Building Green for the Future

Case Studies of Sustainable Development in Michigan

Forest Hills Eastern High School, Grand Rapids

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Architects integrated natural features and common walking space outside of the school to encourage more connection with the outside environment.

Project type	Education
Project scale	Building
Construction type	New Construction - Greenfield
Date completed	August 2004
Address	2200 Pettis NE, Ada MI
Subjects	Energy Efficiency
	Materials Use
	Social Benefits
	Lessons Learned
	Cost Benefit Analysis
Total project costs	$25,385,000
	(land & furniture excluded)
Building square footage	214,000 sq. ft.
Cost / square foot	$118 / sq. ft.

Grand Rapids, Michigan

Forest Hills Eastern High School

History

The guiding principle of Forest Hills Eastern High School / Middle School building design was to create a self-directed, collaborative, and technology-enriched environment for students now and into the future. The design needed to improve utilization and energy efficiency beyond the standard that currently existed in school buildings. The school would open as a 7th -12th grade building and migrate to a 9th -12th grade building to include thematic "schools within a school", with flexible teaching and studio spaces.

Unique spaces within the school include Interactive Learning Centers, the Great Hall, and the studios. These are spaces that enhance the educational environment through their flexibility, variety, and use of wireless technology. The Interactive Learning Centers are student- teacher collaborative spaces incorporated within each of the building's academic wings. They are technology-rich spaces designed to facilitate large group presentations, small group study, and quiet individual research.

The Great Hall, like the Greek Forum, is a place for "seeing and being seen," for academics, for social interaction, for meeting friends, sharing a meal, and for building community. Ideally, all of these activities happen simultaneously within this space.

The studios are designed to accommodate a multitude of enrichment programs, and thus are the most flexible spaces in the building. The studios are larger than the classrooms and equipped with additional storage, enhanced technology and power infrastructure, and plumbing. Their exposed structure ceilings and movable partitions provide additional volume for the space.

The classrooms are consciously designed to be different from classrooms of the past. They utilize large double doors open to the Interactive Learning Center, a mobile teaching station for the instructor, and wireless technology to encourage collaborative and project-based learning.

"I really wanted to be involved in the development of the new Forest Hills Eastern High/Middle School from the beginning. URS listened to what we asked, and because of their careful designing and Barnes Management's ability to bring the project together so fast, we've got a school with cutting edge technology that has been specifically designed to optimize the students' learning experience."

- Linda LaBerteaux, Principal of the New Eastern High/Middle School.

Energy Efficiency

Active energy efficiency design decisions at Forest Hills Eastern include:
(1) energy efficient lighting,
(2) tiered lighting control,
(3) a building energy recovery system,
(4) an energy management system, and
(5) a comprehensive building-commissioning program.

The building design responded to existing site constraints by carefully considering the building's placement on the site, the development of the building section and footprint, the use of operable windows whenever possible, the creation of an efficient HVAC system, and an innovative utility solution. The building section was designed to take advantage of the existing change in the site's topography--moving from southwest (low) to northeast (high). The building maximizes this grade change to control the safety and security of the entry, enhance the spatial impact of the entry sequence, and provide the best view of the rest of the site to the Great Hall.

Examples of creative material use include burnished and glazed block throughout the interior in place of painted block, steel frame construction which allows for quick and efficient change of the interior partitions, a white roof membrane to increase solar heat reflectivity, concrete paving instead of asphalt paving, sun-shading devices on the southwest elevation, and porcelain ceramic tile.

Passive energy efficiency design decisions include: (1) building envelope insulation to meet or exceed industry norms, (2) white EDPM roof to reduce thermal heat gain, (3) the introduction of natural light deep into the building, (4) shading devices to control thermal gain through fenestration, (5) gas-filled insulated low-E glass, (6) an irrigation retention pond, (7) concrete paving instead of asphalt paving, and (8) on-site constructed wetlands instead of a public sewer connection.

An onsite gravel mining operation supplied the needed gravel requirements for the site. This approach was possible because of the site's soil composition and the expertise of the site excavator. The on-site operation was identified as both a cost-savings opportunity for the school, and as a means to reduce fuel consumption for transporting materials to the site.

In addition, the site's irrigation retention pond is supplied by a horizontal well located uphill from the pond, eliminating the need for a traditional well. This system captures subsurface water to maintain the pond's capacity, removes the need to tap into the area's aquifer, and eliminates the pump required to maintain the pond's operational level. The project also includes an on-site sewage treatment system for reduction in sanitary waste water to the city's sewer.

