ISSUETRAK

A CEFPI Brief on Educational Facility Issues

Topic : Sustainable Schools

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CEFPI BRIEF

INTRODUCTION

Education reform is both a business issue and a political platform on the national, state and local level. An integral piece of education reform is creating the right environment for student and teacher achievement. The current physical condition of existing public school facilities in the U.S. (42 years old on average) is questionable. According to the General Accounting Office, public school buildings are in a serious state of disrepair due to past design approaches or deferred maintenance. The cost of bringing America's schools up to contemporary standards will exceed $260 billion (1). It is important to note that half of these facilities have indoor environment issues that directly impact the day-to-day performance of the teachers and students that occupy these facilities (1). Additionally, school growth overburdens existing systems and experts predict that the K-12 population will continue to increase through the year 2028 (2).

Given the vast and serious nature of school facility needs, it is time for a new approach to design and construction, one that looks at them comprehensively. Sustainability— a strategy that works towards a whole building design that balances the total impact of facilities on the environment and community—provides one such approach. Sustainable schools represent an integrated design of the educational program and the school facility that responds to the economic, environmental, and social needs of a community.

THE IMPACT OF BUILDINGS ON EARTH'S NATURAL RESOURCES

Earth has a limited and finite amount of resources, but it is able to sustain a large and varied collection of life forms. A system of integrated/connected and mutually dependent resource cycles (the water, carbon, and nitrogen cycles, among others) support these life forms effectively and naturally, using earth's resources over and over again.

Earth possesses both renewable and non-renewable resources. Non-renewable resources, such as fossil fuels and metal, are the end result of biological or geological processes that are difficult or impossible to replace. Non-renewable resources include the life-giving services of the earth's forests, oceans, and topsoil. Renewable resources, which include trees, fish, nutrients, and fiber, are continuously generated by way of biological or geological processes.

The current human use of the earth's non-renewable resources has both short-term and long-term impacts on human survival. For instance, the nutrient, habitat, and moisture characteristics of topsoil are being lost due to exploitative and abusive land management practices. The bottom line — we lose 14.8 million acres of productive semi-arid land to desert, and 69,500 square miles of tropical forests to development every year. (3)

Sustainability promotes a cyclical use of resources, which is clearly opposite to the unsustainable linear use of resources created by most of our society. Sustainable thinking requires that society consider re-use and expanded uses when they extract a resource, rather than discarding them into the land, air and seas. Resource needs are currently so intense that people are using them faster than they can be regenerated, plus some nonrenewable resources are being depleted at an alarming rate. Consider how buildings affect the earth's resources. Buildings use 40% of the world's energy, 25% of the world's wood production, and 16% of the available water. This huge consumption of the available natural resources does not identify the inefficiency with which these resources are used. For instance, school buildings use 25% more energy than they need because of past design approaches or deferred maintenance (4), which can be easily and quickly addressed.

SUSTAINABLE THINKING AND THE REAL WORLD

The unsustainable linear use of resources affects our economy, the environment, and society. Consider, for example, the negative economic impact on the $26 million/year Louisiana coast fishing industry. Non-point nitrate fertilizer pollution carried by the Mississippi River has created an ever-expanding 7,000 square mile marine "dead-zone (5). Land, sea, and air pollution are well known environmental effects, but according to Scientific American, humans can expect to see major violent social conflicts in the near future over resource depletion (6).

Several initiatives have addressed some of the most egregious and immediately destructive uses of our natural resources. However they have failed to solve the more fundamental problem: how to supply a steady stream of natural resources to support a healthy economy, while concurrently maintaining a healthy environment and providing for equitable resource distribution.

Sustainability has evolved as a response to the linear use of resources. *Sustainability is a principle which states that economic growth (i.e., the generation of wealth) can and should be managed so that natural resources are used in such a way that the resource needs of future generations are assured*. The extensive backlog of critical repair and new school needs provides an unprecedented opportunity to demonstrate the economic viability (demonstrable and realistic paybacks) of sustainable facilities and the importance of long-term thinking in design and construction programs.

