A Perfect MATCH

By Beth S. Pollak

An environmentally friendly renovation creates a new home for a charter school in Boston—and gives new life to a neighborhood landmark.

Creating a modern space for the Media and Technology Charter High School (MATCH) in Boston was an essential part of a renovation project that gave the school a new home. The renovation's green focus served a dual purpose—it created an environmentally friendly building that accommodated the school's hands-on curriculum, and was an example for students of how sustainable design principles can be integrated into everyday life.

"We're a school—we should do not just what's economically feasible but what's environmentally sound and academically beneficial as well," said Alan Safran, executive director of the MATCH school. "The energy saved [as a result of the sustainable design] is measurable and meaningful."

The new charter school was designed as a renovation and adaptive reuse of a concrete-framed building located on Boston's former "Automile" on Commonwealth Avenue. The three-story structure was built in 1918 as a showroom for the Lincoln Motorcar Company, but for the last three decades has housed a retail auto parts store. As part of the renovation, decorative columns and a grand marble staircase with iron grillwork were restored and incorporated into an assembly space, which serves as a performance, dining, and study area. In addition, the new 31,500-sq.-ft. MATCH school has nine general classrooms, two computer labs, a media center, faculty and administrative offices, and small break-out spaces to accommodate the school's morning advisory sessions.

Restoring an existing building saved time and money for the project's fast-track schedule. "We were able to use the entire existing structure, which is the main reason we completed it in such a compressed schedule," said HMFH Project Architect Chin Lin. "The fact that the building is already there allows the construction process to move much quicker." Project design began in April 2001, and the school was complete in July 2002. The total cost was $4.7 million.

Renewing with Steel

The owners chose to preserve the building's historical integrity and aesthetic while creating a functional, high-tech and cost-effective "green" space.

Steel was chosen to reinforce the existing concrete building. "Steel is much lighter [than concrete], requires less material and doesn't add more weight to the building," Lin said. "It also required less transportation. We designed the steel members so that they could be transferred in small units."

The design process began with an analysis of the existing structure, but original drawings did not exist. Designers managed to locate the original building permits, which indicated the design live load of each floor of the building. Boston City Building Codes from the era also were used to verify design live loads and design standards. The existing construction was used for the dead loads. This allowed the engineer to back-figure the loads on each element, approximate the reinforcing in each element, and approximate footing sizes based on new geotechnical information.

The engineer used the loads as specified in Chapter 34 of the Massachusetts State Building Code for a building "not being increased in area or height but having a system not detailed in accordance with the code for new construction" to analyze the system as a reinforced-concrete moment frame. RAM Structural System was used to distribute lateral loads for the concrete frame. Manual calculations were used to check un-reinforced masonry-infill walls.

As was expected, the beams and areas of the slab were well beyond acceptable limits and a supplemental framing system was required. The limiting elements in choosing the type and number of lateral framing elements were the existing footings. Based on the engineer's calculations, the existing footings were assumed to be on the order of 6′ by 6′ to 8′ by 8′. The design consultant's experience indicated that supplemental footing work would be cost prohibitive and General Contractor A.J. Martini supported these assumptions. The team decided to excavate footings in areas of future excavation, such as the proposed elevator, to verify the existing footings sizes. It turned out that the footings were generally 5′ by 5′. This required new analyses by the engineer.

"Our recommendation was to increase the number of lateral-force-resisting elements to minimize the additional over-turning moment loads on the footings," said Matthew H. Johnson, P.E. of DM Berg Consultants, PC. "Based on our experience with existing buildings and supplementary lateral-force resisting systems, steel concentrically braced frames were the obvious choice. They provide the flexibility to fit cleanly within the confines of partition walls, can be erected easily by a small crew, can be detailed to fit within the varied existing dimensions of the construction, and, in the case of this building, can be finished and exposed as part of the architecture."

The building geometry made it most practical to place the bracing on the exterior of the building. "One of the more distressing design and detailing elements of the connections was going to be fastening to the compound curves of the round column capitals that were concave towards the interior spaces," Johnson said. "Our office began design and detailing very early during the project to outline these complications and allow the general contractor to react to the connections. Based on this work and the flexibility of the architect to work the braces into the building's design, we were able to move the braces to areas at the perimeter of the building where columns, capitals, and beams were orthogonal, greatly simplifying the connections."

The 6″-by-6″ diagonal steel X-bracing allowed flexibility and transparency. Placement on the exterior of the building made an architectural statement and freed floor space within the building.

Johnson said that steel's flexibility when used within an existing structure is usually unmatched. "Because of the light weight of the individual steel-bracing members, the fabricator could fabricate a template brace, bring it to site, position it in each location, and determine exact dimensions for each element," he said. "In conjunction with the structural drawings and a non-destructive analysis of rebar locations in the existing concrete at connections, this eliminated any required remedial work in the field."

Above: New lateral bracing was installed along exterior column lines rather than interior column lines to maximize the flexibility of interior spaces.

Below: Ornate column capitals (restored and recreated from pieces of the originals) and a monumental staircase were incorporated into the school's assembly area.

To bring the monumental staircase up to code, new, taller handrails were added to the existing stair railings.

Interior Restoration

Preservation of historic decoration included the restoration and replication of plaster details on column capitals and ceiling molding. "We had to make molds of the existing details that we would use to later restore them," said Marion Williams, project executive for Contractor A.J. Martini. "The difficult part was finding enough that were not destroyed so we could create the molds."

