Sustainability – for anybody who wants to make a profit

Turning Green into Gold

By Alan Whitson

Slowly, green products are working their way into projects. New carpet is now made from old carpet. When that carpet must be replaced, the manufacturer will again recycle it into new carpet. Gypsum wallboard is being made from fly ash, a byproduct of electrical production, rather than gypsum from a quarry. Mercury is a highly toxic but essential component of fluorescent lamps; yet, one lamp manufacturer has invested millions of dollars in reducing the mercury in its lamps, while others simply looked for ways to pass government-mandated tests.

However, sustainability goes beyond using green products; it's the whole process – from concept through operation – that makes a building sustainable. A common misconception about sustainability is that it costs too much. Not only is that wrong, but the sooner sustainability is integrated into the design and engineering process, the greater the opportunity for savings. The objective is to optimize the use of resources, reduce inefficiencies, and save both time and money.

Sustainability is really about adding value, whether it is shareholder value or the value of your building. You can literally turn green into gold.

Let's illustrate by examining the Aladdin Hotel in Las Vegas. This 38-story, 2,600-room hotel was originally designed like most Las Vegas hotels to incorporate a concrete frame. However, when the bids were higher than expected, creative alternatives were needed.

SMI-Owen Steel Co., Columbia, SC, submitted a proposal for a staggered steel truss structural system that cost 10-percent less than the original concrete frame design. Besides saving over $4.5 million in hard construction cost, a major reduction in construction interest expense was possible since the hotel was completed four months sooner. However, the big money was in the ability to start the $2-million-a-day revenue from hotel and casino operations 120 days sooner – that's almost a quarter of a billion dollars.

Developed by MIT in the late 1960s, the staggered-truss system is appropriate for use in such buildings as apartments, condominiums, dormitories, hotels, and nursing homes that are six stories or more in height. This innovative system has most of the advantages of flat-slab concrete construction at significantly lower cost. Neil Wexler, author of *The AISC Design Guide for Staggered-Truss Buildings*, says it's the use of geometry that is the basis for the savings over concrete and traditional steel designs. Other benefits include minimum deflection and greater stiffness in the structure while reducing seismic loads and foundation costs.

The heart of the system is the story-high trusses that span the width of the building. The trusses are concealed inside demising walls with vierendeel openings in the trusses for corridors and door openings. This allows column-free areas up to 60 by 70 feet, while the column spacing for conventional post-and-beam steel construction is 25 feet to 30 feet; for a concrete structural system, it is 18 feet.

Structural elements align from floor to floor in typical post-and-beam construction. However, in a staggered-truss system, the trusses form a staggered pattern; hence, the name. To illustrate, the trusses on the second floor would extend across the building at column lines 1, 3, and 5; on the third floor the trusses would be at column lines 2, 4, and 6. The top chord of the second-floor trusses align with the bottom chord of the third-floor trusses. Precast concrete planks are used to create the floor deck, producing a semi-finished floor and ceiling in one operation, eliminating the wet trades and allowing all-weather construction.

Less is More Green

Currently, 95 percent of all structural steel in the United States is made from recycled steel. But sustainability goes beyond a product's recycled content to include the most efficient use of the product or material. A typical post-and-beam steel frame uses eight to 10 pounds of steel per square foot, compared to the staggered-truss that uses 5.5 to 6.5 pounds of steel per square foot. This can reduce the amount of steel needed by one-third to one-half.

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There's a synergy to this design. Fewer columns are needed and less steel is used. Even the precast floor planks weigh up to 30-percent less than poured-in-place concrete methods. This allows a simpler foundation that further reduces the amount of steel and concrete used in the project.

It is also a practical solution for reducing floor heights. The obvious benefit is the opportunity to increase the number of floors within the building envelope. Another is the ability to reduce the ratio of building exterior to building floor area. While a subtle benefit, a building's exterior skin can cost more than its structural frame. Also reducing a building's exterior surface area can reduce the heating and cooling load for the mechanical system. Other areas for savings include reductions in plumbing riser heights, and the time and cost of applying fireproofing to the steel.

From a construction management perspective, there are benefits as well. Using prefabricated steel and precast concrete allows the work to be done by a single subcontractor rather than multiple subcontractors. Bidding is usually energetic due to a large pool of qualified subcontractors. Since there are fewer structural elements, this translates into fewer shop drawings, fewer trucks making jobsite deliveries, and faster erection that allows other trades to begin sooner.

