Introduction

Research suggests, instances of New Jersey K-12 school construction exemplify and, indeed, the SDA Design Manual itself support that school design and construction in New Jersey embodies and reflects, superiorly, efficient, safe, sustainable and educationally conducive physical spaces. New Jersey school design and construction incorporates, furthermore, in varying degrees within each school designed and built, visions and capabilities beyond that which is extant, anywhere, here or abroad. Clearly, SDA does not own or drive educational programming, for example, which often differentiates a school's physical presence and mission. DOE-prescribed square-footing per student, plus multiplier, for example, precludes aspects of design and construction. Often, local preference or practice, moreover, may preclude or drive certain design and construction considerations. Waterless urinals, for example, can provide many economic and functional advantages to a building; however, as the filter mechanism requires a hex wrench for its infrequent maintenance, the division of labor at a certain school location might preclude such installation. A sod roof may hold preference over a rain-capturing mechanism. Deference to end-users must always be heard, if not heeded. Design and construction's vision and capability, however visionary or capable, must, as these two examples illustrate, necessarily contend with considerations removed from its purview, responsibility—its authority—its vision and capability.

Green Roofing Systems

Green Roofing systems consist of partially or completely vegetative, soil or growing medium, planted over a waterproofing membrane. Advantages of Green Roofing systems include both environmental and economic performance. Simplicity of designs, flexibility of installation and maintenance, as well as modularity, provide further advantages over conventional roofing systems.

Green Roofing systems can be easily adjusted and rearranged after installation to meet changes in style preferences or planting schemes. Importantly, Green Roof systems, as modular systems, can be moved and replaced to address maintenance issues specific to an area. Green Roofing system disadvantages include a more demanding substructure due to possible water retainage and root penetration.

Green Roofing systems can be installed from $18 to $20 a square foot. Data suggests that Green Roof systems extend roof lifetimes from between 100 and 200 percent, compared to conventional roof systems. By protecting the rooftop from ultraviolet radiation, large temperature fluctuations, drying winds and punctures, Green Roof systems reduce membrane maintenance, which contributes to life-cycle cost savings.

Chilled Beams

Chilled beams employ water, rather than air, to remove heat from a space. Advantages of chilled beam systems include noise reduction (no moving parts), absence of equipment/mechanical rooms or large ductwork, significant energy savings, increased occupant comfort and the opportunity to employ conjunctively such green resources as geothermal cooling and water reservoirs. Multi-service chilled beams can decrease building construction time (by as much as 25%) due to the installation of one unit rather than many units. Disadvantages include initial costs, supplier availability, limits of operability (condensation can occur if too cold), MEP technical unfamiliarity, and limits to physical positioning of systems (away from heat sources).

Pre-cast Concrete

Pre-cast concrete modular systems provide several advantages over conventional building construction techniques and components, including options to install on a ground level foundations, slab or grade beam, that can accelerate design and construction times. In addition to accelerating design and construction schedules, pre-cast concrete modular structures eliminate risk of trade unavailability, waste, vandalism and theft, while providing better protection from harsh weathers, sound, fire. Disadvantages to pre-cast include more demanding technical skills for installation, limited design flexibility, additional structural bracing, and increased costs for transportation and handling.

100% Recycled Building Construction

While there is no standard definition for 100% recycled materials, this term generally applies to a category of materials made principally from reused materials that would otherwise end up in the waste stream. Other categories of construction materials include "cradle to cradle" or "hyper green" materials, which are both made from recyclable materials and also fully recyclable. Recycled construction materials include site development (decking and landscape materials), foundations (recycled content concrete block, recycled concrete aggregate), building envelope (recycled concrete roof material, gypsum board made from recycled paper or recycled cellulose fiber, steel studs, recycled gypsum plaster, reconstituted or recycled content siding , fascia, soffit or trim, insulation products), interior finishing (interior doors, carpet pad, carpeting, ceramic tile, content counter tops, paints of finishes, slab foundation used as flooring, content ceiling and suspension systems) and fixtures (furniture, smart boards).

Benefits of using recycled construction materials include LEEDS-eligible points toward certification; detriments in attempting to use 100% recycled materials include unavailability, applicability or confidence in product, among others. Recycled "plastic" lumber, for example, is acceptable for outdoor landscaping but lacks the rigidity to be used in structural applications. Some recycled products may contain volatile organic compounds (VOCs), which can negatively affect indoor air quality.

Recycled products may not offer cost effectiveness because of the limited number of manufacturers that prevents price competitiveness and the lack of subsidies for the development of new products.

Windmills/Turbine-Driven Energy

Large array, wind-turbine derived energy, as used in schools in Australia, Ireland, Scotland, and, within the United States, in Kansas, Nebraska, Montana and South Dakota, is located proximate to areas prone to winds or sizable bodies of water. The Deanburn Primary School in West Lothian, Scotland, employs a wind turbine to provide its energy, with an estimated ₤40,000 or $62,112 cost to construct.

