WE ARE ALL STUDENTS OF GREEN DESIGN

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PROJECT CASE STUDY: KING PAVILION, IOWA STATE UNIVERSITY COLLEGE OF DESIGN

King Pavilion is a 22,000 square foot addition to ISU's existing design center. The addition houses first and second year design students, and serves as a living laboratory for sustainable education. The King Pavilion has received a Merit Award for Architectural Design from the Iowa AIA, and has also been awarded LEED Platinum certification from the U.S. Green Building Council.

KEYWORDS

sustainable education, college sustainability, flexible spaces, performance planning, evidence based design, integrative thinking

INTRODUCTION

The practice of architecture, the academic pursuit of architecture, and the sustainability issues in architecture converge in this project to create a unique opportunity for a didactic building. Unique to this project is the notion that the laboratory itself is the object of direct experimentation—in other words, the design and experimentation take place in the space and the space itself is a laboratory for sustainable practices. The King Pavilion at Iowa State University for the College of Design specifically and purposefully provides this opportunity. The laboratory, a design studio housing freshman introductory design for all disciplines in the college and sophomore level design studios for the programs of architecture, landscape architecture, and interior design, serves the dual role of providing an environment that encourages creativity while acting as a learning lab for sustainable design. Students have direct contact with fundamental sustainable concepts practiced in the pavilion, and the building requires the students to engage the building thereby allowing the students direct contact to the systems and results of the systems in the space.

The concept necessitating the new pavilion started many years prior to design of the building by first building a new academic program. The "core" program merged all design disciplines into a combined series of courses focused on fundamentals in design that all disciplines share. In addition to this tangible efficiency of sharing education are the intangible, but necessary, cross-disciplinary relationships that develop early in the students' careers. The new building is the culmination of the implementa-

FIGURE 1. This is a photograph of the north façade of the King Pavilion addition. The image shows the pavilion's relationship to the existing design center on the left, as well as the pavilion's recessed placement within the site. The roof top light monitor is apparent in this image, as well as the continuous clerestory windows that wrap both floors of the pavilion.

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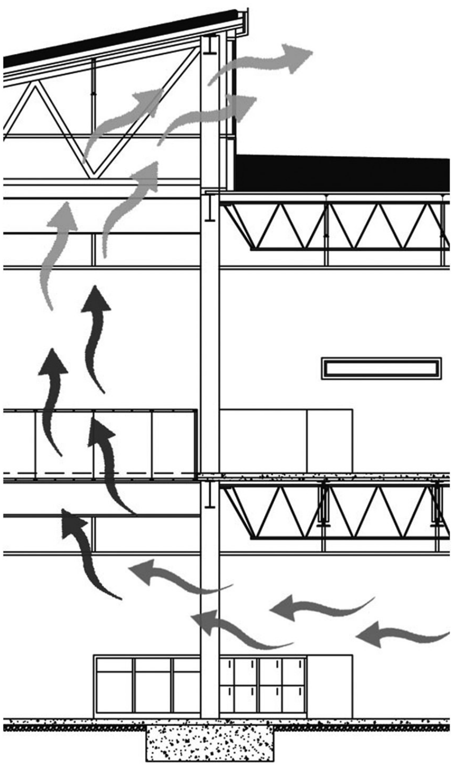
tion of this new program by providing a space where all of these people come together to share ideas and learn from one another.

The building employs a range of both high and low technologies. Indirect light washes the interior space during the day while daylight-harvesting systems allow the space to perform its 24-hour-a-day use. Advanced mechanical systems monitor temperature and CO_2 to supply fresh air when appropriate while traditional stack ventilation techniques allow the students to witness, by their own hands, how they can modify the environment for the same result. This allows students a hands-on example of blended technologies as well as communicating an ethos of choice and opportunity in the built environment.

Such choice is also apparent in the flexible open studios of the King Pavilion. Mid-twentieth century office buildings paved the way for open office space, but in reality the space rarely changed. In academia there is closure every semester and even at the end of mid-semester projects. The open plan of the King Pavilion provides a very useful way to adjust space for specific projects, to expand or contract space for changing class sizes, and even allow students to consider the layout of their own space. The open free-arranging and the ease of moving the desks on wheels allow students to configure infinite possibilities for working relationships or for presentation.

