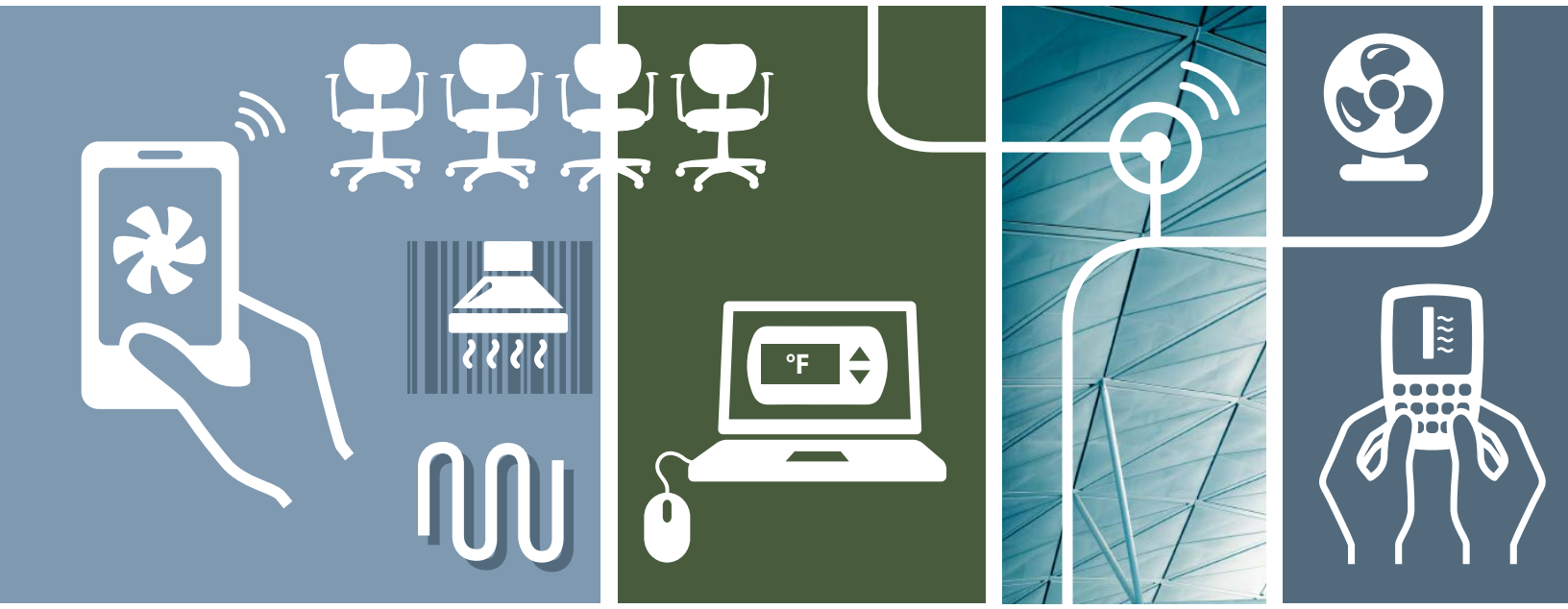
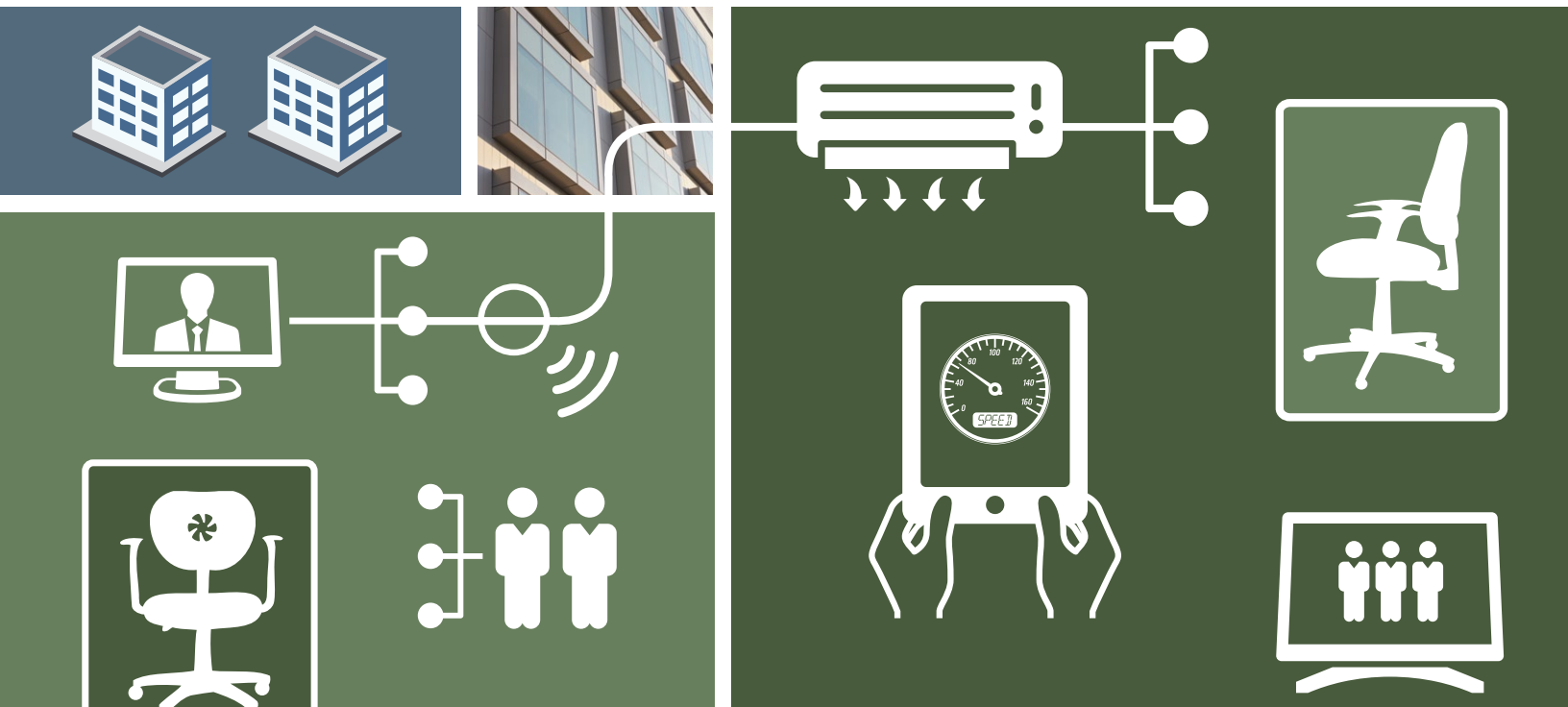
centerline

