Rinker Hall at the University of Florida helps prove that energy performance can be achieved through superior design, not elevated costs. Rinker Hall achieves 56% energy savings over a conventional building. It was built for $6.6 million or $139/ft². This is roughly the same cost of other classroom buildings completed at about the same time on campus but without the sustainable characteristics.
Rinker Hall houses the building construction program within the University of Florida’s College of Design, Construction and Planning and accommodates 450 students in 47,270 ft² of space. The three-level building includes a mix of classrooms, teaching labs, construction labs, faculty and administrative offices, and student facilities.

Developed in parallel with the growth of the U.S. Green Building Council (USGBC) and LEED®, between 2000 and 2003, Rinker Hall was the first building in Florida to be designed under the LEED® program and earned recognition for innovation in education and materials minimization concepts. However, the building goes beyond the current LEED® framework specifically in the areas of building orientation, access mapping and low-cost construction and was an AIA Committee on the Environment (COTE) Top Ten Green Project for 2005.

**Maximum Daylight Duration and Penetration**

At Gainesville’s latitude of 29° 38' 49" N, the south elevation of an east-west oriented building receives high-angle daylight (over 75° inclination), significantly reducing south elevation transmittance through the glass 25% of the time. Rinker is oriented counterintuitively on a pure north-south solar axis and demonstrates the ability to use low-angle light to increase daylighting contribution by 30% and the most effective low-angle light by 48%.

Extensive DOE-2.1E energy modeling and Superlite 2.0 daylight modeling confirmed the effectiveness of this approach, which now has more than four years of operational experience. A complete daylighting control system on the east and west consists of large exterior windows, wavelength selective glazing, shaped ceiling geometry, photosensor controlled electric lighting, upper daylighting louvers, and lower vision panel blinds with reduced transmission in closed position. A central skylight-covered...
atrium provides the open public stairways with dynamic beam daylight, a traverse marking solar noon each day with all shadows parallel to the atrium axis. To fully address solar glare from the north-south building orientation, the exterior windows incorporate a custom dual bay design in which the upper bay has permanent upper position louvers, while the lower window portion has operable perforated metal blinds. The perforated blinds also allow a softer exterior view even in the closed position.

**Solar Egress Path**

The exit pathways are flooded with direct daylight for emergency exit during a daytime power failure. With skylights the full length of the building’s atrium, open views to the exterior on all three levels of the circulation spine, open exterior south stairs, north stairs with a 100% glazed east wall, and a glazed elevator cab facing a full height exterior glass wall, the building remains bright during the daylight hours.

**Building Shading**

Rinker Hall was built on a former parking lot and situated to protect existing trees including heritage.

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North-south orientation compared to east-west orientation in Gainesville, Fla. Note: North-south orientation assumes solid walls on north and south elevations. East-west orientation assumes solid walls on east and west elevations.
live oaks. Rather than a two-story building, the team designed a three-story building to minimize the site footprint and provide for more vegetated areas and open space. The cooling effect of the building’s shade pattern on the north and east was used. The building’s shade benefits the construction yard on the east and the north entry patio and lobby, which merge with the adjoining shade canopy. Furthermore, the assembly area on the north and the construction shop on the east, both in excess of 2,000 ft², have been fully or partially incorporated in the design as indoor/outdoor spaces, taking advantage of thermal shading and sheltering attributes at the edge condition of the building.

**Access Mapping**

Access mapping requires the consolidation and simplified routing of all basic support systems including mechanical, telephone, data and sprinkler. This highway of services is mapped over the floor plans to ensure nondisruptive servicing and large-scale access. The 6 ft to 10 ft of uninterrupted space runs in concert with the structural system from north to south, which is the unobstructed direction for growth and change based on a 4 ft module. The large scale of this open access anticipates technology upgrades and replacements.

Additionally, to maintain free space from exterior wall to central spine for future north-south growth, moment connections rather than the less costly shear walls provide seismic resistance at the intersection of columns and beams. Walls are shifted off structural lines to eliminate intersections with columns and simplify partition insertion and removal. The ability to change is further assisted by the elimination of fireproofing on the steel. This is both an indoor air quality enhancement during habitation and renovation, as well as a safety improvement since fireproofing is easily damaged in renovation but sprinklers are not.

**Renewable Future**

Rinker Hall was designed for a future massive photovoltaic upgrade, incorporating the near threshold technology of dye-sensitized nanocrystalline solar cells. First patented by Dr. Graetzel in Lausanne, Switzerland between 1990 and 1993, dye-sensitized nanocrystalline solar cells are transparent and use both direct and diffuse light. Current applications of the cells are moving up in scale from watch crystals and cameras to glazing assemblies.

The building anticipates this emerging technology through building orientation and organization. For example, the entire mechanical room for the building has been located at grade on the south end for ease of access and to leave the roof flat and open for maximum future solar harvest. The roof has the capacity to hold 8,500 ft² of monocrystalline silicon photovoltaics and the east-west glazing can accommodate 10,110 ft² of transparent dye-sensitive nanocrystalline photovoltaics. Incorporation of this renewable technology would yield an average 10 W/ft² peak from the roof, 4 W/ft² peak from the east-west glazing, and an overall 122.64 kW. For reference, this is approximately 90% of the current 135 kW peak demand (although it would not be simultaneously available).
The three-story building minimizes the site footprint and provides more vegetated areas and open space.

