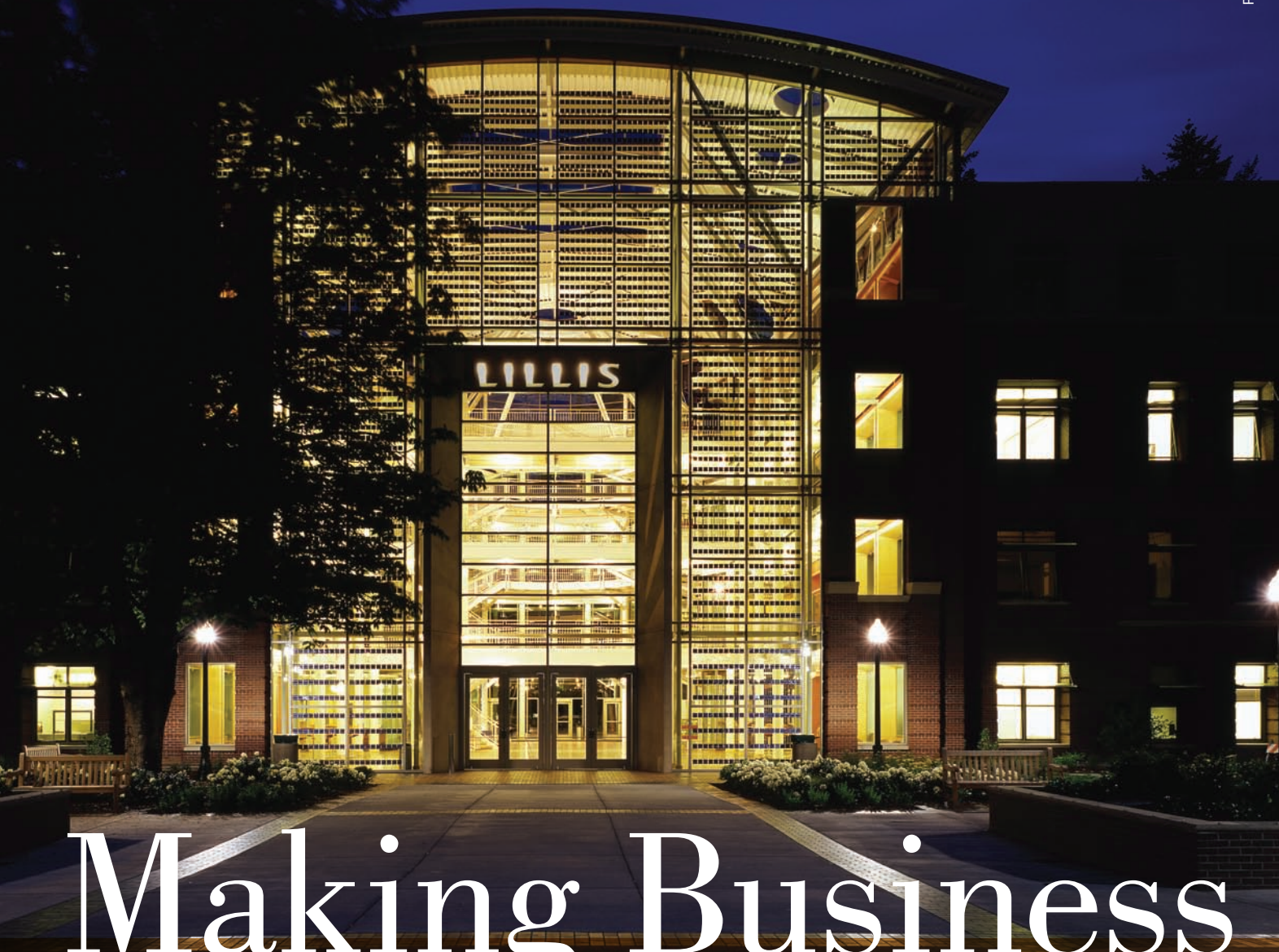


The following article was published in High Performing Buildings, Summer 2008. ©Copyright 2008 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. It is presented for educational purposes only. This article may not be copied and/or distributed electronically or in paper form without permission of ASHRAE.