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Project Strategies to Keep More Green (as in Money)

Going green is a lot easier if you keep track of all the numbers, which means paying attention to more than just direct construction costs. Indirect costs can easily be 30 to 40 percent of total project cost. Construction loan interest and opportunity costs for a developer's equity are a significant component. Let's examine how using systems and products that shorten the construction period and pushing spending into later stages of construction can impact total project cost.

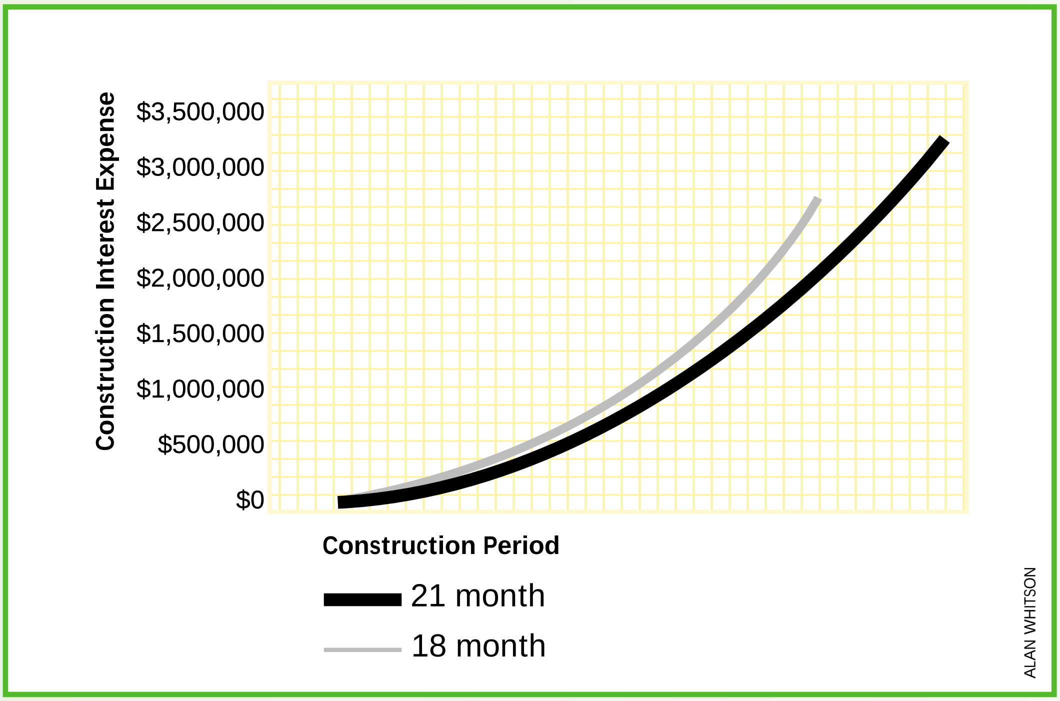
Let's assume a project has an estimated total cost of $39.1 million, and 32.6 percent – $12.7 million – is indirect cost. The developer has an equity investment of $8.1 million. By investing in this project, the developer will forego the opportunity of earning 11.38 percent on the money during construction. A construction loan of $31 million was arranged at 13-percent annual interest rate. The monthly construction loan draw is $1.325 million. A total of more than $3.315 million of interest expense will incur on $27.825 million of loan draws over the 21-month construction period.

Construction loans are structured so principal and interest are due at the end of the project. As the project moves forward each month, the loan balance grows and so does the interest expense. By month 21, the monthly interest expense is $301,437 or 9 percent of the total interest expense for the project. Condensing the construction period by three months to an 18-month schedule will cut the total interest expense to approximately $2.864 million, saving $452,156 or 13.6 percent. Additionally, it will reduce the opportunity cost on the developer's equity from $1.774 million to $1.499 million, saving $275,575.

An advantage of "greening" the design and engineering process is the savings typically identified in the mechanical and electrical systems that can be used later in the project on items like movable walls; access floors; carpet tile; or higher-grade, longer-life carpet. These items pencil out on a life-cycle cost basis and create more flexibility, but are often cut from the original budget by "first-cost" conscious developers. Delaying a $1 million expenditure from month seven to month 16 of the truncated project reduces interest expense to $2.766 million, saving $97,500.