Rinker Hall transformed the University of Florida’s building program through successful involvement with administration, faculty and students. The design team started the project with a three-day charrette that included the university’s administration and the faculty and students of the schools of architecture and construction. The group developed consensus on project goals, siting, and overall design concepts. Additionally, members of the design team worked with students to integrate lessons from the design process into class work. Students participated in workshops and explored building material choices through a regional material mapping exercise. These positive experiences and the success of Rinker Hall moved the Gainesville campus to adopt LEED® Silver as the minimum standard going forward.

Access mapping ensures nondisruptive servicing and large scale access.
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**Thermodynamics**
A design challenge emerged when analysis demanded a glass and metal building that releases heat quickly, while campus culture demanded a masonry exterior wall that would actually retain heat. The resolution was a metal and glass building with a freestanding masonry shade wall on the west and south sides, balancing out the higher thermal western loads (75% west, 25% east).

Of the 55% peak load reduction, 40% of the reduction is achieved by the project’s 8 ft diameter, 12 in. thick enthalpy wheel (energy recovery ventilator), and 60% is achieved through optimization strategies such as daylighting, the building envelope, the roof, occupancy sensors, shading, and the west thermal wall. As indicated by Rinker Hall’s location in a humid climate belt and confirmed by DOE-2.1E modeling analysis, the enthalpy wheel alone achieves a 22% reduction in peak load, which is 40% of the total energy reduction. Overall, the high performance design of Rinker Hall has resulted in a building with 56% energy savings on regulated loads over a comparable baseline building, according to ANSI/ASHRAE/IESNA Standard 90.1-1999, *Energy Standard for Buildings Except Low-Rise Residential Buildings*.

**High Performance Cost Benefit**
Rinker Hall was built at a construction cost (not including site cost) of $6.6 million for 47,270 ft² or $139/ft². Other classroom buildings without the high performance characteristics of Rinker were completed on campus in the same time frame and with the same budget, meaning Rinker Hall had no additional cost for sustainable design. The building achieves value-engineering or enhanced performance through superior design and not elevated cost.

Using the Building Life-Cycle Cost Program (BLCC) method of the National Institute of Standards and Technology (NIST), the team confirmed an 8.3 year simple payback as well as individual strategy paybacks. The incremental investment of all the strategies was $182,000 with a $21,900 annual utility savings. The team considers this to be conservative based on widely held views for energy cost projections over the next 25 years, but stayed with NIST norms for purposes of analysis. The client readily accepted the 8.3 year payback, knowing that this is conservative based on future energy cost.
LESSONS LEARNED

Although east-west is the conventional energy-efficient orientation for a rectangular-shaped building, north-south orientation produced a number of advantages at the southerly latitude of 29° 38' 49" N.

Daylight Duration The total duration of daylight hours increased more than 30% with the north-south orientation. Half of the solar day is glare-free light (west/morning and east/afternoon) and the other half of the solar day has the sun traverse from sunrise to noon and noon to sunset. Modern glazing, lighting technology, exterior wall options and interior architecture strategies used in high performance buildings have helped to solve past problems caused by glass façades. In addition, at this latitude, the noonday sun is high in the sky, varying from 37° in the winter to 83.8° in the summer. For this reason, significant reduction in the net deep daylight potential of a south-facing elevation exists.

Circadian Cycle Preserving the natural or benign variability of the light while the glare, heat and ultraviolet components are moderated results in an interior space that tracks a day in nature. The variability of cloud cover, angle of the sun, and color of the sky creates a stimulating and deep-seated connection to circadian and seasonal cycles that are central to human biological function.

Energy Savings Because the number one consumer of electricity in the workplace and learning environment is electric lighting, the most economically beneficial use of solar energy is to use its visible light spectrum to directly replace electric light, avoiding pumps, collectors, silicon panels, inverters, etc. Therefore, maximizing the amount and depth of daylight projected into Rinker Hall reduced energy use from electric lighting.

An important tool available to the architect/engineer to reduce energy use from electric lighting is the continuous dimming photocell sensor with the solid-state electronic ballast of the lighting system combined with an effective low-angle daylight louver and diffusion system, appropriate ceiling geometry, and a range of interior surface reflectances. The final facilitation of this strategy comes with joining the thermally advanced performance of exterior walls to the correct ratio and positioning of the high performance and wavelength selective glazing.

The lesson learned is that the thermal advantage to be gained in the conventional east-west orientation can be more than offset in the north-south orientation by the additional electrical lighting savings, not to mention the productivity and well-being enhancements of an optimized distribution of low-angle daylight.

Materials Minimization A vigorous pursuit of materials minimization led in one case to an acoustical problem associated with HVAC noise in several classrooms. In a visually shielded area at the front of the typical classroom, a 100% accessible ceiling, open to the underside of the slab above, was used to achieve maximum accessibility for future retrofits. Overzealousness in leaving this exposed underside of slab had to be compensated for by an acoustic surface retrofit on the exposed slab.

The metal and glass building is preferable for Rinker’s location in a humid climate belt, while the freestanding masonry wall addresses campus context and moderates high thermal loads on the west.

escalations and does not capture the productivity and well-being benefits.

Rinker Hall raises a basic question about green premiums, which is the additional cost of sustainable design. If this building was completed at the same cost per square foot of a nongreen building via strategic redistribution of total dollars and also met the conventional building schedule, no premium exists. Simply stated, for any given budget and schedule, there is a highest sustainable outcome, and Rinker Hall confirms how significant that highest outcome can be.

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