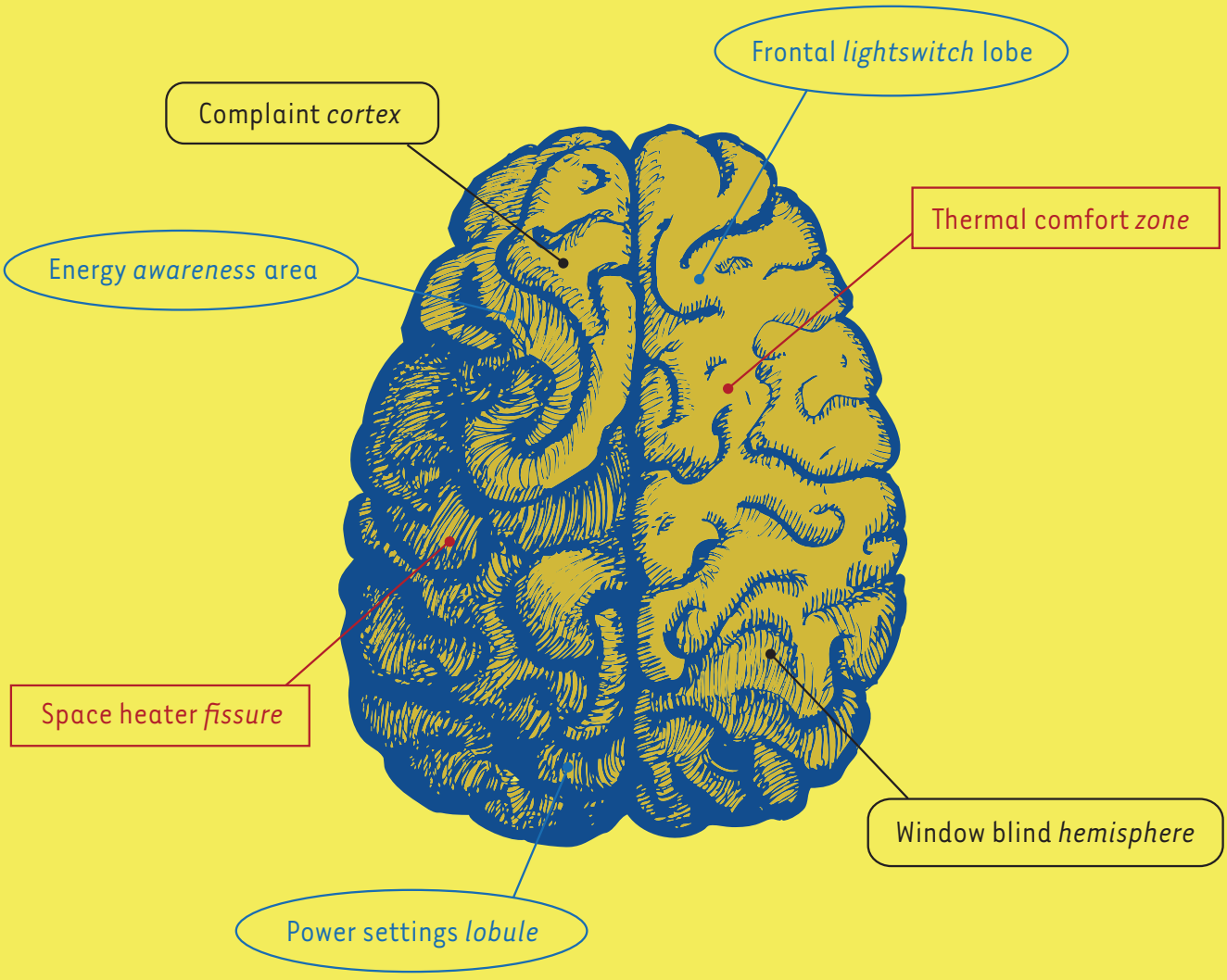
centerline

Newsletter of the Center for the Built Environment at the University of California, Berkeley

Summer 2010



Behavior and Buildings

Director's Note

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Dear Industry Partners,

Buildings are dynamic, and the interactions of operators, occupants, and designers all influence the way in which buildings will perform. At the core of our research is the belief that technical solutions alone are not sufficient to reach the goals that are ahead of us, and that we must engage multiple building stakeholders to succeed. In this edition of *Centerline* we describe several of our research projects that look at the behavior of occupants, work which we hope will ultimately provide industry professionals with valuable guidance.