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

Summer 2013





OCCUPANT-RESPONSIVE BUILDINGS

Director's Note

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Dear Industry Partners,

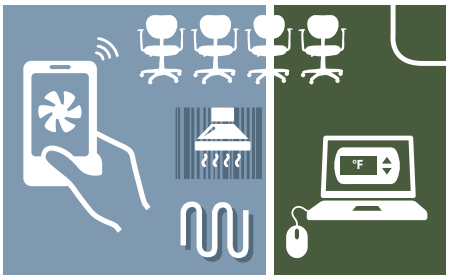
We received exciting news this summer when a significant research proposal to the California Energy Commission was accepted for funding with high marks. The research will be centered on an integrated set of occupant responsive building technologies and will be launched this fall, as we describe in this edition of *Centerline*. This encouraging outcome was the result of an intensive and highly collaborative effort between CBE, several CBE industry partners and on-campus collaborators. This work will advance several of our core research tracks, and allow us to explore new directions and work with new collaborators. We thank those CBE partners that contributed to this effort: Taylor Engineering, LPA Inc., HOK, Perkins+Will, and Pacific Gas & Electric. We also thank all of our members for their ongoing participation, as your support allows CBE to offer match funding when we compete for grants, which in turn greatly leverages your investment in our work.

This summer we also welcomed a new group of graduate students to our program, including several who come to us with strong professional credentials from their experience working with prominent industry firms such as Atelier Ten (CBE's newest member) and the U.S. General Services Administration (a founding member of CBE). We now have one of the largest contingents of graduate students in the building science program, and I hope you have a chance to meet some of them at our upcoming Industry Advisory Board Conference next month. Our staff and I greatly look forward to seeing many of you then, and to our future collaborations with you and your colleagues.

Sincerely,
Prof. Edward Arens
Director, CBE

High Tech Meets High Touch: Controlling Buildings Using Occupant Feedback

A new collaborative research effort will strive to create innovative solutions to persistent commercial building control problems.



With funding from the California Energy Commission, CBE will launch new interdisciplinary research this fall to develop and test innovative ways to expand the roles of occupants, operators and automation in the control of building HVAC systems. The overarching goal of the work will be to create advanced HVAC controls, integrated with occupant inputs, to optimize the operation of commercial buildings. This work builds on several important threads from CBE's recent work: using occupant feedback to inform building operations, low-energy personal comfort systems, and optimizing the control of variable-air-volume (VAV) systems.

The new 3 ½-year study will be conducted in collaboration with UC Berkeley's Department of Electrical Engineering and Computer Science (EECS), CBE Industry Partner Taylor Engineering, and the California Institute for Energy and Environment (CIEE). The research proposal, titled "Changing the rules: Innovative low-energy occupant-responsive HVAC controls and systems," was given the highest ranking among all proposals submitted in its category.

In addition to research team members listed above, support for the proposal was provided by CBE Industry Partner firms HOK, LPA, Perkins+Will, and PG&E; and also from UC Berkeley's Operational Excellence Program. The research award of $1.6M, announced in May, will leverage match funding provided by CBE's industry consortium. The UC Berkeley News Center published a media release on the award, which has been picked up by a number of news outlets.

Controlling a building based on generalized occupant preferences – not complaints – is a revolutionary approach.

It is estimated that the proposed combination of techniques may reduce HVAC electricity use by 30%, and natural gas use by 39% in typical California commercial office buildings. Targeting primarily office and university buildings, the research team will test new control approaches on a diverse set of building types, vintages, and control systems on the UC Berkeley campus and in other locations.

Putting buildings occupants in control of systems

A central theme underlying this work will be testing new technologies that give occupants direct control of their environments – from the level of the individual workplace to larger building zones – using web-based applications for mobile devices and PCs. Such occupant control applications have already been built and tested by students at UC Berkeley, including those for control of lighting and HVAC. For example, one application allows individuals to "vote" to make office spaces warmer or cooler, making the HVAC system respond immediately, providing that more than one person votes similarly. Another application tested on campus allows people to scan a "QR" code in a room

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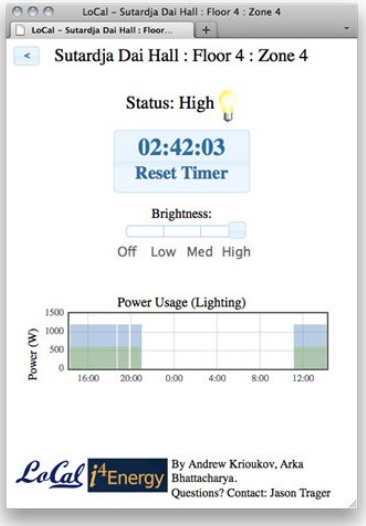

An occupant lighting control application was part of UCB's sMAP project. Image: i4 Energy and LoCal.

Researchers assembling low-energy heated and cooled office chairs to be tested in conjunction with occupant-responsive building controls in several campus buildings. Image: CBE.

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using a mobile phone, and then setting lighting preferences for that space using a simple interface.

