Renovating the Design and Construction Process for Sustainable Success

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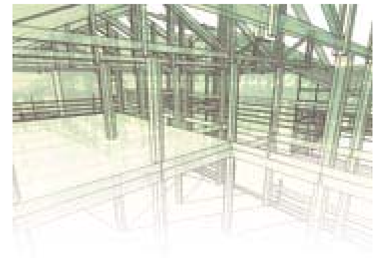


As green building becomes mainstream, architects and engineers must work together with colleagues and clients to achieve superior economical and environmental results.

The number of green buildings is growing worldwide, demonstrating the potential for success in a wide range of applications, climates and cultures. Green is going mainstream.

But despite the momentum and proven examples, these ideas and techniques remain most influential at the cutting edge. The adoption of new ideas (and even established approaches) into common usage is slow. The number of architectural and engineering firms with comprehensive capabilities and strong track records in green design is growing, but remains relatively small.

This is not because people are hostile to the idea of environmental improvements. But standard practices rarely produce excellent performance. Tight schedules and budgets dominate project decisions, creating disincentives to trying new approaches. Often sustainable features are included in a design at the beginning, only to fall victim to the process along the way and fail to make it into the final structure. Many buildings have one or two green attributes, but overall fall short of best environmental practices.

How can those involved in the design-build process collaborate more effectively to make greener structures? In this article we will explore some common obstacles to creating more sustainable buildings, and suggest ways that architects and engineers can work together with colleagues and clients to achieve superior economical and environmental results. We draw upon our years of experience in architecture, mechanical engineering, and project management and consulting. Others such as Amory Lovins and his colleagues at Rocky Mountain Institute also have contributed important work to this analytical and applied approach.

Standard Practice Works, But It Isn't Green

It is very important to incorporate green elements from the very beginning of a project. An old design axiom says that all the really important mistakes are made on the first day. Even small decisions taken early on have significant influence on future building performance and costs. In his book Lean and Clean Management, energy efficiency expert Joe Romm cites research indicating that initial costs (including design, construction and land) comprise about 25% of the life-cycle cost of the building (excluding demolition and occupant personnel costs). These initial costs equal just one-third of the total amount spent on operations and maintenance (O&M) over a building's lifetime. Romm notes that, on average, by the time 1% of project costs are spent, roughly 70% of the life-cycle cost of the building has been determined; by the time 7% of costs have been spent, up to 85% of life-cycle costs have been determined. It seems obvious that it is worthwhile to "measure twice and cut once" where building design and performance are concerned.

But in the workaday world, green building experience is lacking, and schedule and budget pressures limit the amount of effort put into design and construction. If the owner doesn't ask for green features, it is up to another project participant to promote them. Champions of sustainable design face many obstacles in implementing their ideas, both in the marketplace and even within their own organizations. Selling environmentally friendly approaches and equipment to clients, managers and colleagues often remains challenging, especially if it asks them to do anything differently or spend more time and money. Most design and construction professionals have little or no training or direct experience in sustainable building techniques. They don't see much incentive to try something new if they think it might increase the risk of a lost bid or unhappy client. As the saying goes, it can be hard to teach old dogs new tricks. Common practices, habits and perspectives don't prioritize green techniques.

This should not be surprising. After all, the usual ways of doing things seem to work. Buildings get built, their systems function, people occupy them and go about their business, and complaints are relatively few. Architects and engineers get paid and move on to the next project. Most of the parties involved are satisfied. If the system isn't broke, why fix it? The answer is that the public, government agencies and design-build professionals are increasingly realizing the benefits of environmental improvements, and are asking for—and getting—better results. This is clearly a growing trend, to be ignored at commercial peril.