The team also developed a solution to update the grand staircase. Current codes required higher handrails on the stairs. Rather than remove the existing decorative ironwork rail, the team designed a supplementary wood rail.

The renovation project also helped restore the existing building's transparency. Window openings that had been bricked over for decades were reopened and glazed with energy-efficient glass, providing daylight for students and reinforcing the connection between the school and the urban neighborhood.

With little room for staging during construction, the project team took advantage of the building's old automobile elevator. Construction materials were stored on the third floor—which was to be left unfinished until a tenant moved in—and transported to the lower floors as needed.

It's Easy Being Green

Some "green" features of the building include the use of mostly second-hand furniture; LCD laptops rather than CRT terminals to reduce energy consumption; highly absorptive fiberglass acoustic ceiling panels; and a cooling tower rather than chiller to reduce neighborhood noise and to save energy. Only limited parking facilities were made available to discourage dependency on cars and encourage the use of public transit. The restoration of window openings in the building allows many classrooms to have enough natural daylight to reduce dependency on artificial light. At the same time, shaded windows minimize solar heat gain. Another green feature is a heat-

Panel Power

The MATCH school is the first Massachusetts public-school solar project to be completed with assistance from the Renewable Energy Trust, a fund administered by Massachusetts Technology Collaborative. The school received a grant for $491,530 from the trust, which promotes the design and construction of resource- and energy-efficient "green" buildings and schools. The school installed 22 kW of solar photovoltaic panels on its roof to provide electricity to the building. This installation, combined with savings from energy-efficiency measures, reduces the building's energy use by 33%. MATCH students are involved in the monitoring the system, which reinforces the school's philosophy of integrating technology and education. Live output of the PV system can be viewed at **www.matchschool.org/solar**.

Solar Design Associates worked with PowerLight Corporation and the International Brotherhood of Electrical Workers, Local 103 of Boston to complete the project.

"We helped to write the proposal that resulted in the grant," said Solar Design President Steven Strong. "That grant helped the school cross the gap between the cost of the renewable energy system and its short-term payback. It also enabled installation of the data acquisition and monitoring system. This way the school can integrate information into the curriculum, so that the students benefit not only from the solar panels on the roof, but from the system as a teaching tool."

The school prepared the building's electrical system for the solar panels before it was clear that the grant had been awarded. "All of the electrical connections were installed so if the grant went through, additional money wouldn't be required to undo other work [to accommodate the solar-energy system]," said Marion Williams, project executive for Contractor A.J. Martini. "Two months after we finished the project, the panels were available and the building was ready for them."

The PV system utilizes a PowerLight® mounting system. This system lies flat, on top of the roof with no penetrations. Each PowerLight tile is comprised of two Shell® photovoltaic laminates mounted to an extruded polystyrene backer board. The tiles interlock in a tongue-and-groove fashion and are secured around the perimeter with a ballasted curb. The entire array is comprised of 144 of these PowerLight tiles. Additional blank T-Clear tiles were used to create a walkway through the middle of the array for rooftop equipment access. A 20kW Xantrex® inverter interfaces the photovoltaic system to the school's distribution system. The system is monitored with a National Instruments® Data Acquisition System, which also was designed and installed by Solar Design Associates. The data acquisition web presence was developed with assistance from Skyline Technologies Inc.

"The panels provide up to 14% of what the school uses, which is a substantial amount for building of this size and footprint, and considering that a school consumes a fair amount of electricity," said HMFH Project Architect Chin Lin.

Strong says that many other schools and universities are pioneering the use of solar panels in the United States. "Because of increased environmental awareness, the escalation of energy prices, and the understanding that we are dependent on foreign sources for our energy, educational institutions are choosing solar panel systems not just for energy efficiency, but for educational tie-ins. They are realizing that the next generation will bridge the transition to the post-petroleum world." ★

pumping system that, during winter, removes waste heat from interior spaces and transports it to the building's perimeter.

Lin says that the sustainable school presents an important learning opportunity. "Students learn that [when we dispose of] waste it doesn't disappear—often we're just moving trash from our domain to someone else's. We have to be a lot more sensitive to the way we treat our environment. [Learning this] fits into the school's educational goal."

Managing Costs

Choosing sustainable design involves careful decision-making. "There are items that cost you more money, but at the same time there are decisions that you can make that have minimum or no cost impact," Lin said.

One example is the use of concrete with fly ash. "Fly-ash is a byproduct of coal-burning power plants. It actually makes the concrete stronger. It's a no-cost alternative," he said.

Some "green" decisions might add to the initial cost of a project, but save clients money in the long term. "Purchasing energy-efficient windows, with more expensive glazing means a higher cost for the windows," Lin said. "But then you have less demand for air conditioning, which means a smaller chiller on the roof, as well as lowered energy costs. Everything is a balancing act, and you have to look at the whole picture."

Williams said it's unusual for a small non-profit school to go the extra step in sustainability. "All of this made for a wonderful blend of old and new."

Lin agrees that working on the project was a fun challenge. "It is a joy to take an old building full of history and give it a new life."

The new MATCH school building won first prize in the "Solar Electric Buildings" category in the 2003 Northeast Green Building Awards. It also was awarded the 2002 Boston Preservation Alliance Achievement Award for a significant restoration or renovation preserving Boston's architectural or cultural heritage; and a citation award in Design Share's 2002 Awards for Innovative Learning Environments.

To learn more about structural steel's role in sustainable construction, visit **www.aisc.org/sustainability**. ★

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