Crafting Energy Solutions

BY MIKE NICKLAS, FAIA

Creativity flourishes here. In bright, open spaces conditioned by the North Carolina mountain air, nimble hands craft clay, wood, fibers and metals into one of a kind works of art.

The new home of the internationally acclaimed Professional Arts program at Haywood Community College is designed to inspire artists' creativity. Instead of making the best of the former cramped, rundown facility, artists now create their crafts in open, well-designed spaces with lots of light. The move has attracted new students to the program and increased the quality of students' work. But, pottery studios where toxic glazes are used require extensive indoor air quality measures, the detailed work of jewelry making and weaving demands enhanced lighting levels and a dust collection system is critical to ensuring safety in a woodworking shop. Creative design solutions to these challenges were found in largely passive designs tailored to the needs of each space. Energy efficiency, passive heating and cooling, daylighting, solar thermal heating and cooling, and photovoltaics reduced the first year's energy consumption from the national Commercial Buildings Energy Consumption Survey (CBECS) energy use intensity (EUI) average of 120 kBtu/ft²-yr to a gross EUI of 33.4 kBtu/ft²-yr and a net EUI (after solar photovoltaics) of 21.7 kBtu/ft²-yr.

The Challenge
The 41,000 ft² facility is designed to accommodate the college’s growing clay, jewelry, wood and fiber programs for full-time students and associated night classes for continuing education students. The three-level building that steps down a heavily wooded, south-facing hillside opened in March 2013. The college wanted the Creative Arts Building to demonstrate the college's commitment to sustainability. And, the goal was to achieve energy-efficiency levels commensurate with the 2030 Challenge objective of at least a 60% energy reduction, or a net (after on-site renewable energy) EUI of 36 kBtu/ft²-yr or less despite several challenges:

- Similar existing facilities consume 120 kBtu/ft²-yr;
- The ASHRAE Standard 90.1-2007 baseline is 91.6 kBtu/ft²-yr;
- Curriculum-required equipment loads were projected to account for over half the building’s energy use;
- The building has extended hours of operation; and
- The site is difficult for solar access.

The team also decided to design the building to LEED Platinum standards. Plenty of challenges existed for this goal as well, including high water demands, extensive runoff from the rest of the campus, and numerous energy and air quality challenges posed by nine electric and three gas kilns, pottery glazes, paint and selndering booths, woodshop equipment and an array of power tools.

A key objective was to retain the rural campus character and improve pedestrian ways by implementing a design that saved existing vegetation and harmoniously fit into the rolling mountain site. To preserve and enhance natural site features, the building conformed to the sloping site, creating three, stepped east-west oriented wings that facilitate solar access, daylighting and natural ventilation while retaining as many trees as possible. The stepped approach also met another objective by providing ground-level access to all of the facility’s studios. To improve the site’s water quality, campus storm water is treated via sand filters, a constructed wetland pond and bioswales. These measures reduce pollutants from the storm water runoff, recharge the aquifer and replenish local mountain streams with cleansed water.

Bioclimatic Design
Haywood County is located in the mountains of western North Carolina, has sunshine 59% of the time (1.36 kBtu/ft²-yr global horizontal) and receives 48 in. of rainfall that comes rather uniformly throughout the year. While the average annual temperature is 55°F, temperatures range from 100°F to 16°F.

Energy demands are predominantly driven by heating. From purely a degree-day perspective, heating outweighs cooling by 85%.
to 15%. However, due to the anticipated extremely high internal loads, actual demand for supplemental energy shifted to 60% heating and 40% cooling.

**Energy Efficiency**

Selecting energy strategies started with addressing energy efficiency. Creating a high-mass, well-insulated building shell provides lag time and energy storage benefits, and increased comfort and durabil-

ity. Exposed interior mass in the walls and floors plays a significant role in retaining thermal stability despite the high levels of ventilation required for many spaces. The bermning of the two lower wings, through contact with the earth, also provides significant thermal benefits.

**Passive Heating**

Given the predominant heating load, south-facing glazing strategies are implemented to maximize daylighting and passive heating benefits. Lightshelves are placed immediately below the daylighting glazing areas and above the view glass on the south, which enhances daylighting and helps shade the lower view glass in warmer months.

**Daylighting**

Controlled daylighting is a key strategy in reducing energy consumption and improving indoor environmental quality. More than 85% of the facility’s regularly occupied spaces maximize daylighting by providing superior light levels during two-thirds of the daylight hours. A variety of strategies are used to address varying demands including:
- Fiber-filled south glazing with exterior lightshelves;
- North clerestories with clear glazing; and
- Roof monitors. Because of the types of tools and equipment used in the studios, it is critical that the strategies used be glare free, eliminating all direct beam radiation and routinely producing the high, 75 to 100 footcandle levels required for acute visual tasks. Supplemental light levels in all daylight spaces are controlled by daylighting sensors that automatically dim energy-efficient light fixtures to optimum levels.

