INTEGRATED DESIGN IS GREEN

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INTRODUCTION

Good design is sustainable. A truly sustainable project is well designed and is a desirable building. Early discipline integration is a key element of an integrated, holistic design process and results from core design values. Merging a passion for design excellence with values of site sensitivity, resource efficiency, energy-saving technologies, and conscientious material use involves each member of the project team. This approach produces quality design that goes beyond prescriptive sustainable design guide requirements.

The topics discussed in this article draw upon experience from a selection of more than twenty projects totaling over six million square feet, including projects that are LEED® registered and certified, including projects pursuing gold certification, following Minnesota's Sustainable Building Guide (B3) and following Green Guide for Health Care™ (GGHC). Project types drawn upon for this article include office buildings, hospitals, laboratories, museums, multifamily housing, education facilities, green design done prior to today's recognized design guides, and those projects that go beyond the checklist. This article will focus on selected green strategies that have been common among many projects. It will also look at challenges faced by some building types; the overall design and project process; representative project examples; and specific strategies that involve early interdisciplinary coordination, cost considerations, material examples and specifications issues, and construction quality.

DESIGN

Great sustainable design results from a passion for design excellence. To be truly sustainable a building needs to be programmed and designed to stand the test of time. People will love it and want to take care of it. They will want to use it and reuse it. It will inspire people today and for many decades to come. Sustainability is inherent in good design. It is at the core of what an integrated architecture and engineering practice means. It results from strong ideas and quality solutions. It is found in a whole building coordinated approach to design that has been common to good design throughout the past and has been outlined in several design guides common today. This approach has been a common theme that threads through various building types.

Sustainable design is not only about environmental sensitivity but also satisfies the triple bottom line concept of balance between environmental, economic, and social interests. Architects and engineers have been concerned about efficient use of energy and appropriate use of materials for a long time. Energy recovery systems, indoor air quality, building systems commissioning, and life cycle cost analysis for a variety of energy sources have been a common part of a good design process long before the current emphasis on sustainable design. A sustainable design process involves evaluating the owner's key functions with the staff, the patient or customer experience that gives the design team information used to develop potential sets of design options, and it gives the owner information about how to improve the culture of the organization. This information is reported using spreadsheets. It is then integrated into the project. First cost, life cycle cost, long-term environmental impact, energy conservation, and commissioning impacts are considered. Current sustainable design guides are a great starting place but much more can be done than just those items on the checklists.

Great green design can include corporate buildings, historic renovations, live/work space, healthcare campuses, and cultural and educational facilities. All these projects incorporate customized sustainable solutions that transform a building into the client's most cost-effective and strategic business advantage. The design process should engage owners, building occupants/users, and all design

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disciplines and construction trades in a collaborative process to create excellence in design. It comes from seeing opportunities that may not be obvious and valuing what has gone before.

PROJECT EXAMPLES

The following buildings exemplify effective and valuable green design. The HGA Architects and Engineers Minneapolis office was an adaptive reuse of an existing building. This building is located in the historic warehouse district of downtown Minneapolis, Minnesota, which is undergoing revitalization. The building was originally a biscuit bakery in the early 1900s and then became a paper warehouse. It is now on its third major use as an architecture and engineering office. The interior lobby and public gallery space was originally the loading dock area. In addition, there is HGA's Milwaukee, Wisconsin office, a converted marine terminal building, located in Milwaukee's downtown historic third ward. This project was a LEED Commercial Interior pilot project participant and was one of the first to earn a LEED CI Silver rating. Both projects feature open collaboration spaces and open work areas to promote spontaneous interaction between all disciplines. Each of these projects showcases the use of daylighting, a common design element pursued on projects that has benefits for productivity in office buildings and healing healthcare environments. Daylighting and lighting design with sensors and controls to balance artificial lighting with daylighting is a common feature of good design regardless of the building type. Additional recent project examples that highlight daylighting design and interior open spaces include the Mankato State University Trafton Science building (MN B3), a LEED Registered office building in Minnesota, a hospital in New Jersey (LEED Registered), an office building renovation in California (LEED Registered), and Jefferson County Health Center (GGHC).

FIGURE 1. HGA Architects and Engineers Minneapolis office, 2003 AIA Minnesota Honor Award.

FIGURE 2. HGA Architects and Engineers Milwaukee office, LEED® Commercial Interiors (CI) pilot participant and LEED® CI Silver Certified.

Jefferson County Health Center

Jefferson County Health Center is a 115,000-square-foot replacement hospital with clinic that will incorporate sustainable design features as outlined in the Green Guide for Health Care. This 25-bed hospital will be completed in early 2009.

It is a registered Green Guide project and is among 119 pilot projects under the Green Guide for Healthcare that represents 30 million square feet of healthcare construction in the United States and abroad.

The Green Guide for Health Care, which models its organizational structure from the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Green Building Rating System, establishes its own point system in two areas: Operations and Construction.

FIGURE 3. Jefferson County Health Center, GGHC, Fairfield, Iowa.

The Jefferson County Health Center project design incorporates spaces planned to enhance the patient experience with an emphasis on privacy, convenience, and confidentiality. The site plan gives the hospital prominent visibility, while allowing future growth and development. The site layout also allows separation of patient, staff, truck, and ambulance traffic, which enhances safety of the total environment.

The exterior uses brick and rough-cut stone to blend with the natural setting. The building's primary feature is the entry lobby, with broad expanses of glass framing views to the outside. A sunlit corridor accented with rough-cut stone columns connects the entry lobby to the nursing area along the south side of the building. Natural daylight brightens the open public spaces throughout.