FIGURE 2. This image is a north/south section through the pavilion's central core. This double-volume space utilizes operable windows in the rooftop light monitor to provide natural ventilation for the studio spaces.

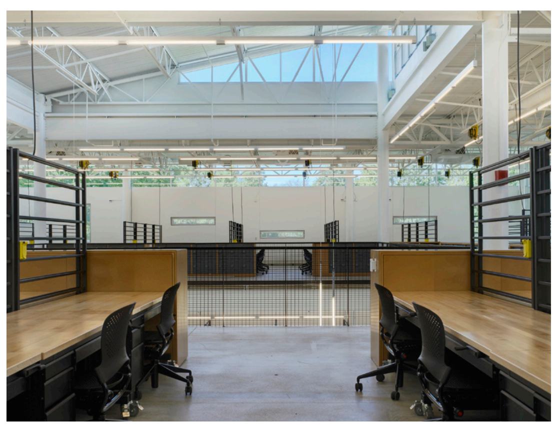


TWENTY-FIRST CENTURY BUILDINGS HOSTING TWENTY-FIRST CENTURY EDUCATION

The brick and mortar classroom is a staple of higher education institutions and often conjures images of the ivy-league campus steeped in history and tradition. These hundred-year-old (or even twenty-year-old) rooms feel inappropriate for the type of education occurring. To keep pace with a changing culture where schools like Kaplan University and the University of Phoenix are competing in the marketplace, higher institutions must show their willingness and malleability to change with the culture—to keep pace with the social and technological ethos of contemporary culture.

Just like higher education, developments in architecture are microscopic and revolutionary. In

FIGURE 3. This image shows the open floor plan of the pavilion. You can see the movable furniture, polished concrete floors, clerestory window bands, as well as the form of the rooftop light monitor.



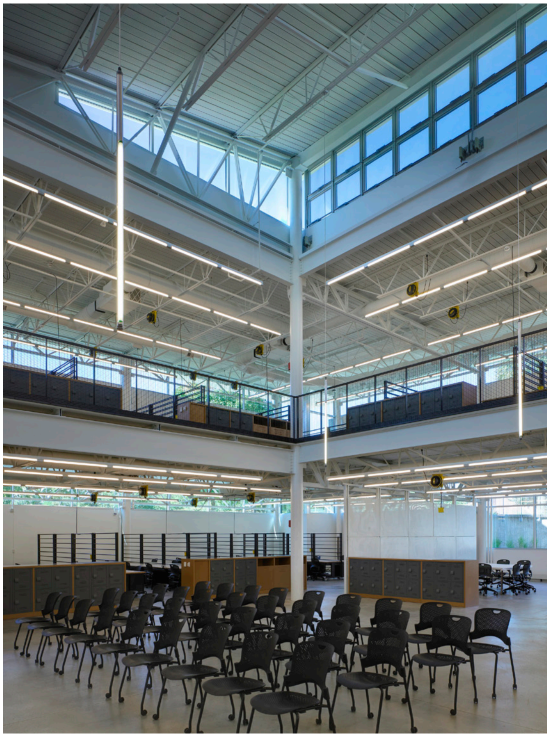
other words, very small steps are great achievements because the complexity and number of constituents are overwhelming. For example, the perspective of how a building is programmed may seem simple and historically was a process of identifying needs and making space fill the need. To truly be a sustainable building, the structure must both serve the immediate need and anticipate a potentially unknown future need. Regulations are one example of unknown future needs. Codes and standards keep people safe but these restrictions veil a severe potential for failure. Designing to meet or exceed these standards does not guarantee success, indeed following the rulebook may result in failure simply by ignoring the obvious. The social, environmental, and economic impacts of building are concerns that no code can effectively prevent or predict.

The King Pavilion facility is for higher education and higher education is changing at an accelerating pace. The methods of instruction are shifting, the format of instruction is being redefined, and the relationship between teaching and learning is practiced in a host of ways. "Multi" and "inter" disciplinary educational formats are necessary—particularly in the disciplines hosted in this college of design.