“I have said repeatedly to the press and visitors that I’ve already experienced a change in the quality of our student’s work,—I attribute this to the many ways that the building works splendidly, especially the quality of light and the well-designed spaces,” said Terry Gess, Chair, Professional Arts, Department of Creative Arts, Haywood Community College.

**Ventilation**

To maximize the potential for natural ventilation, operable windows (motorized on the high north side) are placed throughout the facility,
Solar Heating and Cooling

The 152 solar thermal collectors (29 ft² each) on the south wing roof provide heat for a radiant floor heating system that extends throughout the facility. Additionally, this same solar system supplies more than 200°F water to a 50 ton absorption chiller. A vertical, 15,000 gallon thermal storage tank is located outside and immediately adjacent to the main mechanical room, which houses the absorption chiller and two electric up through the shafts and exiting high above the rooftop. The fan-assisted ventilation option is manually initiated (via a switch) and automatically turns off the mechanical system.

Two main dedicated systems that serve the entire building induce fresh air and incorporate heat recovery. The other significant heat recovery system is installed at the kiln room where heat is captured in the colder months and redirected to a close-by variable air volume unit.

Solar Heating and Cooling

The most cost-effective strategies used in the Creative Arts Building are realized through the integration of natural daylighting and energy-efficiency strategies. However, the engagement of a solar developer in the project ultimately reduced energy use to a net level seldom seen in public buildings in North Carolina, while still keeping the project financially viable. The power that is produced by the array is sold to the utility, Duke Energy-Progress (fulfilling the utility’s state mandated Renewable Energy Portfolio obligations). This approach, all implemented with private financing, has reduced the college’s operating costs from day one. The college has the option to purchase the systems in six or seven years, when the revenue derived from the energy savings will be significantly greater than the expense associated with the purchase and long-term maintenance.

Building Envelope

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<td>Orientation</td>
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chillers. A gas boiler provides backup heating, and, if adequate solar energy is not available for cool-

the electric chillers are activated.

A closed solar loop is protected from stagnation by diverting flow from the solar loop to the same cool-

tower used by the chillers. In the event of an unscheduled power failure during ideal collection times, a backup generator is engaged to con-

tinue the flow within the solar loop and cold municipal water is allowed to flow to a heat exchanger in the solar loop that cools the collectors.

The municipal water is, in turn, routed to the rainwater harvesting tank to conserve the water.

Solar Water Heating

Domestic hot water is required for the lavatories, studio sinks and

general cleaning. Seven collectors, coupled with a 400 gallon storage tank, provide the majority of the facility’s domestic hot water needs.

Photovoltaics

A 112 kW peak photovoltaic system consumes the majority of the remaining roof area. A total of 468, 245 W photovoltaic mod-

ules generate power that is being directed back into the utility’s grid. In approximately five more years the college will likely purchase the PV system, at which point the PV-produced electricity will be used to offset the building consump-

ion in a net-metered approach.

BUILDING TEAM

Building Owner/Representation: Bill Dechant

Architect, Energy Modeler, LEED Consultant: Innovative Design

General Contractor: B&F Consulting

Mechanical, Electrical Engineer, Lighting Design: Elm Engineering

Structural Engineer: Lysaght & Associates

Civil Engineer: B&F Consulting

Environmental Consultant, Landscape Architect: RN&M

Commissioning Agent: RN&M

DESIGNING TO MEET STUDIO NEEDS

The specific uses of each studio posed vary-

ing challenges to providing good indoor envi-

ronmental quality, requiring specific designs to meet the demands of each space.

Within the clay studio, solutions to energy consumption and comfort were dominated by the need for eight electric kilns and three gas kilns. The use of toxic glaze chemicals dictated that extensive measures were used to address air quality. The jewelry program, also has kilns as well as soldering booths and, because of the close-up, detailed work involved in the studio, enhanced lighting lev-

els are critical.

The wood studio, with a full carpentry shop, contains numerous table saws, planes and drills in addition to paint booths, all necessitating extensive ventilation and dust collection systems. Because of the potential dangers associated with operating the equipment, desired light levels are also elevated and glare is minimized.

The fiber studio is less energy intensive from an equipment standpoint, but work at the looms required high light levels. More attention was placed on good ventilation strategies in the dye room, but also the main studio spaces where small fibers could easily become airborne.

More than 85% of the facility’s regularly occupied spaces are designed to maximize daylighting. But the functional needs and conditions expected within each space dif-

fered, requiring the design team to imple-

ment multiple daylighting strategies.

Solutions for the studios had to address the fact that these spaces would routinely be dirty and house potentially danger-

ous equipment. While desired light levels were high (75 to 100 footcandles in some locations) it was critical that glare also be minimized and safety improved. Fiber-filled glazing was selected because it very effec-

tively filters the sunlight, minimizes clean-

ing issues and provides the added benefit of improved conductive performance.