The Jefferson County Healthcare Center achieves the many sustainable benchmarks from the Green Guide for Health Care.

The contractor used some creativity in its construction activity pollution prevention plan. Fast growing native grasses were planted at the beginning of construction as a cover crop to reduce soil erosion and water run-off. At the end of construction final landscaping was planted. The county government also helped by establishing policies to protect the natural landscape and priority sensitive areas, prevent disturbance to natural resources, wetlands, and endangered species, and handle and store fossil fuels to prevent spills that would pollute the soil.

Rather than have one large water retention area as is often done, this project controls it storm water runoff and treats the storm water on-site with many small retention ponds and "rain gardens" designed at parking lot islands, which adds to the character of the project. When projects have parking lots this strategy can be employed regardless of building type.

The roof membrane was Firestone's white TPO membrane, which helps reduce heat island effect from the roof and helps reduce cooling loads thereby allowing opportunity for mechanical equipment size to be reduced. This is a feature that can be included in projects of all types.

An important feature for all building types is a connection to the natural world. This feature is especially important for healthcare facilities because

FIGURE 4. Jefferson County Health Center, healing garden.

they need to have a healing and restorative environment. This hospital has places of respite connected to the natural environment and are key elements in defining a supportive, high performance, healing environment with proven effects on patient, staff, and visitor well-being and improved clinical outcomes, which includes a landscaped site and central garden that is visible and accessible from the primary public corridors. Large windows and vistas will take advantage of the natural rural setting to create a visual connection between inside and outside. This type of design feature can also be included in schools, offices, and many other building types.

Water use reduction also can be addressed on all projects. It is a particular challenge for healthcare facilities due to process water use. This hospital employs technology to reduce potable water use for medical equipment cooling. Water use can be further reduced by using no water for landscaping throughout the site. This is accomplished by using indigenous prairie grass for landscaping that can survive without irrigation. Besides reducing water use this landscape strategy makes the design unique and helps ensure the site will remain as natural as possible. It also helps reduce landscape maintenance costs and fertilizer use. Lastly, to reduce water waste and save energy this hospital employs sensors on the majority of plumbing fixtures. Low-flow fixtures will help achieve conservation metrics in lavatories, showers, urinals, and toilets. These products can be considered for any project but in a hospital with frequency of fixture use are especially helpful in reducing water consumption.

Resource conservation especially in furniture and equipment is a fast expanding market for all buildings. This hospital will reuse much of the furniture and medical equipment from the original building, thereby reducing costs and waste. However, if they decided not to reuse it themselves vendors are available that help to broker reuse of furniture and equipment to avoid having it wasted. One such service is Green Solutions North America www.revive-d.com. Besides material reuse it is important to consider flexibility in the design. This new hospital is designed to accommodate future growth to increase the life span of the facility. The hospital design includes "soft" space such as offices next to clinical departments for future expansion. The design plans also include strategies for horizontal building expansion with minimal demolition to fixtures and walls to reduce disruption and dust during expansion construction. Adaptability of spaces also allows greater utilization of furniture and equipment. All buildings can benefit from this consideration.

FIGURE 5. Jefferson County Health Center, typical patient room with a residential feel, view to healing garden.

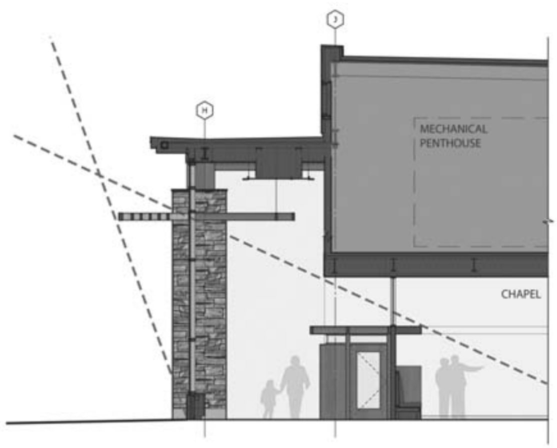
Since we spend approximately 90 percent of our time indoors, indoor air and environment quality needs to be considered for every building. The hospital includes a ventilation monitoring system that verifies the recommended outdoor airflow rate is being achieved at all times. Low-VOC interior finishes and paints were selected. In addition, interior finishes such as the carpeting and acoustical ceiling tile include recycled content. These products are readily available from many manufacturers and can be easily considered for all projects.

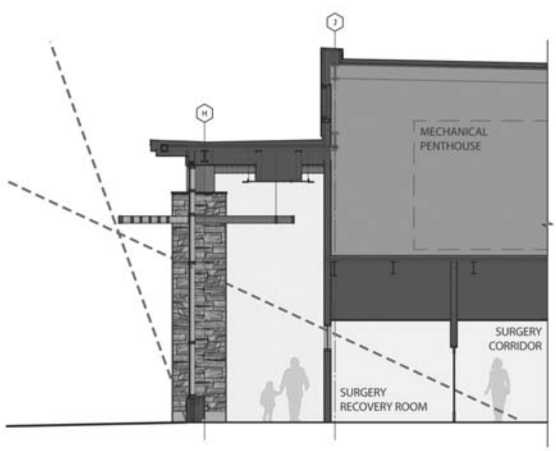
Entryways connected to the outdoors, for instance, are at least six feet long in the primary direction of travel to capture dirt and particulates from entering the building. The hospital will also provide pressurized entryway vestibules at the building entrance to minimize entry of such contaminants as vehicular exhaust, pesticides, herbicides, helipad exhaust, diesel generator fumes, among other potential airborne pollutants. These are good design practices for any building. The hospital is designed to minimize cross-contamination of occupied spaces. In hospitals space pressurization is an important safety feature and a special challenge just as it is for laboratory building and specialty manufacturing facilities. In this hospital pressurized exhaust systems help prevent gases from moving from one room to another, particularly in areas where hazardous gases or chemicals may be used, such as garages, soiled utility areas, sterilization and disinfection areas, and housekeeping/laundry areas. Careful mechanical engineering is a must on every project to provide quality indoor air, safe breathing environments, and energy savings.