These applications were built on an open-source protocol, developed by EECS faculty and students, dubbed sMAP (Simple Measurement and Actuation Profile). The protocol allows diverse types of building data to be utilized via common internet standards, enabling communication with many commercial building management systems. The sMAP system also enables the integration of multiple systems, for example lighting and HVAC, so that advanced control methods can be implemented at low cost and across multiple buildings, including visualization and control features.

Expanding the role of personal comfort systems

The new funding will also enable CBE to greatly expand its demonstration of personal comfort systems (PCS), and to provide a new sMAP data layer based on occupant feedback, with the potential to impact HVAC and lighting operation in real time. The PCS devices, developed at CBE, consist of low-energy rechargeable battery-powered chairs with integral heating and cooling, miniature desk fans and footwarmers. Some of the devices include data collection systems based on inexpensive "Arduino" microcontrollers to monitor indoor temperature, occupancy, and the settings for heating or cooling selected by occupants. Such detailed data collected on the level of individual occupants offer numerous opportunities for use as control system inputs. The PCS devices are now being tested in a series of field demonstrations on the UC Berkeley campus. Preliminary results from the winter season are promising, revealing that the devices can keep people comfortable with indoor temperatures from 70°F to as low as 66°F, and that heating energy savings with lower thermostat settings may be as much as 30-50% (with mild outdoor winter temperatures).

As part of the study, CBE will fabricate 75 chairs with integral heating and cooling, and will conduct detailed investigations to identify the potential annual whole-building

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energy savings when the devices are used with energy conserving HVAC controls. The research team also plans to integrate these research activities with related field studies planned for near zero-net-energy buildings with in-slab radiant systems. Although radiant systems are highly energy efficient, they tend to respond more slowly than forced air systems, and in some cases have lower cooling load capacity. Because personal control devices provide instantaneous comfort when needed, when combined with radiant systems they provide a highly energy-efficient and integrated solution. Finally, the team will also produce performance specifications and methods for testing various types of personal comfort devices (including fans and heaters) in order to assist manufacturers to develop products that are both effective and energy efficient.

Breaking rules-of-thumb to optimize HVAC control

A related aspect of the research plan will be to demonstrate new ways to optimize the control of HVAC systems, in simple yet effective ways that have already been proven in CBE's recent research. Last October our research team, working with Taylor Engineering, presented new findings showing that reducing the minimum VAV airflow rate, from the industry standard of 30% (of the maximum design airflow) down to approximately 10%, reduced annual electricity savings by 8-22%, and annual gas use by 4-19%, while simultaneously improving occupants' comfort during summer. Partly as a result of this study minimum airflow rates have been reduced to 20% in the California Title-24 energy standard, and proposals for an even lower minimum are under consideration. CBE's new research effort will build on this work and also test advanced approaches that offer significant improvements over current practices of VAV operation. For example, the team will work on establishing methods to identify optimal thermostat settings, based on occupant-responsive control algorithms, and methods for controlling for "rogue zones" that negatively impact whole building energy performance.

Researchers will test mobile phone and desktop applications to allow occupants to control aspects building systems.

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Links and References

Office too hot or cold? Researchers aim for comfort, energy efficiency.
http://newscenter.berkeley.edu/2013/08/27/office-too-hot-or-cold-researchers-aim-for-comfort-energy-efficiency/

Changing the rules: Innovative low-energy occupant-responsive HVAC controls and systems.
http://uc-ciee.org/cat-noteworthy/occupant-comfort-energy-savings-are-dual-goals-of-cec-funded-program

Advanced personal comfort systems.
http://www.cbe.berkeley.edu/research/personal-comfort-systems.htm

UC Berkeley's sMAP Project (EECS).
http://www.cs.berkeley.edu/~stevedh/smap2/index.html

***Journal paper:* Low-power task-ambient conditioning system.**
http://escholarship.org/uc/item/5j8071wn

***Journal paper:* Energy savings from extended temperature setpoints.**
http://escholarship.org/uc/item/28x9d7xj

Project Updates

Innovation Ecosystems: Leveraging Transdisciplinary Research to Benefit the Building Sector

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As outlined in the project proposal, the research team estimates that adoption of these coordinated technologies could yield annual energy savings worth over $60 million in California alone. To increase the likelihood that such approaches will be widely adopted, the work will conclude with numerous technology transfer activities, creating a deployment and commercialization plan, and participation in California Title 24 and ASHRAE standards committees.

The project leadership includes principal investigator Carl Blumstein (CIEE), co-principal investigators Edward Arens and Stefano Schiavon (CBE) and David Culler (EECS), and Gwelen Paliaga, Jeff Stein, and Steve Taylor of Taylor Engineering. Fred Bauman (CBE) will act as project manager, and Karl Brown (CIEE) will coordinate the field demonstrations.

A recent report by the American Academy of Arts and Sciences suggests that transdisciplinary research that breaks down traditional boundaries will lead to important technological advances, and that "innovation ecosystems" promote discovery through multiple pathways. The building industry has historically benefitted from adapting new technologies developed in other industries, for example from the automotive sector.

High performance glazing is one example of technology migrating from automotive R&D to buildings. The life span of a car is considerably shorter than that of a building, allowing for new products to be tested with less risk from failure over a long time period. Electrochromic glass technology, now being broadly marketed for buildings by companies such as Sage and View, were first tested on automotive mirrors. Researchers at Lawrence Berkeley National Lab tested switchable windows for its ability to reduce air conditioning in electric vehicles. Eleanor Lee, an LBNL staff scientist who was involved in those early tests, suggests that model predictive controls, such as those being used in self-driving cars, is making its way into the building industry, and may lead to more efficient and effective control of HVAC, lighting, and envelope.

Research staff at CBE have fostered ongoing collaborations with automotive manufacturers for many years, and this summer we established a new working relationship with a major manufacturer of automotive cabin interiors. CBE's research team and product developers identified several areas of shared interest, including how CBE's unique capabilities in human comfort research may be beneficial in the development of the next generation of cabin conditioning systems for electric vehicles. In electric vehicles managing the power demand from heating and cooling cabin interiors is critical to having a good driving range. Over the next two years CBE researchers will provide feedback on new automotive prototypes and concepts, and test them in UC Berkeley's human subject chamber.

