An Introduction to Green Building

By Alexis Karolides

Part 1: Resource Efficiency

Today it is commonly assumed that the built environment will degrade the natural one, but this belief is not based on historical evidence. For most of earth's history, structures built for shelter have typically enhanced biodiversity and benefited the surrounding community. Beaver dams, for instance, create eddies where wetlands form, supporting a vast array of diverse life. Why should an office building be any different?

"Green building" is a way of enhancing the environment. It benefits humans, the community, the environment, and a builder's bottom line. It is about tailoring a building and its site to the to local climate, site conditions, culture and community, in order to reduce resource consumption while enhancing quality of life.

There is no singular "look" for a green building. While natural and resource efficient features can be highlighted in a building, they can also be invisible within any architectural design.

Likewise, a green building is not an assemblage of "environmental" components or a piecemeal modification of an already-designed, standard building. These approaches not only add to the building's cost, but also produce marginal resource savings at best. True green building takes a holistic approach to programming, planning, designing, and constructing (or renovating) buildings and sites. It involves connecting often-interlinked issues such as site and climate, building orientation and form, lighting and thermal comfort, materials, etc., and optimizing all these aspects in concert. In order to capture the multiple benefits of synergistic design, the "whole system" design process must occur early in the building's conception and involve interdisciplinary teamwork. In the conventional, linear development process, key people are often left out of decision-making or brought in too late to make a worthwhile contribution. Early and complete collaboration, however, can reduce or eliminate both capital and operating costs, while at the same time meeting environmental and social goals.

It is precisely the integrated approach described above and the multiple benefits thereby achieved that allow many green buildings to cost no more than standard buildings, even though some of their components may cost more. Green design elements may each serve several functions and might allow other building components to be downsized. For example, better windows and insulation can result in smaller heating systems; photovoltaic panels can double as shade for parking or can replace a building's spandrel glazing.

Buildings use 40 percent of total U.S. energy (including 60 percent of electricity) and 16 percent of total U.S. water; they produce 40 percent of the waste in landfills. *Natural Capitalism* documents how radical improvements in resource efficiency are readily possible—today's off-the-shelf technologies can make existing buildings three to four times more resource-efficient and new buildings ten times more resource-efficient.

Reducing energy use in buildings saves resources and money while reducing pollution and CO_2 in the atmosphere. It also leverages even greater savings at power plants. For the average 33-percent-efficient coal-fired power plant, saving a unit of electricity in a building saves three units of fuel at the power plant.

As RMI's Amory Lovins has often said, "It's cheaper to save fuel than to burn it." But full financial benefits will only be realized by using the integrated approach described above (high performance windows will increase initial costs unless the designer takes proper credit for smaller heating and/or cooling loads and equipment). Just as important as what goes into a green building is what can be left out. Green building design eliminates waste and redundancy wherever possible.

One of the key ways of reducing resource consumption and cost is to evaluate first whether a new building needs to be built. Renovating an existing building can save money, time, and resources, while often enabling a company (or a family, if it is a residential building) to be located in a

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part of town with existing infrastructure and public transportation, enhancing convenience and reducing sprawl. If a new building is required, it should be sized only as large as it really needs to be. Smaller buildings require fewer materials, less land, and less operational energy. Our cultural assumption is that we should buy (or lease) as much square footage as we can afford. Yet the average new house size has steadily increased over the past few decades while families have gotten smaller. Smaller houses and commercial buildings allow the budget to be spent on quality, not "empty" quantity.

Energy. The easiest and least expensive way of reducing operational costs in a building is to lower its energy consumption—best done by increasing energy efficiency. There are great energy-cutting opportunities in simple designs that respond to location and climate. Most North American buildings should face their long side to within 15 degrees of true south (and use proper shading to block summer sun but not winter sun). This can save up to 30 or 40 percent of the energy consumption of the same building turned 90 degrees.

Heat travels in and out of buildings in three ways: radiation, convection, and conduction, all three of which must be addressed. Radiation is the transfer of heat from a warmer body to a cooler one via infrared rays. They can be blocked by using reflective surfaces. Convection is the transfer of heat by heat-driven circulation of a fluid or gas, such as air. Convective heat transfer can be controlled by sealing gaps around windows, doors, electrical outlets, and other openings in the building. Conduction is the transfer of heat across an immobile substance. Every material has a specific conductivity (U-value) and resistance (the inverse of the U-value, called the R-value). Metal is a great conductor, so if high-performance windows have metal frames, there will be a "thermal break" in the frame (an insulating material inserted to block the heat transfer across the metal).

As the above descriptions suggest, one of the best ways to reduce heat loss or gain is by installing the appropriate high-performance window for the given climate. The right window can save energy, enhance comfort, allow space-conditioning systems to be downsized, reduce fading from ultraviolet light, reduce noise from outside, reduce condensation, and improve daylighting.

Once the building envelope is designed to reduce heat flow, we can use a number of natural heating and cooling methods to downsize or even eliminate fossil-fuel-based heating and cooling systems. Techniques include daylighting, passive solar heating, natural ventilation, passive cooling, efficient and right-sized HVAC systems, and utilization of waste heat.

Daylighting enhances visual acuity for occupants, creates a connection to nature, and increases productivity and well-being. It also reduces operational energy costs as electric lights are turned off or dimmed when daylight is sufficient. This points out the importance of integrating all the technical systems—daylighting, lighting, and space-conditioning. It is also important to design systems for varying loads.

When energy loads are as small as practical, appropriate renewable energy sources should be evaluated. These include wind, biomass from waste materials, ethanol from crop residues, passive heating and cooling, and photovoltaics. An electrically efficient building might be less expensive to build with "off-grid" power than to connect to the grid.

Demolition/Construction Practices. With any site development it is important to protect adjoining agricultural areas, rivers, and trees, and to be especially vigilant about erosion control. Rather than degrading the surrounding environment, development can enhance it.

Next, demolition and construction should be carefully planned to reduce or eliminate waste. Typically, demolition and construction debris account for 15–20 percent of municipal solid waste (and sometimes as much as 40 percent), while estimates are that 90 percent of this "waste" could be reused or recycled. Reusing and recycling waste is not only the environmentally friendly thing to do, but could save money and promote local entrepreneurial activities.

It is critical to note that reusing, salvaging and/or recycling materials requires additional up-front planning. The contractor must have staging/storage locations and must allot additional time for sorting materials, finding buyers or recycling centers, and delivering materials to various locations if buyers don't collect them.

Third party commissioning. When the building is completed, third party building commissioning—making sure systems are installed and running as designed and as efficiently as possible—can save as much as 40 percent of a building's operating costs for heating, cooling, and ventilation, according to Lawrence Berkeley National Laboratory. Ongoing regularly scheduled maintenance and inspection are also critical to maintain the performance and efficiency of the building and its mechanical systems.

Recycling. Americans produce an estimated 154 million tons of garbage—roughly 1,200 pounds per person—every year. At least 50 percent of this trash could be, but currently isn't, recycled. Recycling doesn't stop at the jobsite. The building should be designed to foster convenient recycling of consumer goods throughout the life of the building. This usually entails easily accessible recycling bins or chutes, space for extra dumpsters or trash barrels at the loading dock, and a recycling-oriented maintenance plan.

Next issue: Environmental Sensitivity.