Good lighting design is essential in the architecture of all buildings. Lighting design helps create the character and feel of a space. It also helps to reduce light pollution and reduce energy loads. Strategies used in this hospital that can be applied elsewhere include designing the angle of interior lighting to intersect opaque building surfaces rather than exit through windows and use of automatic controls to minimize energy use after hours as well as balance use of electric lights with daylight. “Dark-sky” compliant fixtures are used for exterior lighting.

Hand-in-hand with lighting design is daylighting design. It is a common design feature and benefits any project. Accomplishing daylighting design must be considered during the overall planning and layout of a building. Deep building footprints with interior corridors need to be addressed. Daylighting of occupied spaces has documented benefits for healing environments, productivity for office work and learning spaces. The shape of the Jefferson County Health Center reduces the impact of large wall masses and maximizes windows. Daylight streams into the building through a number of window sources. Two-story-high windows infuse the public corridors with daylight, while high windows at the end of the corridors further brighten interior spaces. The effect is a warm and inviting interior.

FIGURE 6. Jefferson County Health Center, daylighting studies.





In the surgery recovery rooms, light enters through clerestory windows from the public corridor. The patient rooms, too, have large windows overlooking the prairie landscape. Glass-enclosed family waiting spaces in the patient care unit are located at the ends of corridors to help bring daylight into the interior. Daylighting design can be addressed on any project and will make any building better and increase its long-term appeal.

Besides having outdoor places of respite with connection to the natural world it is important to have indoor places of respite. In this hospital the cafeteria, for instance, looks across the public corridor to the central garden. Family waiting areas take advantage of the ample windows, allowing family members to enjoy the daylight and landscaping during the long hours they may spend in the hospital. A meditation space uses borrowed light from clerestory windows, while an outpatient rehab center has extensive windows framing outdoor vistas.

To address the impact electric lighting has on patients' health, Jefferson County will employ a number of lighting design features in the patient areas, including a separately controlled nighttime navigational lighting system; patient rooms shielded from bright lights of work areas; and nighttime shielding of patient rooms from exterior light sources. In the staff areas, the hospital will include daylight access for all staff on their regular work paths. Accomplishing the selected strategies discussed helped this hospital be a better healthcare environment but these design features can also be applied to other building types.

Saint Paul Public Housing Agency

The Saint Paul Public Housing Authority Office Building is a green design project that exemplifies many innovative strategies. This office building was completed in 2004 and is 33,000 square feet plus 19,000 square feet of leasable space. The cost was $12 million and 2 percent less than a projected conventional construction budget. The anticipated savings: Paybacks for most strategies range from approximately 2 to 6 years. This high-performance building was designed to use 50 percent less energy than required by code. Energy-efficiency measures include dimmable controls on direct and indirect light fixtures; variable speed drives, pumps, and fans; sun control devices on the south side to reduce solar gain; and extensive daylighting, among others. Flexible floor plans help to reduce churn rate or the number of office transitions within a particular year, expressed as a percentage of the total occupied space.

FIGURE 7. Saint Paul Public Housing Authority Office Building, Saint Paul, Minnesota, green design.

This project is situated on a previously developed site thereby avoided using undeveloped land that may not be centrally located near public transportation. Site enhancements and water reduction focuses on a unique urban rain garden on the west side of the building. This feature reduces storm water runoff while naturally filtering pollutants. In addition, native plantings help to reduce heat island effect and provide a pleasant green oasis in the other wise stark urban fabric.

Reducing energy use is common among green projects. The Saint Paul Public Housing Authority Office made a significant effort to reduce energy use by combining many strategies that resulted in a projected 50 percent reduction in energy use compared to the applicable code. Sun control devices on the south side reduce solar gain; dimmable lighting controls on direct and indirect light fixtures help to balance use of artificial lighting with the abundant daylighting available even in the inner core of the building. These results came from a focused planning effort to maximize daylighting. This allows all occupants to have access to natural light and views to the outside. The building orientation reduces heating and cooling demands and exterior lighting uses fixtures that control light.

The indoor environment quality is significantly enhanced by the daylighting and lighting control features that also save energy described above. In addition, increased outdoor air is provided so occupants have more fresh air flowing inside the building. Additional controls for zones are provided so occupants can benefit from greater thermal comfort. At the work stations care was taken to reduce glare on computer monitors by providing direct/indirect light fixtures and a balance of daylighting using north facing glass.

The design features made use of recycled content interior finish materials; low-emitting paints, sealants, and adhesives; and carpet such as Interface carpet tiles.

