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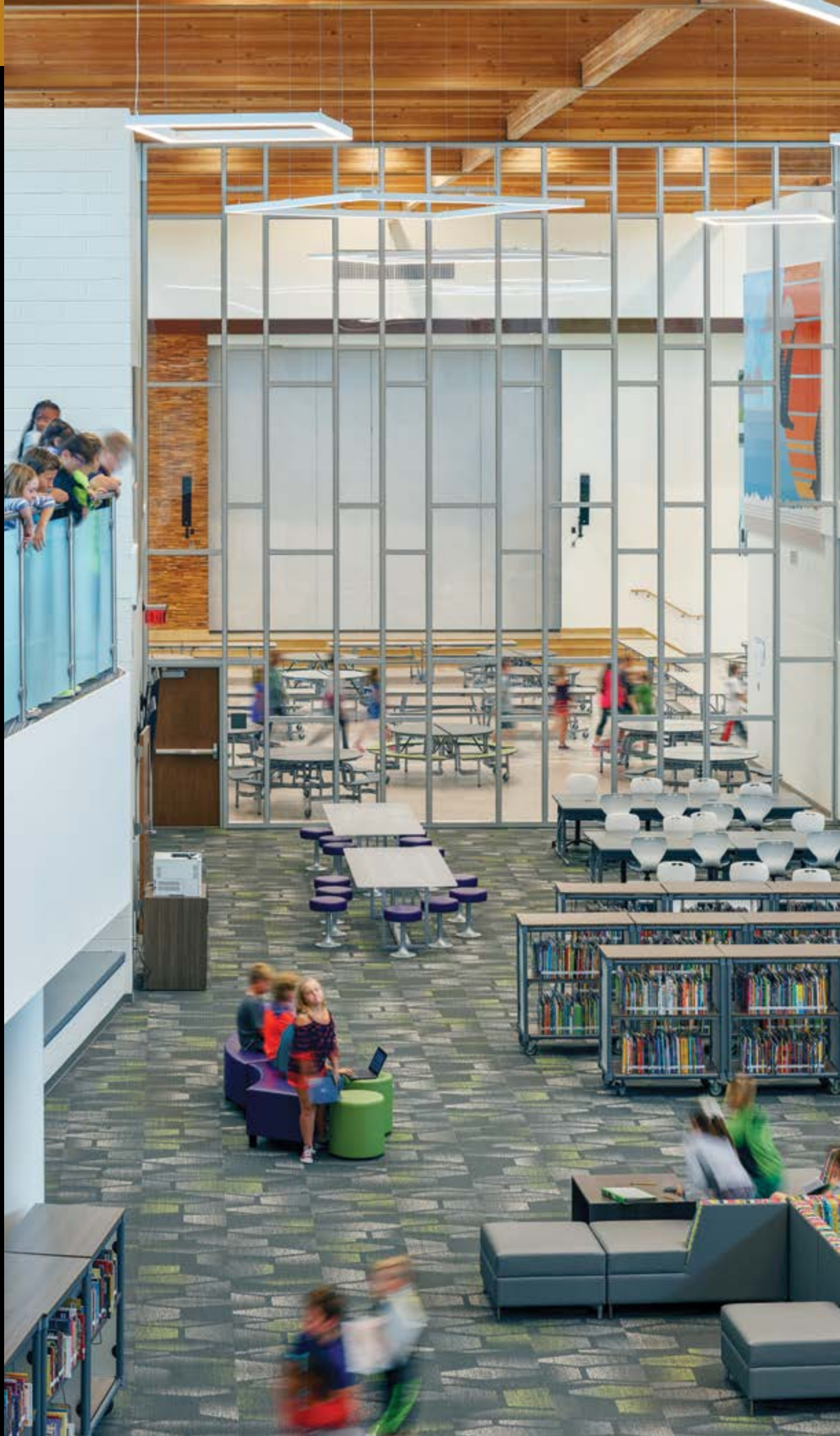


Student-centered learning commons at St. James Intermediate School in Horry County, S.C. Photo: Tom Holdsworth Photography, courtesy of SfL+a Architects/ Firstfloor.