As summer winds to a close, we have the excitement of new graduate students joining our program, and we also welcome two new staff members—Sabine Hoffmann, a building physics specialist from Germany who is supporting CBE's human comfort research, and Kira Abrams, who joins us as CBE's Research Program Coordinator. We also welcome three new industry partner firms: Cannon Design and LPA Inc. joined us in April, and HMC Architects will be joining CBE in time for the October conference. The firms are all leaders in design and sustainability, and we look forward to our future collaborations with them. With the addition of new staff members and the ongoing support from all of our industry partners, we have been able to expand the scope of our research in exciting new areas.

Sincerely,
Edward Arens

Behavior and Buildings

Leveraging occupants to improve energy and comfort

Kroon Hall, the new home of the Yale School of Forestry and Environmental Studies, is a LEED-Platinum building that showcases some of the latest developments in green buildings. Of the building's many green features, one of the more unusual is a system of red and green lights that indicate to occupants when they should open and close windows. This system exemplifies what is becoming to be seen as a great untapped opportunity for improving energy performance and operations in buildings, namely occupants. However, as the experience from Kroon Hall shows, knowing whether occupants will accept such information, and how they will interpret and act on it, can be a very complex task.

The idea that we can rely on building occupants to positively impact building energy use and operations is contrary to the conventional approach. Buildings are engineered using tested components and generally reliable systems, whereas humans can be unreliable, variable, and perhaps even irrational. Although humans certainly express these traits, they also come equipped with powerful sensing equipment, along with tremendous abilities for experimenting, analyzing, and problem solving.

Past research shows that feedback is effective in causing people to make environmentally responsible choices in residential buildings, but few studies have looked at energy-related behavior in offices and workplace environments. When we consider the relative complexity of houses and office buildings, its easy to see why environmental psychologists would choose residential sites. Homeowners exert a great deal of influence over the use of energy in their homes, and it's relatively straightforward to demonstrate relationships between interventions and an energy outcomes. In commercial buildings, however, numerous parties can influence energy use: owners and design professionals, operations staff, and ultimately the occupants themselves. In spite of the challenges inherent in such research, understanding how to influence the behavior of commercial building users in positive ways is an important task that researchers at CBE are beginning to address.

The idea that we can rely on building occupants to positively impact building energy use and operations is contrary to the conventional approach.

Theoretical models of environmental behavior

These new research efforts benefit from a legacy of studies of environmental and behavioral psychology spanning several decades. Much of this research has been structured around various models of human behavior that attempt to explain our actions. For example, the attitudinal model tells us that people will behave in ways that are consistent with their

values, attitudes, and beliefs. This model would predict that people with positive attitudes towards energy conservation would be likely to make energy saving choices such as biking to work or turning off lights when leaving a room. However, research shows that attitudes alone are not good predictors of behavior. For example, people who consider themselves to be environmentalists may still drive gas-guzzling SUVs so they can drive out into nature on the weekends. While learning about people's attitudes may give us insight into their motivations, observing their actual behavior will provide more reliable findings and give us a better ability to predict patterns of behavior.

CBE research related to environmental behavior

The research team at CBE is conducting several projects related to people's behavior in workplace environments. For example, we are looking at how occupants interact with building features such as such as operable windows, and studying how to accurately simulate these passive features. Also, as part of a project on visualizing energy information, we asked building occupants about their actions and motivations for conserving energy at work, and whether getting better feedback about their energy use would influence their behavior. In this edition of *Centerline*, we provide an update on these projects that explore buildings and behavior. (See page 10 for an upcoming project on organizational behavior related to building operation and energy management.)

