MOUNT ANGEL CENTER FOR THEOLOGICAL STUDIES

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Energy Trust of Oregon

PROJECT OVERVIEW AND TEAM

BUILDING OWNER: Mount Angel Abbey

SIZE: 21,600 square feet

LOCATION: St. Benedict, Oregon

UTILITIES: Portland General Electric, Northwest Natural

COMPLETION DATE: Fall 2006; retrofits and repairs summer 2008

PRACTICE CHANGES: Exceptional integrated design process, construction and testing of a prototype high-performance classroom

TECHNOLOGIES: Passive heating, cooling and ventilation; daylighting; small radiant heating systems; heat recovery ventilators

ARCHITECT: SRG Partnership, Inc.

MECHANICAL, ELECTRICAL AND ENERGY ENGINEER: James Graham & Associates (now part of Interface Engineering).

BUILDING ENERGY DESIGN: Energy Studies In Building Laboratory, University Of Oregon

Exterior of Annunciation at Mount Angel

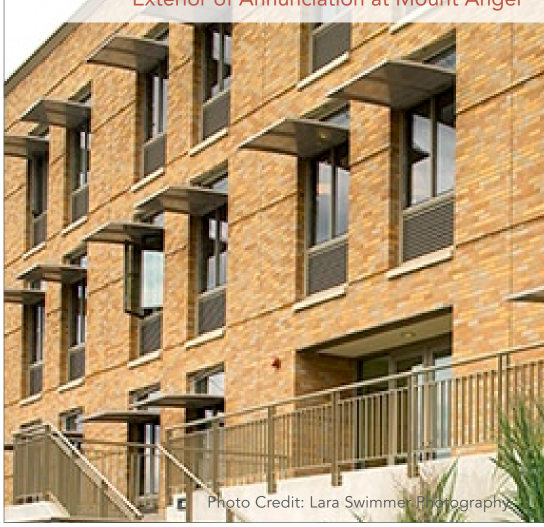

Photo Credit: Lara Swimmer Photography

INTRODUCTION

Mount Angel Abbey's new Annunciation Center for Theological Studies completes the Benedictine teaching, retreat and worship center on the hill above Mount Angel, Oregon. With its expansive views of the Willamette Valley, and soaring, arched windows and ceilings, the building nurtures the contemplative study of God.

Annunciation is the result of a close and dynamic collaboration between Mount Angel Abbey, SRG Partnership, SOLARC Architecture & Engineering, the University of Oregon's Energy Studies in Buildings Laboratory (ESBL) and BetterBricks.

The 21,600-square-foot building includes six classrooms and a boardroom in a single-story portion, and 25 faculty and administrative offices and student and faculty support spaces in a three-story portion. Classrooms are used primarily September through May, but the other spaces and offices are designed to be used year-round.

The concept for Mount Angel started with data drawn from a study funded by BetterBricks of a high performance classroom innovation by ESBL, BOORA Architects and Solarc. SRG saw the findings and models and with the help of ESBL built a prototype to test and refine the design concepts for application at Mount Angel. The design innovation included a large central skylight with special integrated shading and light diffusion devices as well as optimum use of natural ventilation (see description below). *The real key to success though was the willingness of the designers and owners to do the research and testing of multiple options to find the best, most cost-effective solution.*

The owners and design team chose challenging goals: to employ no mechanical cooling and provide 95 percent of the annual classroom lighting demand through daylighting. To achieve these goals, they designed synergistic daylighting, and passive heating, cooling and ventilation systems. *As a result of this integrated design implementation, the energy analysis completed toward the end of the design identified the building to be 62 percent more energy efficient than Oregon Energy Code required at that time.* These goals honor the Benedictine traditions of hospitality, fine craftsmanship and stewardship of the earth's resources.

STRATEGIES & FEATURES

Daylighting. The team sought glare-free, evenly distributed daylight in all rooms during 95 percent of normal occupancy hours. Based on studies of classroom lighting levels in other countries, the U.S. and their prototype classroom, they aimed for a minimum-maximum range of 20-40 footcandles at four percent daylight factor.

Photo Credit: Lara Swimmer Photography

Daylighting Reflector in Classroom

According to Kent Duffy of SRG Partnership, "This addresses a variety of tasks and ambient lighting conditions. The daylight factor was higher in order to bring in the required light levels through more hours of the year, particularly during the winter months." The daylighting goal displaces significantly more electric lighting than USGBC's LEED and Illuminating Engineering Society (IES) standards.