This work builds on past CBE collaborations with automotive manufacturers GM and Delphi. Much of the fundamental research that led to CBE's Advanced Thermal Comfort Model — one of CBE's core research tools that has been used by many

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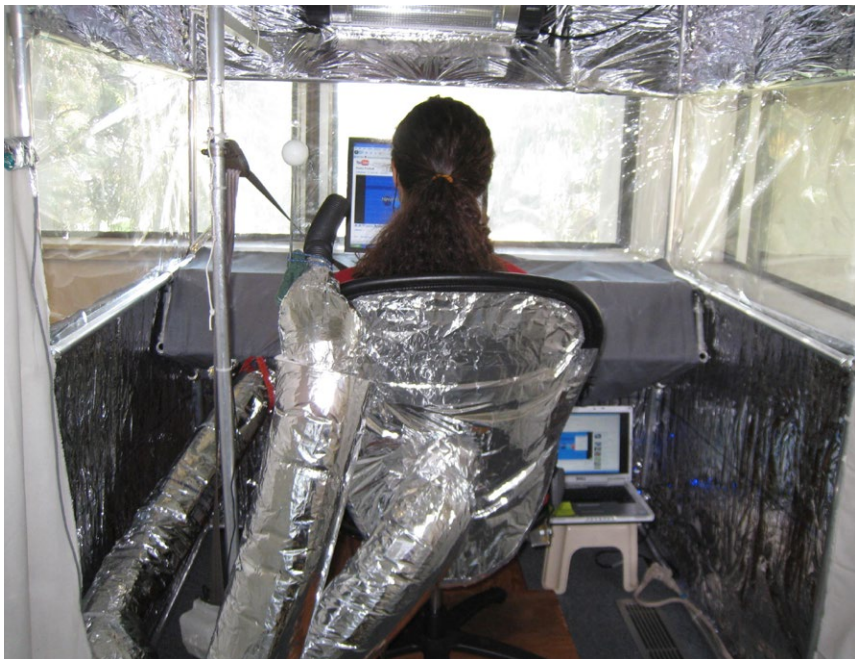

Researchers built this supply air "manifold" to test various air supply options in the cabin mockup.

CBE researchers created a mockup of an automotive cabin in CBE's human subject test chamber to study low-energy vehicle conditioning ideas. Images: CBE.

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of CBE's industry partners — was developed through funding from the Department of Energy through the automotive group of the National Renewable Energy Laboratory (NREL). As we further developed this simulation tool for vehicle cabin simulations, we added in the capability to model indoor building environments, including the ability to model various HVAC systems, facade treatments, and room configurations. Over the last three years we again worked with GM and the U.S. Department of Energy, constructing a physical mockup of a vehicle cabin and conducting human subject tests. The tests were used to evaluate energy efficient ways to focus ventilation, heating and cooling directly to the driver and vehicle occupants, for example providing air from the seat belt, steering wheel, or specialized vents.

Ironically we may have much better control over our thermal comfort while in a car, compared to our workplaces where we spend considerably more time. Even a driver and passenger, who are inches apart, can get different conditions, something not available in even the world's best Class-A buildings.

This automotive research has been informing CBE's studies of building environments as we develop and demonstrate personal comfort systems (PCS) that save energy and allow individuals to control their environment. As we report in this *Centerline* (page 3) new funding from the California Energy Commission will support innovations in building controls and personal comfort show promise for energy efficiency and improved workplace comfort.

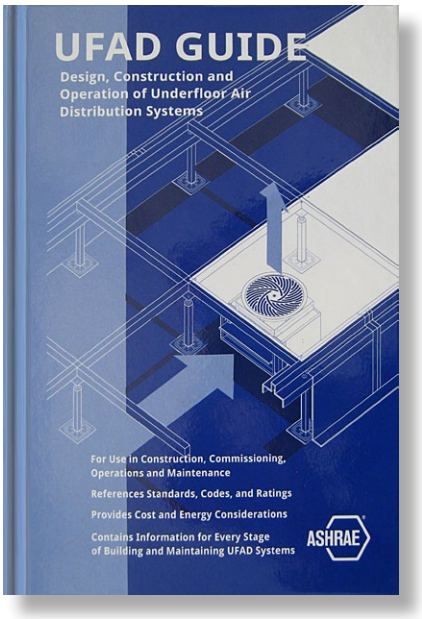
Improved UFAD Design Guide Covers a Decade of New Knowledge and Resources

The most current understanding and guidance on the design, construction, commissioning, and operation of underfloor air distribution (UFAD) systems has been consolidated in a publication released this summer by ASHRAE. The new release marks the ten-year anniversary of the first UFAD design guide, released in 2003 and authored by CBE Research Scientist Fred Bauman.

The new guide builds on an improved understanding of UFAD systems that has emerged over the past ten years, as well as the expanded number of UFAD configurations and products available. Fred Bauman points out that detailed field studies and the development of new design tools by CBE have informed practitioners on best practices for implementing UFAD. When the first design guide came out, "we did not have reliable energy simulation or design tools, and we did not understand the heat transfer dynamics. A lot of new information that we now have changed the thinking about UFAD systems," he explains.

The revised guide includes many new and expanded sections, for example, an expanded chapter on controls. This chapter explains the specialized control strategies that are unique to UFAD, as the typical temperature and pressure rules from overhead systems do not work in UFAD systems. The chapter on system configuration has also been expanded, and diagrams 16 prototypical approaches intended to help practitioners to tailor systems for specific requirements. Also included is a new chapter on building commissioning, including a plenum leakage testing protocol developed by CBE researchers, and construction diagrams that alert readers of construction issues (in particular sealing of the underfloor plenum) that can impact performance.

