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What 150 Green Buildings Taught Us

Feed the Passion

Why? A successful green building follows a journey and each journey has its twists and turns. Owners who ask for a green building typically have a passion for a building that stands out among others delivering high performance for the occupants, the environment, and for the Owner's balance sheet. The passion that is expressed at the beginning of the project needs to be fed as it will carry the project to a successful conclusion.

How? While the architect is programming the building spaces, concentrating on space layouts and interior issues, a green building expert needs to augment this process by programming mechanical and electrical systems. Does the Owner have preferences for the approach to the engineered systems? How did the Owner come to want a building that is green? Is the Owner concerned about global warming? Does the Owner look at the building as an advertising opportunity? Has the Owner read or heard about promising technologies that they want to consider for their building? Make sure your green building expert is present during the initial stages of design to document the Owner's priorities when it comes to green upgrades to be included in the building.

Define the Destination

Why? It is easy to get lost on a journey if you don't know your destination. Wandering down dead-ends wastes time and money while frustrating Owners, diminishing their passion for the project. A successful green building meets the Owner's time and budget requirements. To do this a destination needs to be identified and documented early in design.

How? Document when the Owner expects to occupy the building and how much the Owner is budgeting? This information provides the compass direction for the journey. For bid-build projects, the budget needs to remain confidential until the contractor is selected. Nevertheless, designers must have this information early to prevent a monster called value engineering from rearing its head late in the journey rather than early in the journey when changes are easier and less painful to make.

Document Green Goals

Why? The term "green building" started to be used back to the early 1990's and, decades later, many people still disagree about what makes a building green. If green goals are not clearly defined early on, the Owner can be easily disappointed in the result.

How? Owners typically value the following in green buildings: a healthy environment for occupants, low energy costs, good water conservation, and low maintenance. Early in design, set green goals with the Owner and, wherever practical, assign a numeric value to each goal. For example: The building will be designed to achieve an Energy Star® rating of 85 or higher. Another example: Plumbing fixtures will use 35% less water than code minimum fixtures. If the Owner is seeking third-party green building certification through a system like Green Globes® or LEED®, specify what level of certification the Owner wants to achieve. For example: The Owner seeks a Two Green Globes rating or a LEED Silver rating.

- **Green Globes is a Registered Trademark of The Green Building Initiative (www.thegbi.org)**
- **LEED is a Registered Trademark of the United States Green Building Council (www.usgbc.org)**

Identify Low-Lying Fruit

Why? Value engineering, applied properly, takes place before construction documents are under development. Once contractors have submitted their bids, value engineering can easily become a desperate chaos where good systems and designs are dropped as the only issue being considered is getting a bid under budget. In most cases, these decisions are regretted years later.

How? Provide a cost analysis of the green upgrades early in design. Give realistic estimates of the upgrades and their potential savings before construction documents are being developed. **Use rate of return to evaluate the savings provided by each upgrade, do not use simple payback.** Simple payback was developed in the 1970's and is clearly out of date. It only makes sense if the Owner is paying up front with cash and is not using any form of financing which is extremely rare in today's economy. Rate of return gives the true picture of how each green upgrade will affect the Owner's balance sheet. If the Owner is borrowing money on a 15-year loan at 4% annual interest rate, any upgrade that lasts for 15 years and yields a higher annual rate of return (more than 4%) is an instant money maker for the Owner and will continue to make money for the Owner

every year for 15 years! These upgrades are the low-lying fruit of green. Identify them early on.

Light is Best When It's Indirect

Why? People inside a building need to feel connected to the outdoors. This is typically achieved with glass. However, poor placement of the glass and poor glass performance can lead to high energy bills and excessive glare. The type of light that people prefer, which also makes them the healthiest and most productive, is indirect daylight.

How? The following information applies to buildings in the northern hemisphere:

1. The north exposure gets indirect light most times of the year and that is the best place for glass.

2. Glass on the south, east, and west exposures needs to be clear glass with a solar heat gain coefficient (SHGC) of 0.5 or less. These exposures will also require indoor operable window shades with high reflectivity on the outside surface (surface facing glass).

3. Ideally, the glass on the south will include external shading that extends at least 4-feet out from the glass surface.

If the building is in the southern hemisphere, just swap north for south in the steps above.

Light interior colors, particularly for the finished ceiling, will help bounce indirect light through occupied spaces. Skylights should not exceed 5% of the total roof area, otherwise too much energy will be lost through the skylights and too much glare introduced.

Insulate Exterior Wall Studs on the Outside

Why? Exterior metal and wood studs act as thermal short circuits allowing heat to bypass insulation located between the studs. Hold a long nail on a hot heating element and you can feel the heat transfer quickly to your hand. This same effect takes place through metal studs and wood studs aren't much better.