SUSTAINABILITY AS A CONCEPT VERSUS SUSTAINABILITY AS A WAY OF THINKING

The world is ready for sustainability. Students are not trained to study a topic of sustainability in design, they are trained to imbed sustainable consideration into every decision. From embodied energy to the gas bill, the notion that every decision by the designer has far reaching implications is well known. However, the base knowledge does not always translate into practice. Perhaps because the primary tangible data is the energy bill, most people find it hard to see the value of up-front investment and find it even harder to see the value of simply choosing a material that may be more expensive but has less embodied energy. With a centralized power plant at the university, it is easy to argue for ways to reduce the load on that resource, but much harder to argue for less tangible benefits such as recycling rooms and materials that have less embodied energy or are simply renewable. Ultimately, organizations like the USGBC help to identify and acknowledge

FIGURE 4. Another view showing the open floor plan of the pavilion, the movable furniture, polished concrete floors, clerestory window bands, and the form of the rooftop light monitor.



those benefits and help communicate with the multi-tiered constituents in the design process the quantifiable benefits of qualitative improvements.

LEED was a necessary step in the transition into sustainable thinking. It has had great success in educating the professionals and the public about sustainable design. But it is not the whole picture. It is a well-constructed outline with a series of organized standards to help industry and the general public meet basic requirements for sustainable design. As with any outline, there is no ideal recipe for success. For example, too many architects have gained some platinum status for their building only to later realize that it failed in some fundamental way in terms of sustainability. LEED is a way to educate, a way to be informed, a way to celebrate success, but it is not a way of thinking. Sustainable thinking is part of integrative thinking, as Tim Brown describes in his book, *Change by Design* (p. 85). In it he argues that

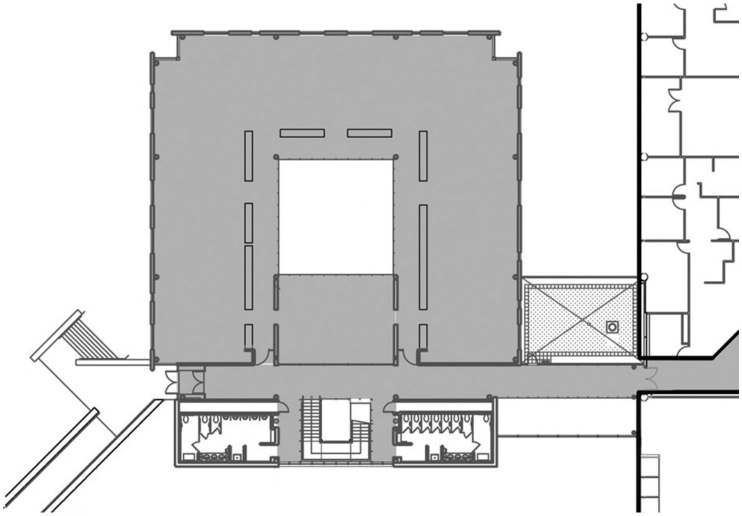


FIGURE 5. This image is the main floor plan of the pavilion. You can send the center core surrounded by studio classrooms, as well as the circulation corridor connecting the pavilion to the existing College of Design facility.

"integrative thinking" is not a precise framework or methodology. Successful design and integrative thinking blends qualitative tools visual thinking and storytelling. In this way, while learning and using the LEED model as a guideline, the innovative, integrative, sustainable thinker can flesh out the outline and create something beautiful.

PROJECT SUMMARY

The King Pavilion is a relatively small addition to the rear of the existing six-story College of Design facility. The design solution is that of a pavilion design, pulled slightly away from the main building and organized as a two-story form. Open studio classroom environments are efficiently organized around a central core space that functions as flexible experimentation space. A two-story center volume allows natural daylight to penetrate into the lower level.

Clerestory windows and full height corner windows allow daylight to enter into each studio classroom, and provide opportunities for exterior views. The building essentially requires no electric lighting during daytime hours. The use of a vegetated roof on the facility reduces the heat island effect and complements stormwater management needs on the property.

The space to the rear of the existing College of Design building was an underutilized plaza, consisting of multiple features formed of concrete: site walls, circulation bridge, and seating. The addition utilized as much of the existing site materials as possible. Several of the existing site walls were salvaged, as well as the existing circulation bridge. This allowed for the reuse of materials, and created a design that worked within the existing context of the plaza. The resulting building form is recessed into the site, presenting a lower profile against the existing design center. The conservation and reuse of materials as well as effective daylight strategies are two major contributors to the project's sustainable

FIGURE 6. This image shows the recessed profile of the addition with the existing college of design facility in the background. Notable features: clerestory window bands, small operable windows for views from classrooms as well as natural ventilation. Rooftop light monitor is also apparent.

success. Early in the planning process, Iowa State University set a target of LEED Gold certification. This target was met and exceeded by the project team, ultimately achieving the highest level of certification awarded by U.S. Green Building Council—LEED Platinum.