In this example, interest expense was cut by 16.6 percent, and the opportunity cost on the equity investment was cut 15.5 percent. Total savings: $825,231.

Remember: Green is also the color of money. B



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Specification Overkill

The design and engineering process must address a long list of criteria, including building codes, laws of physics, and rules of thumb that have developed over the years. However, criteria based on experience may no longer prove valid.

The proliferation of desktop computers, laser printers, and fax machines in the early 1980s overwhelmed the mechanical and electrical capacity of the typical office building. Building systems designed to accommodate an electric typewriter could not meet the stress created when desktop computers started appearing on every desk. Clearly, greater mechanical and electrical capacity would be needed to handle the increasing amount of technology finding its way into the office.

Today, a plug load capacity of four to six watts per square foot is a requirement for many tenants seeking space. A building with only three watts of plug load capacity may find itself excluded from consideration by the tenant. The irony is that it is difficult to exceed a plug load of 1.5 watts per square foot. The typical office building has a plug load of about 1.0 watts per square foot.

As developers, architects, and designers were busy increasing the mechanical and electrical capacity of office buildings to meet the increased technology, the high-tech industry was moving in the opposite direction: reducing power consumption levels. Early desktop computers consumed several hundred watts. By the early '90s, power consumption for the typical computer fell to roughly 120 watts. Introduction of the U.S. EPA's ENERGY STAR® program in 1993 helped reduce power use further by encouraging the development of the "sleep mode." This allowed a computer and monitor to consume a miserly 75 watts and 12 watts, respectively, when in the sleep mode. The savings potential is enormous, considering that the average desktop computer is on seven hours per day, but used for four hours, and 30 percent of computers are left on overnight and weekends. The City of San Francisco saves about $150,000 each year through a program of encouraging city employees to use the sleep feature and turn off equipment before leaving the office.

The trend of laptop computers replacing the traditional desktop also has a dramatic impact on power consumption and heat load. At 15 watts or less in power use, laptop computers offer a 90-percent reduction in power use without losing computing power and the added benefit of mobility. Continued improvement in efficiency and power management may reduce their power needs to less than five watts.

Power consumption for lighting also dropped during the last 20 years. Improvements in lighting technology suggest the trend will continue. For example, in 1980 the typical lighting load for office space was three watts per square foot. Ten years later, it dropped 50 percent to a peak use of 1.5 watts per square foot. By 2000, peak lighting load had dropped to 1.0 watt or less per square foot. As lighting controls become more common, further reductions in heat load for the mechanical system will be possible. As a result, many office buildings have oversized mechanical systems, creating a huge penalty in operating efficiency. Even buildings with systems correctly matched to peak load requirements will operate at partial load conditions over 90 percent of the time. A chiller with a design efficiency of 0.5 kW per ton can operate at 1.0 kW per ton or more during partial-load conditions. Alternatives – multiple smaller chillers for multi-staged operation, or a single chiller with a variable speed drive – are more efficient at partial-load conditions. Clearly, the potential for savings in both construction cost and operating costs are great.

Rather than use four to 10 watts per square foot for lighting and plug load levels, a more sensible standard would be 1.5 watts for plugs and 1.0 watts for lighting. While still conservative, it would allow the mechanical systems to run more efficiently and lead to reductions in first costs, operating costs, and pollution. A reduction in the mechanical system load of 2.5 tons or more of cooling per 1,000 square feet is possible. This translates into savings of $4 per square foot in construction costs and $0.50 per square foot in annual operating costs.

The financial impact of this on an investment-grade office building is dramatic. Office buildings are typically valued by the income capitalization method. Using this approach, the net operating income (income minus expenses, but not including debt service) is divided by a capitalization rate to establish a building's value. A reduction in annual operating costs of $0.50 per square foot at 8.25-percent capitalization rates would increase a building's value by $6.06 per square foot. In short, a developer could reduce construction costs $4 per square foot and increase building value by $6.06 a square foot.

Even more dramatic is the impact on a company that owns its facilities or leases them on a triple net basis. Assume the company has a price earnings ratio of 22 and owns a 350,000-square-foot headquarters. Saving $0.50 per square foot in operating costs is equal to adding $3.85 million to the company's market value, with 20 million shares – that's 19.25 cents per share.

No question: Sustainable products are important. Yet, equally important are the design, engineering, and operation of a building. Opportunities to protect natural resources, create a healthy productive workplace, and save money can appear in the most mundane places. B

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