The book describes useful design tools developed by CBE since the first edition, including the cooling load design tool, and the UFAD module for EnergyPlus for whole-building energy simulation. New information on the comparative cost of UFAD systems has also been included, using insight from CBE research funded by the U.S. General Services Administration. Throughout the book readers will find examples and lessons learned from CBE's detailed case studies, such as that conducted at the Denver EPA Headquarters. (A recent article in the Environmental Building News discusses some of the lessons learned regarding UFAD, and quotes several design guide contributors. http://buildinggreen.com/auth/article.cfm/2013/7/28/Underfloor-Air-Rising-Above-a-Checkered-Past/.)



The revised guide was authored over the past five years by an ASHRAE committee that included many current and past CBE member firms and other experts representing design, manufacturing, and operations. Key authors and contributors from CBE's membership include Fred Bauman, Stefano Schiavon and Tom Webster of CBE; Julian Rimmer and Jerry M. Sipes of Price Industries; and Bill Reynolds of Tate Access Floors.

The new guide is available in electronic and print versions and may be purchased using the following URLs:

http://www.techstreet.com/ashrae/products/1859223

http://www.amazon.com/UFAD-Guide-Construction-Underfloor-Distribution/dp/1936504499

CBE-Inspired Adura Technologies Acquired by National Market Leader

San Francisco-based Adura Technologies, a developer and manufacturer of lighting controls that emerged from research first conducted at CBE, was acquired earlier this year by Acuity Brands, a leading provider of energy-efficient lighting and control technologies. The initial R&D conducted at CBE was led by Charlie Huizenga, who was an adjunct faculty member at UC Berkeley and a leader of CBE's research team for over 20 years, and later became the co-founder and chief scientist of Adura Technologies. The company's system was based on mesh-networked radio frequency (RF) technology that was developed in large part by affiliated researchers at UC Berkeley, and in the mid-2000s several persuasive proof-of-concept studies done at CBE showed that the system provided convincing energy savings. By the time of the acquisition this year, Adura Technologies had installed its products in millions of square feet of commercial space, for both new and retrofit projects, and had shown the systems to be cost effective, with simple payback of less than one year in some cases.

Acuity Brands has retained Adura's San Francisco location, and staff there are currently working to integrate Adura's ZigBee-compliant controls into many of Acuity Brands' product lines. Charlie Huizenga, who now serves as V.P. for Innovation, notes that the acquisition will make it easier to provide customers with a fully integrated package of lighting and controls. His group is working to build wireless controls into various lighting products, with a near-term focus on garage and high-bay industrial fixtures. He notes that one challenge for garage applications is that fixtures are farther apart than in office applications, and the weather-resistant enclosures do not have openings that would be advantageous to low-power RF signals. He also says that the thrust of his team's efforts are working with LED fixtures, and that LEDs are poised to greatly expand their market share. At a recent lighting expo, he observed that "all the new R&D is focused on LEDs, although they only make up about 15% of the market today, in two years this may be 40-50%."

Charlie Huizenga, one of three co-founders of Adura Technlologies, is now V.P. for Innovation at Acuity Brands. Image: CBE.

We at CBE congratulate Charlie and his colleagues for their success with commercializing an innovative technology, and hope to build on this experience to bring to market other CBE research concepts.

For more information

Background on Adura's beginnings is included in a previous *Centerline:* http://www.cbe.berkeley.edu/centerline/summer2011.pdf

The CBE-funded study that led to Adura's lighting approach is at: http://www.cbe.berkeley.edu/research/wireless_lighting.htm

Read about the acquisition: http://aduratech.com/news/press/acuity-brands-acquires-adura-technologies-inc

Livable Buildings 2013

This year's awards recognize a pioneering research center and a near zero-net energy architectural office.

This summer we announced the winners of our 2013 Livable Buildings Award, representing projects that showcase resource efficiency, compelling architectural design, and livability as measured by CBE's Occupant Satisfaction Survey.

The **UCSF Ray and Dagmar Dolby Regeneration Medicine Building** (RMB) in San Francisco, California, has been awarded the top prize this year. The nearly 70,000 ft^2 building boasts LEED Gold certification from the U.S. Green Building Council, and follows Labs21 Environmental Performance Criteria, established by the U.S. Department of Energy and Environmental Protection Agency.

Located on the University of California, San Francisco's Parnassus campus, the project team was challenged with a narrow, steep, and sloped urban location. To overcome the site constraints the design team created a series of terraced building levels that extend horizontally across the site, on a steel truss space system to minimize the building footprint below. The resulting design includes laboratory spaces, private offices, meeting rooms, and plenty of outdoor space on elegantly landscaped roof terraces that afford breathtaking views of San Francisco, the Golden Gate Bridge, and the Pacific Ocean.

To meet the tight 24-month design and construction schedule demanded by the funding agency, UCSF opted for using a design-build delivery method. The winning team, led by DPR Construction (a CBE Industry Partner), SmithGroup, and Rafael

Roof terrace and interior of the 2013 Livable Buildings Award winner, the UCSF Ray and Dagmar Dolby Regeneration Medicine Building in San Francisco, California. Images: Bruce Damonte.

Morphosis Architecture Studio was recognized with an honorable mention. Images courtesy of Morphosis Architects.

Viñoly Architects, was awarded the project based on a series of quantitative and qualitative metrics.

The occupants of the building are highly satisfied with all indoor environmental quality (IEQ) factors as shown in their impressive occupant survey results. One area that stands out is acoustic quality — buildings frequently show poor levels of satisfaction in this category, but the overwhelming positive response in the RMB sets this project apart.

The award jury also recognized the **Morphosis Architecture Studio** in Los Angeles, California, with an Honorable Mention. With the goal of becoming net-zero, the project team used innovative technologies to help them approach this goal: Monodraught Windcatchers, a natural ventilation product not previously used in the U.S.; underfloor air distribution; and photovoltaic panels installed over parking structures. Together they provide net measured energy use below 10 kBtu per year. By working closely with engineering firm Buro Happold, Morphosis also used the post-occupancy evaluation to help them see the impact of these energy saving ideas on their occupants.