Teacher and student absenteeism runs as much as 40 percent lower in schools with fresh ventilation and lots of daylight. They also tend to feel happier and more contented at school. (Source: Environmental Protection Agency, The Indoor Air Quality Solution)

white roof - *A daylighting strategy that allows natural light to bounce off a shelf located in a window and onto the ceiling to bring light deep into the interior of a space.*

low-E glass - *Low-emissivity windows: glazing that has special coatings to permit most of the sun's light radiation to enter the building, but prevents heat radiation from passing through.*

Natural sunlight through the windows decreases overall lighting energy expenses for Forest Hills.

Materials Use

Forest Hills Eastern High School / Middle School implemented creative techniques to maximize energy output and savings by using innovative materials and design processes. The school is served by a central chilled water system and a central heating water system that transfers energy out to the building. The building has eleven main air handling systems that heat and ventilate the entire building. Ten of the eleven systems (gymnasium excluded) are conditioned by the chilled water system and the central chilled water system incorporates thermal ice storage for off-peak chilled water generation. The ice storage tanks have a storage capacity of 1725 ton-hours. The use of ice storage allows the building to reduce both electrical demand and overall energy costs. The ice storage system uses a chiller to make ice at night when electric utilities lower their rates. Chilled water is generated by a 330-ton packaged air-cooled chiller. Both chiller and storage tanks sit outside in the chiller yard.

Electrical System Features

The Forest Hills Eastern High School/Middle School building is served by a 2500-amp main electrical distribution system, at 480Y/277V, 3 phase, 4 wire. The distribution equipment is centrally located to deliver power to the many different wings of the structure. All feeder conductors were designed to have a maximum voltage drop of 2% or less. Branch circuit conductors were designed to have a maximum voltage drop of 3% or less.

The central heating plant is powered by five gas-fired modular boilers. The modules allow the boilers to match the system load over a wide range. Using modular boilers provides a high level of redundancy and ease of future replacement. Each module achieves a thermal efficiency of 88%.

Ventilation is delivered to the building using two distinct strategies. For areas which have a consistent occupancy load, such as classroom wings, media center, and music areas, there is a constant ventilation rate. The ventilation air is pre-treated through one of seven energy recovery units, reducing heating and cooling needs. For areas with large fluctuations in occupancy, such as the Great Hall and gymnasium, the occupancy is determined by the level of carbon dioxide in the space. The ventilation dampers modulate to maintain an acceptable level of carbon dioxide.

The interior lighting controls combine multiple switching, occupancy sensors, an energy management system, lighting contactors, and time switches to provide an increase in energy savings with the ability for user intervention, ease of use, and flexibility. The interior lighting power allowance, determined by using a space-by-space method, illustrated that the majority of the areas had lighting power densities that were equal to, or less than, requirements of ASHRAE 90.1-1999.

Exterior lighting is controlled by the building energy management system with control input from photocells and occupancy, and building use schedule. Maximum energy efficient security illumination is provided at building entrances, exits, and parking lots. Electric vehicle recharging stations were installed at the base of the parking lot light poles to accommodate 3% of the total vehicle parking capacity.

Social Benefits

Sustainably-built schools have health, social, and educational benefits. School facilities that have ill-advised designs, inadequate ventilation, poor acoustics, dim lighting, and inefficient heating and cooling systems can create conditions that impair a student's ability to learn. In fact, recent research reveals a strong connection between the use of daylighting in school buildings and student performance. Incorporating natural daylight was a main objective for Forest Hills and the architects made efforts to incorporate large windows that would both increase the amount of daylight coming into the building and provide students and teachers with outside views of nature.

According to a recent study conducted by the architectural firm Innovative Design, students clearly benefit from daylighting in school buildings. Benefits include:

Students who attended daylighted schools outperformed students who didn't by 5-14%.

The impact of daylighting exposure increases. Eighth graders improved by 21% between 1992 and 1995, compared to a country average of 10%.

Source: Rebuild America: Helping Schools Make Smart Choices About Energy

Lessons Learned

Early programming meetings with the school district guided the architects design to meet the community's needs. One of the most influential early programming sessions involved input from Superintendent Washburn''s Business Advisory Committee. This group of local business leaders provided insight into the employable skills necessary for success after high school.

After the sessions, it was clear that one of the challenges was to create a facility that was designed to allow for a smooth transition from middle school and high school to the business world. Forest Hills Eastern High School / Middle School meets this challenge by creating spaces that supplement the traditional classroom and encourage unique forms of interaction.

Cost Benefit Analysis

During the planning process, the community decided that a school facility is an excellent place to teach environmental responsibility, and the decision to approach a sustainable architectural solution was driven more by the community desire to do the right thing than by financial necessity. As a result, a formal cost-benefit analysis was not completed.