How? Put at least 2-inches of continuous exterior rigid insulation outside of the studs. This will provide a continuous blanket around the exterior walls, reduce heat loss in the winter, reduce heat gain in the summer, and reduce comfort complaints from people seated near exterior walls. Provide proper weather sealing, vapor barriers, and retarders for the local climate. In hot sunny climates this insulation also prevents the exterior wall mass from heating up during the day and creating high air conditioning demand all night long as this stored heat transfers into occupied spaces.

Cut VOC

Why? Volatile organic compounds (VOC) contribute to unhealthy indoor air quality (IAQ). Many contribute to sinus congestion and eye irritation, aggravate asthma, depress the immune system, and can become allergens when occupants are exposed to them for hours. Some are toxic and some are carcinogens. VOC are emitted from paints, glues, adhesives, and sealants commonly used in architectural materials.

How? For most buildings, the primary sources of unwanted VOC are paints, carpet adhesives, and particle board. To cut VOC specify the following:

1. Flat paints will have no more than 50 grams per liter (g/L) of VOC
2. Glossy paints will have no more than 100 g/L of VOC
3. Metal paints will have no more than 250 g/L of VOC
4. Carpet and carpet adhesives must be certified Carpet and Rug Institute (CRI) Green Label Plus
5. Wood cabinets, desktops, counters, doors, shelves, and wood trim will have no added urea-formaldehyde

Use LED Lights

Why? Light-emitting diodes (LED) have created a revolution in the way we light buildings inside and outside. LED uses a fraction of the electric energy of fluorescent lights while providing better quality light. Furthermore, LED can last 10-years or more with no maintenance. The only artificial light source that will use less electric energy is a candle.

How? The high cost of LED has vanished as mass production took over several years ago. If your lighting designer is still specifying fluorescent lights, find another lighting designer! LED fixtures in parking lots, streets, and walkways are an easy sell: Just tell the maintenance people they will last for 10-years or more. That's 10-years where they won't have the expense of going up on equipment to change bulbs 15-feet or higher above the ground. Similarly, LED indoors means no fluorescent tube replacements which typically takes place every 5-years due to bulb yellowing. Finally, the people paying the electric bills will see those costs plummet with LED. Fluorescent fixtures in commercial buildings typically consume 20 to 40% of the total electric energy. LED will use less than half that amount.

Dual Flush Is Better Than One

Why? Since the environmental movement began, people have pondered ways to reduce the amount of domestic water needed to flush a toilet. Clean domestic water is a valuable resource and using that water to flush waste is itself wasteful. In 1992 the United States Government set a standard of 1.6 gallons per flush for toilets, a standard that still exists today. Since that time, toilets that only use 1.28 and even 1.1 gallons per flush have become readily available. But some have had reservations due to the concerns about waste line clogging that can occur if not enough water is used to flush solid waste.

How? We have not seen issues with the 1.28 gallon per flush toilets being installed in new buildings. If the toilet is located near a vertical drop, as they usually are in floors above street level, or the waste pipe runs no more than 20-feet in the horizontal direction we have not encountered complaints about clogging. However, buildings constructed before 1992 may not have adequate slope in their waste lines and several plumbing contractors still comment on the potential for clogging with the new toilets. We have found the compromise of a dual-flush toilet works in these situations. These toilets offer the user two options: use one gallon to flush liquid waste or 1.6 gallons to flush solid waste. These toilets save water and still deliver the full 1.6 gallons to flush when needed.

Slow The Flow

Why? Stormwater runoff creates many environmental issues including soil erosion, contamination of rivers and lakes, and the overflowing of municipal storm sewer systems. A new issue rearing up is the sheer damage done to buildings and foundations

when historic rain events, which have become common, overwhelm drainage systems and stormwater backs up into the building. If sites are designed to store some of this water and release it more slowly, floods and their resulting damage can be reduced or eliminated completely.

How? During a 3-inch storm, one cubic foot of stormwater will be generated for every 4-square feet of roof, parking, sidewalk, and driveway area (hardscape areas). If you have one-half (1/2) acre (21,780 square feet) of hardscape, a 3-inch storm event will generate 5,445 cubic feet of stormwater. This stormwater can be stored in a 2-foot deep depression that is 2,723 square feet in area or typically less than 12% of the site.

A 3-inch storm event is considered a major storm for most areas of the United States. All this water can be retained using only 12% of the site, reducing soil erosion and contamination of the local rivers and lakes, reducing municipal sewer overflows, and keeping this water away from the building and foundation. By installing deep rooted native or adapted plantings in the depression, this water can be quickly absorbed which will reduce the opportunity for mosquitos to breed after the storm event. The plantings will also absorb oil and grease from parking runoff and use them as food.