Within the main display gallery as well as in the multipurpose classroom spaces, north-facing roof monitors with clear glazing were selected to minimize the sizes of the apertures. Located on the top floors of their respective wings, the clay and fiber studios incorporate high, north glazing to provide excellent controlled light.

Additionally, small PV systems power two emergency call stations, and a 1.6 kW dedicated array mounted on the roof of the Creative Arts Building powers a recirculation pump treating runoff water in the constructed wetland.

Water Cycle

Whole-water cycle approaches are implemented to address the objective of improving water quality at the site while also serving to treat runoff from 3.45 acres of the campus imme-

diately surrounding the building. Using native planting and a comprehen-

sive storm water management approach that uses two sand filters, a constructed wetland pond and bio-

swales, more than 95% of the immediate site runoff, plus the runoff from the surrounding areas, is captured and treated. The net effect is that less nitrogen and total suspended solids leave the site now than before the project was constructed.

The vegetation in the bioswales and constructed wetland was specifically selected to capture nitrogen and filter the runoff water before it reaches the local mountain streams. The attractively driven current pump circulates water throughout the wetland pond during the day to

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Top left: High, north-facing glazing provides superior daylighting in the classroom and studio spaces located on the north side of the three wings. Top right: Artwork created in the Creative Arts Building by students is often exhibited and sold throughout the region. A recent exhibit at the Southern Highland Craft Guild in Asheville, N.C., showcased the works of recent Haywood graduates.

Above: The main north entry hall features student produced artwork. Exposed interior mass in the walls and floors plays a signifi-

cant role in retaining thermal stability.

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Above: The main north entry hall features student produced artwork. Exposed interior mass in the walls and floors plays a significant role in retaining thermal stability.
enhance water treatment. Post-development runoff from a two-year, 24 hour storm is less than predevelopment, and the implemented strategies are capable of treating a 10-year storm.

Low-flow fixtures reduce potable water demands 151,700 gallons per year below code requirements. The rainwater harvesting system, collecting from roof areas and using a 25,000 gallon underground tank and UV-treatment, saves more than 570,000 gallons of potable city water each year. The combination of low-flow fixtures and the rainwater harvesting system, used for toilet flushing and cooling tower makeup, reduces potable water demands by 74%.

Energy Design and Verification Process

The facility’s excellent, monitored energy consumption and below budget construction cost can be traced to extensive daylighting and whole-building energy simulations initiated at 50% through the schematic design phase and revisited throughout the remaining design phases. Because of differing lighting needs and occupant requirements, each major space was simulated to develop optimum daylighting solutions.

This analysis started in early schematic design as the design was being optimized and spaces were modified to optimize daylighting contribution. An important component of this analysis was the team’s working closely with different studio instructors and determining their particular requirements—some driven by controlled, glare-free lighting levels and others by maintenance within their shops. The daylighting analysis conclusions at each design phase, consisting of contributions at multiple grid points within each space, served as hourly input into the whole-building energy simulation.

LES SONS LEARNED

Account for Potential Solar Developer Modifications to Design. Design team often relied on default occupancy loads in the beginning of the energy simulation work during schematic design. In this particular building a significant difference existed between typical estimated occupancy loads, the more accurate estimates provided to us by the individual student instructors later in the design process, and the ultimateactual occupancy that was experienced in the first year of operation.

The design team never would have been able to exactly predict occupancy, but the sooner in the design (and energy simulation process) that they could have moved from default estimates to the more accurate representation, the sooner they would have had better simulations.

Like the daylighting simulations, the energy simulations started at 50% schematic design and were updated throughout the design process. Given the college’s tight budget, the early whole-building analysis was vital in evaluating alternative approaches early in the design process.

A submetering system provides verification of the performance of each of the major energy-saving components. An extensive green monitoring system is additionally linked to a more detailed website accessible by the design team. Through real-time, daily and monthly subsystem monitoring, the design team was able to identify and correct during commissioning problematic control and mechanical components early in the first year of operation.

Conclusion

Haywood Community College faced numerous obstacles in its pursuit of a sustainable building that also preserved and enhanced the site. Despite the energy demands of the studios, the shade from surrounding trees and extended operating hours, the building meets energy reduction goals and improves the site’s water quality while preserving as many trees as possible.

Creative energy and environmental solutions, such as daylighting, passive heating and cooling, and solar energy and solar cooling, were key to achieving the college’s goals. Whole-building energy simulations also played a critical role in taking full advantage of passive strategies and reducing energy use.

Ultimately, the college, students and the region benefit from the building’s reduced environmental impact and operating expenses. Students can pursue their artistic interests at community college prices, strengthening the region’s cultural and economic fabric.

ABOUT THE AUTHOR

Mike Nicklas, FAIA, is president of Innovative Design in Raleigh, N.C.