Feedback for occupants with operable windows

With a number of low-energy buildings, we are seeing a shift away from fully sealed and centrally conditioned buildings to those that take advantage of natural ventilation or mixed-mode cooling strategies (combining natural ventilation and mechanical cooling.) This evolution represents a new paradigm in which occupants are given the responsibility for managing certain aspects of the building. Some researchers have asserted that human-based control systems are more reliable and robust than automated building systems. However, to properly take advantage of passive features such as operable windows, occupants need guidance about how to operate them, and HVAC systems must be carefully controlled to reduce energy losses.

In a new study started by CBE this past spring, we identified 16 buildings that use indicator lights to tell occupants when they should open and close windows. Katie Ackerly, the UC Berkeley graduate student who is conducting field study research on these buildings, notes that "optimizing for natural ventilation while accounting for human behavior is difficult," and that "these systems are a compromise between manual and automatic control philosophies." The purpose of the research is two-fold: to analyze the range of control strategies designers have used with these systems, and to understand how occupants respond to the indicators.

Some researchers have asserted that human-based control systems are more reliable and robust than automated building systems.

The project has already yielded interesting discoveries. For example, at Yale's Kroon Hall, the window indicator lights had been red throughout most of the spring, during days that seemed perfectly reasonable for

opening windows. The occupants learned to disregard the lights, and on one warm afternoon opened the windows, thinking that ventilation would be beneficial. However occupants soon discovered that offices with closed windows remained cooler, and that in fact the red lights were providing the useful information.

Although our findings are preliminary at this point, they seem to show that people are more likely to observe window indicator lights in buildings where occupants have been educated on the principles behind the light signals. The study also reveals the gap between how designers expect occupants to use a building, and how they will actually operate it. Preliminary findings of this project will be presented at CBE's Advisory Board Conference in October, and the complete report is expected to be published at the end of 2010.

Predicting human behavior for energy simulation

As part of an analysis of mixed-mode ventilation strategies, UC Berkeley Professor Gail Brager and Graduate Student Researcher Sam Borgeson studied how to account for occupant behavior in energy simulations. A challenge lies in the fact that models for human behavior and for energy simulation are based on fundamentally different approaches. Models of human behavior are based on statistical algorithms that predict the probability of an action or event. Building simulation tools, on the other hand, are based on heat transfer and thermodynamic equations, and generally model human actions (e.g., operation of lights, blinds, and windows) based on unrealistic fixed schedules.

Sam Borgeson explains that they were frustrated by limitations to energy simulation tools for modeling people's interactions with buildings, and notes that these tools only support "implausible forms of human behavior." For example, EnergyPlus models the control of windows as if they would be opened or closed incrementally, using a linear relationship based on temperature. However, research shows that temperature is not the only factor involved in window operation, and that people open windows to get fresh air, often keeping them open even when doing so is not ideal in terms of temperature.

After assessing the limitations of the simulation tools, and reviewing approaches tried by others, CBE's research team created a climate-based window operation schedule, approximating the probability of expected window operation. The findings of this study were reported in an internal report on modeling behavior in mixed-mode buildings; the final report—on the feasibility of mixed-mode buildings in various climates—will be published later this fall.

> Researchers found that many energy simulation tools only support "implausible forms of human behavior."

Information feedback and energy behavior

Well designed feedback has been shown to help people save energy in their homes, but could feedback or other methods influence energy-related behavior for people at work? Addressing this question was one of the goals of a recent CBE study on visualizing energy in commercial buildings, in which we conducted a survey of 170 office workers regarding their energy attitudes and actions at work. Specifically, we asked people about their current sources of energy information, their efforts to save energy, and about the kinds of energy

information that might make them likely to try to save more energy.

We were surprised to learn that more than half of the respondents have received some sort of energy information at work, either from co-workers, company communications, lobby displays, or through web-based energy dashboards. We were also surprised to learn that over 90 percent of respondents report that they make some effort to conserve energy at work, and over half report that they save energy by turning off ceiling lights, desk lights, equipment, and/or by using energy-saving settings for computers and monitors. Although such high levels of self-reported energy savings may not reflect actual behavior, it provides an intereting insight into their intentions. The primary motivations for such eco-friendly behavior seems to be largely driven by the need to benefit the environment, "because it is the right thing to do," and/or to save money for the company. In addition, the survey found that people think they would make more of an effort to conserve energy if they had more knowledge of the amount of energy used, or the associated costs.