Follow the Money to Get to the Motives

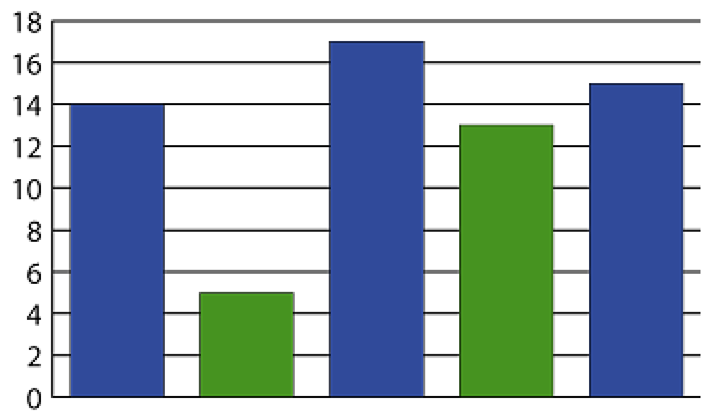
Some might ask, if green building is so cost-effective, why isn't more of it happening in the free market? Surely if it were profitable, people would do it. Well, lots of people are doing it, and making money. There are many demonstrated economic benefits to more sustainable real estate development, but they don't all accrue to the same parties. Some benefits aren't counted directly in our economic system, such as reduced environmental impacts. But most importantly, we don't live in a free market; we live in the real world. Free markets exist only in theories and textbooks. Actual markets function under the influence of human and organizational behaviors and dynamics that prevent more optimal results.

In politics, it is said that if you want to know why something happens (or doesn't), follow the money. The same is true in building, including green development. One needs to look more closely at the economic incentives (and disincentives) facing the various parties to the design-build process to understand why more buildings aren't more sustainable.

Usually there are several different companies and individuals involved in a construction project. Sometimes one party profits at the expense of another party in the same project (even in the same firm). For example, a contractor or project manager might buy cheaper, inefficient mechanical equipment to save money from their budget or to speed delivery. As a result, the tenant or facilities manager pays higher energy bills. For each decision or action, determine whom benefits, and you will often understand why a better outcome for society and the environment (if not for the owner) didn't occur.

Let us now take a closer look at the incentives and disincentives faced by the various parties to the design-build process, and explore why standard practices and paradigms often block environmental improvements. Then we will suggest effective remedies.

The Current Design-Build Process Paradigm



Site Water Energy Materials Indoor Env. Quality
Chart One: Engineers play a primary role in design processes that affect more than half of the points awarded in the LEED rating system.

Consider a representative list of the different parties involved in creating typical commercial buildings. The owner might be building developers seeking to sell or lease the property; or it might be a business, public agency, educational institution or other organization that owns its buildings. The project manager might be an employee of the owner, or a general contractor. The design is created by contractors and consultants, or sometimes by staff of the business owner, including architects, structural engineers and mechanical engineers. Construction is typically contracted out, or sometimes performed by a unit of the developer or business owner. Facility managers operate and maintain the buildings.

Now consider some of the common pressures and motivations that each of these parties face. Any of them can champion sustainable design, but also can undermine it—often unintentionally—by pursuing goals that their position or employer's policies dictate. Each project and decision-maker is different, and generalizations are only useful to a limited extent. Nevertheless, one can draw insights by considering typical incentives and disincentives that come with a given job description and role in the design-build process, regardless of the opinions and values of the person who is doing that particular job. Scholars of organizational behavior note that "where you stand depends on where you sit."

Developers often build on speculation. The lower their initial costs the greater their potential profit from sale or lease. The structural shell is designed before tenants are found, and performance specifications are unlikely to exceed building code requirements. Developers might buy low-quality equipment to save money, but they don't ultimately pay the energy bills. They might be experienced in green building techniques, but probably not. Many see little incentive to risk slowing their project turnover rate, increasing costs, or alienating potential customers with unfamiliar green features.

Tenants usually have little control on building design, and tend to have a short-term perspective on costs. Even buyers of spec buildings often have no influence on the design or performance.

Organizations that own their buildings are more likely to take a more integrated long-term perspective on life-cycle cost and performance (especially for new construction). They might be more interested in green building concepts than other players might—or at least more likely to push for improvements. Even then, senior managers might share and communicate a greener vision, but face competing pressures from project managers or department heads within their own firm or among their contractors.