You can view more details about the award winning projects on our website: http://cbe.berkeley.edu/livablebuildings/index.htm.

We congratulate all of the award winners and finalists for their outstanding achievements, as very few buildings qualify for this award. We also thank our jurors, a distinguished group of CBE Industry Partners, for reviewing and considering the projects, and selecting those for recognition.

The award, now in its seventh year, looks at the key categories of the CBE Occupant IEQ Survey, and also energy performance, resource efficiency, architectural design, and design integration. This program is unique among building industry awards as it is the only one to include the preferences of building occupants in its selection criteria.

To be considered for the award buildings must rank among the top scorers in CBE's Occupant Indoor Environmental Quality Survey. This survey, used to study occupant satisfaction with the quality of the indoor environment, has been implemented in over 600 buildings around the world.

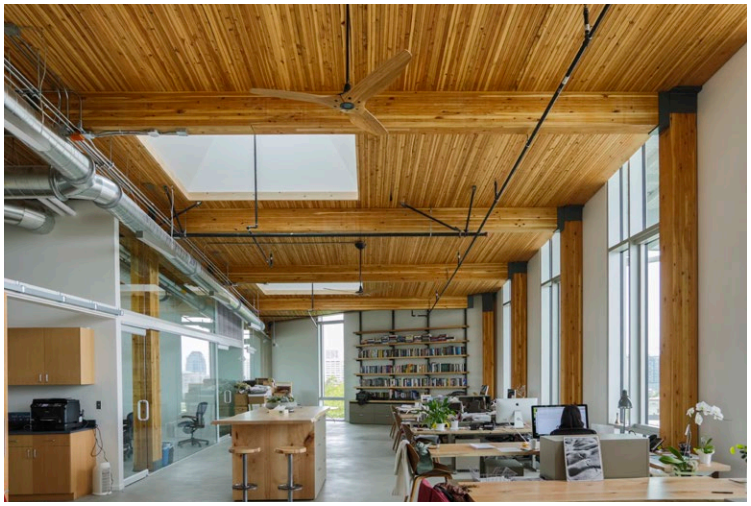
Partner News

CBE Industry Partners Push the Boundaries of Sustainability

CBE Welcomes New Consortium Member

Project review at Atelier Ten's office. Image: Atelier Ten.

This fall we welcome **Atelier Ten** to CBE's industry consortium. The firm provides environmental design consulting, energy analysis, lighting and daylighting design, benchmarking, carbon management, and sustainable masterplanning services on projects ranging from homes to urban masterplans. A10 staff work with design teams to implement creative solutions that improve energy efficiency, water conservation, thermal and visual comfort, resource use, and carbon emissions. The firm's recent work on the Vasquez Rocks Park Interpretive Center in Southern California helped earn a LEED Platinum certification for the project. The park, noted for its prehistoric cultural and geologic artifacts, needed an interpretive center to provide context for its pristine surroundings and to demonstrate its commitment to sustainability. In addition, the Keeling Apartments at Revelle College, UC San Diego, also a LEED Platinum project, was selected as one of the 2013 AIA COTE Top Ten Green Projects.

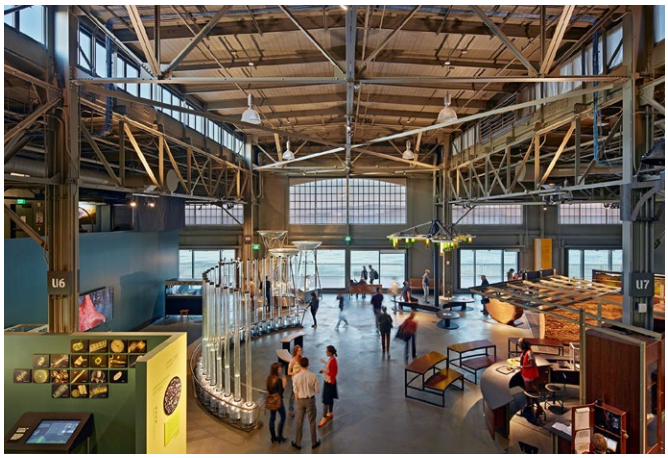


Tenant areas of Seattle's Bullitt Center incorporate Haiku fans to target net-zero energy goals. Image: Big Ass Fans.

Project News from CBE's Industry Partners

Energy efficient Haiku® ceiling fans from the **Big Ass Fan Company** were installed in the recently completed Bullitt Center, a project designed to meet the ambitious goals of the Living Building Challenge, a rigorous one-year certification process which includes net-zero requirements for both water and energy. The six-story, 50,000 ft^2 project located in Seattle incorporates a variety of features to ensure the building is eco-friendly and sustainable: limited on-site parking, composting toilets, photovoltaic panels and strategic daylighting. To adhere to a strict energy budget, building tenants have turned to efficient products such as the Haiku fan that includes patent-pending electronics and a cool-running motor with an integrated inverter drive that delivers an 80 percent improvement in energy efficiency over conventional ceiling fans. ENERGY STAR tests show the Haiku to be the most efficient ceiling fan among all tested, making it a clear choice for tenants in the Bullitt Center.