As a part of our study, we also wanted to see if there was a correlation between people's energy behavior at work and at home. We expected that people might be apathetic regarding energy use at work, but we found that people seem to have a similar level of concern about their energy use at work as they do at home. In fact, close to 90 percent of respondents report that they take steps to reduce energy use costs both at home and at work. Although survey respondents may be over-reporting the extent to which they actually do take steps to save energy, these results hold promise for the idea that occupants can contribute positively towards energy conservation in commercial buildings.

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Reseach such as the topics described here illustrate the complexity of designing buildings for human actors. Pursuing new human-centric design approaches, learning to harness the potential of building occupants, and engaging them in the problems of making buildings work, will be a worthwhile pursuit which we expect to provide interesting challenges that will lead to multiple benefits in the future.

Links

Occupant Control of Windows: Accounting for Human Behavior in Building Simulation

Sam Borgeson and Gail Brager, CBE Internal Report, October 2008
http://tinyurl.com/WindowSimulation

Social and Behavioral Aspects of Energy Use

Loren Lutzenhiser, Annual Review of Energy and the Environment, 18 (1993), pp. 247–289
http://tinyurl.com/Lutzenhiser

Behavior, Energy and Climate Change Conference

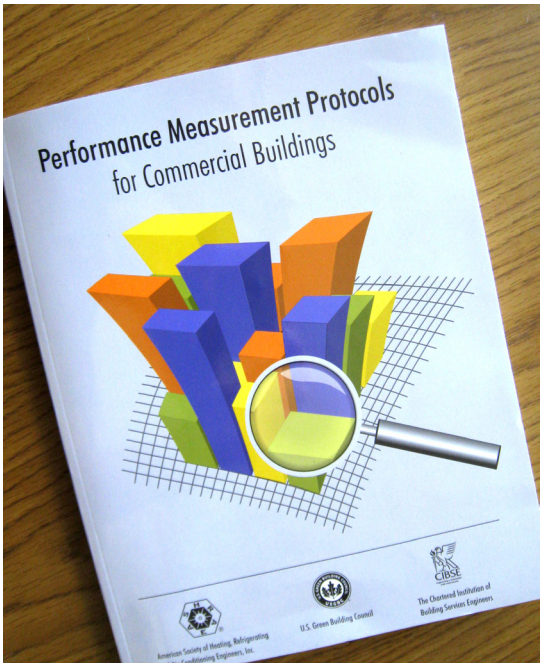
http://beccconference.org/

Project Updates

CBE Contributes to New Building Measurement Protocol

A quote attributed to the 19th century physicist and engineer Lord Kelvin, is that "if you cannot measure it, you cannot improve it." (The unit of temperature measurment is named in his honor.) This adage is perfectly applicable to the performance of commercial buildings. Although LEED and building codes effectively influence design intentions, until recently, few commonly accepted performance standards have been available for broadly measuring buildings in operation. Recently, faculty and staff at CBE have been contributing to the development of a new resource specifically for this purpose. The new method, jointly sponsored by ASHRAE, USGBC and CIBSE, was recently published as "Performance Measurement Protocols for Commercial Buildings." The document, dubbed the 'PMP' in short, details a series of standardized methods for evaluating performance with respect to energy, water, and indoor environmental quality (thermal comfort, indoor air quality, lighting, and acoustics).

CBE Director Edward Arens and Research Specialist Hui Zhang co-authored the thermal comfort performance criteria, a two-year effort conducted in coordination with multiple chapter authors and editors. The new PMP is based on three levels of performance criteria.



The "basic" level provides low-cost methods to evaluate buildings' general performance trends, compare them to benchmarks, and to diagnose problems. The "intermediate" and "advanced" levels provide for increasingly detailed and expensive types of measurement and analysis.