To achieve this, each classroom has a large central skylight with louvers that automatically rotate to control daylight levels. The final design also features triangular extruded aluminum reflector tubes arranged in concentric layers of diminishing density from the center outward. As opposed to having a bright area under the skylight, this reduced the light at the center of the room while maintaining a high level at the edges. The result was more uniform light levels—an ideal combination for quiet and purposeful study.

The skylight louvers, as well as the sunshades and light shelves on all south-facing office and classroom windows, reduce glare and moderate solar heat gain. All windows also have roll-down shades to control sunlight.

High-efficiency electric lights, equipped with dimming ballasts and occupancy sensors, provide additional illumination when needed. SRG specified T-5 High Output (HO) lighting adjacent to the classroom reflectors, T-8s for the marker boards and offices, and compact fluorescents in the corridors.

Integrated Passive Heating, Cooling And Ventilation. Working with ESBL and the mechanical engineer from the beginning, the design team worked to take advantage of the local climate conditions, particularly the diurnal temperature swing, focusing on passive techniques to heat, cool and ventilate all the building spaces. These techniques rely on climate, convection and human bodies as resources. The passive approaches are supplemented by a right-sized radiant heating system, plus heat recovery ventilators, ceiling fans, electric lighting and performance-boosting controls. The heat recovery ventilators in each classroom and the larger one serving the offices and corridors run at 70 percent and 80 percent effectiveness, thereby reducing one-fourth the building's heating load. The offices are primarily passive solar heated. Using computational fluid dynamics optimization, the team designed air inlets and outlets to maximize cooling and minimize conductive heat loss.

During warm weather, the sunshades, light shelves, roll-down shades and louvers in the classroom skylights reduce heat gain. Convection draws cool outside air into the classrooms through manually operated louvers on either side of the classroom windows, and automatically-controlled dampers above each window. Each office has an operable window, air inlet and transom above the door to the hall.

The cooler outside night air flows through automatically controlled inlets and past the thermal mass in the floors and ceilings. Ceiling fans boost air movement when needed. Excess heat is exhausted passively through turbine ventilators in the roof.

The fans, combined with the area's low seasonal humidity, allowed the designers to achieve acceptable comfort with indoor temperatures three to four degrees warmer than the 80-degree ASHRAE Standard 55 maximum, greatly extending the hours when mechanical cooling is not needed.

To make the night flush system work best, the team installed temperature sensors in the thermal mass, and suppressed the radiant heating system so it does not activate on cool summer mornings.

Photo Credit: Lara Swimmer Photography

Mount Angel Classroom

Controls. A digital control system operates pumps, valves and dampers, and monitors wind speed, CO_2 sensors, temperature sensors and other controls. The team wrote user interface instructions about the system based on seasonal differences for both office and classroom spaces. The controls contractor trained building operations and maintenance staff to use the system. Additionally, the digital control system is connected to the Web, allowing the design team and owner to monitor building performance remotely.

Financial and Energy Analysis

- **Total Project Cost:** $6.2 million ($288 per square foot); according to SRG Partnership, construction costs "likely are in a similar range to some of the nicer private institutions."
- **Incremental Cost:** $174,000
- **Annual Energy Savings:** based on the energy study; the building is 62 percent more energy efficient than Oregon Energy Code. Actual savings achieved in 2008: 120,635 kWh of electricity and 5,106 therms of natural gas.
- **Energy Trust of Oregon Incentives:** energy-efficient building shell with wall and roof insulation and glazing: $3,029; high-performance integrated lighting, and passive heating and cooling: $12,494; custom boiler: $625. Total incentives: $16,148

Lessons Learned

- **Spread Of Concept.** The high-performance classroom concept was refined during this project, particularly through evaluation of the full-size test prototype. SRG continues to evolve the model in other projects, including a high-performance music classroom for da Vinci Arts Middle School in Portland and a laboratory and classroom building for Spokane Community College. BOORA Architects is using a similar model for its addition to the Canby Middle School.
- **Benefits Of Daylighting.** In addition to the now widely accepted view that daylighting is good for human performance, Mount Angel's daylight provides another, less tangible, but significant benefit. As Father Michael Mee, who chaired Mount Angel Abbey's Building Committee, notes, "The lighting goes beyond just the energy efficiency, to a theological aspect. The students who study here are studying theology—the study of God—and preparing themselves for the priesthood. They sit in these classrooms, so filled with wonderful light. They're bathed in light, their minds are to be bathed in light, and they're to be enlightened in these classrooms."
- **High Efficiency At Lower First Cost.** The original high-performance classroom study showed that high levels of efficiency could be achieved at lower first cost than traditional construction. The Mount Angel project proved that the team could obtain high performance within the project budget.
- **Integrated Design Is Crucial.** Integrated design is especially important when using passive ventilation. The project team needs to determine how "smart" the air is going to be. Computational fluid dynamics optimization is a valuable tool.
- **Search For Synergies.** According to G. Z. Brown of Energy Studies in Buildings Laboratory, "The heart of the integrated design process is the search for synergies among the attributes of climate, use patterns, design and systems that will result in increased performance, while reducing project first-cost and operating expense."