Grass Is Ornamental

Why? Most ornamental grass is not native to the United States and cannot survive without a lot of help in the form of regular applications of water, fertilizer, pesticide, and herbicide along with regular trimming with gas-powered equipment. Native or adapted plants, once established, are low maintenance and require no chemicals or irrigation to keep them alive. Many are also drought-tolerant and better at absorbing stormwater, an environmental win-win.

How? This is one of the most difficult sells for green building advocates. When owners and developers are told the benefits of native vegetation over ornamental grass, they nod in agreement. But, they then turn around and direct their design team to put in the ornamental grass since their building “needs it”. Most of this push-back comes from bad experiences on previous jobs. When we researched these events, we frequently found the landscaping contractor had little knowledge of how to plant and care for native plantings and that is why they failed to establish properly. The specifications for the landscaping must include the following:

1. Use only native or adapted, non-invasive, drought-tolerant plant species in all areas except the following: Ornamental grasses are allowed within 20-feet of the building, within 5-feet of parking lots, drives, and sidewalks, and on designated sports fields.

2. The landscaping contractor must have at least 10-years of experience with establishing native plants and must include in their cost a 5-year maintenance agreement to maintain the plants while they become established.

You Can't Control What You Don't Understand

Why? Energy efficiency can only be achieved if a building is operated the way it was intended. If people leave the lights on when no one is in the building, set the thermostats to keep the building at a toasty 75°F all night, or chill the interior to 72°F throughout the summer, the high energy bills will speak to the damage being done to the environment and will disappoint the owner who thought they were getting a good green building.

How? We have come to rely on something called a building automation system (BAS) to give us energy efficiency. A BAS is essentially a laptop computer. Too many people have come to believe that a computer can make decisions the way people do. A BAS knows nothing about making a building energy efficient no matter how much they cost and how much software they have running. Only people, with or without a BAS, can make sure the building gets operated properly and conserves energy.

Occupancy sensors should control most light fixtures inside a building. Timers and photosensors should control most light fixtures outside a building. Setback thermostats with limited occupant control must be programmed to provide proper temperature during occupied hours and when the building is unoccupied (setback). Complex BAS systems can be justified in hospitals, large laboratories, campuses and other applications where the owner is willing to pay for multiple shifts of well-trained operators. For all other buildings, we have found that simple controls work best.

Turn Exhaust Into Free Energy

Why? Whenever a building is occupied, exhaust fans are used to pull contaminated air out of bathrooms, janitor's closets, kitchenettes, and copy rooms. Frequently this air is only contaminated with unwanted odors, nothing else. The heat in this air can be recaptured in winter months to heat air coming into the building through ventilation systems. Some systems are available that also use the coolness of the exhaust air to pre-cool ventilation air in the summer. This is one method to take waste in the form of exhaust air and use the temperature of the air as a resource to save energy.

How? Air-to-air energy recovery systems are available to take the free heat/cooling from the exhaust air and transfer this free energy to ventilation air entering the building. This is done without the transfer of contaminants into the ventilation air. Such systems offer many green advantages include the following:

1. Reducing the energy needed to heat and cool ventilation air

2. Insuring a constant amount of ventilation air enters the building, improving indoor air quality

3. Allowing rooftop units and air handling units to process more ventilation air since that air is being pre-conditioned

4. Reducing the size of heating and cooling equipment

5. Eliminating many high humidity complaints in the summer and cool draft complaints in the winter

Heat and Cool Ventilation Air Separately

Why? Heating, ventilating, and air conditioning (HVAC) systems have become very expensive and complicated over the years. Many HVAC systems, such as the all-too-common variable air volume (VAV) reheat system, rely on complex and expensive equipment, complicated control strategies, extensive setup routines, and ongoing maintenance agreements to make people comfortable while reducing energy use. This approach has been widely applied since the 1970's and has left many owners disappointed particularly given the high investment made in the systems and controls. A new approach, called a dedicated outdoor air system (DOAS) is quickly gaining favor in the design community.

How? Ventilation air, also called outdoor air, must be introduced into a building to keep the indoor air clean and to remove airborne contaminants. This air presents many challenges to the HVAC system since it is frequently very hot and humid or very cold and dry. To make matters even more challenging, the temperature and humidity of this air can change significantly from one hour to the next. A DOAS does nothing more than process 100% outdoor air, heating it in the winter and cooling/dehumidifying it in the summer. Typically, this conditioned ventilation air is injected into the return air systems of air handling units or rooftop units. By adding an air-to-air energy recovery system to the DOAS, energy will be saved, operation will be improved, and in many cases wasteful reheat is reduced or even eliminated.

Do you want to know more about what we learned from 150 green buildings?

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