For all of the indoor environmental quality issues, the PMP relies heavily on the CBE survey at its basic level of measurement. Although there are many possible surveys, the CBE survey is unique (along with the BUS survey in the UK), in that it has a systematic database of accumulated responses that can be used for benchmarking. Its diagnostic branching pages also permit problems to be detected and isolated before any physical measurements are made. For intermediate level measurements, "right-now" occupant surveys in combination with physical measurements of indoor conditions are specified.

Prof. Edward Arens explains that "this may be the first time that occupant surveys are being widely recommended for evaluation of building quality." CBE researchers have begun to apply the standard in a number of field studies (see page 8) in order to test the new protocol, to provide insight to potential users of the PMP, and to provide feedback to authors. We are also conducting an evaluation of the acoustics protocol in collaboration with Charles Salter and Associates, using the Kresge Foundation Headquarters field study as a test site. In the near future, Prof. Arens will contribute a chapter to a new ASHRAE guide on best practices for building commissioning using the PMP.

The PMP can be purchased from the ASHRAE online store ($89, $75 for ASHRAE members) from: http://www.techstreet.com/cgi-bin/detail?product_id=1703581

CBE Field Studies Provide Feedback on Advanced Integrated Systems

One of CBE's primary goals is to "take the pulse" of buildings in operation in order to provide feedback about new design strategies and technologies to design teams and building operators. Currently this effort is being pursued in a number of energy-efficient buildings as part of CBE's Advanced Integrated Systems (AIS) research funded by the California Energy Commission PIER Program, CBE's industry consortium, and other sources.

We are continuing our field research work at the David Brower Center in Berkeley and at the Kresge Foundation Headquarters in Troy, Michigan. In July we also conducted a detailed study of the California State Teachers' Retirement System (CalSTRS) headquarters in West Sacramento, a LEED-NC Gold certified building completed by CBE partners HOK and HMH/Swinerton.

Graduate student researcher David Heinzerling using the CBE measurement cart during CalSTRS field study.

A large number of wireless sensor devices are part of CBE's field study toolkit.

At the Brower Center we facilitated the installation of new power metering equipment in April, and since that time we have been verifying the accuracy of the energy measurement through the BMS. This is allowing us to break down the energy consumption by end use—including lighting, plug loads, and HVAC equipment. We are finalizing the Energy Star calculation of the building, in conjunction with Integral Group's Oakland office, and the results look very promising. We also completed an occupant survey of the building, with specific questions about the unique aspects of the building (shading devices, UFAD system), and preliminary results show that occupants are quite satisfied with the indoor environmental quality (IEQ) of the building. Fred Bauman, who leads this research effort, says that the building is a good example of using integrated systems, in this case UFAD and radiant slab technologies, to meet high standards for energy and IEQ.

Our field study research team recently released the phase one report on the Kresge Foundation Headquarters. We found that the occupants are quite happy in the building, in fact occupant survey scores place it in the top quartile for

Exterior view of CalSTRS Headquarters. Architecture: HOK

five of seven IEQ categories compared to all the buildings in the CBE database. In addition, eighty-nine percent of occupants are satisfied with the building overall. As is common among buildings we have surveyed, occupants in enclosed private offices are happier with their workspaces than their counterparts in shared or open office configurations. However, we also learned that the energy use has been higher that expected, and we have made a series of recommendations for ways to improve this in the future.

In July, our AIS research team spent a week collecting data at the CalSTRS headquarters. We used our mobile measurement cart to record thermal conditions in the building and characteristics of the UFAD plenum metrics. We also conducted a detailed study to determine effects of window blinds on temperature control and energy use with UFAD systems. We are now obtaining the BMS data which we will analyze and include in our final report to PIER. This building includes a UFAD system, and is expected to consume 20% less energy than Title-24 allowances. Paul Woolford, HOK's Director of Design, explains that as CalSTRS has focused its investment strategy on sustainable investments, the CalSTRS Headquarters was built as a symbol of this commitment to sustainability.