PERFORMANCE PLANNING

Be sustainable. This was the seemingly simple direction given to the project team by the college. Designers around the world have probably received similar direction from clients. But what is sustainable? How does a project achieve sustainability? If these questions were asked to multiple individuals, multiple definitions would be received. The key to a successful "sustainable" project is a clear understanding of this word—and it must be clear to each and every individual team member.

A method that is used to bring clarity to a project team is performance planning. This process requires a project team to set detailed performance goals at the very beginning of a project. To accomplish this, multiple levels of information must be gathered. Think of a project as a fresh onion. A project team is given a whole onion at that beginning of a project, which is believed to be a complete understanding of the issues. In practice, this level of understanding is too often accepted by a project team, and the design process moves forward. To get to core issues, additional layers of information must be exposed. This process and the information that results are fundamental to effective communication—the core of every successful project.

During planning, do not simply mark the box on a LEED checklist and refer to this action as goal setting. Start the process by identifying broad goals, such as resource conservation, cost savings, community interaction, etc. The next step is to prioritize these goals. If resource conservation is identified as a priority, define this term. To the client, the phrase "resource conservation" may refer to carbon reduction. This phrase could also refer to stormwater management, or selection of renewable materials. This is why it is important to discuss and record a common definition of each goal—to come to a common understanding. Design teams need to work with the client to identify why these goals are important to the project and together prioritize strategies designed to achieve these goals.

The final step in the performance planning process is setting performance targets. For example, if energy efficiency is a top priority, what amount of energy savings will be targeted—20%, 40%, perhaps 60%? Each of these performance targets may require a separate and distinct design solution to achieve. This can result in separate and distinct characteristics, including construction cost, project aesthetics, site locations, and building operations. A detailed understanding of variations between multiple design solutions is necessary for a project team to make informed decisions, a process referred to as evidenced based design.

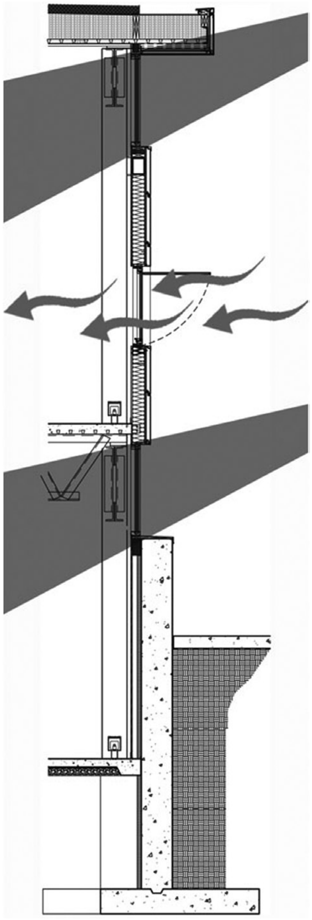
EVIDENCE BASED DESIGN

For the King Pavilion project, several consulting groups were engaged during the planning phase. Each group participated in goal setting activities with the owner, and contributed detailed analysis that was used to evaluate design options. The ability to make informed decisions based on analytical data is an extremely valuable tool early in the design process. This evidence based design approach helps to educate client groups on the life cycle costs of products and systems. This approach also informs architectural decisions, such as window placement, space planning, and envelope design.

To expand on architectural decisions, there are several visual keys that are apparent in the design of the King Pavilion. The most apparent visual is perhaps the sloped light monitor that emerges from the vegetated roof. This architectural feature provides light deep into the building's core spaces, and is a necessary strategy to achieve the project's performance target relative to the goal of natural lighting. In addition to the light monitor, clerestory windows wrap both floors of the pavilion, and provide uniform lighting levels around the entire perimeter of the building. Together, these features exceed LEED daylight requirement in 100% of the program spaces. The amount of glazing area, the selection of glass, the building's orientation, selection of interior finishes, and the location and proportion of fenestration patterns were all balanced to achieve a calculated effect. This "balance" was made possible through the use of sophisticated daylight modeling tools, and was the result of the project team working toward a performance target that was communicated early in the planning process.