Benefits of wind energy include a significant reduction in carbon dioxide emissions, its renewability, availability, reliability, permanence, and comparative low cost. Detriments include creation of noise and variability of wind speeds, as well as limitations on strategic, advantageous geographical positioning.

Subterranean/Monolithic Dome Construction

Subterranean school construction drastically reduces environmental impact, conserves, promotes and repairs natural areas, reduces energy and construction material needs, light and sound pollution, and footprint, while providing additional resistance to fire and storm damages and additional space above (athletic fields). Detriments include additional needs for concrete, control of vapor, water table and earth toxicities, as well as building code accommodations. No subterranean public school construction (K-12) has been identified in New Jersey but several such schools exist in the United States, including, most notably, Terraset Elementary School, Reston, VA, placed in use in 1977.

Monolithic domes, a one-piece concrete building, can provide initial lower costs for construction, especially for such large, open spaces as gymnasiums, libraries, cafeterias, auditoriums and theatres, energy savings via thermal mass, low maintenance, fire and storm resistance (reducing insurance premium), and radial spaces (no corridors, hallways). Detriments include unused space and conversion of square footage requirements and standards to radial footage.

Net Positive Energy Building

Net positive energy buildings or, alternatively, zero-energy structures, as currently proposed for corporate buildings in Masdar City, Abu Dhabi, and Pearl River Tower, Guangdong, China, would generate as much energy through renewable means as they consume. Proposed designs for these buildings include multiple energy-generating systems, elimination of carbon emissions, and reduction of liquid and solid waste. Using sustainable materials, integrated wind turbines indoors, air quality monitors outdoors, and one of the world’s largest applications of solar arrays, the Masdar City, Abu Dhabi building will comprise 1.4 million square feet at an estimated cost of over $300 million ($215 per square foot). Construction features include sub floor air distribution, natural shading, daylighting, and thermal-driven cooling and dehumidification systems.

Design of the Pearl River Tower includes a sculpted facade that will direct winds to a pair of openings on the building's mechanical floors to drive turbines. Radiant slabs, geothermal heat sinks and integrated photovoltaics provide support for the net-positive, zero-energy intent. Energy consumption is reduced by maximizing natural daylighting, reducing solar gain in air conditioned spaces, retaining rainwater for gray-water usage and using the sun to heat the hot water supply.

Daylighting

Daylighting consists of employing natural light to illuminate building spaces. Advantages to daylighting include improved life-cycle cost, user productivity and reduced emissions. Clearly, sunlight is free, clean, efficient and available. Additionally, daylighting reduces the need for electric lighting, which produces heat, among other disadvantages, while connecting people to the outdoors. Daylighting can reduce needs for air conditioning systems and other mechanical systems. Disadvantages to daylighting include climate modulation (too sunny, too cloudy), calibration of specific heat gains and losses, and glare control.

Post Occupancy Evaluation (POE)

Post occupancy evaluation (POE) is the systematic evaluation of buildings in use from the perspective of end users. Using teachers, parents, administrators, students and maintenance staff, the goal of the POE is to assess how well the buildings match users' needs and identify ways in which to improve building design, performance and fitness for purpose. POE uses the direct, unmediated experiences of building users, unlike such evaluative tools as a Lessons Learned currently required of CMs or PMFs. Benefits of POE include provision for "fine tuning" of buildings to increase users benefits, improved design for future buildings, accountability through assessment of building quality, and customer relations through involvement of building users in defining how the building works for them. POE could also be defined as a part of the 11-month walk through.

Detriments of POE include replication of building designs and information on design efficiencies that may not be applicable to future projects, schools districts that may opt out of the program, working assumption that all punch list work is completed, and the estimated length of time to complete an individual assessment (7 to 10 weeks).

Building Information Modeling (BIM)

Building Information Modeling (BIM), a software-driven repository of project data generated by the design process itself for a given project, is used by firms in the U.S., U.K. and Australia. BIM combines all design and construction documents as well as building maintenance information into a single database. The project database provides ability to use and share stored information to create three-dimensional models, enabling faster, higher-quality design processes and accessibility to the process. With project information organized electronically, designers, consultants, engineers, contractors and project managers share such project information as design documents and construction drawings. BIM allows a seamless transition from the design phase to the construction phase and further along to the owner's facility management phase. The American Institute of Architects (AIA) Technology in Architectural Practice (TAP) awarded the Willie Coy Payne Jr. High School in Gilbert, Arizona, for its achievement in quantifiable benefits in cost, schedule and quality in use of BIM.

Advantages of BIM include provision of warranty periods, system training schedules, and operations and maintenance manuals to be digitally imported, tracked and reviewed. Detriments of BIM include software learning curve and experience, especially with programs such as Expedition. Legal exposures incurred from use of parametric modeling for the design and construction phases serves as an additional detriment. BIM use increases challenges to design and construction, such as in the movement from physical models—and hard-copy plans and specifications—to the primary information generators for a digital database. Ownership and control of the digital information, regulation or control of revisions to the model remain added uncertainties.