Project managers are often rewarded for completing work ahead of schedule and under budget. This can provide incentives to cut corners, reject or redo design features and specifications (such "value engineering" often undermines integrated design), squeeze more out of contractors, and proceed with the most readily available options without pausing to make improvements or even to correct non-critical shortcomings and mistakes. If the manager's budget is funding construction but not building operation, there might be an incentive to use cheaper but lower-quality materials and equipment and leave any increased maintenance or cost concerns to somebody else. These factors apply to both owners' employees and general contractors alike.

Architects are encouraged to innovate, and are rewarded for interesting new designs with recognition and further work. But environmental attributes do not often rank high in the review criteria of their clients and peers. Architects might have significant training or experience in whole-system, resource-efficient sustainable design, but probably not. If the client hasn't asked them to create a green building, they have little incentive to struggle to explain the potential benefits to the owner or contractor. As Lovins puts it, when fees are based on a percentage of project cost, the compensation structure rewards architects for what they spend, not for what they save the client (or whomever ultimately pays the utility bills) in reduced energy or water use and costs.

Architects and engineers must work together on the same design, but that does not mean that they necessarily coordinate their efforts to produce an optimal building. In many cases the architects and engineers are from different contractors. Even when they are from two departments within the same firm, all too often there is relatively little communication and harmonization of design approaches and equipment specifications. The architect completes the design with minimal input from the engineers, and in effect rolls up the drawings and pushes them through a little hole in the wall into the engineering department to execute the next project phase. The design process is sequential rather than simultaneous, and literally disintegrated.

There are two main tribes of engineers involved in building. Structural engineers are relatively conservative in their approach, because if their design doesn't work, someone could die. Safety and consistency are prioritized over innovation. Mechanical engineers (MEs) face less pressure in that their worst-case design failure scenario is that building occupants might have to buy a fan or heater. But MEs are ultimately responsible for the majority of a building's energy use. For example, HVAC systems comprise almost half of the energy use of a typical San Francisco office building, the largest share of the load. (Next largest are lighting at more than one-fourth, and plug loads at over 10%, of the building's total electricity use.) Yet better mechanical systems designs are typically invisible to users. Even if those paying the utility bills realize lower costs, unless they share the savings with the engineering team, the MEs are typically not rewarded for innovation or greater effort to green the design.

As Chart One above indicates, MEs also have significant influence over a building's potential LEED rating system score. Of the five primary categories, ME decisions determine or significantly affect building performance in the areas of Water Efficiency (5 points), Energy and Atmosphere (17 points) and Indoor Environmental Quality (15 points). These categories total 37 of the total possible 64 points. The other two categories are Materials and Resources (13 points) and Sustainable Sites (14 points).

Both types of engineers face incentives to over-design structural and mechanical systems, as excess capacity provides a margin of security (but often wastes resources). Both types labor under the same tight budgets and short timelines. They often specify average rather than premium quality equipment to cut initial costs, and use design rules of thumb to save time. Indeed, if a problem arises, the engineer's best defense is that the design follows standard practice. Techniques that worked in the past (or at least did not fail) are copied and re-used. Measurement and analysis of previous structures' actual performance is not commonly incorporated into improving the next similar design. Unlike architects, the engineers are quite happy to make a building look and perform like the one next door. These habitual approaches produce functional but energy-intensive designs.

Facility managers' experience and input is rarely solicited and incorporated into the design process. Typically they are handed the keys after the building is done, and tasked with keeping the lights on and the floors clean on a limited budget. Increasingly their function is outsourced. Their staff might not have the time or training to commission, maintain and operate systems at peak environmental performance. They might not pay the utility bills, nor have much funding for investment in building improvements. Even if they do, they might not be inclined to increase energy and water efficiency and cut costs if their reward is a smaller budget next year.

The typical result of this collective process is safe, interesting looking structures with poor energy performance and average (read: excessive) environmental impacts. This is insufficient for sustainable development. Yet most of the parties described above are used to these standard approaches and common dynamics, adhere to them habitually and expect them intuitively. They see nothing abnormal and little need for improvement, given that for the most part the end-user clients and occupants are satisfied, or at least not complaining any more than usual. No market failures are required to explain this outcome, although it imposes unnecessary costs on society. All of the participants in this process are acting in their economic rational self-interest, within the bounds of their knowledge.

This is part one of a three-part series.