Minnesota Bio Business Center

The Minnesota Bio Business Center is a $35 million dollar project located in the heart of downtown Rochester between the Central Business District, the Mayo Clinic Campus, and the Urban Village redevelopment area. The Center will be an eight- to nine-story mixed use building containing 130,000 to 150,000 square feet of space. The Minnesota Bio Business Center is under construction and is designed to meet the Minnesota Sustainable Building Guide: Building Benchmarks and Beyond (B3) and is a LEED registered project. The Minnesota Bio Business Center is a new, 8-story office building with an associated parking ramp expansion. The project is registered for LEED® for Core and Shell for the building portion and has a goal of silver certification.

The façades of the building respond to distinctly different conditions. Glazing design was a key element of this project.

The East façade is the primary public face of the building. Rochester hopes to encourage an "urban village" feel to this portion of the downtown area. This elevation is open, inviting, and as transparent as possible even though this might result in less-controllable morning sun. Valuable floor area on the front of the second floor was devoted to a connection to the city's skyway system. The glass selected was Viracon VNE 1-63 with visible transmittance of 63 percent, shading coefficient 0.31. This façade is 41 percent glazed. At the south side of the east façade the upper floors of the parking ramp were pulled away from the office building to maximize daylight access to the office floors. A landscaped area was developed on the roof of the parking ramp using a pre-vegetated modular green roof system, LiveRoof modules provided by LiveRoof, Inc., as the basis of design. This planted roof system features removable planted panels that address urban heat island and reduce storm water runoff while offering easier maintenance and do not require watering. The windows have a visible lower section, an exterior solar screen and celestory section with integral mirrored louvers. The louvered portion stops direct sun, but reflects light up on the ceiling. This glazing type allows for light shelf performance while maintaining the plane of the wall system. Glare is reduced by selection of a glass with a lower visible transmittance. The glass specified was Viracon VNE 1-37 with visible transmittance of 37 percent, shading coefficient 0.21 at lower lites and OkaSolar panels by Schott North America as the louvered glass panels at upper lites above the sun screens. The east façade is 22 percent glazed (first 3 floors covered by parking ramp). On the north end of the east façade the window area was increased to take advantage of northern light and views to the Mayo Clinic Building and Plummer Building, which are icons in Rochester's skyline. Open area of glass on the north and west sides were limited by the proximity to the property lines. Glass specified was Viracon VNE 1-63 with visible transmittance of 63 percent, shading coefficient 0.31 per-

FIGURE 8. Parking ramp left (Minnesota B3), Minnesota Bio Business Center office right, Rochester, Minnesota, LEED® registered.

cent east and north façades 35 percent glazed. At the west façade the window area was reduced to minimize low angle west sun and minimize unappealing views across the alley to the adjacent heating/cooling plant. The chillers in the adjacent building are very noisy, so laminated glass was used to cut down on sound transmission. Glass specified was insulating laminated glass with 2 layers of 3/16 inch glass inboard to achieve STC-42 sound rating with visible light transmittance of 37 percent, shading coefficient 0.28 at lower lites and laminated OkaSolar louvered glass at upper lites above. This façade is 15 percent glazed.

This site was a brownfield redevelopment. Because of this the design includes a below-grade gas retarder system for both vertical wall and sub slab conditions. HDPE and LLDPE geomembranes with both smooth and textured surfaces were specified by the owner's specialty soil remediation consultant. The contract documents require construction work to be performed in accordance with the Voluntary Response Action Plan (VRAP) and the Environmental Contingency Plan for the property as approved by the Minnesota Pollution Control Agency. This process is an important part of making a Brownfield site buildable. The documentation for this work required careful coordination with waterproofing and moisture protection. This was accomplished by separating the soil remediation work from the rest of the construction, which facilitated document preparation and delineating clearer lines of responsibility. The VRAP and other environmental plans were referenced in the specifications but not bound into the set. Since the site was adjacent to an existing structured parking area, the project expands the structured parking and integrates the façade design between the building and the parking. The roof membrane is reflective roof to reduce cooling loads using a laminated white on black fleece back membrane by Carlisle.

Light pollution is reduced by careful placement of interior lights to avoid spilling light from the interior to the exterior and being selective with exterior lighting. In addition to following the LEED® for core and shell requirements, this project included developing tenant build-out guidelines to help assure the improvement to the building would be consistent with the green core and shell.

Water efficiency measures designed into this building include no potable water be used for irrigation because the pre-planted panels for the roof discussed previously use drought resistant species. A 30 percent water use reduction is projected by specifying low flow fixtures such as the EcoPower system's, self-generating sensor facets that are low flow (0.5 gpm, 0.09 gallons per 10 second cycle) by Toto USA Inc.

High performance envelope design together with the glass design discussed previously and other measures result in the design for 21 percent energy reduction. In addition, a green power contract is to be purchased from the local utility.

Other strategies designed into this building that have become typical for projects include: diverting 50 percent of construction waste from landfill to recycling, recycled content materials, regional materials, certified wood, outdoor air delivery monitoring, construction IAQ plan, use of low-emitting materials, and indoor chemical and pollutant source control through use of entrance matting.

California State University Northridge Performing Art Center

The Center features a 1,700 seat, technically and acoustically superior performance hall. Unique design elements are carefully integrated to allow for acoustic, audio, and lighting adjustments to successfully host professional orchestra, theatre, opera, musicals, and film. Through an innovative design the hall will accommodate this fine-tuning yet retain its dramatic appearance regardless of acoustical transformations. A gracious drop-off area is framed by the grand lobby space with its adjacent reflecting pool.

The site has a public face in all directions, so the building has been designed to have no exposed service area. A full service dock and prominent artist's entry are provided, but loading, trash, and trucks are hidden behind moveable screen walls designed to complement the architectural whole.