FIGURE 7. This photograph was taken on the green roof, and shows the sloped roof monitor emerging from the vegetated roof. The windows are operated by a control system with which the students and faculty can interact.

FIGURE 8. This image is a wall section showing daylight entering through the clerestory windows as well as air flow through the operable classroom windows.



In the previous paragraph, architectural decisions were used as an example. It is important to note that evidence based design is just as important in the decision making of all disciplines. In fact, the true value of this process is the synergy realized through integrative thinking. To expand on natural light, a building's envelope design may allow for effective levels of light penetration, but the quantity of light is not the only consideration. Solar heat gain, heat loss, and glare are additional considerations that impact performance—energy performance, as well as human performance. Good design solutions evaluate all such considerations holistically; they do not simply evaluate singular consideration. All glass façades and large skylights are effective architectural features for allowing huge quantities of light into a building, and natural light and exterior views are highly desirable; however, such architectural features also bear a penalty in the form of heat transfer and quality of light. In other words, the penalty is paid with each month's utility bill, as well as with the comfort and productivity of the building's occupants. Effectively predicting such tradeoffs require a multidisciplinary approach to design—it requires integrative thinking.

INTEGRATIVE THINKING

No one person or discipline has all the knowledge needed to deliver a quality project. Since the inception of LEED, many firms across the country have been marketing multidisciplinary design services, as well as integrated project delivery methods. Both concepts are at the core of contemporary sustainable thought. In fact, at the national level the AIA and USGBC have documented practices and procedures relating to both trends, and the term "integrated design" has become a buzz word that is often used in our industry. Similar to "sustainability" this term requires additional description. Integrated design is not the result of simply including multiple disciplines on a project team; the engagement of a variety of consultants is a necessary step in modern project delivery. This is a common method used around the country, and is not innovative; it is simply the act of inclusion. Integrated design is a result of integrative thinking. It is the result of knowledge sharing, informed design, and a project team working together to achieve common goals.

Synergies that are realized through integrative thinking can provide a great deal of added value to a project. There are many aspects of a project that are easy to quantify: energy use, rain water volumes, lighting levels, material costs, etc. However, there are also aspects of a project that are unquantifiable. Qualitative traits such as delight, aesthetics, and comfort escape traditional measures. An evidence based design approach is excellent for evaluating decisions based on scientific analysis, but integrative thinking is necessary to ensure that project teams are not only pursuing the functional efficiency of building components, but also considering experiential components as well.

For the King Pavilion, the vegetated roof is an example of a component that provides synergy through integrated design. The roof's characteristics improve the overall performance of multiple building systems. One such system is stormwater management. The green roof's plantings and growing media were specified to provide water treatment and reduce runoff volume. The roof design mitigates 95% of rain events. This water is now managed on-site instead of being directed to the campus storm sewer system—a conscious decision to relieve dependency on an aging infrastructure. Additionally, in summer months the roof's vegetation provides evaporative cooling benefits through the process of evapotranspiration. As a result of this natural process, the building's cooling loads are reduced by nearly 5%. This improves overall energy performance and carbon reduction and drastically reduces the heat island effect in the surrounding area. Material savings is a third outcome of the roof design. The manufacturer of the roof membrane provided statistical data indicating that the reduction in UV exposure that results from the installation of a green roof system can increase the life expectancy of the PVC membrane by nearly 200%. This is extremely valuable information for an institutional client that is concerned with the life cycle performance of materials and systems.

To this point, all of the stated outcomes are quantitative. They are calculated reductions in a unit of measure, describing the performance characteristics of stormwater run-off, cooling loads, and UV degradation. In addition to functional performance, the green roof also creates outcomes that are not as easy to measure—qualitative impacts. The green roof on the King Pavilion provides a great educational piece for student programs; it serves as a recruitment tool for the college and university; its aesthetic appearance drastically changes the experience of the plaza when viewed from the upper floors of existing design center, as well as the entrance experience when approaching the addition. These elements were not calculated. They were not included as part of a life cycle cost analysis or a return on investment (simple payback) report. But these elements did bring recognized value to the project—a teaching tool, a recruitment tool, a special experience. These unique qualitative elements, as well as the enhanced functional efficiencies of the building's components, are the result of the project team following an integrated design process: performance planning, evidence based design, and integrative thinking.

FIGURE 9. This photo is the green roof as seen from the upper stories of the existing College of Design facility. In this image you can also one of the corner rain chains and detention cell, as well as the permeable paver courtyard on the right hand side.