Photo Credit: Lara Swimmer Photography

Mount Angel Exterior

- **Adjust Occupant Expectations.** It is important to adjust occupants' expectations about comfort in a passive building. As Kent Duffy of SRG Partnership explains, "People need to realize they can be comfortable in a relatively benign climate without a huge mechanical plant."
- **Commissioning Is Crucial.** A post-occupancy review by ESBL revealed an infiltration rate higher than anticipated that affected thermal performance. As a result, building occupants used more perimeter radiant heat than anticipated during the first two winters. This could have been avoided with commissioning. It is important for design team leaders to discuss the critical importance of commissioning with their clients early in the project, to ensure that it is integrated throughout the process.

ADDITIONAL CONTACTS & RESOURCES

Read a three part series drawn from a roundtable discussion that occurred in August 2007 about integrated design, among principal project team members responsible for design of the Annunciation New Center for Theological Studies. The cross-disciplinary collaboration among project team members was a hallmark of this project, but specific areas of responsibility are indicated for each of the panel participants.

Part I
www.betterbricks.com/DetailPage.aspx?ID=915

Part II
www.betterbricks.com/DetailPage.aspx?ID=939

Part III
www.betterbricks.com/DetailPage.aspx?ID=942

Brochure on Mount Angel produced by SRG Partnerships
www.betterbricks.com/DetailPage.aspx?ID=942

SRG Partnerships
www.srgpartnership.com

James Graham & Associates (Interface Engineering)
interfaceengineering.com

Energy Studies in Buildings Laboratory
aaa.uoregon.edu/esbl

Energy Trust of Oregon
1.866.368.7878
www.energytrust.org

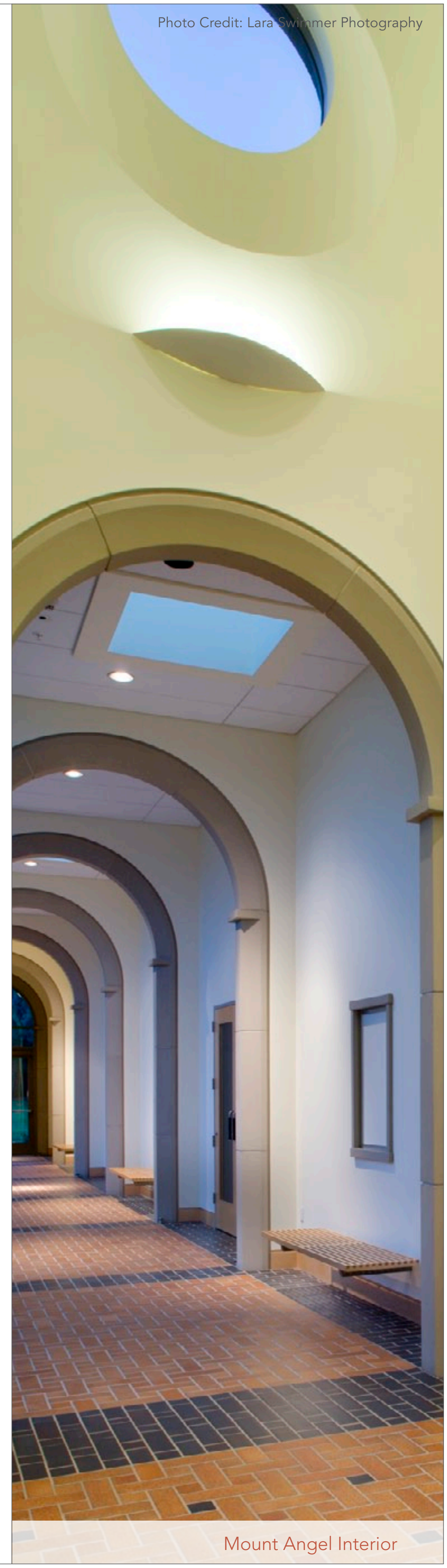
Photo Credit: Lara Swimmer Photography

Mount Angel Interior