Districts planning extensive renovation and construction projects can take some steps toward sustainable school design and construction, which will result in sustainable schools having the following characteristics:

- **Reduce waste during the design, construction, and operations of schools by using resources (materials, money, people) effectively.** Most school systems are driven by tight budgets to meet this goal in a narrowly defined way, but sustainable thinking adds a new dimension to reducing waste. During design, the project team should integrate facility *systems* so that the school achieves the greatest facility performance while using the least amount of resources. This is called design optimization, which means the team looks beyond individual facility elements (windows, air handlers, etc.) to take advantage of interconnections of different building systems (lighting, air conditioning, thermal insulation, plumbing, etc.) so that they work together to enhance building performance. At Clackamas High School (CHS) of North Clackamas District #12 in Clackamas, Oregon, significant multi-system facility integration resulted in the substantial downsizing of the facility's HVAC system. One contributing factor to this reduction was increased interior daylighting, which decreased the artificial lighting required, which in turn decreased the heat load caused by the lights.

  During the construction of a school, monitoring the materials that come onto the construction site and managing construction waste on and off the site can help reduce waste and associated costs. In addition, careful attention to the correct use and maintenance of the facility and its systems can reduce waste in school operations. This includes scheduling regular and preventive maintenance and monitoring facility system performance to ensure that the facility is operating as it was designed and specified.

- **Use renewable resources whenever possible** in school construction and operations so that non-renewable resources are left undisturbed. This allows the non-renewable resources to continue to generate sufficient renewable resources. A good choice for a renewable resource, that is also recyclable and compostable, is linoleum flooring. This flooring is highly durable, can be maintained with non-toxic cleaners, and is manufactured from renewable resources that can be recycled. If necessary, the linoleum can be broken down into nutrients by composting, so that a resource cycle that mimics nature is designed into the facility.

- **Generate replacement resources from the school's own operations**. Earth's remaining undeveloped areas are humanity's most valuable resource for bio-diversity (earth's genetic repository) and useful biological processes. But, these undeveloped areas do not contain sufficient resources to supply all of our current and future needs. Therefore, the developed areas of the earth, including school facilities, must be designed and constructed to generate renewable resources to serve the needs of current and future human populations

  Several available technologies can convert a school facility from a resources "user" to a net resource "producer". At the Roy Lee Walker Elementary School (RLWES) in the McKinney Independent School District of McKinney, Texas, electrical power to run irrigation and cistern pumps is generated from an on-site windmill. Water is collected by way of a roof rainwater catchment system in which rainwater is captured and stored for use in 70,000-gallon cisterns. At CHS, a two-electric meter system shows the power that the school draws from the municipal power grid, as well as the power that it pumps into the power grid from its eight photovoltaic panels.

- **Take advantage of the climate and urban context of a school site to reduce reliance on fossil fuels.** Designing a school for passive lighting, ventilation, heating, and cooling operations can meet the need for human comfort, while significantly reducing the school's dependence on energy-intensive technologies (HVAC, lighting systems). Also, locating schools near public transportation and residential neighborhoods reduces the energy used in the busing and single car transportation of children to school. Passive facility design and effective school location work together to reduce fossil fuel consumption, which translates into reduced toxic pollution (carbon monoxide, lead, gasoline additives), prevention of local and global ecosystem disruption (global warming), and protection of earth's non-renewable resources.

The passive ventilation system designed for the classrooms at CHS is another outstanding example of achieving human comfort without depleting resources. By using a combination of temperature differences between the classroom and outdoor environment, a unique manually controlled through-wall ventilation louver at the exterior wall, and a thermal stack located at the back of the classroom, the passive ventilation system exhausts warm air while exceeding classroom ventilation requirements. The warm air (generated mainly by classroom occupants) moves passively up the thermal stack, which creates a negative pressure in the classroom, drawing in outside air through the manually operated ventilation louver.

- **Create healthy and safe schools with reasonable operating costs.** Today's design professionals and schools system administrators have the ability to design and operate schools with off-the-shelf design methods, materials, and building technologies that will create healthy and safe school facilities, which in the case studies cited in this report, cost less to operate. There is no reason to design and construct school facilities that are unhealthy or expensive to operate.

  Research shows that a facility's physical and environmental quality directly affects the health of building occupants and academic performance. A study of 21,000 students in 2,000 classrooms demonstrated that students who were provided the most daylighting progressed over 20% faster on math and reading tests, when variables such as age and socio-economic status were accounted for [(7)]. In another report, Pennsylvania Power and Light experienced a 25% decrease in absenteeism, while Lockheed realized a 15% drop [(8)], following facility upgrades that enhanced one or more indoor environmental characteristics.