Life-Cycle COST ANALYSIS

The whole is greater than the sum of its parts

— Robbie Ferris

There are two ways to perform life-cycle cost analysis (LCCA) and they produce very different results. The traditional method of LCCA evaluates the life-cycle cost of specific systems such as heating, ventilation, and air conditioning (HVAC). However, it does not focus on the total cost of ownership for the building. A more comprehensive method of LCCA compares the total cost of owning a specific building against other, similar buildings. Often this is a comparison of a high-performance building to a baseline building. Is this true? Does LCCA only apply to high-performance buildings? Could this analysis be conducted on any building? I would call this whole-building analysis. While each method is valid, the results of the analysis are typically very different. If the results are different, which method is best?

If you are only going to replace the HVAC system in an old building, the traditional method is probably the right choice. If you are trying to decide whether to replace a building or renovate it, looking at the whole building is the method that will produce accurate results. Additionally, if you are comparing the LCCA for renovating with building a baseline building and/or building a high-performance building, then using the whole-building method is essential. Some would argue that both methods allow you to compare the total cost of a baseline building to a high-performance building. While that is partially true, the reality is the integration of the systems in a high-performance building leads to significant LCCA savings. Once again, you must choose the method that is right for your project.

BEGIN WITH THE END IN MIND

The traditional LCCA process has a very narrow perspective. It leaves you with a set of systems that supposedly have the lowest life-cycle cost and, for the most part, those systems don't impact each other. For example, the type of HVAC system has little to nothing to do with the shape of the building in the traditional LCCA process. Whole-building analysis is about selecting systems based on the big-picture goals for the project and the qualities you are looking for, and then optimizing how one system impacts the other. The goals are well established and guide the process. We have

Solar trees at Sandy Grove Middle School. Photo: SfL+a Architects/ Firstfloor.

all heard building owners say something like, "We really wanted to try out a geothermal HVAC system, or solar panels, or a handful of other things, and we just could not make the math work." The problem is that without big-picture goals, the design and implementation are less likely to take into account how these decisions would impact other building systems. The following case study illustrates this point.

SANDY GROVE MIDDLE SCHOOL

In 2009, SfL+a Architects began the design of Sandy Grove Middle School in Hoke County, N.C. For this traditional school the owner wanted an "E" plan and had ideas about what the building should look like. As the recession set in, the district reviewed its projected total cost of ownership, estimating the debt service payment combined with the electrical bill to be $1.5 million per year. The project went on hold. In 2011, the district came back to SfL+a and said they desperately needed the new facility but could only afford $450,000 per year for the first 8 to 10 years. We said, if you let us redesign the building to eliminate the electrical bill and you lease the building from us, we can get the payment down to $450,000 per year. Setting the lease payment at what the district could afford was the defining moment in the LCCA process. Our team divided the total cost of ownership into categories: capital cost, interest cost, electricity and other utilities, and tax credits and incentives. We found that maintenance costs would be about the same regardless of the systems selected, so we focused on the things that had the biggest impact. We then realized that electrical costs were almost 30% of the total cost of ownership over the 40-year life expectancy of the systems. We realized that we had the most control over electrical costs and could eliminate them. Knowing that we needed to generate 30% more electricity than we would consume, we factored in the number of solar panels we could install on the roof and their subsequent energy production, and determined that the building needed to achieve an energy use intensity (EUI) of approximately 20. The EUI goal led to our using the most efficient systems we could find, such as a geothermal HVAC system, LED

The traditional LCCA process has a very narrow perspective.

lighting, a super-insulated roof, foam insulation in the cavity wall, and a variety of other energy-conserving measures. Our next focus was the interest costs, which we creatively found a way to eliminate. Additional savings came from tax credits that were available for the project, which made it a win-win for everyone. Over 40 years, Sandy Grove Middle School will save Hoke County Schools $37.2 million.

