education and awareness of the building's design.

**Performance Based Design Studio.** We co-led a studio with Perkins + Will focused on designing a mixed-use building in South Lake Union, 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 multiple workshops on energy efficiency, facade design, building economics, water efficiency, and renewables.



## OUTCOME III: TECHNICAL INFLUENCE ON DESIGN & CONSTRUCTION

In the past decade, IDL's interdisciplinary faculty and students have influenced over 20 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.

**UW Campus Lighting.** An interdisciplinary team led by graduate student Kelly Douglas with support from IDL, Seattle City Light, and the Office of the Campus Architect created a roadmap for sustainable exterior lighting as the UW transitions to more energy-efficient lighting technology. Sponsored by the UW Campus Sustainability Fund, the roadmap will establish design guidelines that detail best practices toward creating an environmentally sensitive nighttime campus.

**Olympic High School Remodel. SKL Architects.** We provided innovative daylighting design assistance and digital simulation for the modernization and renovation of the Olympic High School on the Kitsap Peninsula. Our work will help SKL Architects meet high performance daylighting goals for the school's classrooms, library, circulation areas, and multipurpose commons area.

**University of Washington Medical Center Phase II Expansion. NBBJ.** To assist with the UW Medical Center expansion, we partnered with SOLARC Energy Group to provide energy goal

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

setting, strategy selection, energy modeling, implementation evaluation, and utility incentive support services. Energy analysis indicates savings 36% (beyond code) energy on the build-out of new floors and spaces in Montlake Tower and 57% savings over existing performance (29% beyond code) in the existing spaces, which are undergoing deep renovation.

**Rowland Hall Middle School. EHDD.** We worked with EHDD on a new middle school building in Salt Lake City to ensure classrooms had optimal daylight distribution and common spaces had natural light. The IDL has provided technical assistance for multiple buildings on this campus and continues to work with the architect to improve the educational experience through high performance design.

**Harrison Medical Center Expansion. NBBJ.** We partnered with SOLARC Energy Group to provide performance goal setting, energy modeling, and energy performance design support for the Harrison Medical Center expansion in Silverdale, WA, with an aim to reach at least a 30% energy reduction from Washington State Energy Code (2012).

**Seattle Children's Hospital. Strategic Energy & Water Plan.** We partnered with SOLARC Energy Group to produce a strategic plan for Seattle Children's Hospital to reach 20% energy and water reductions by the year 2020. As part of this work we conducted interviews, researched previous analyses, conducted energy and water walk-throughs of the facility, and conducted focus group sessions to evaluate an action plan for the hospital to meet its stated goals.





## 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.

### **Occupant-Behavior-Driven Energy Savings at the Bullitt Center in Seattle, Washington<sup>1</sup>**

The Bullitt Center employs several design strategies meant to encourage energy conserving decision making by building occupants. This paper explores how human behavior impacts energy use, focusing on the Bullitt Center's energy performance and its connection to external influences such as visual cues, building design, and social norms that promote energy efficiency.

### **Metered Energy Efficiency Transaction Structure in Ultra-Efficient New Construction: Pay-For-Performance at the Bullitt Center in Seattle, WA<sup>2</sup>**

The Metered Energy Efficiency Transaction Structure (MEETS) is an unprecedented approach designed to achieve deep energy efficiency improvements in commercial buildings. Seattle City Light piloted MEETS in Seattle's Bullitt Center, yielding extraordinary energy savings to date. This paper explains how the program operates, how the baseline for a new building was modeled, and how the DeltaMeter® (which calculates savings) functions.

### **Building User Audit: Capturing Behavior, Energy, and Culture<sup>3</sup>**

We recently led a project to develop the Building User Audit Procedure (BUAP), an analysis tool that measures how people impact energy use in campus buildings. This paper reviews BUAP's pilot implementation at the University of Washington and reports findings on how occupants influenced energy use in campus buildings.

### **The Bullitt Center Experience: The Light Dynamic – Measured Performance of Lighting and Daylight Systems<sup>4</sup>**

The Bullitt Center's lighting system was designed to consume 67% less energy than current similar-sized code-compliant Seattle office buildings. To measure lighting performance, the IDL monitors and evaluates daylighting, electric lighting, and lighting controls system performance data. Findings are presented in this paper.

### **Health in the Built Environment: Testing Health Impacts of Green Buildings<sup>5</sup>**

We used the Bullitt Center as a pilot project to develop and implement methodologies for collecting

data on buildings and building occupants related to health impacts at the building scale. This paper reports findings from our study.

### **Health Impacts of Green Buildings<sup>6</sup>**

The built environment impacts health in multiple dimensions, from large infrastructure to the microscopic molecules and organisms that are not seen or perceived in daily life. In light of the complex interaction between various health-related impacts of the built environment, we applied a multi-disciplinary approach using the Bullitt Center as a pilot project to develop and implement methodologies for collecting data, described in this paper.

### **Toward Net Zero Energy Buildings with Energy Harvesting Electrochromic Windows<sup>7</sup>**

Recent developments in material science offer the potential for energy harvesting electrochromic (EHECW) windows. We simulated energy performance of EHECWs in commercial office buildings in four climate zones and present the findings in this paper.



## UW IDL STAFF

**Christopher Meek, M. Arch, AIA, IES**  
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## PUBLICATION CITATIONS

<sup>1</sup>Gilbride M, Loveland J, Burpee H, Kriegh J, Meek C. (2016) *Occupant Behavior Driven Energy Savings at the Bullitt Center in Seattle, WA*. 2016 ACEEE Summer Study on Energy Efficiency in Buildings, Pacific Grove, CA.

<sup>2</sup>Egnor T, Hayes D, Jennings J, Reichmuth H, Rodenhizer D, Van Den Wymelenberg K, Meek C. (2016) *Metered Energy Efficiency Transaction Structure in Net Zero New Construction: Pay-For -Performance at the Bullitt Center in Seattle, WA*. 2016 ACEEE Summer Study on Energy Efficiency in Buildings, Pacific Grove, CA.

<sup>3</sup>Burpee H, Kriegh J, Borhani A, Dossick C, Neff G. (2016) *Building User Audit: Capturing Behavior, Energy, and Culture*. 2016 ACEEE Summer Study on Energy Efficiency in Buildings, Pacific Grove, CA.

<sup>4</sup>Meek C, Gilbride M, Ojaama H, Norwood W. (2016) *The Bullitt Center Experience: The Light Dynamic – Measured Performance of Lighting and Daylight Systems*. University of Washington, Seattle, WA.

<sup>5</sup>Burpee H, Meek C, Douglas K. (2016) *Health in the Built Environment: Testing Health Impacts of Green Buildings*. PLEA 2016, Los Angeles, CA.

<sup>6</sup>Burpee H, Beck D, Meschke JS. (2014) *Health Impacts of Green Buildings*. AIA, Washington, D.C.

<sup>7</sup>Meek C, Bruot A. (2013) *Toward Net Zero Energy Buildings with Energy Harvesting Electrochromic Windows*. 13th Conference of International Building Performance Simulation Association, Chambéry, France.

## INSTITUTIONAL

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