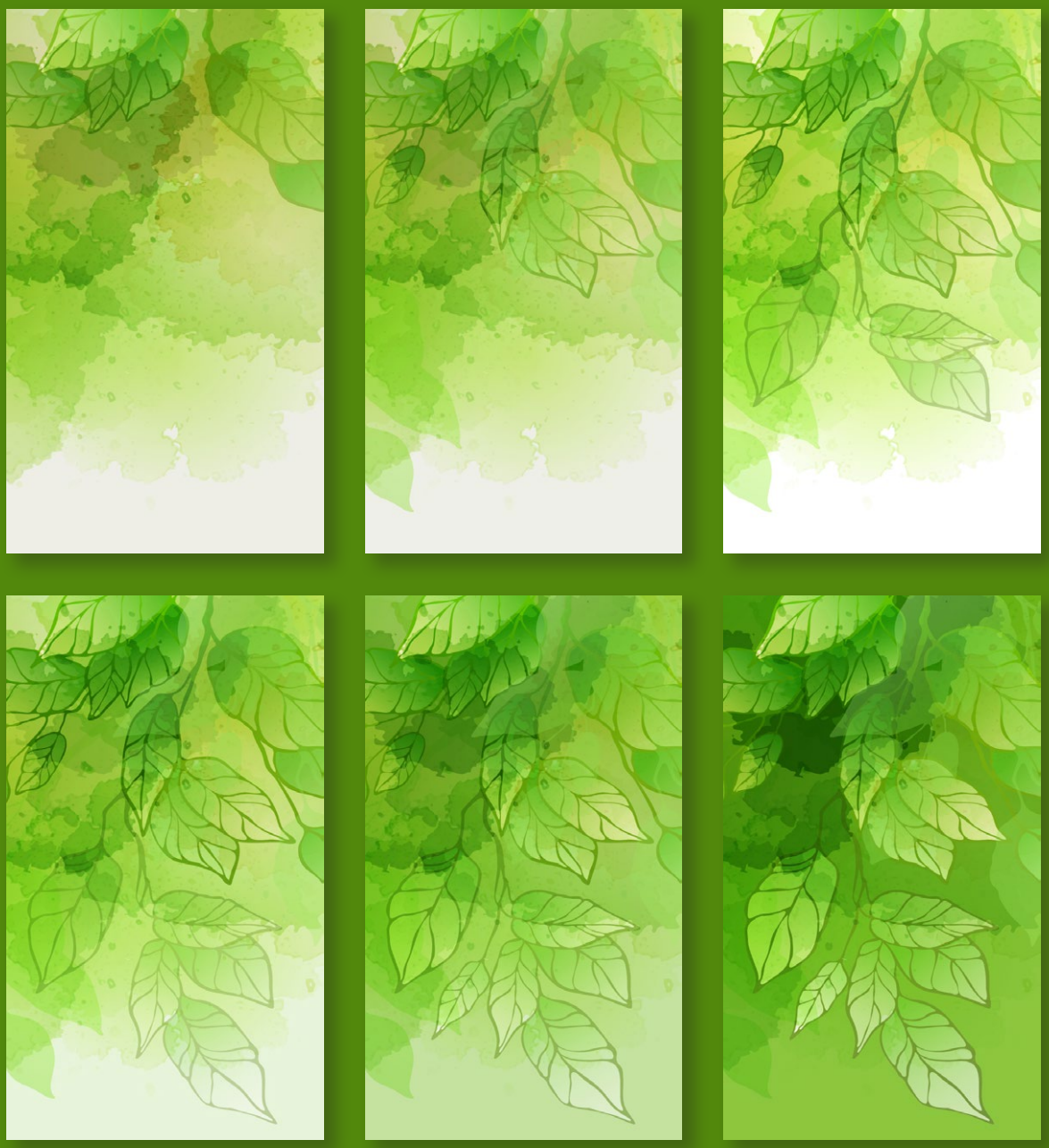
centerline

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

Winter 2013



GETTING TO GREEN

Director's Note

Contents

On the cover: CBE researchers will use this ambient feedback display to give office workers qualitative information on their individual energy use.

centerline

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Dear Industry Partners,

In this edition of *Centerline* we provide you with updates on our research, and also recent news about our faculty and growing list of industry partners. We have made a number of positive strides recently with our research on personal comfort, including the application of a provisional patent for a "conditioned chair" prototype that allows individuals to be comfortable in a range of temperatures, potentially saving whole-building energy. Several industry partners and recent visitors to our lab have shown interest in this prototype, and we are looking for opportunities to commercialize this innovation in workplace comfort. Last fall we also had students from the Berkeley Cleantech to Market program evaluate the market for CBE's personal comfort system, which is now being demonstrated on campus (see page 4). It's worth noting that a previous patent based on CBE research, for a wireless lighting control technology, helped launch Adura Technologies, acquired this winter by the global lighting leader Acuity Brands.