Making Business

BY KENT DUFFY, FAIA

It started as a simple remodel. The University of Oregon sought to redesign and add to its existing business school because room sizes were not meeting the needs of their teaching models. However, the architects discovered that every interior wall was a shear wall that could not be removed without breaking down more of the building. In the end, it was more cost-effective to build a new building which would meet and adapt to the needs of the college of business. The small remodel became the Lillis Business Complex, a four-story, 140,000 ft² building that demonstrates responsible business through sustainable design.

First Order of Business

Today, the Lillis Business Complex is a focal point for the business school and the university for its green design and its prominent presence on campus. In building the facility, we joined it to two adjacent buildings, Gilbert and Peterson Halls. The buildings form a u-shaped complex, which opens into the university's central quadrangle.

Early in the planning, the faculty and students of the college of business made it clear that they needed a building demonstrating environmentally responsible decision making.

"Businesses that do not employ sustainable business practices simply will not survive in the coming decades. They will not be able to afford the resources or energy or transportation costs that will be required to stay in business. We are here to prepare the leaders that will thrive in that environment. We need a building that changes people's perception and expectations about these issues and helps

In a commitment to energy conservation and building functionality, the University of Oregon sacrificed additional LEED points, which could have elevated the building's status to LEED Gold, for a more sustainable end result. For example, the building's emphasis upon natural ventilation using stack effect for a night flush cycle precluded the use of the filters required for LEED's indoor air quality points. The university gave up both the filters and the points to move such a large volume of air without using fan energy.

Elevating Performance

The Lillis Business Complex is 44% more efficient than required by ANSI/ASHRAE/IESNA Standard 90.1-2001, *Energy Standard for Buildings Except Low-Rise Residential Buildings*, and 37% more efficient than Oregon's energy code. The complex also achieves annual energy savings of \$52,514. A number of integrated strategies elevated the performance of the building.

Building Organization

The organization of the relatively narrow building with a long east-west axis provided an orientation with significant exposure to the north and south for daylighting as well as prevailing breezes in both summer and winter. Existing buildings block the southerly winter winds, and the campus landscape with large shade trees cools the northerly summer breezes.

The organization of the activities within the building also was carefully considered. Activities with comparable comfort criteria are located near each other to simplify the passive systems within the building.



BUILDING AT A GLANCE

Building Name Lillis Business Complex

Location 1276 University of Oregon, Eugene, Ore.

Size 137,346 ft²

Started March 2002

Completed December 2003

Use Academic building with classrooms and faculty offices

Cost \$30.3 million

Distinctions LEED-NC Silver; Grand Award from ACEC (American Council of Engineering Companies) in 2005; Building Team Project of the Year Award from Building Design & Construction in 2005; Hammurabi Award of Merit for excellence in design and use of masonry in 2005

BUILDING TEAM

Owner University of Oregon

Architect and Interior Designer SRG Partnership, Inc.

Sustainability Design Consultant Energy Studies in Buildings Laboratory, G.Z. (Charlie) Brown

Structural Engineer Degenkolb Engineers

MEP Engineer Balzhiser & Hubbard Engineers

Landscape Architect Cameron McCarthy Gilbert & Scheibe Landscape Architects LLP

Energy/Commissioning Agent SOLARC Architecture and Engineering, Inc.

Lighting Designer Benya Lighting Design

Acoustical Designer Altermatt Associates, Inc.

Photovoltaic System Designer Solar Design Associates, Inc.

Contractor Lease Crutcher Lewis

Sense

them take fresh and innovative action," said Mike Russo, Professor of Sustainable Management in the business school.

We intended to raise sustainability issues in the design phase of the process, expecting that it might not be the university's highest priority. However, the university challenged us to bring the issues to the forefront, resulting in a USGBC LEED® for New Construction (NC) Silver rated building.

Photovoltaic modules on the 64 ft high south-facing glass wall prevent heat gain and generate electricity.



Lighting Levels

Daylighting elements include clerestory windows, skylights, operable shades and louvers. Case study rooms combine controls for daylight, occupancy sensors, electric lighting and operable shades in an integrated system. A flipped switch in a classroom turns on the lights and opens the shades. When the daylight sensors acknowledge that the desired lighting level has been achieved through daylight, the electric lights dim to off. When class is over, the occupancy sensor sends a signal that the room is empty, triggering the shades to close and the lights to dim to off. If the desired lighting level cannot be delivered by daylight, then the electric lights turn up to the appropriate level.