The upper lobby levels and roof terraces will capture the spectacular views of the Valley and the surrounding Santa Monica and Santa Susanna Mountains. The large rehearsal/entertainment space looks out to the canopy of the historic Orange Grove. A courtyard rehearsal room serves as traditional

FIGURE 9. California State University Northridge Performing Art Center, Northridge, California—LEED® Registered.

rehearsal space, but added flexibility is created through a wall that opens to the courtyard for performances and events.

Space in the building includes a 250 seat Studio Theatre, KCSN Radio, dressing rooms, and green room; costume, scene, props, and paint shops; lighting, scenery, acting, sound, and multi-media labs; and a 225 seat recital/lecture hall.

This performing art center is LEED® registered. Grand opening is scheduled for 2010 after construction is complete. As a special challenge for this building, like other buildings that are part of a campus, is providing preferred parking for car and van pools or for low emitting fuel efficient vehicles. This project is seeking to implement the intent of this requirement by providing signage that designates preferred parking for such vehicles in existing parking lots that are most likely to be used for this building.

Water efficiency has also been a special focus by seeking up to 50 percent reduction in water use by specifying low flow fixtures such as Ecourinal by Ecotech water and other low flow fixtures by Zurn and Kohler. White roofs are common to many projects. This project specifies the Energy Smart roof G410 by Sarnafil. For a small portion of roof area a modified bitumen membrane was required but white coating is required as the finished surface.

Performing art centers present special challenges with high occupant loads and process loads such as lighting during performances and very low loads when there is no performance. Acoustic concerns from air noise need to be addressed as well. Controlling air noise and reducing energy use of air handling systems result from using computational fluid dynamics modeling. Slower air helps reduce air noise achieved by slower air velocity. This means fan sizes are smaller but duct sizes are larger. The system uses less energy to address acoustical concerns from air noise but increases first cost resulting from larger ducts sizes. A displacement air distribution system is used in the auditorium. The design exceeds California Title 24 by nearly 18 percent. California Title 24 is one of the most stringent energy codes in the country and compares to LEED® EA credits. The air handling system helps address occupant comfort, energy efficiency, and acoustical control. This project is supplied by a central plant system. This causes special challenges showing specific efficiency improvements within the building itself for credit calculations. If the central plant is very efficient and that is the main source of energy for the building, it does not leave much opportunity to make improvements within the building design itself.

Materials include low emitting paints, sealants, adhesives, and carpet that can be commonly addressed in any building type. Steel structure buildings can usually meet the 10 percent recycled content requirement with structural steel alone. Since performance halls are mostly a big black box obtaining daylighting and views credits depends greatly on what constitutes regularly occupied space. The lobby and pre-function space receive generous daylight from the full height curtain wall. Obtaining this credit will depend on the full time equivalency (FTE) calculations and if the lecture hall and performing spaces are excluded from the calculation.

LEAN PRINCIPLES AND SUSTAINABLE DESIGN

To create designs of lasting value means looking beyond the building itself and to evaluate and modify the services provided within the facility being designed. The Jefferson County Health Center is just one example of LEAN manufacturing principles which in this case have been applied to hospital design using principles of industrial engineering. When these ideas are applied together with the new integrated service agreements, the result has produced improvements to the way healthcare service is provided. These changes then inform how a hospital is designed producing innovative design solutions. This process starts by evaluating the patient experience and staff activities using a process called value stream mapping. Low value actions, steps, or processes are removed or modified. Staff is led through an engaging process to develop new ideas and then applying those to a building design. This unique approach improves the healthcare services provided, informs the design process, and results in healthcare facilities that are sustainable by assuring the building will last longer because services provided inside the building are forward looking. LEAN manufacturing principles can be applied to a wide variety of building types and functions.

The Project Process

Making LEED certification a priority on a project involves integrating that work into all the project meetings so it is not a stand-alone separate effort, but is an active part of the project. One way of achieving this integration is to have a green build project champion in each discipline, and one that does overall coordination for LEED certification.

Kick-off for the Design Process

A significant key, regardless of building type, size, or green building guide, is how well each team member is integrated in the design process. Below is an example of a kick-off workshop process that has been effective in not only integrating each design discipline, but engages both the owner and users. Owner and user integration is important to successful sustainability since they will be operating and using the building long-term.

Workshop goals:

1. Set the vision: Motivate participants by presenting and jointly developing an overall vision of project goals. For example, understand what design guide will be followed or such visionary goals as carbon neutral, zero net energy used. These can be related to various levels of LEED certification or go beyond current checklist requirements. This vision will guide decisions for the rest of the design process.
2. Understand the owner's and user's values.
3. Educate attendees about certification process or design guide requirements.
4. Identify the major concepts in which the client is most interested in pursuing.
5. Explain the major concepts of sustainable design, how the LEED rating system works, and how it can be used as a tool for the project.
6. Brainstorm relevant strategies.
7. Encourage out-of-the-box thinking and integrated design strategies that need to surface in schematic design.

Workshop format:

1. Introduction: Give overview of the meeting and discuss vision and goals.
2. Educate: Present a Power-Point presentation that outlines facts on sustainable design, introduces LEED or other guides, gives an overview of major sustainable concepts and design strategies, and covers case studies of strategies used on other projects.
3. Open Time: This is a brief period of time to allow participants to understand the information presented. Encourage idea sharing and write down first impressions.
4. Identify Strategies: Participants offer ideas that are posted on boards. Facilitators should also participate and pin-up any strategies or concepts that they would like to specifically address during the discussion.
5. Discuss and Rank: As a group, discuss the strategies listed on the sticky notes individually. Rank the viability of the strategy by moving the sticky notes into the agreed-upon column (Yes, Needs Investigation, Probably Not, No).
6. Analyze/conclude: After all issues, concepts, and questions have been discussed, gather together for a final discussion.

