Transforming Older Schools for Sustainability

By Peter Gisolfi, AIA, ASLA, LEED AP

Goodhue Memorial Hall, Hackley School

In a discussion of transformation and sustainability, the first question is this: How is sustainable design different from energy conservation? We already know what needs to be done to save energy in our older school buildings, but how is this different from what we now mean by sustainable practice?

ILLUSTRATIVE PROJECT:
Goodhue Memorial Hall - Hackley School, Tarrytown, NY

Goodhue Memorial Hall, the iconic 1903 Neo-Classical building on the campus of the Hackley School, was ravaged by a fire in 2007. The building has been reconstructed, and its usable area has been doubled mostly within the building's original volume. Glazing and insulation have been dramatically improved to reduce energy loss; a new closed loop geothermal heating and cooling system results in a major reduction in energy use. The building will receive LEED Gold certification.

Energy conservation was an important topic of conversation in the late 1970s, during the Carter administration, when the price of oil rose precipitously. Typically, schools would replace old, single-glazed windows with new ones that were double-glazed, or they would replace roofs, adding significant amounts of insulation. Some schools replaced older boiler plants with new, more efficient boilers or dual-fuel boilers, which burned both gas and oil. Basically, public schools picked "the low-hanging fruit." In so doing, they probably succeeded in reducing energy consumption by 15 to 30 percent. Sustainable practice addresses larger issues. It is based on the premise that the designed environment (buildings and landscapes) should have the least possible negative impact on the natural environment while taking the greatest advantage of what nature—that is, the local environment—offers.

Sustainable practice applies to outdoor space as well. Do the building and its other impervious surfaces overload the storm sewers? Is there too much runoff? Is there adequate shade on the sunny side of the building or in other places that need it? Do the building and its asphalt parking lots create a heat island that adversely affects the neighborhood?

Energy conservation has advanced substantially beyond the practices of the 1970s and 1980s. Employing appropriate sustainable strategies—even in older, existing buildings—can reduce energy consumption by as much as 50 percent.

Reprinted from Learning By Design, *November 2010*

Intelligent Transformation

Existing education buildings change constantly. They change when additions are made, and they change when renovations become necessary.

Whenever a change of either type is imminent, it is common practice to determine the functional needs and space requirements for the future based on demographic information and pedagogical intentions. Sustainable objectives might include intentions such as reducing energy consumption by 50 percent, generating 30 percent of the energy used by the building from green sources, and improving indoor air quality.

Intelligent transformation creates something new and different from what was there previously. At the same time, it can preserve and enhance the most valuable aspects of an older building.

Essential Strategies

It is easy to embrace a sustainable, holistic approach in the design of a new building. But how can an existing building reduce its negative impact on the natural environment? The most obvious answer is that the building can use significantly less energy. But that's just the beginning. Our purpose is to understand the basic strategies that can be employed to achieve significant sustainable results.

The site of an existing building is a given, but it can be significantly improved. Simply coming up to current code practice with regard to stormwater runoff would be a major improvement for the surrounding environment. Biofiltration (the use of planting material to filter and purify runoff) is not required in all municipalities but would be a significant contribution to overall environmental quality.

School buildings are commonly surrounded by vast heat islands of asphalt parking lots. These areas can be shaded by trees, which can increase comfort on the site and produce oxygen. Vegetation can be used intelligently for wind breaks and shading, where appropriate. The vegetation selected for all of these purposes should be native species that do not require irrigation and are self-sustaining.

If the building and its site increase the production of oxygen and reduce the production of carbon dioxide, the result is a substantial reduction in the negative impact on the natural environment.

Water is a precious resource, especially in some parts of the country, and it can be used much more intelligently than in the past. Rainwater can be harvested for building and site use. The profligate use of irrigation on the site can be addressed with environmentally appropriate plant material and by using greywater (wastewater generated from domestic activities, such as laundry, dishwashing, and bathing that can be recycled on site), rainwater, or even groundwater instead of municipal drinking water for necessary irrigation.

The exterior building envelope, or building shell, is the assembly of systems and materials through which the building interacts with the exterior environment. Today, there are techniques for improving the performance of the building envelope. In a poorly insulated building, heat is transferred in from sunshine and hot air in warmer seasons, and heat is transferred out in colder seasons. A significant portion of the building's energy is lost through leaky window systems.

At the same time, it is common to find older buildings constructed of heavy masonry with high thermal mass, which means they change temperature very slowly. This is a valuable asset in conserving energy, especially during the warm season.

Indoor environmental quality depends on intelligent use of the benefits offered by the natural environment. These benefits include fresh air, daylight and sunshine, and temperature control.

Fresh air depends on adequate ventilation and operable windows. Contrary to the practices of the 1970s, sustainable design provides the maximum amount of fresh air possible to the building and its users. Oddly enough, most school buildings are used only 40 or 50 hours in a week, which contains 168 hours. Obviously, ventilation systems have to be controlled in a way to maximize ventilation in each occupied space and allow the building to hibernate at other times. Unfortunately, many ventilation systems do not operate effectively, or they may have been eliminated as part

ILLUSTRATIVE PROJECT
White Hall at Cornell University, Ithaca, NY

White Hall is an Italian Renaissance-style building constructed in 1869 on the Arts Quadrangle at Cornell University. Its exterior shell has been completely restored and its interior completely transformed. Innovative energy systems were utilized to decrease energy use from conventional design. Those features included dedicated outdoor air (without heat recovery) and four pipe heating and cooling recirculating air handlers, all with daily schedules. Separating sensible heating/cooling from ventilation air reduces unnecessary cooling and reheating for humidity control, reducing fan energy usage.