In each classroom, students can take notes by daylight while the instructor uses video projection without daylight washing out the image. Daylight enters the classroom through clerestory windows with fabric shades on the wall opposite the projection screen and blackboard. Daylighting sensors control the position of the shades, allowing only the appropriate amount of daylight to enter. Angled ceiling panels reflect daylight toward the student seating area and away from the projection area. Consequently, the daylight level drops off significantly near the projection screen side of the room.

Fabric Shades

Because the highest portion of the window brings the most daylight deepest into the room, we designed fabric shades that retract into the sill of the clerestory windows instead of the head. We had not tried such a configuration in previous projects but



Photo © Lara Swimmer



Photo © Lara Swimmer

Stack effect in the four-story atrium draws ventilation air through the building.

In the lecture hall, angled ceiling panels reflect daylight toward the student seating area and away from the projection area.



Photo © Rick Keating

have become strong proponents of the approach based upon the resulting performance. The arrangement allows the highest portion of the window to be the first portion to let in daylight and the last to be closed to daylight. The fabric is a bronze color with perforations that allow 5% of daylight to penetrate, even when the shades are closed. The color and perforations also allow some degree of view through the shades and enough light to maneuver within the room even with the shades closed and the lights off.

Thermal Mass

Thermal mass and ceiling fans combine to expand the comfort range of building occupants by five degrees. Increasing the thickness of the concrete topping slab by 2 in. at each floor level and adding the same con-

crete topping to the roof assembly achieved the thermal mass in this steel-framed building. The approach provided a net savings of \$1 million over a concrete structure.

During the design process, an analysis of how much thermal mass would be required for the building to perform at the projected level showed a high level of impact for the first 2 in. of additional concrete. The impact became more modest as additional concrete was added beyond that level. This amount was required for the building to perform and could be supported by the steel structure that had been designed without increasing the steel member sizes.

Quarry tile and linoleum floors facilitate thermal transfer between ventilation and night flush air and thermal mass. Ceiling fans help

achieve comfort for occupants. Operable windows are implemented throughout the building.

Night Flush Cycle

A night flush cycle combined with thermal mass cools the building for all but a few hours of the year: four hours per year in the 60-person case study rooms, and 93 hours per year in the 290-person auditorium. In each case study room, ventilation air is drawn through louvers past a control damper, through a raised floor plenum, between risers into the room and past occupants. The air vents high on the presentation wall to corridor ducts and then the atrium. Although the building includes an active cooling system as a backup to these passive cooling strategies, it is reduced in size and used for few hours per year.

Advertisement formerly in this space.



Photo © Rick Keating

The atrium has no conditioned air supplied to it other than the recycled air from the classrooms.

Stack Effect

Stack effect in the four-story atrium draws ventilation air through the building. Variable speed drives on the required smoke evacuation system assist the stack effect if, for any reason, it is insufficient to draw air through the space. The atrium has no conditioned air supplied to it other than the recycled air from the classrooms. Though rarely used, radiant heating coils in the floor are in place for cold mornings.