We are excited to report on about several new research projects recently underway or soon to start, including field studies in "near net-zero" buildings, and evaluating the non-energy co-benefits of green buildings. We are also pleased to announce in this *Centerline* new faculty, awards, and several industry partners that have joined CBE's consortium since our meeting last fall.

Sincerely,
Prof Edward Arens
Director, CBE

Project Updates

Defining and Improving Personal Comfort: in the News and in the Lab

As CBE faculty and staff advanced numerous personal comfort research projects last fall, articles in the mainstream press explored diverse perspectives about comfort and air conditioning. In a *NY Times* article from January 2013, "What Does It Mean to Be Comfortable?," science writer Maggie Koerth-Baker explains that a wide range of conditions are considered comfortable around the world, and how sociological factors impact adaption, behavior, and energy use related to comfort. She notes that different people experience a given temperature quite differently, something that comes as no surprise to building industry professionals. Click here to read the piece.

An article in *The Economist*, "No Sweat: Artificial Cooling Makes Hot Places Bearable—But at a Worryingly High Cost," provides an interesting background on the history of air conditioning, and discusses the 100-year-old technology in terms of both unintended consequences and also important benefits. While America's AC addiction has been called "the most pervasive and least noticed epidemic," it has also been credited with increased productivity, and saving lives during periods of extreme heat. Read the original article.

CBE's conditioned chair prototype incorporates reflective materials and low energy fans. Controls are located in the left arm rest.

CBE developing conditioned chair concept, completes first step in patent protection

The Economist article cited above notes that mesh chairs and fans are good approaches to personal cooling. CBE researchers have brought both ideas together in a new user-controlled chair prototype that CBE will soon test under both lab and field conditions. The chair allows users to control heating and cooling that is provided directly through the mesh surfaces of a chair, allowing people to be comfortable under a wide range of room temperatures. Previous CBE research shows that expanding the range of indoor air temperatures can reduce HVAC energy use by about 5% per degree Fahrenheit. CBE's chair uses low-energy fans (less than 4 watts total) located behind the chair's mesh surface for use under warm temperatures. A reflective exterior and small heating elements (11 watts max) provide warmth under cool conditions. An occupancy sensor saves energy when not in use, so the lithium ferrophosphate battery can power the chair for several days between charges. A simple control in the armrest sets the heating and cooling intensity.

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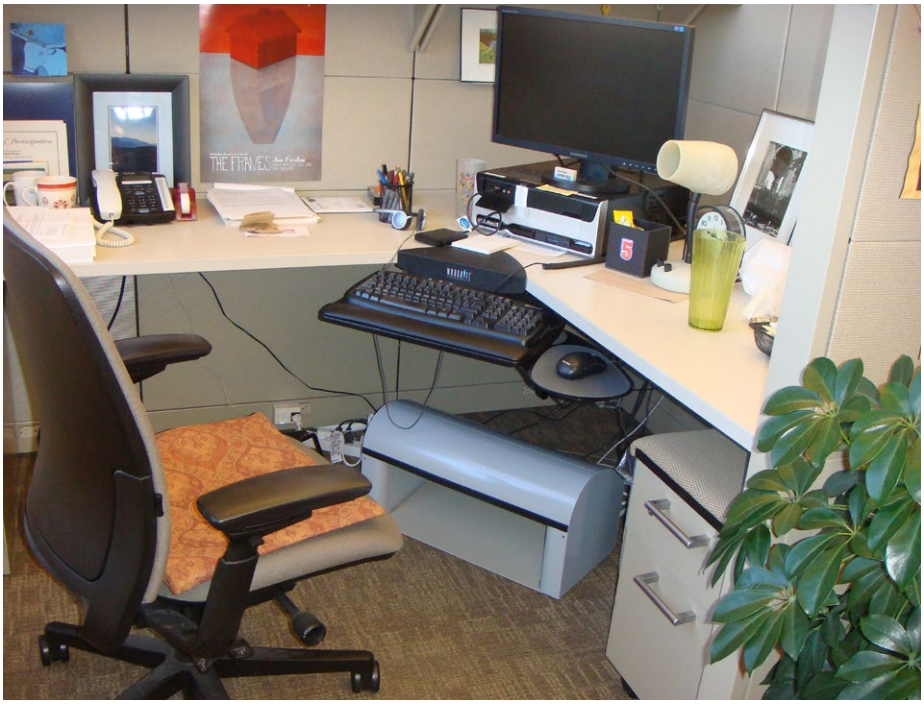

Personal comfort demonstration installation, showing the footwarmer below the desk, and the desk fan (white cylinder to right of monitor).