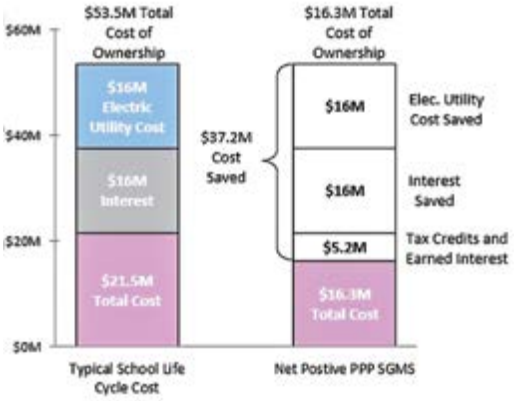
WHOLE-BUILDING LCCA VERSUS TRADITIONAL LCCA

Let's compare this process to the traditional LCCA process, where we invest exhaustive amounts of time comparing HVAC systems, insulation, roofs, etc. If we're doing our job correctly, there are literally hundreds, if not thousands, of combinations of systems that we should compare. In practical terms, comparing combinations of systems rarely, if ever, gets done. Eliminating the electrical cost is typically not a project goal because no one ever stood back and looked at where the real money is being spent. Most design/construction teams do not think this is within their control, thus it is not addressed. Under the traditional LCCA process, the team focuses on the details without looking at the big picture. When looking at the whole building cost for Sandy Grove Middle School, we never even considered systems that would not get us to an EUI of 20, and consequently, we only needed to evaluate two HVAC systems. Under the traditional LCCA process, we never would have decided to add roof insulation because most engineers will tell you that once you have 4 to 5 in. of insulation, the difference in energy consumption is not worth the investment. In our case, we had to get to an EUI of 20 and adding roof insulation needed to be part of it. There were many other decisions we made similar to this, and it's clearly different from the traditional LCCA process.

> Stand back and look at the big picture goals before getting into the weeds analyzing systems.

Anytime you start a project, you should stand back and look at the big picture goals before getting into the weeds analyzing systems. If you use this approach, you will likely eliminate the infinite number of options that usually lead to ordinary buildings. What are we trying to say here? Focus on the big picture goals.

Main entrance at St. James Intermediate School. Photo: Tom Holdsworth Photography, courtesy of SfL+a Architects/Firstfloor.



Over 40 years, Sandy Grove Middle School will save Hoke County Schools $37.2 million.

Aerial view of Ten Oaks Middle School, Horry County Schools. Image courtesy of Metcon/TA Loving.

If time is your biggest issue, focus on what can be prefabricated and then analyze the remaining systems. For example, our team designed five new schools for Horry County, S.C., that had a tight 20-month design-permit-build schedule. To meet the schedule, we chose to prefabricate the HVAC penthouse and to use precast concrete for the roof and floor structure. These schedule-driven choices, along with the program requirement to generate more electricity than we consumed, drove most of the system decisions in the building.

Looking at the whole building produced an exceptional end product.

Our architectural team (SfL+a, Stantec, and Mozingo + Wallace) responded with a compact floor plan that reduced the amount of exterior wall and exterior glazing while maximizing views and daylighting. The compact plan also made for some very dramatic interiors. Reducing exterior walls reduced first cost, as well as energy and maintenance costs. The floor system is a hollow-core concrete, and we used the hollow-core as the ductwork for the building. This allowed us to store thermal energy in the concrete and reduced the height of the building by 6 to 8 ft, thus reducing first cost, electrical costs, and maintenance costs. We used a geothermal HVAC system with a prefabricated HVAC penthouse, which allowed us to use three air handlers for the entire building, resulting in the maximum opportunity for diversity. This system combination reduced HVAC system tonnage and gave the client more control of the building when there are exceptionally large people loads in certain areas like the gym and lobby. Looking at the whole building produced an exceptional end product that would never have been achieved using the traditional LCCA process.

Robbie Ferris is the CEO of SfL+a Architects and Firstfloor.