7. Document and Update: Record the strategies discussed to be included in meeting minutes or report. A spreadsheet format with each strategy identified and a responsible person for each item is a good way to proceed and maintain coordination and maximum participation. A steward for each credit can help ensure each is maintained and followed through the entire design process. When a contractor is on board, each credit will have at least one design team name and one contractor name for each credit.

Alternative Energy Sources

Some projects are well suited for geothermal, others for solar or wind. Sites in urban downtowns often are limited in space and are connected to district energy sources. Each site has its unique opportunities, so it is important to find and benefit from them. A few selected examples are Northland College using wind power, AIA Top 10 Green Design 2001, Geothermal at the Olmsted Medial Center Minnesota (LEED Registered), Solar panels at Como Park, Education Resource Center, Saint Paul, Minnesota, Biomass Gasifier at University of Minnesota Morris campus.

Energy Analysis

The use of detailed energy analysis has measurable benefits for projects. This process considers the impact various sets of related design elements have on the energy savings. This process has produced significant positive measurable outcomes. Seventeen projects were surveyed that used an energy analysis process and have the following calculated results based on the design sets chosen for each project. These seventeen projects include commercial office buildings, laboratories, a hospital, a dance studio, an art center, a large zoo building, and a church. The aggregate results of these projects that span 16 years and represent approximately 6 million square feet are:

- 32% average savings compared to code.
- Annual ongoing electric energy savings of 40 million kilowatt hours.
- Annual ongoing saving of 3 million dollars (2007 dollars).
- Annual ongoing reduction of 30 million pounds (15,000 tons) of carbon dioxide.

Projecting the future savings for these projects over a twenty-five-year period is approximately:

- 375,000 tons of carbon dioxide reduced from the atmosphere.
- 1 billion kilowatt hours saved, which is the quantity of power used by approximately 130,000 homes for an entire year in Minnesota (estimated based on 2000 kilowatt hours per year, 2000 square foot house using Minnesota 2008 rates).
- 75 million dollars (2007 dollars) saved.

Operational procedures in owner's control, such as plug loads, may cause actual performance of these buildings to vary, but the design options selected contribute to these reductions compared to other design choices. Design options include many variables, but usually include evaluation of various building envelope materials, especially the glass types.

FIGURE 10. Northland College, Ashland Wisconsin, 2001 AIA Top 10 Green Design Winner.

Materials and Design, Glass Selection—An Integrated Team Example

Few material selections impact more parts of green design than the glass selection and the window system. To accomplish energy savings, it is necessary to right size the mechanical system, provide daylighting, and take an early look at the glass selection. This one material and its related systems involve advanced thinking by the architect, specifier, mechanical engineer, estimator, and designer. Many projects have benefited from a glass coordination discussion early in the project. For example, the mechanical engineer uses information about glazing to determine heating and cooling loads more precisely. The designer and architect are involved to balance façade and daylighting design. They discuss questions like the following: Is the glass clear or tinted? How much visible glass is needed to provide views and daylighting without compromising the ability to meet ASHRAE 90.1 requirements? What glass performance is needed or available? What performance would the mechanical engineer like it to have? Visible light transmittance, shading coefficient, glare from too much light, and U value all need to be balanced between the various interests. In addition, specifying a higher performing, non-metallic spacer for the insulated glass units improves the thermal performance and condensation resistance of the glass. There are several performance values published by most glass fabricators but four performance values are important to thermal performance and daylighting. These include: Visible Light Transmittance, U value, CRF, and Solar Heat Gain Coefficient. Specifying a product as the "Basis of Design" helps clarify the design and performance intent. Specifying thermal modeling to be performed by the supplier can identify areas needing additional attention to refine the system and maximize the system performance. See examples below:

Example 1: Typical insulated glass unit with warm edge spacer.

Clear Low-E Insulated Glass Unit: One inch thick unit constructed of 1/4 inch clear exterior lite, high performance low-emissivity coating on No. 2 surface, SST warm-edge spacer, 1/2 inch space filled with Argon 0.24 gas, and 1/4 inch clear interior. One or both plies heat strengthened where required for wind pressure or thermal stress.

- Visible transmittance: 62 percent
- Shading coefficient: 0.31
- Nighttime Winter U-value: 0.24 BTU/hour/square foot maximum
- Basis of Design: Viracon: VNE 1-63 with Argon .24 gas

Example 2: Glare Reducing Glass.

Glare-Reducing Insulated Glass Unit: One inch thick unit constructed of 1/4 inch clear exterior lite, high performance low-emissivity coating on No. 2 surface, SST warm-edge spacer, 1/2 inch space filled with Argon 0.24 gas, and 1/4 inch clear interior lite. One or both plies heat strengthened where required for wind pressure or thermal stress.

- Visible transmittance: 37 percent
- Shading coefficient: 0.21
- Nighttime Winter U-value: 0.25 BTU/hour/square foot maximum
- Daytime summer U-value: 0.20
- Shading coefficient: 0.28
- Solar Heat Gain Coefficient: 0.38
- Basis of Design: Viracon: VNE 1-37 with Argon 0.24
- Comparable product of other specified manufacturers

Example 3: High Performance Glass as Part of a High Performance Framing System.