Dave Troup, Senior Vice President and Head of Mechanical Engineering of HOK, tells us that the project team relied on design recommendations from CBE's UFAD research for this project. For example, they specified insulation below the floor slabs on each floor, and optimized airflow rates to improve energy and stratification performance. The project also uses a web-enabled BMS, allowing graphics and data to be viewed remotely via the Internet. Dave also notes that the design team found this system to be an invaluable tool at building start-up, as it allowed observation, trouble-shooting, and data trending on a real-time basis at all times of the day.

CBE hopes to do additional evaluation of the CalSTRS building in collaboration with HOK as part of a study of organizational behavior and building operations (see page 10). We will be presenting updates on all of these field study projects at our October meeting.

Public Release of Final UFAD Cooling Load Design Tool

Optimizing the design of underfloor air distribution systems requires a fundamentally different approach than that required for conventional overhead systems, especially with respect to airside design sizing. To assist design engineers with this problem, CBE has created simplified and practical design procedures and associated software tools to determine design cooling airflow requirements for UFAD systems. We released a preliminary design tool and published guidance for the use of the tool in the *ASHRAE Journal* (October 2007), and we recently completed a significant upgrade to these resources.

In July, we posted the improved software tool along with new documentation to the CBE website. The new tool includes the capability to analyze perimeter zones and other features not included in the preliminary version. We have also included user notes and have written a new practice-oriented article which has just been published in the September 2010 issue of the *ASHRAE Journal*. We invite you to use this resource and to give us your feedback. You can download the tool and other reference materials from: http://tinyurl.com/ufadtool.

Healthcare and Organizational Behavior Study Expand CBE's Survey Research

Our occupant survey team has been busy supporting a number of new research initiatives this past spring. Expanding our studies of indoor environmental quality (IEQ) in healthcare facilities, we completed surveys in eleven hospitals as part of a study conducted by the non-profit Center for Health Design, with funding from the USGBC Green Building Research Fund, and in collaboration with Kenneth Roy of Armstrong Industries. The goal of this project was to develop a framework "for understanding the impacts of healthcare facility design on patient, worker, and environmental outcomes in healthcare organizations." The final report was completed in August and will be available publicly soon. We will also present this research at the Health Design Conference this November in Las Vegas, with a focus on acoustics and worker stress in hospitals.

CBE's survey team is also collaborating with Alan Meier of the UC Davis Energy Efficiency Center and Mithra Moezzi of Portland State University, for a study of organizational behavior and practice related to building operation and energy management. This project, funded by the California Air Resources Board, seeks to fill a void in knowledge about day-to-day practices and the dynamics of energy use in commercial buildings. The project team hopes to understand, for example, why facilities often do not set back thermostats even when so many occupants complain that they are too cold in the summer, or why energy-saving features on electronic equipment are so often disabled or unused.

As part of this work CBE will develop a "conservation and adaptation" survey module focusing on behavioral energy conservation, attitudes toward existing energy use and environmental controls, how occupants adapt to or cope with the building's physical environment, and interactions with building operators and energy managers. This module will be developed to complement existing CBE survey instruments, and would combine fixed response questions with probing questions in free-response format.

The research will also include detailed case studies of buildings based on focus groups and interviews, with the aim of combining building operator experience with occupant perspectives. We are beginning to look for potential case study buildings this fall and we invite CBE Industry Partners and others to suggest possible sites. Ideally, case study projects would be relatively close to our project team (San Francisco Bay Area) and represent major facilities (~25,000 sq. ft. or larger). If you know of a candidate site please email us at: cbe-survey@berkeley.edu.

People

New Talent to Advance CBE's Human Comfort Research

Sabine Hoffmann, a building physics specialist from Germany, joined CBE this summer to support CBE's human comfort research. Sabine previously worked with CBE in 2007 as a visiting scholar. Since then she has worked in Germany for the glazing systems manufacturer Seele, a company known for high-profile projects such as the Apple "glass cube" store and the Seattle Public Library by REM Koolhaas. Sabine was responsible for evaluating the building physics aspects of Seele's many international facade projects, studying impacts of facades on thermal comfort and energy consumption. Her work included notable projects such as the expansion of Kimbell Art Museum in Fort Worth, and the Institute of Peace in Washington, D.C.