Restored exterior of White Hall, Cornell University

New single-loaded corridor at White Hall overlooks Cornell University's Arts Quadrangle.

of past energy conservation strategies. These systems should be upgraded with mechanical system improvements, and they should be controlled effectively.

Many older buildings feature large window openings, which provide ample daylight and sunshine. These openings should be preserved and not covered with insulating panels, as was the habit in the 1970s and 1980s. Fortunately, the quality of fenestration and glazing has changed dramatically. Today, buildings do not have to lose as much energy through the windows; instead, double- or even triple-glazed windows, thermally broken windows, and coated glazing can be used. There are other techniques, such as insulating blinds, for further reducing heat transfer through these openings.

Effective temperature control is essential for indoor environmental quality and is often lacking. The new, digital generation of temperature control devices offers intriguing possibilities for the future, but often these devices and systems are complicated and unreliable.

Material Choices and Reuse

Most older buildings were constructed with nontoxic materials, especially if the asbestos has already been eliminated. It has been common practice to add toxic materials on a regular basis, such as vinyl flooring, nylon carpeting, and a variety of paints. These more recently added materials can be eliminated, and green substitutes can be installed.

A major advantage of renovation, expansion, and transformation is that older buildings and all of their materials continue to be used. We can save all of the energy that might be used to demolish an existing building, dispose of all of its materials, and construct a new building using new materials. Many older buildings can be sufficiently upgraded to be equal in all ways to newly constructed buildings. In fact, many institutions, particularly schools, can appreciate the historical continuity of using and reusing buildings from generation to generation. Basically, transforming and expanding existing buildings is an inherently sustainable approach.

Mechanical Systems and Controls

Mechanical systems typically include heating, ventilating, and cooling a building. The most complicated aspects of these systems are the control mechanisms that run them. The control systems must operate a large building in a manner that saves energy and ensures that the building hibernates effectively or "sleeps" when it is not occupied.
Many school buildings are occupied only about 50 percent of

the days of the year (180 days out of 365). On the days they are open, they may be used only about 42 percent of the time (10 hours per day). If you combine those calculations, a typical school building might be occupied only about 21 percent of the time in any given year. The challenge is to understand how these buildings operate when they are not occupied, and to understand how we might occupy them more efficiently.

Daylight and Electric Lighting

Ideally, if there is sufficient daylight, we should leave the lights off. However, many teachers will turn on the lights when they enter the classroom, and will leave them on all day.

Two strategies to minimize this energy waste are possible. The first is to switch the lights so two or three levels of lighting can be achieved and, at the same time, to switch the lights so the fixtures closer to the windows are controlled separately from those that are farther away. Teachers and students would then have to embrace using only the necessary lights.

The second strategy is an automatic switching or dimming system, controlled by light sensors responsive to sunlight. The advantage of such a system is obvious, but the disadvantage is that these systems are costly to install and are likely to cease working once the building's occupants have tampered with them. A simple switch that turns the lights off when the room is unoccupied can be applied to either option. This application has become standard practice.

Onsite Energy Sources

Green energy sources, such as geothermal heating and cooling systems, windmills, and photovoltaic panels that convert solar radiation to electricity, are now readily available. In many localities, these energy sources are subsidized by government agencies and are quite affordable. These green energy sources are part of an emerging industry that will provide us with extraordinary opportunities for sustainable practice in the future.

Even now, it is becoming common practice to install geothermal heating and cooling systems in renovated buildings that require cooling all summer. These systems, which are actually ground-coupled heat pumps or groundwater-coupled heat pumps, tap into the constant temperatures below the earth's surface, making it possible to transfer the earth's heat to the building in winter, and transfer the building's heat to the ground in summer.

Another strategy is to take advantage of vast areas of flat roofs that are common on school buildings. These can be covered with an array of photovoltaic panels to capture the sun's energy and simultaneously shade the roof. Similarly, parking lots can be covered with trellises made of photovoltaic panels to provide shade for parked cars and, simultaneously, generate electricity.

The library at Goodhue Memorial Hall, Hackley School

Final Thoughts

As school buildings are modified and evolve, the sustainable aspects of the buildings and sites require upgrades as well. The techniques for heating and cooling buildings will change and become more efficient. The strategies for onsite energy generation will also improve. In this environment, we have to be ambitious and flexible to constantly update our objectives.

A school building and its site are moving targets. The people who use them change. The pedagogy changes. Our culture changes. Buildings and sites have to change over and again to keep up. When sustainable objectives are embraced, the buildings will turn out even better than anticipated.

If we act intelligently, the people who use the buildings will be more comfortable and healthier. Students, faculty and staff will work more effectively. Energy and money will be saved. And the overall health of the environment will be improved.

The more general idea is this: Buildings consume approximately 40 percent of the energy we use in the United States. We should aim to cut that energy consumption in half. It would be impossible to reach this goal simply by constructing new, sustainable, and energy-conserving buildings. Our most important task is to transform older buildings so they become more energy efficient.

Peter Gisolfi, AIA, ASLA, LEED AP, is senior partner of Peter Gisolfi Associates, a firm of architects and landscape architects in Hastings-On-Hudson, NY. He is chairman of the Spitzer School of Architecture at the City College of New York and author of the book, Finding the Place of Architecture in the Landscape.