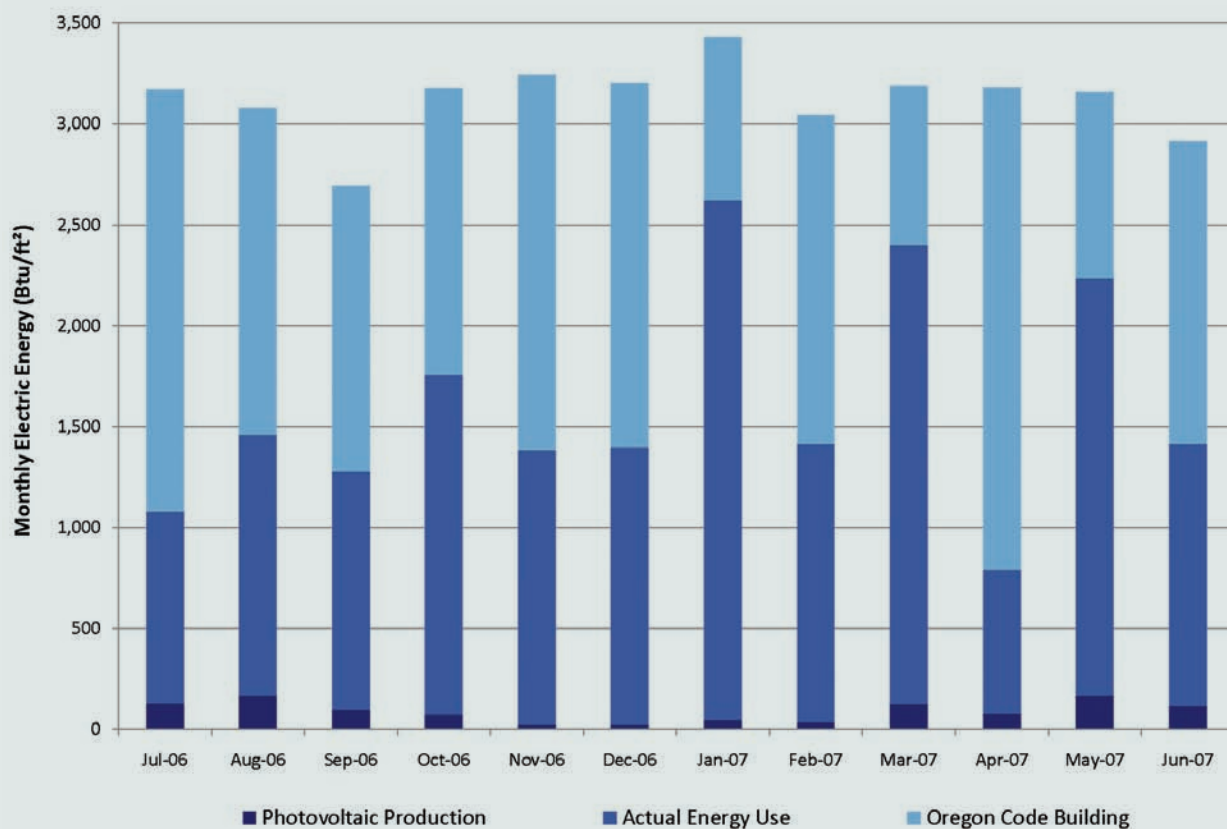
The atrium is a popular gathering space for students and faculty. The new building manager arrived shortly after the building was completed and commented that he expected the atrium to be a problem because it has a 65 ft high glass wall

facing due south. However, in more than four years of use, he has not had a single complaint about comfort in the atrium. The volume of air in the atrium, reusing the air from the classrooms, and the number of air changes create a level of comfort that serves a broad range of people.

Signature Photovoltaics

As we considered a range of approaches to provide shading on the 65 ft high south-facing glass wall in the atrium, the possibility of using photovoltaic modules to prevent heat gain and generate electricity arose. The 45 kW photovoltaic array includes four types of photovoltaic panels. Two are integrated into a glass curtain wall system and skylights,

PHOTOVOLTAIC PERFORMANCE REDUCING ELECTRICAL LOADS



Advertisement formerly in this space.

PERFORMANCE DATA FOR LILLIS BUSINESS COMPLEX

Electric Energy Use Based on SEED Report

Month	Jul 06	Aug 06	Sep 06	Oct 06	Nov 06	Dec 06	Jan 07	Feb 07	Mar 07	Apr 07	May 07	Jun 07	Annual
Lillis, Gilbert and Peterson actual in Btu/ft²	1,356	1,638	1,436	1,890	1,585	1,585	2,584	1,578	2,377	1,126	2,266	1,577	20,998
Lillis actual in Btu/ft²	1,082	1,462	1,280	1,757	1,386	1,401	2,624	1,417	2,403	793	2,239	1,416	19,259
Lillis code building in Btu/ft²*	3,172	3,079	2,694	3,178	3,242	3,203	3,430	3,046	3,188	3,182	3,159	2,915	37,489
Savings**	66%	53%	52%	45%	57%	56%	24%	53%	25%	75%	29%	51%	49%

*Based on Standard 90.1-2001.

** (Lillis code – Lillis actual) / Lillis code

The State Energy Efficiency Design (SEED) program originally was established in 1991 as a result of Oregon state law, ORS 276.900-915. This law directs state agencies to work with the Oregon Department of Energy to ensure cost-effective energy conservation measures are included in new and renovated public buildings. It was revised in 2001 to require that all state

facilities constructed on or after June 30, 2001, exceed the energy conservation provisions of the Oregon state building code by 20% or more.