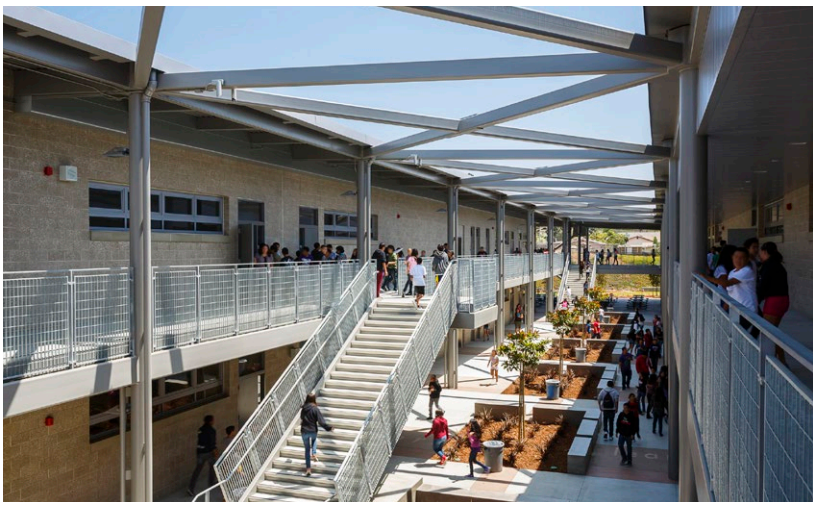
Rendering of the Los Angeles Harbor College Sciences Complex. Image: HGA.



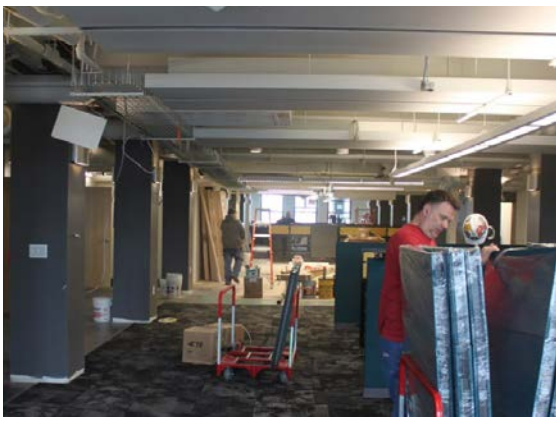
The Exploratorium's new home in San Francisco's Pier 15 aims to become the largest net-zero energy museum in the U.S. Architecture by EHDD and mechanical engineering by Integral Group. Image: Bruce Damonte.

Opening to students in fall 2013, the new $44-million Los Angeles Harbor College Sciences Complex was designed by **HGA Architects & Engineers**. The design includes a comprehensive net-zero energy plan that sets new benchmarks for a holistic approach to sustainability. The facility consists of two L-shaped, steel-frame structures: a three-story east wing and a two-story west wing with lecture halls, classrooms, laboratories and offices. The project puts science on display with natural ventilation, abundant daylight, connection to the outdoors and innovative technologies to lessen the energy load. Targeting LEED Platinum certification, the building has the potential to use 53 percent less energy than baseline. The building features a canopy of solar photovoltaic (PV) panels that are projected to generate 32 percent of the energy needed, with the remainder coming from campus PV capacity. The building is projected to use 53 percent less building water and zero potable water for landscape irrigation when community supply line is available in 2017. During construction 98 percent of construction waste was diverted from landfill, and material sourcing exceeded the LEED credit minimum by three times for recycled content, two times for local supply and over 50 percent for certified wood.

LEED certification is generally accepted as a starting point for many projects, however designers and builders are now looking to higher standards such as the Living Building Challenge (LBC) and net-zero energy. However, it's becoming apparent that cost-effective achievement of net-zero and regenerative buildings may require a radical rethinking of design, project delivery, and operations. **Integral Group** is partnering with Davis Langdon and BNIM to explore the cost implications of building to "next generation" standards. The report uses statistical analyses and anecdotal assessments of actual projects, and describes the strategies and methodologies that enable effective cost management of such projects. Researchers include the authors of "Understanding the Cost of Green" (2004), and practitioners who are building today's greenest buildings and communities. This collective experience, along with access to cost and benefits data for over 200 "next generation" projects, forms the basis for the research. More information is available on the "Cost of Next Generation Green" website, as well as the projects, standards and initiatives factored into the study, including: LEED v.4, Living Building Challenge, COTE Top Ten, and Architecture 2030.



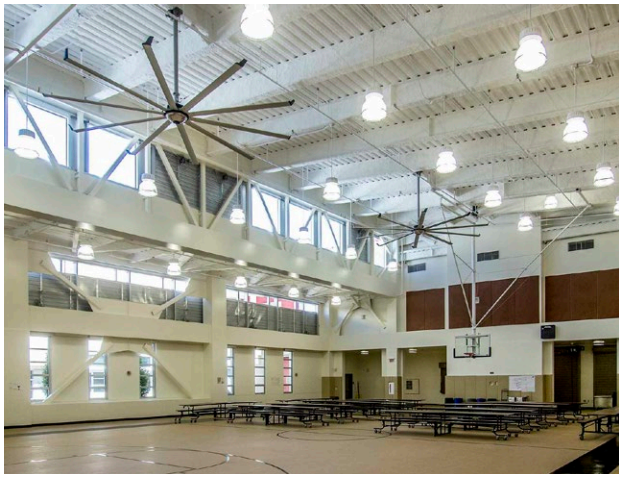
Montgomery Middle School addition, San Diego, CA. Image: LPA.



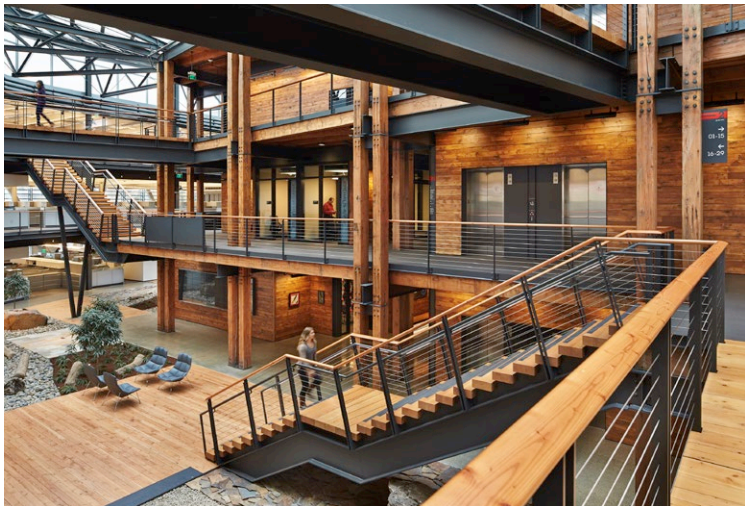
Price is providing many energy efficient HVAC products for the Building Technology Showcase in Boston. Image: Fraunhofer USA.