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With new funding from the California Institute for Energy and Environment (CIEE), CBE will fabricate approximately 25 chairs and field test them on the UC Berkeley campus. We also plan to conduct laboratory testing under conditions well outside the normal range of indoor temperatures to identify the full extent to which the chairs can keep users comfortable (temperature thresholds). Tests that CBE conducted with another "active" chair kept people comfortable under all temperatures tested, from 61°F to 84°F.

CBE recently completed a conditional patent application for its chair concept, which provides protection of this innovation for one year. We have already seen interest in this concept from CBE partners, and we invite interested parties to contact us for more information.

Personal comfort system field demonstration

Just as task/ambient lighting systems save energy by providing light when and where it's needed, CBE has devised a personal comfort system (PCS) that lets individuals control their own focused cooling and heating, saving whole-building energy by expanding the range of acceptable indoor temperatures (similar to the chair concept described above). Last fall CBE began its first field demonstration of a personal comfort system consisting of small desktop fans and foot warmers, which CBE previously identified as very effective ways to help keep people comfortable under warm and cool temperatures, respectively. Unlike conventional fans and space heaters (which can use up to 1500 watts in the case of heaters), the Berkeley devices, on average, use only 1.4 watts for cooling and 40 watts for heating. The CBE devices also include occupancy sensors to further reduce energy use, and additional sensors that will record the user-selected settings and indoor temperature for research purposes.

The research team led by Edward Arens, Hui Zhang, and Fred Bauman, installed the PCSs in 15 office workstations in a UC Berkeley office building, and are monitoring occupant comfort, building operations, and how occupants use the devices. During the winter season we conducted several interventions, changing the indoor temperature to four different settings ranging from 70°F down to 66°F, each time for a two-week period. The team monitored energy use in the test area, using data from the building management system, and from temperature loggers installed in the space. Two to three times a day

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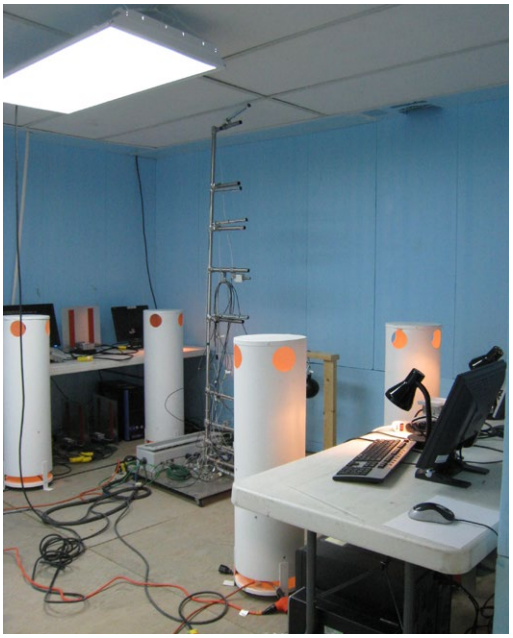
(continued from page 4)

the study volunteers received email reminders to take a short survey, with questions about their perceptions and comfort at a given moment. As an incentive, they are offered a gift card if they take the survey at least ten times per week.

Project Scientist Fred Bauman explains that this is a very involved study that will characterize both the building energy savings and the occupant comfort. He says that preliminary results are promising, showing that reheat energy use was reduced. The team is now analyzing weather data that will be used to normalize the energy figures. CBE is currently making plans to conduct another PCS demonstration study in additional Berkeley campus buildings that will include warm season tests. In addition, the research team will also send PCS units to CBE Industry Partner LPA Inc., for use in its San Diego office as part of the study. Preliminary results from the demonstration study will be included at CBE's advisory board meeting in April.

Sharing Results from Advanced Integrated Systems Research

Over the last several months our research team has been actively engaged in technology transfer – via reports, publications, and seminars – sharing recent findings from CBE's advanced integrated systems (AIS) program. Below we provide some highlights from this work.



Test setup in Price Industries' test chamber showing simulated loads, sensor "tree" and radiantly cooled ceiling.