Her research at CBE will focus on developing the UCB Comfort Model, for example, to improve its ability to represent clothing affects on comfort, and how the tool can be applied to outdoor conditions to inform how to create comfortable and livable urban spaces. Sabine tells us that she looks forward to the new challenges in this work, and that she is excited about "being part of a fantastic team of outstanding engineers and thermal comfort experts."

Sabine received a PhD in building physics and a master's degree in construction management from Bauhaus Universität Weimar, Germany.

CBE Researcher Sabine Hoffmann

Grad Student Awarded EPA Fellowship for K-12 Schools Study

Graduate Student Researcher Lindsay Baker has received a prestigious award from EPA's Science to Achieve Results (STAR) Fellowships for Graduate Environmental Study. This fellowship will provide three years of support for Lindsay's PhD dissertation work, in which she will use CBE's occupant survey and other methods to evaluate building performance factors in K-12 schools. Lindsay says that this award will allow her to make valuable field visits to schools she is studying, to look more in depth at the complex set of factors that contribute to high performance schools. Her focus will be on understanding behavioral factors that affect energy consumption in schools. Last April, Lindsay presented her initial findings from a study of over 60 K-12 schools at CBE's Industry Advisory Board Conference.

The STAR Fellowships are highly competitive and are awarded to only 120 students nationwide, and we commend Lindsay on her accomplishment. She joined CBE with substantial experience related to energy and green building programs, including working with the USGBC coordinating the development of LEED rating systems and standards procedures, and developing the LEED for Schools program.

EPA Fellowship Awardee Lindsay Baker

Industry Partners and Events

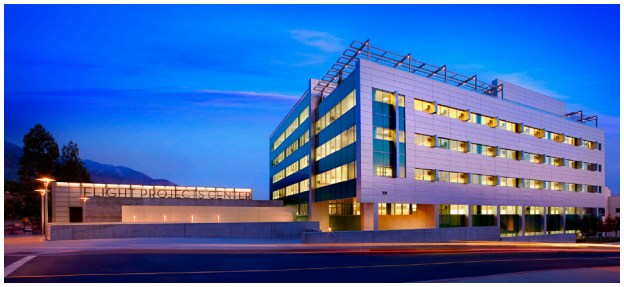
CBE Welcomes New Architecture and Engineering Members

CBE is happy to announce several new partners representing leaders in green design and engineering. Cannon Design and LPA Inc. joined us this past April, and HMC Architecture will be joining CBE in October.

Founded over sixty years ago, **Cannon Design** is now ranked among the world's leading international architectural, engineering, and planning firms. The firm employs a staff of 1000, delivering services in 17 offices throughout North America, as well as abroad in Shanghai, China, and Mumbai, India. Ranked the 14th largest practice in the world in *World Architecture's* 2010 global survey, Cannon Design has been recognized with over 250 awards for design excellence, technological innovation, and creative thought leadership. Cannon Design's unique single firm, multi-office (SFMO) practice approach enables the full integration of all its offices around the world into a unified firm without walls.

University of California, San Diego, Price Center East. Architecture: Cannon Design

Cucamonga Valley Water District Frontier Project. Architecture: HMC



NASA's Jet Propulsion Laboratory, Flight Projects Center. Architecture: LPA

Founded in 1965, **LPA** has more than 220 employees with offices in Irvine, Roseville, and San Diego, California. The firm provides integrated, multi-disciplinary design services: architecture, planning, interior design, engineering, landscape architecture, and graphics, for education, commercial, civic, retail, and institutional clients throughout California. At CBE's April conference, Dan Heinfeld, FAIA, President of LPA, gave a brief introduction to the firm's work and broad focus on sustainable design. Dan noted that LPA has completed 12 LEED certified buildings and that nearly 80 percent of LPA employees are LEED-accredited professionals. Erik Ring, an LPA Associate and mechanical engineering project manager, is a graduate of UC Berkeley's Building Science Program, and during his time working with CBE he participated in research on mixed-mode buildings with Prof. Gail Brager.