	Base Building Case	FH Eastern	Savings
Energy Costs	$184,000 / yr	$124,000 / yr	$60,000 / yr ($60,000 / 7years)

"Flexibility, collaboration, and community support were the keys to this successful project."
- Michael Van Schelven, senior project designer for URS Corporation

The Bottom Line

Green building is smart economically, educationally, and socially. Parents, teachers, administrators, and students are increasingly more aware of the benefits of healthy, environmentally sensitive buildings, and the consensus and collaboration help build the new Forest Hills School. Even in a public school system, collaboration towards green building can work. The Forest Hills Eastern High School is a prime example.

Energy efficient lighting is dominant throughout Forest Hills. Large open spaces allow for greater interaction and help to create a stronger community.

Contact Information

Client	Forest Hills Public Schools, Tom Walters, twalters@fhps.k12.mi.us
Architect	Mike Van Schelven, URS Corporation, mike_vanschelven@urscorp.com
Construction Manger	Russ Barnes, Barnes Management, rbarnes@barnesmanagement.com

Resources for further information

www.fhps.k12.mi.us/easternhighmiddle/ www.urscorp.com www.barnesmanagement.com www.usgbc.com

Urban Catalyst Associates

Urban Catalyst Associates

Urban Catalyst Associates (UCA) is an interdisciplinary team of recent University of Michigan graduate students who have combined their experiences, interests, and educations to create a positive impact on the future of the State of Michigan. The team holds a strong passion for fostering innovative, sustainable development that will shape the evolution of the new urban environment.

In collaboration with the Michigan Department of Environmental Quality, Urban Catalyst Associates developed this handbook to serve as inspiration and ready reference to the development community and other interested groups. As the State furthers its investment in green development, the UCA team hopes that this handbook will encourage developers to infuse elements of environmental sustainability into their planning and development processes.

Urban Catalyst Associates can be contacted via email at uca@uca-michigan.com. See the contact information below for information on contacting individual team members.

Zeb Acuff

Zeb holds Master's degrees from the School of Natural Resources and Environment and the Taubman College of Architecture and Urban Planning, both at the University of Michigan in Ann Arbor. He is also a 2001 graduate of the College of Agriculture and Natural Resources at the University of Delaware. Zeb has extensive experience in farmland preservation and local planning research, as well as familiarity working with demographic and social science media. His professional interests include parks and recreation planning, non-motorized transportation, trails and greenway development, and public transit systems. Zeb and his wife currently reside in Dexter, Michigan. Zeb can be contacted via email at zeb@theacuffs.com.

Bryan Magnus

Bryan graduated from the University of Michigan in April, 2005, with an MBA from the Ross School of Business and a MS from the School of Natural Resources. His undergraduate degree is in Finance and Actuarial Math from Bryant University in Smithfield, Rhode Island. Bryan has extensive knowledge of socially and environmentally responsible business with an emphasis on renewable energy and alternative transportation. He has interned with General Motors' Fuel Cell Activities Group as well as Honeywell's Transportation Systems, and is currently employed by Honeywell TS as a Marketing Analyst. Bryan, his wife Lynn, and their "child" Meadow (dog) live in Ann Arbor, Michigan. Bryan can be contacted via email at magnusb@umich.edu.

Aaron Harris

Aaron will complete his final year at the University of Michigan in spring 2006 with both an MBA from the Ross School of Business and an MS from the School of Natural Resources and Environment. Prior to Michigan, Aaron co-founded Harris Brothers LLC, a real estate development/management company based in Chicago and focused on green building design and environmentally sensitive renovation projects. Upon completion of graduate studies, Aaron plans to return to the real estate field to pursue urban brownfield redevelopment projects. Aaron graduated from the University of Wisconsin-Madison with a BA in Sociology (Honors) and a Certificate in Environmental Studies. Aaron can be contacted via email at aaronmh@umich.edu.

Allyson Pumphrey

Allyson graduated from the School of Natural Resources & Environment with a Master's degree in Landscape Architecture in April 2005. Prior to attending the University of Michigan, she received her BS in Landscape Horticulture & Design from Purdue University in West Lafayette, Indiana. Allyson has experience in residential site design and urban redevelopment projects. Her professional interests include urban trails and greenways, brownfield redevelopment, and urban design. Allyson is employed by InSite Design Studio, Inc. in Ann Arbor, Michigan. Allyson can be contacted via email at apumphrey@insite-studio.com.

Larissa Larsen

Larissa Larsen, Ph.D., is an assistant professor with positions in both the School of Natural Resources and Environment and the Urban Planning Program at the University of Michigan. Larissa has a Master's in Landscape Architecture degree from the University of Guelph in Canada and a Ph.D. in regional planning from the University of Illinois at Urbana-Champaign. Prior to becoming a professor, Larissa practiced landscape architecture and urban planning in Chicago. Her current research investigates the ecological and social impacts of urban settlement patterns. Larissa can be contacted via email at larissal@umich.edu.