Integrated radiant cooling systems studies

At the February meeting of the Golden Gate Chapter of ASHRAE, Fred Bauman and Stefano Schiavon of CBE, along with Julian Rimmer of Price Industries, presented recent findings on thermal comfort, air change effectiveness, and energy implications of using radiant chilled ceilings (CC) combined with displacement ventilation (DV) for cooling. The CC/DV combination is promising as both approaches are highly energy efficient, and when properly integrated into a single solution, take advantage of the stratified temperatures and improved ventilation performance common in DV systems. Last year CBE worked with Price Industries staff on an extensive series of lab tests at Price Industries' Hydronic Test Chamber in Winnipeg, Manitoba. The study showed that the CC/DV approach was effective for providing good comfort and enhanced ventilation performance compared to overhead systems, even for large heat loads up to 8.5W/ft^2 (91 W/m^2). The experiments also demonstrated that raising the height of heat sources in the space reduced cooling energy use in this stratified system. The paper on this work will be published this summer in *Energy and Buildings*, and is online at: http://escholarship.org/uc/item/58m8302p

CBE researchers and PhD candidate Jingjuan (Dove) Feng recently published results from a simulation study on the design of radiant systems

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with significant solar gain. Radiant floor cooling systems are increasingly being used in large glazed transition spaces such as atria, airports, and perimeter areas. However, current design standards and test methods provide limited guidance on sizing such systems and their associated air systems with incident solar radiation. CBE's study, which has been accepted for the CLIMA 2013 conference, provides useful guidance for designers and energy simulators of radiant systems with direct solar gain. The paper is available at: http://escholarship.org/uc/item/2913930b.

For the next major phase of radiant systems research, we will conduct detailed case studies of near net-zero energy buildings that use radiant systems, with funding from the California Energy Commission's Public Interest Energy Research Program. We are currently compiling information on potential case studies in California.

NY Times calibrated model shows 24% energy savings with integrated UFAD design

Last fall researchers from CBE and Lawrence Berkeley National Laboratory (LBNL) completed a detailed evaluation of the key innovative energy efficiency measures installed at the *New York Times* Headquarters in Manhattan — external and internal shading, dimmable electric lighting, and underfloor air distribution (UFAD). This study was sponsored by U.S. DOE's Commercial Buildings Partnerships Program, which encourages building owners and operators to collaborate with research staff at national laboratories and universities to explore energy-saving ideas and strategies in retrofits and new construction.

During the study, CBE focused on assessing the performance of the UFAD system, while LBNL studied the shading and lighting performance. The team monitored building performance data on one typical floor to determine lighting energy use, UFAD operations, and other loads within the open plan office. Monitored data was then used to create a calibrated whole-building energy simulation model that could be compared to a baseline VAV overhead system. The simulation study shows that the integrated project saves 24% on energy overall, with large savings in lighting electricity (43%) and total heating energy (51%).

CBE's research team used a specially designed, wireless-enabled data collection system at the *NY Times*. Show at left is the base unit that measures temperatures from floor to ceiling, communicates with wireless sensors, and cradles a laptop computer used to monitor the study.

The report on this final phase of work for this collaboration is online at: http://buildings.lbl.gov/sites/all/files/lbnl-6023e.pdf.

Additional background on the project is available at: http://windows.lbl.gov/comm_perf/newyorktimes.htm.

New Thermal Comfort Tool Supports LEED Documentation, Natural Ventilation Design, and More

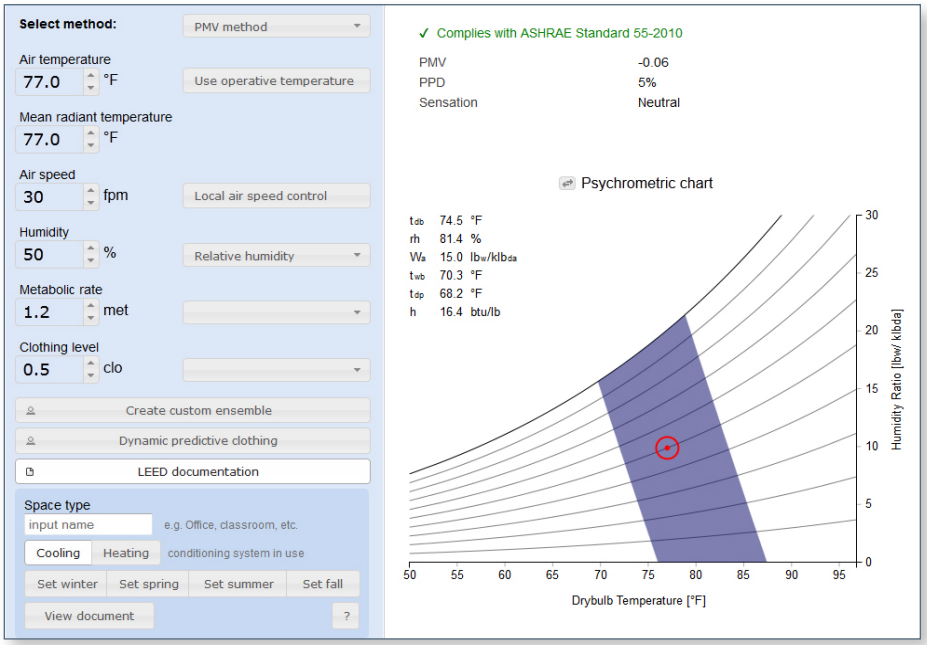
Last year CBE launched an online Thermal Comfort Tool (for ASHRAE Standard-55) to help practitioners wanting to explore novel approaches for saving energy while still keeping occupants comfortable. CBE staff have recently added many useful capabilities to the tool that will make it more useful for designers of naturally ventilated buildings, and to facilitate LEED documentation.