(continued from page 12)

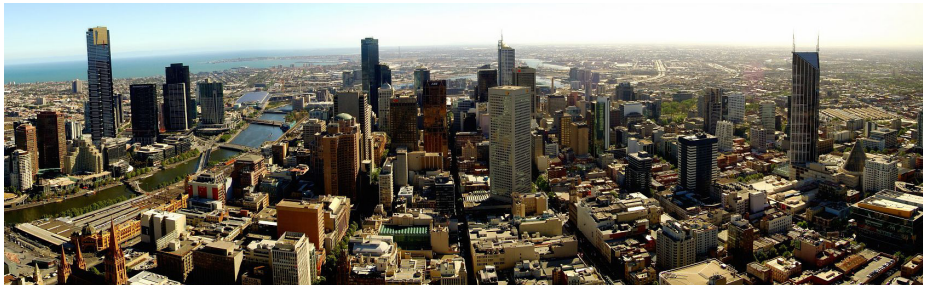
Joining CBE this fall, we also welcome **HMC Architects**, one of the nation's prominent designers of education and healthcare facilities, who provide a range of professional services from master planning through construction administration. With 70 years of project experience, HMC now has nearly 400 professionals in nine offices, committed to the creation of public facilities that enhance their surrounding communities, and to providing leadership in the realm of forward-thinking, energy-efficient, and environmentally sensitive design. The firm's practice is based on principles of evidence-based design, sustainability, and collaboration with industry clients. In August, HMC launched a firm-wide initiative grounded in research and metrics to bring forward leadership in the delivery of high-performance architecture that equates the balance between project budget, energy conservation, functionality, relevance to site, and the well-being of its occupants. Pablo La Roche, PhD, HMC's Sustainable Design Director, is also an Associate Professor of Architecture at Cal Poly Pomona and has been actively involved in passive systems research including work with Murray Milne and Baruch Givoni at UCLA.

The Road to 2030: Deep Energy Reductions in Existing Buildings

For past CBE Advisory Board Conferences we have organized pre-conference events on topics related to our research, often in collaboration with our industry partners. Last April we worked with Robert Marcial, Director of the Pacific Energy Center, on a highly successful event on integrated facades. (Materials from this event are on CBE's website at www.cbe.berkeley.edu/research/facade-symposium.htm.)

This fall we are again coordinating with Robert and his staff, and the ASHRAE Golden Gate Chapter, to support an upcoming event planned for Wednesday, October 20, in advance of CBE's membership events scheduled for October 21-22. This event, "The Road to 2030: Deep Energy Reductions in Existing Buildings" will take place at the Pacific Energy Center in San Francisco.

Because up to 70 percent of today's building stock will still be in use in 2030 —the mandated milestone for commercial zero net energy buildings— major improvement of existing buildings is critical for climate change mitigation. Speakers will provide a wide range of perspectives on this issue, including confirmed speakers Glenn Friedman, Principal with Taylor Engineering; Martha Brook of the California Energy Commission; Michael Bangs of Adobe Systems, Inc.; and Jordan Daniels, Director of Business Development at BuildingWise. More information is available on the PG&E website at: www.pge.com/pec/classes/4422.htm. (To register for the webcase see: www.pge.com/pec/classes/4434.htm.) Registration for this event is now available using the links above.



centerline
Summer 2010

Industry Partners at the Center for the Built Environment

CBE's research is supported and guided by CBE's consortium of industry partners, a diverse group of leaders in the building industry. The Center's membership includes the following firms and organizations:

Armstrong World Industries
Arup*
California Energy Commission
Cannon Design
Charles M. Salter Associates
Coherent Structures
Cohos Evamy
DPR Construction
EHDD Architecture
Glumac
Haworth
HMC Architects
HOK
KlingStubbins
LPA Inc.
Pacific Gas & Electric Company
Price Industries
Integral Group Membership Team:
- Integral Group
- CPP
- Mahlum Architects
- Mithun
- Perkins+Will

Skidmore, Owings & Merrill
Southern California Edison
Syska Hennessy Group
Tate Access Floors*
Taylor Membership Team:
- Taylor Engineering
- CTG Energetics
- Guttmann & Blaevoet
- Southland Industries
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