- **Create a school environment that becomes an integral educational tool and community resource to demonstrate and inform the students and the community about their economy, environment, and society**. For instance, a playground that is designed to contain traditional playground areas, along with "undisturbed" natural areas and/or edible landscaping (i.e. fruit bearing trees) and food gardens, provides teachers a number of scientific, economic, government, and social educational opportunities. Additionally, by locating the school so that a neighborhood has easy access, the school not only acts as a place for community activities, but also as a means to demonstrate sustainable resource use in the building's design, construction, and operations.

  At CHS a switch will allow the classrooms to be isolated from the external power grid and run exclusively from the eight photovoltaic panels installed directly over the science classrooms. The panels will act as a demonstration of the practical application and capabilities of this sort of technology. The playground and surrounding site areas of the RLWES include an "Eco-pond" to demonstrate issues relating to ecosystems and landscaping and produce gardens to allow student involvement in growing useful plants. In the case studies discussed in this report, the schools have also been designed to allow for community use after hours throughout the week.

CONSTRAINTS

There can be significant constraints to the application of sustainable design and construction to school facilities. Institutional and community issues (such as ignorance, skepticism, tradition, and risk aversion), legal and regulatory constraints (conflicts between new building materials and systems and local health and building codes, separation of school construction and maintenance & operations budgets), and project issues (whether an existing facility can be renovated to accommodate contemporary academic programs and resources) can all act together to pose significant barriers to the successful realization of a sustainable designed and constructed school facility. While many barriers exist, it is worthwhile for districts to consider the positive aspects of sustainable design. Even if only small steps can be made, the long-term beneficial impact can be considerable. It should be noted that the Clackamas High School and the Roy Lee Walker Elementary School were not faced with any significant barriers relating to sustainable design and construction issues, which is a hopeful sign for the future of sustainable schools.

CONCLUSION

Unlike conventionally designed and constructed schools, sustainable schools offer the means to go beyond mere housing of students to comprehensively address many of the environmental, economic and social challenges facing schools. The lessons learned from pioneering sustainable schools can contribute to developing an education for our children that is truly representative of our expectations for the 21st century.

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CASE STUDIES INFORMATION

	Roy Lee Walker Elementary School	**Clackamas High School**
Owner	McKinney Independent School District McKinney, Texas Contact: Wyndol Fry, Executive Director of Facilities and Construction	North Clackamas District #12 Schools Clackamas, Oregon Contact: Bill Dierdorff, Ed.D, Business Manager
Architect	SHW Associates; Dallas, Texas Contact: Scott Milder, Director of Communications Innovative Design; Raleigh, NC (Consultants) Contact: Mike Nicklas, AIA	BOORA Architects; Portland, Oregon Contact: Heinz Rudolf, AIA
Completion Date	June 2000	Under construction for completion in summer 2001
General Project Description	New, free-standing, one-story, 69,000 GSF elementary school to service 685 K-5th grade students.	New, free-standing, one and two-story 275,000 GSF high school to service 1,800 9th through 12th grade students.
Costs/Grants	*Project Costs*: $10.6 million *Construction Costs*: $9.25 million *Cost/SF*: $152.00 *Compared to Conventional School Construction*: An additional $1 million due mostly to the roof structure for the roof-top monitors, water cisterns, and Windmill for poser generation. *Grants:* $200,000 for energy design	*Project Costs*: $38 Million *Construction Costs*: $30 Million *Cost/SF*: $119.00 *Compared to Conventional School Construction:* No more expensive but an additional $89,000 was paid by the client for design services to achieve sustainable performance. *Grants:* $100,000 for energy design and $30,000 for sustainable design work.
Expected Savings/Payback and Facility Life Cycle	***Expected Savings:*** *Estimated Yearly Savings:* $50,000/Year in energy alone. This does not account for other life cycle savings due to water conservation, durable and low maintenance materials, or for potential student and teacher performance increases. *Expected Building Lifecycle:* 50-75 Years	***Expected Savings:*** *Estimated Yearly Savings*: $56,000/Year in energy, maintenance, and photovoltaic energy credits. This does not account for other life cycle savings due to water conservation, durable and low maintenance materials, or for potential student and teacher performance increases. *Expected Building Lifecycle*: 100 Years

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