New LEED compliance features allows users to input project design parameters, modify as needed for heating, cooling and for all four seasons, and to receive instant feedback on whether the values comply with Standard-55. Once the inputs are set, users can then generate an HTML page complete with the tables that document all required values and compliance. The page can be easily printed from a browser and included as part of a LEED submittal (for example, for NC IEQ credit 7.1).

The new version of the tool also includes new visualizations, providing real-time feedback as users change inputs, and also a rectangular charting option (relative humidity vs. dry bulb temperature) that may be more intuitive for users not accustomed to using psychrometric chart displays.

For designers of naturally ventilated buildings, the tool provides additional support for the adaptive comfort method feature. Airspeeds can be changed to move the comfort zone, and results are shown dynamically on the graphical display. The tool also provides compliance feedback about discomfort for specific parts of the body, information that may be useful for exploring comfort implications of radiant, UFAD, displacement systems, and fans. Finally, one new innovation is the dynamic clothing predictor, which is based on research conducted at CBE by Stefano Schiavon, allowing users to set an estimated CLO level by entering a 6:00 AM outdoor temperature.

We welcome you to use this tool and to give us feedback. It is available at http://www.cbe.berkeley.edu/comforttool.



The updated comfort tool allows users to change parameters (on the left) and see results immediately displayed. The LEED documentation button brings up completed forms for use in LEED documentation.

New Research Focusing on Non-energy Benefits of Green Buildings

While estimating energy benefits of green buildings is relatively straightforward, quantifying non-energy benefits can be considerably more complex. A new research effort underway at CBE will quantify the "co-benefits" of green buildings — those that lead to lower greenhouse gas (GHG) emissions due to reductions in transportation, water use, and solid waste disposal. Having this information available will be valuable to governmental agencies developing green building policies, and to businesses and property owners who are increasingly responsible for documenting enterprise-scale carbon impacts.

Electric car charger in Portland, Oregon parking garage. Image: Bruce Ely.

This study, which began in fall of 2012, is funded by the California Air Resources Board and is being led by CBE Research Specialist John Goins in collaboration with UC Berkeley's Center for Resource Efficient Communities (CREC). The project team, including William Eisenstein (CREC) and Kimberly Seigel (CBE/CREC), will compare business-as-usual scenarios against estimated green building adoption scenarios. Kimberly Seigel recently joined our research team, having previously worked as a sustainability consultant with CBE partner Arup, and developed climate change baselines and action plans for AB 32 implementation (California's global warming law which limits GHG emissions).

The researchers first identified key GHG metrics that are applicable to green building certification systems such as LEED, and also to state energy and climate policies. The team is now compiling data from a sample of California certified green buildings to create a database that will enable users to compare GHG reductions from certified green against baseline values. Towards this end, CBE plans to conduct surveys to building occupants and operators on a range of topics, such as building operations, commute and transportation patterns, and electric vehicle use.

Finally, the project team will provide recommendations for extrapolating these findings to a wider population of buildings that will enable comparisons between green buildings and conventional buildings, so that design teams and policy makers can calculate non-energy GHG emissions from transportation, water and waste, and at a building or regional level.

People

New Faculty Member Luisa Caldas Holds Joint Architecture and LBNL Appointment

At CBE's advisory board meeting last October, we had the opportunity to introduce the latest addition to UC Berkeley's Building Science Group, Professor Luisa Caldas. Luisa holds a joint appointment with the Department of Architecture and as a Joint Faculty Scientist at Lawrence Berkeley National Laboratory (LBNL). We are excited about working with Luisa to build on our already strong collaborative relationship with researchers at LBNL. As part of her bridging role between LBNL and the Department of Architecture, Luisa is interested in the integration of energy simulation tools developed at LBNL into the architectural design process. Her research interests also include generative design systems in architecture, and the development of new construction materials in collaboration with industry. She plans to continue her past teaching activities that focus on the integration of sustainability and energy into design.