Triple Glazed Insulated Glass Unit: 1-3/4 inch thick unit constructed of three 1/4 inch clear lites with high performance low-emissivity coating on No. 2 surface, using SST warm-edge spacer, for two 1/2 inch air spaces filled with Argon 0.24 gas. One or both plies heat strengthened where required for wind pressure or thermal stress.

Coordinate use of this glass type with framing system design. Complete window assembly including window frame must have a net "U" value of 0.39 for complete system calculated using LBNL WINDOW 5.2 Therm Modeling. Manufacturer must provide Window 5.2 modeling demonstrating compliance. Coordinate design of System with Section 084400.

- Center of Glass U-value: 0.22
- Basis of Design: Viracon: VE 12-M#2 with Argon 0.24

Construction Quality Control and Sustainability

It is important to implement the designed level of quality in the field during construction; otherwise sustainable design may not become a sustainable building. One example of how quality level is specified comes from how the exterior envelope is specified, and then how quality of installation is monitored. Below is a specific example of performance requirements and field testing for an aluminum curtainwall framing system.

Framing System Example: The size and type of thermal break affects the thermal performance of a system.

- Air Infiltration: Air infiltration of not more than 0.06 CFM per square foot of fixed area per ASTM E283 and applicable AAMA methods. Limit air infiltration to 0.10 cu. ft/min/lineal foot of sash crack for operating sash.
- Water Leakage: No uncontrolled water penetration per ASTM E331 and AAMA 503 at pressure differential of 15 pounds per square foot without a reduction for field testing.

This is an important performance property not all systems can meet. It is important because it establishes not only a level of product design and fabrication quality, but provides a factor of safety in field performance as well as installation quality control. To pass the field test at this level, attention to installation details is important. Proper installer training and supervision is required. A test run at this level helps assure installation quality is high. This helps sustainable building issues by reducing possible water penetration into the building. If maintained in the field, this performance property may indirectly affect thermal performance because the quality of construction has a higher level of attention in order to pass this test.

The new AAMA 503 field test standard allows a reduction of the specified performance value for field testing unless the specifier indicates otherwise in the construction documents. It is important to remember that industry association test methods and standards are minimums and do not take precedence over requirements in the project construction documents. It is important to maintain these performance values.

It is important to specify condensation resistance that helps with frosting and condensation, and will also provide better thermal performance of the glass and framing system. Specify the conditions that apply both for the exterior and interior based on actual project conditions. If you neglect to do this, the defaults in AAMA 1503 will apply and may not be appropriate for your project. Require the submittal of test reports showing compliance with these conditions. Check carefully the submittals of product information and test reports, and be sure those reports show the conditions. Often test reports show high CRF ratings based on warmer temperatures, lower humidity, and slower wind speeds. If the supplier's previously tested conditions do not match those specified by construction documents, then the supplier will need to run a test based on the conditions specified for the project to show compliance.

FIGURE 11. This photo shows an aluminum window field test used to verify resistance to water infiltration.

Condensation: Achieve CRF values listed in Part 2 for each type per AAMA 1503 so condensation is not formed on interior frame and interior window surfaces at the following conditions, unless project humidity conditions and specific location conditions are more severe per ASHRAE Handbook of Fundamentals, Weather Data and Design Conditions.

- Interior Air Temperature: 75 degrees F.
- Interior Humidity: 30 percent.
- Exterior Air Temperature: minus 15 degrees F.
- Wind Speed: 15 miles per hour unless other indicated.

For the construction phase, using infrared photography to check thermal performance and air leakage can help identify problem areas and make corrections as needed.

Sustainable Design and Cost

One of the many pervasive misconceptions is that sustainable design costs much more than traditional design. For example, some who provide prices for buildings intended for LEED certification have added significant premiums using dollars per square foot or percent of the construction value. These methods artificially inflate the true costs of doing a LEED certified building. It is true that some individual credits do have a cost, but many do not have any effect on construction costs and have much lower administrative/submittal costs than pricing reflects. Using dollar per square foot, percent of construction costs, or historical cost data are not accurate reflections of the real costs of sustainable projects.

The best approach is to estimate costs based on actual credits selected using today's market conditions and pricing. Many have little or no costs, and a few have measurable costs. For example, Construction Activity Pollution Prevention does not cost extra for most jurisdictions because it is typically required. However, enhanced commissioning does cost extra. The amount for each project depends on the design of that building, its size and system configuration. Diverting 50 percent of construction waste from landfill to recycling in a market like Minneapolis does not cost extra but can in other markets depending on recycler availability and tipping fees. But it can cost more if site sorting is required to obtain 75 percent diversion. The cost will be in extra dumpsters and a worker to monitor sorting.

The cost of green building is small compared to all the benefits (see http://cbpd.arc.cmu.edu/ebids/ for more information). Looking only at first cost is short sighted. Although payback times are trending toward shorter periods of time this analysis alone does not capture all the cost benefits.

Materiality—Sustainable Specifications

Specifications incorporate substantial sustainable design information to provide specific requirements for environmental goals and resource efficiency in construction projects. During pre-construction conferences, project meetings and correspondence specification requirements raise important discussions that increase the participant's awareness.

A master specification should contain information to establish a green baseline as well as ongoing knowledge sharing to keep specifiers informed on how to specify sustainably and how to make project specific edits.