Actual monthly electric energy for Lillis, Gilbert and Peterson was collected together. Lillis is not metered alone. For Lillis, 137,346 ft² floor area is assumed, and 38,343 ft² for Gilbert and Peterson.

The total floor area for the three buildings is 175,689 ft². Based on the SEED report for Gilbert and Peterson, the code electric energy use for these two buildings was removed from the actual monthly electric energy for the three buildings, leaving an estimate for the actual electric energy use for Lillis alone.

LESSONS LEARNED

Expanding Comfort Range Users can be comfortable, even outside the traditional comfort range. We aimed to create occupant comfort which diverged from a typical narrow temperature range. After the building had been in use for several years, the student newspaper interviewed University of Oregon Energy Studies in Buildings Laboratory director and professor of architecture G.Z. (Charlie) Brown and me. An alleged 5°F variation in temperature within the building implied a flaw in building performance. As the discussion ensued, the actual temperatures were cited, and we discovered that they were in the middle of the expanded comfort range, not on the edges. Although we had no independent verification that the temperature variations occurred, they were well within the design parameters. Gradually, people are becoming

aware that they can be comfortable even when experiencing temperatures outside those traditionally cited as the comfort range. We need to continue to increase awareness in high performing buildings about what impacts comfort.

Evaluations Evaluate the prototype classroom prior to full build-out. Evaluating the first case study room after completion allowed users to confirm settings in a full-size prototype before other case study rooms were constructed. Additionally, evaluate total energy savings, not just improvement over code. This benchmark encompasses more and may include savings associated with architectural decisions, zoning, building programming, efficient office equipment and other issues not regulated by codes. Include electrical

metering equipment so that actual energy use can be measured and tuned with the design intent.

Cornerstone Strategy Make daylighting a cornerstone strategy. Daylighting can cut energy bills 20% or more and significantly affects the quality of the space.

Modeling Use energy, daylighting and airflow models simultaneously to predict performance and guide specific incremental design improvements. Prepare models prior to design charrettes to jump-start discussions.

Life-Cycle Cost Base energy decisions on life-cycle cost. Include life-cycle benefits in the project budgeting process.

one uses thin film technology applied to a standing seam metal roof on the mechanical penthouse, and the final array is a collection of modular crystalline photovoltaic cells.

Different types of installations allowed the university to analyze which approach was most cost effective and produced the most electricity. The modular crystalline array produces almost two-thirds of the output. The installations also provided faculty with the desired visible symbol of the school's commitment to sustainable business practices. The photovoltaic installation was funded in part by an innovative use of state business tax credits, which were passed on to a donor through a program initiated for the first time by this project.

Reducing Electrical Loads

Our approach to reducing electrical loads initially focused on reducing lighting and cooling loads. In an effort to further reduce loads, we considered ways to reduce the plug loads. Although many pieces of equipment incorporated a sleep mode, we discovered that in a building of this size the amount of equipment in sleep mode still added up to a significant load, warranting an alternative strategy.

As a result, faculty offices have two color-coded control sets of electrical outlets. One set has dedicated power; the other has intermittent power controlled by the occupancy sensors required for the lighting. Items such as central processing units and clocks are plugged into the dedicated power outlets, while items such as monitors, printers and desk lamps are plugged into the intermittent power supply. When a faculty member leaves the

office for a few minutes but ends up being away for longer, items plugged into the occupancy sensor-controlled outlets power off. When the faculty member reenters the room, everything powers back up.

A Collaborative Effort

The Lillis Business Complex project required a team effort that became transformative for everyone involved. In spite of the project team's depth of experience, team members performed tasks they had never done before and depended upon each other to ensure

the project's success. We found confidence in new ideas and techniques that we had not anticipated at the beginning of the project. The Lillis Business Complex not only emboldened our approach to subsequent projects, but also stands as a daily model of sustainable innovation for the future business leaders it serves. ●

ABOUT THE AUTHOR

Kent Duffy, FAIA, is a principal at SRG Partnership in Portland, Ore.



Photo © Lara Swimmer

Building orientation provides exposure to the north and south for daylighting as well as prevailing breezes in summer and winter.