Prior to joining UC Berkeley, Luisa was a Professor of Building Technology at the Technical University of Lisbon. She holds a PhD from MIT in Architecture/Building Technology, and an MSc in Environmental Design and Engineering from the Bartlett School of Graduate Studies, and was trained as an architect at the Technical University of Lisbon. She is also the author of GENE_ARCH, a generative design system that integrates a "pareto genetic algorithm" with EnergyPlus. Luisa will present some of the new simulation software she has been involved with during a panel session planned for CBE's April industry advisory board meeting.

Prof. Luisa Caldas

CBE's Stefano Schiavon Recognized with ASHRAE Nevins Award

We are happy to announce that Stefano Schiavon, Assistant Professor of Architecture, was awarded with the 2013 Ralph G. Nevins Physiology and Human Environment Award by ASHRAE. The award is given annually to a young researcher who has distinguished him or herself through studies on human responses to the environment, including effects from thermal, visual, acoustical, olfactory, and other factors on health, comfort, and well-being.

Stefano joins an impressive group of CBE faculty, researchers and graduate students who have been recognized with this award in the past: Gail Brager (1989), Marc Fountain (1995), Clifford Federspiel (1997), Hui Zhang (2004), Charlie Huizenga (2007) and Gwelen Paliaga (2010). We congratulate Stefano on this well-deserved accomplishment and look forward to his future contributions.

Asst. Prof. Stefano Schiavon

Interview

David Fannon Senior High Performance Specialist, Syska Hennessy Group, New York City

You graduated from UC Berkeley last fall and now work for one of CBE's industry partners. Tell us about your new role.

I'm part of our high performance solutions team. This includes building scientists and simulations people, and we support teams across offices, and also consult externally on other projects. With my background in architecture and building science, I get to think about broad approaches. It's a strategic role on projects.

What types of projects are you working on?

It's an interesting mix, I have worked on small retrofits for local buildings, and also huge towers and campuses in Korea, China, and Saudi Arabia, often focusing on energy, water, lighting, and daylighting.

You previously worked as an architect, and now are working in a global engineering firm.

One good thing is that I am not expected to be an engineer. People say the language of architects and engineers is different, so sometimes I am just translating. The language differences also reveal differences in approach and values. But we are all on the same team, working towards the same goal to make great buildings.

What excites you about your new work?

One of the neat things being on this team is that we get to do some weird, interesting things, and keep abreast of the new things. We also keep in touch with colleagues in research and industry, and work with other firms that are CBE members.

How has your experience at CBE helped you in your current work?

Beyond the technical things I learned, I think there are two big themes. First is an ethical stance about comfort, whether that is lighting or thermal, which means thinking of people as the driver for buildings.

Second, I gained a research perspective, how to test things and figure them out, which I bring to projects. For example, a client purchased an office tower in Manhattan from the 60s, and wanted to know what to do first to save energy and improve comfort. We are putting in measurement devices, and using surveys to learn about comfort and energy problems.

You were a major contributor to the development of CBE's personal comfort research, does your work allow you to continue this?

I certainly push for finer-grained occupant control because people will tell us what conditions they want if we let them. For a project in design we plan to get the LEED point for individual control, through additional thermostats and ceiling fans in conference and meeting areas.

How was it adapting to NYC being back on the East Coast, after years in Berkeley?

It has been great. I actually live in the town where [CBE Director] Ed Arens grew up, Irvington NY, in the Hudson Valley, about 20 miles from my office. I take the Metro North train to Grand Central Terminal. From there I walk to our offices on Times Square.

This also puts me much closer to the tree farm my sister and I own north of Syracuse. We grow mixed northern hardwoods like maple, cherry and black walnut. Neither of us live there, but we go there regularly to keep it in order. We have a cabin with a very over-designed outhouse that I joke we should submit for LEED!

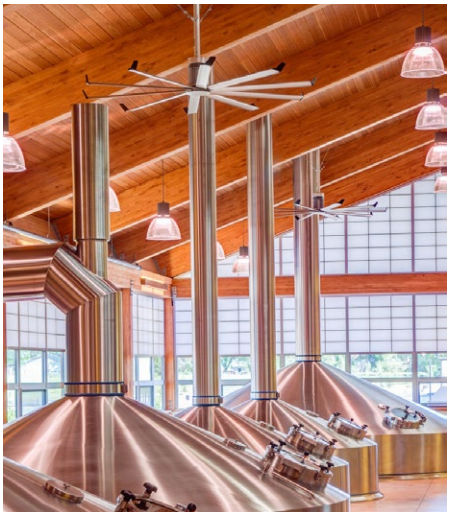
Partner News

Five New CBE Members Represent Expertise in Manufacturing, Engineering and Workplace Consulting

We are pleased to introduce new CBE partners who represent leaders in energy efficiency and sustainable environments, who bring a diversity of knowledge and perspective to our center.