A new addition to Montgomery Middle School in San Diego, California designed by **LPA** includes a number of innovative strategies and is on target to achieve LEED for Schools Platinum certification. The two-story, 18-classroom building also includes a new library, counseling center, and food service facility. Providing integrated architecture and engineering, LPA designed the project based on a mixed-mode conditioning strategy including thermal displacement ventilation in each classroom. The single-loaded classrooms include manual operable windows on opposing elevations, with magnetic window contacts that interface with the HVAC system controls. The classrooms each include four 5 ft.-by-2 ft. displacement diffusers (provided by CBE partner **Price**) integrated into the corners of each room. Dedicated VAV package units serve each classroom allowing for control of air volume, supply air temperature, and ventilation rate to optimize energy performance and indoor quality. The HVAC units are located in equipment wells, allowing for an open pitched roof that will host a 200-KW photovoltaic array.

The Fraunhofer Center for Sustainable Energy Systems is an applied research and development laboratory located in Boston, Massachusetts. In 2013 Fraunhofer completed work on the Fraunhofer's Building Technology Showcase (BTS), a deep-energy retrofit of a 100-year-old building which includes an interactive educational exhibit and numerous advanced research facilities. The project represents a broad approach to sustainable design, combining energy efficiency, design innovation and historic urban architecture. **Price** is providing much of the energy efficient HVAC equipment for this living laboratory, including chilled beams and sails, displacement ventilation, and controls. These Price products were selected for their ability to minimize heating and cooling loads, and will contribute to substantial reductions in whole-building energy consumption. This collaboration between Fraunhofer and Price will also benefit future product development by providing real world test data for energy analysis.



The "Great Room" at the OUSD Downtown Educational Complex provides low-energy cooling boosted by evaporative towers and ceiling fans. Image: OUSD.



Timber reclaimed from a non-historic warehouse on the site is a focal point for ZGF's Federal Center South Building 1202. Image: Benjamin Benschneider.

Going to school in Oakland just got much cooler. The Oakland Unified School District (OUSD) Downtown Educational Complex is a new campus and administrative facility, designed by a team that includes **Taylor Engineering** and IDeAs (now part of **Integral Group**) that was recently awarded ASHRAE Technology Awards at both local and regional levels. The project includes numerous system innovations, including displacement ventilation using 100 percent outside air for cooling, and nighttime thermal mass charging that is controlled by temperature sensors embedded in floors and walls. The cooling strategy also includes automatically-controlled high volume, low speed (HVLS) ceiling fans from **Big Ass Fans**. The fans also assist with heating, operating at low speed to destratify the space and ensure uniform heating. In the "Great Room" with high occupant densities, two passive evaporative downdraft towers equipped with high level fogging nozzles provide additional cooling. The towers also have a wind scoops which face into the prevailing wind to provide cooling and ventilation without evaporation when the weather is suitable.

Federal Center South Building 1202 is a U.S. General Services Administration's (GSA) Design Excellence project. **ZGF Architects LLP** and Sellen Construction partnered as a design-build team to develop and deliver a high-performance workplace solution highlighting aggressive reuse and energy-performance strategies. The 1202 building transforms a 4.6-acre brownfield site into a highly flexible and sustainable 209,000 ft^2 regional headquarters for the U.S. Army Corps of Engineers (USACE) Northwest District. The "oxbow" building form is part of an integrated strategy to provide measurable energy-performance benefits and a functional and infinitely flexible workplace to support the USACE's team-based work. Building 1202 is anticipated to perform in the top one percent of energy-efficient offices buildings in the U.S., and is one of the first projects in the region to combine geothermal heating and cooling systems with structural piles. CBE is working with ZGF to conduct a post-occupancy evaluation, and the project will achieve LEED Gold certification.

Events

Seminar on Radiant Systems will Explore Design, Energy, and Architecture

Radiant systems offer numerous benefits for commercial buildings, however as with any emerging technology, identifying best practices and training design professionals is critical to successful adoption. CBE is supporting the ASHRAE Golden Gate Chapter and PG&E Pacific Energy Center in organizing a free day-long seminar on radiant systems. (The event is scheduled in coordination with CBE's October membership conference.)

The event will provide diverse perspectives including HVAC design, architecture, energy simulation and human comfort, and will feature current and past CBE partners, and CBE faculty and staff.

Presenters will provide an introduction to thermally active floors, designing efficient systems, energy performance modeling, and the architectural design and comfort implications of these systems.

Presenters are professionals with many years of experience designing radiant systems, including Daniel H. Nall, Senior Vice President at Thornton Tomasetti, and Scott Shell, Principal with EHDD. Edward Arens, Director of CBE will discuss comfort implications of radiant systems, and Dove Feng, a UC Berkeley Ph.D. student, will present energy performance tools and results. Radiant heating and cooling has been identified by the AIA "50>50 strategy," and this course qualifies for AIA sustainable design (SD) learning units.

Radiant Systems: HVAC Design, Energy Assessment and Architectural Implications

Wednesday, October 16, 2013
9:00 am - 4:00 pm

On site at 851 Howard Street, San Francisco, CA 94103

Also available by live webcast.

Registration for San Francisco: www.pge.com/pec/classes/6472.htm

Registration for live webcast: www.pge.com/pec/classes/6571.htm

Radiant system installation at the recently opened Exploratorium in San Francisco. Image: Amy Snyder © Exploratorium.

The SMUD East Operation Campus in Sacramento, California will be the subject of a CBE case study on near ZNE radiant systems. Image: HRGA.

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 the design and operation of commercial buildings through their collaborations with CBE.

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