As an example, Section 099000 on Painting, specifies low or zero VOC products as the base requirements for the products. This can be done regardless of the particular design guide that applies for the project, or even if there is not one specifically being followed. The LEED EQ credits can be implemented on nearly all projects. Choose products that have the lowest VOC ratings available for products that meet the performance requirements for the project. It is important to also evaluate durability of products for the application. For a green master specification it is also important to include requirements that can be implemented on all projects and make it easy to include edit sections to meet project specific requirements such as LEED certification submittals. Every project can specify low VOC paints but only projects seeking LEED certification will need language in Part 1 of the specification requiring submittals to validate information for LEED letter templates. This helps reduce time required for document production and reduces overall cost for LEED certification. It also accomplishes the transformation of design and construction intended by LEED. By greening master specifications and making project specific editing practices fast, green specifications can be achieved.

Many material selections such as the interior finishes have so many variables that establishing a basis of design product is not practical. Much of the specifying depends on the choices of the designers. Greening the specifications and altering how we practice by providing ongoing knowledge sharing within a design practice is essential to have both a green master and a green practice. It is important to continuously evaluate selections for products on performance, long-term durability, and quality that relate to the broader perspective of sustainability.

Local supply within 500 miles requires developing relationships with local representatives and giving time to meeting with and evaluating products. By doing this, architects can help transform industry so green design choices are available. Partnering with environmentally-conscious manufacturers helps advance product choices throughout the industry. In one case a wood supplier partnered with an architectural firm to develop a training program on sustainable forestry and certified wood sources. This information was included in master specifications, the sessions presented to the sponsoring firm and then to other firms, raising the overall green practice related to sustainable forestry.

Examples of how to apply green principles into a specification master or Project Manual:

1. General reuse of existing buildings and materials rather than building or buying new. Salvaging of materials during demolition for reuse and recycling by others. Recycled aggregates in pavements.
2. Recycled content materials specified: Insulation, interior finishes, millwork core board, steel, paint where available.
3. Low VOC paints.
4. Rapid renewable products specified such as wheat board, sunflower seed board, bamboo flooring, and cork flooring and wall coverings.
5. Specify Forest Stewardship Council (FSC) or similar wood products wherever possible. Example, Ipe' wood used on Como ERC building, Walker Art Center addition, Discovery Center at Lake Michigan. Ipe' is an FSC certified wood that is affordable and very durable.
6. Native landscape planting.
7. Fly Ash in concrete. Maximum recommended is 25 percent.
8. Recycled steel minimum for industry is 25 percent.
9. Wood products of recycled, natural, non-hazardous, low VOC, non-toxic content.
10. Garden roofs.
11. High efficiency doors, windows, and glass.
12. Recyclable roofing materials.
13. Environmentally sensitive and resource efficient insulation systems.
14. Recycled and natural content flooring.
15. Recycle program carpets.
16. Low maintenance exterior and interior materials.
17. Movable furniture/partition systems instead of building inflexible/waste prone spaces.
18. HVAC system designs: under floor air distribution for improved indoor air and more efficient delivery of air.
19. Design of energy efficient and low life-cycle cost heating and cooling systems; geothermal, heat pump, passive solar, etc.
20. Glass selection for design of spaces using natural daylight and energy efficient lighting systems.

SUMMARY

Many LEED® credits can be implemented in various building types. Daylighting, lighting design, site location, massing, building orientation, materials, waste reduction, storm water control and treatment, evaluation of alternative energy, material use reduction, recycled content or renewable resources, low emitting products, and system commissioning can be achieved on most projects. A few challenges exist in particular buildings. Hospitals have challenges with water reduction and energy efficiency. However, solutions can be found. Changes to traditional operation need to be considered. Performance halls have acoustical, daylighting, energy efficiency, and air distribution challenges. Buildings that are part of a campus or a district energy system need to consider impacts of the energy source but may have limited control over energy reductions for individual buildings.

Innovation credits commonly considered are: green cleaning programs found in LEED® for existing buildings' operation and maintenance and green education programs for users and occupants. As building systems become more sophisticated we find that start-up procedures, user orientation, and operations staff training need to be much more in depth; extended and follow-up service with refresher training is needed to help realize design intent in the actual operation of the building.

An integrated design approach that values design excellence is really just good design and good design is sustainable.

"LEED" is a registered trademark of United States Green Building Council (USGBC).

"Green Guide for Health Care" is a trademark of Green Guide for Health Care, www.gghc.org

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In 2007, HGA received the National Environmental Stewardship Award from the Construction Specifications Institute (CSI), citing HGA's "Practice of Sustainable Design, promoting environmental awareness in the construction industry, and educating others in the advantages of sustainable design." Hammel, Green and Abrahamson, Inc. (HGA) was founded in 1953 and is a full-service, integrated, architecture, engineering, and planning firm with offices in Los Angeles, Sacramento, and San Francisco, California; Minneapolis and Rochester, Minnesota; and Milwaukee, Wisconsin. HGA is at the forefront of green building design, with many LEED® or equivalent projects completed, under construction, or in design. A corporate member of the United States Green Building Council (USGBC), HGA has more than 25 percent of its professional staff as LEED® accredited professionals, including architects, engineers, interior designers, and specifications writers. HGA believes that this in-house expertise in green design is crucial in the creation of good building design.

At HGA, we translate our core belief—good design is sustainable—into professional practice. We consistently raise the level of design excellence and sustainability as priorities. Our Strategic Plan, corporate values, and management practices promote continued commitment and leadership in protecting the environment. We have taken the word "sustainable" from a catch-phrase to a way of working, living, and creating. Our goal is to create architecture that promotes our clients' business strategies while respecting the planet.