Last October we welcomed **Big Ass Fans** to CBE's consortium. As the name implies, Big Ass Fans is a preeminent designer and manufacturer of fans for commercial, industrial, agricultural, institutional, and residential buildings. The company has headquarters, research and manufacturing facilities in Lexington, KY, and additional facilities in Queensland, Australia. Their products contribute to the sustainability of a building by reducing ductwork, increasing the effectiveness of air distribution systems, and reducing the energy required to provide comfort to occupants. Included in company's products is the Haiku® fan, made from FSC bamboo and recently named as a Top-10 Green Building Product in 2013 by *BuildingGreen*. Haiku is certified by ENERGY STAR as the world's most efficient ceiling fan, using only 2-30 watts (compared to 90-110 watts for a typical fan).

Big Ass Fans generously donated fans for use in CBE's human test chamber, and we look forward to working with them and other industry partners on the development of new standards for testing fan performance.



Big Ass Fan brewery installation at Bell's Brewery, Kalamazoo, MI.

Representing the first CBE member headquartered in Asia, **LG Electronics** joined CBE last October. LG is a global leader in consumer electronics, appliances, and commercial building HVAC, solar cells, and lighting. The firm is a leader in variable refrigerant flow (VRF) technology for commercial, education, hospitality, retail, and healthcare applications, and also duct-free technology for residential and light commercial markets. The company provides numerous technical and engineering resources to assist specifiers.

Dr. Juyoun Lee, a principal research engineer with LG Electronics Research Center, has worked with CBE as a visiting scholar for over a year, and has worked with CBE researchers on

LG Electronics provides a wide range innovative products for commercial HVAC.

laboratory and simulation studies on human comfort. Dr. Lee is our primary liaison with LG, and is now supporting new CBE market research in collaboration with LG.

We also welcomed **P2S Consulting Engineering and Commissioning** in October, when the firm joined CBE as part of the Integral Group team. CBE members may remember P2S founder Kent Peterson, who was our guest speaker at CBE's October 2010 advisory board meeting. P2S offers engineering services including MEP, energy efficiency, commissioning and technology for both new and retrofit construction projects. The firm's practice includes a broad range of project types including education, government, laboratory, industrial, clean energy, infrastructure, and more.

P2S' technical staff, comprised of over 50% LEED Accredited Professionals, are passionate about providing sustainable solutions and

Mary Davidge Associates.
Image: Kevin Burke.

Aditazz's winning entry for Kaiser Permanente's Small Hospital Big Idea Competition. Image: Aditazz.

expertise in high-performance green building projects, and helping clients reach their sustainability goals., The firm has been named for three years in a row as one of the best places to work in Los Angeles, by the *Los Angeles Business Journal*. The recognition cites the firm's offices in Long Beach, CA, located in a LEED-Gold tenant improvement project that includes morale boosting features such as a fitness center and a green workstations.

This winter we also welcome **Aditazz** to the industry consortium. The San Bruno based firm offers a complete scope of design services, using highly refined computer simulation and optimization strategies. The company has developed an integrated platform for healthcare that allows stakeholders to virtually operate a building model while still in the design stage. Their overall goal is to improve patient care through a new design approach, enabling the creation of better buildings faster, and at a lower cost than conventional delivery methods.

CBE members may remember Benjamin Welle, who participated on a panel on building information modeling (BIM) at a past CBE advisory board meeting. Ben is now Mechanical System Product Design and Development lead at Aditazz, and will participate again on a CBE panel in April, on new integrated design tools.

Finally, we welcome **Mary Davidge Associates (MDA)** to CBE's consortium. The firm consults with major technology corporations, helping them to define and implement their vision for the built environment. They bring a practical, integrated approach to developing and implementing environmental strategies for the high-performance workplace with a particular emphasis on human health. The MDA team itself has specialists with backgrounds in engineering, building sciences, knowledge management, and biology and uses innovative and technology-based solutions to achieve the goals of its clients. MDA provides consulting services during design, construction and operations, ensuring that sustainable design and operations goals are executed through an integrated process. MDA's services include a focus on materials toxicity screening, where it has served in a pioneering role in the building industry.

Fullerton College Library renovation by P2S Engineering.
Image: RMA Photography.

We welcome the support and participation of these new industry leaders, and look forward to our future collaborations with them.

Events

April 17th Symposium on the High Performance Workplace

CBE is collaborating with the Pacific Energy Center to host a symposium in conjunction with CBE's April industry advisory board meeting. This spring's event, scheduled for April 17th, will focus on high performance workplaces, featuring design and workplace strategy professionals from CBE's industry partners and other leading firms. Speakers will explore the multiple issues driving the design of today's innovative workplaces: how to increase innovation, collaboration, and productivity, while creating healthy and sustainable spaces rich with amenities. Through theory and case studies, speakers will discuss how workspaces can support a wide range of work activities while enabling highly mobile work styles.

Speakers include Kathy Berg and Jan Willemse of ZGF, Georgia Collins of CBRE Workplace Strategy, Antonia Cardone and Louis Schump of HOK, and Henry Cheung of IDEO.

This event is free and open to the public, and will be followed by a networking reception. Also available by live webcast.

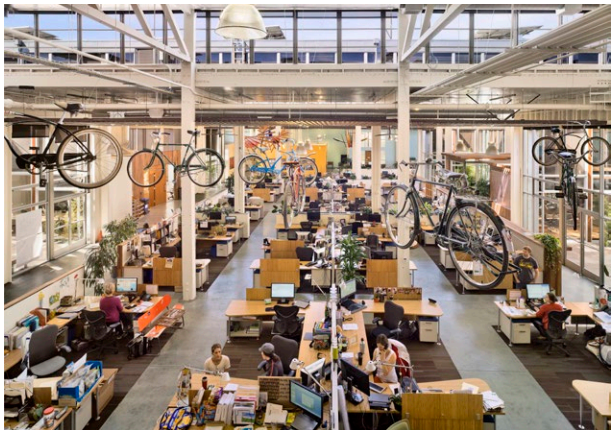
Event Details

Wednesday, April 17, 2013; 1:00 PM – 4:45 PM
PG&E Pacific Energy Center
851 Howard Street, San Francisco, CA

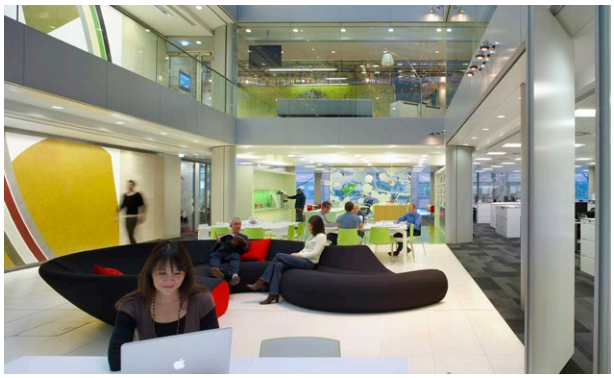
Registration
Pre-registration for the event is recommended as space is limited.

Register for the symposium in San Francisco:
www.pge.com/pec/classes/6349.htm

Register for the live webcast:
www.pge.com/pec/classes/6350.htm



2012 Livable Buildings Award winner Clif Bar Headquarters by ZGF will be a featured case study.



Collaborative space at HOK's London office.

Industry Partners at the Center for the Built Environment

CBE's research is supported and guided by a consortium of industry partners, a diverse group of building industry leaders who are working to advance standards for the design and operation of commercial buildings through their collaborations with CBE.

The Center's membership includes the following firms and organizations:

- Aditazz
- Affiliated Engineers, Inc.
- Armstrong World Industries
- Arup*
- Big Ass Fans
- California Energy Commission
- Cannon Design
- Charles M. Salter Associates
- DIALOG
- EHDD Architecture
- HGA Architects and Engineers
- HOK
- Integral Group Membership Team:
  - Integral Group
  - CPP
  - DPR Construction
  - P2S Engineering
  - Perkins+Will
- Interface Engineering
- LG Electronics
- LPA Inc.
- Mary Davidge Associates
- M.E. GROUP
- National Security Agency/Central Security Service (NSA/CSS)
- Pacific Gas & Electric Company
- Price Industries
- REHAU
- RTKL Associates
- San Diego Gas & Electric
- Skidmore, Owings & Merrill (SOM)
- Southern California Edison
- Syska Hennessy Group
- Tate Access Floors*
- Taylor Membership Team:
  - Taylor Engineering
  - Cadmus Group
  - Guttmann & Blaevoet
  - Southland Industries
  - Swinerton Builders
- Webcor Builders*
- WSP Flack + Kurtz
- ZGF Architects

* founding partner

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