RESOURCE CONSERVATION

For the King Pavilion, the project's overarching goal was sustainability and verification of sustainability through third party certification. Resource conservation is the main strategy that was implemented to achieve this goal. The project had multiple performance targets relating to each of the following: water conservation, energy efficiency, material conservation, and human performance. These four components were the foundation to achieving certification; each component relates to categories the USGBC identifies in their LEED (Leadership in Energy and Environmental Design) rating system—the rating system chosen by Iowa State University to provide third party verification.

WATER CONSERVATION

In today's market, energy efficiency is often the first thing that comes to mind when the topic of resource conservation or environmental stewardship is being discussed. I believe this to be because rising energy costs are widely publicized and easily quantifiable. Water conservation, on the other hand, is sometimes wrongfully overlooked as being a less important issue.

Water conservation strategies that have been utilized in the design of the King Pavilion have dual focuses: reducing water use by the building occupants, and also effectively managing rain events on-site. For the occupants, water use reduction was simply achieved by specifying low-flow and ultra low-flow fixtures. This is an easy and cost effective strategy to reduce a facility's water consumption by around 40% when compared to traditional designs. Such fixtures are competitively priced, readily available, and have an immediate impact on a building's water use. As an example, code compliant urinals use one gallon of water per flush. In contrast, ultra low-flow urinals can use as little as one pint (1/8 of a gallon) of water per flush.

When designing for stormwater management, the project team had two challenges; controlling the quantity of run-off, and providing opportunities for treatment prior to any water entering the storm sewer system. For new construction projects and developments, stormwater retention requirements are an increasing trend. Development in an urban area provides opportunity to improve the stormwater performance of a site. In other words, make a bad situation better. Look for opportunities to be regenerative. Efficient strategies will reduce the rate and quantity of site run-off, help reduce demand on infrastructure, and potentially reduce a projects utility costs and municipal fees.

The existing condition of the College of Design plaza was over 70% impervious areas. A vast majority of rain that landed on the site was not allowed to infiltrate; it ran off the impervious cover and was directed to the storm sewer system. This is a common situation on most developed sites around the country. Such situations provide no treatment of the water quality, and they also produce large quantities of runoff that can lead to flash flooding events in aging storm sewer systems. The preconstruction grounds contributed to the poor water quality of the local basin in several ways: sudden surges in the water volumes led to bank erosion and sedimentation, and excess nutrients and pesticides were being added to the river basin due to the abundance of turf grass fertilizers and pesticides. Even with best management practices in place, these contaminants eventually reached local water bodies.

The site plan for the new addition addresses these concerns by replacing turfgrass plantings with native herbaceous and shrub plant material. The plan also treats stormwater before it is detained through the use of biocells, which encourage the infiltration of stormwater because they contain soil amended with sand, which increases its permeability. The vegetation in the biocells also filters sediment from the runoff, helping to treat the water on-site. The current design of the site is now nearly 80% pervious. This was accomplished by utilizing a series of stormwater management practices, including vegetated roof, permeable courtyard pavers, and a series of rain gardens.

The vegetated roof is an extensive system with four inches (4″) of engineered growing media. Plantings include over twenty varieties of succulents. Once water is filtered through the green roof it is collected in a series of biocells and allowed in infiltrate into the site. Beyond the green roof, water that falls on the site is allowed to infiltrate through the designed discovery garden to the north of the building, or can be infiltrated through permeable pavers in the east courtyard as well as permeable pavers on the west walkway. Similar to the green roof runoff, excess stormwater from the courtyard is also directed via storm runnels to the retention cells for storage and to the rain gardens for treatment. These decisions were respectful of existing sites contours, led to a sensitive balance between quantity and

FIGURE 10. This image shows the rain chain on the northeast corner of the building—water moves from the green roof down the rain chain into the concrete detention cell that is part of the site's stormwater management system.

quality control, and also successfully demonstrate the concept of stormwater management in a new outdoor teaching environment.

As a result of incorporating these features, stormwater discharge from the site is limited. The site provides detention for up to a 100-year rain event. The detention is provided in underground gravel cells that also serve as the foundation for the plaza's permeable paving. The vegetated roof, gravel infiltration trench, permeable paving, underground gravel storage, and outlet restrictors are designed to control the 2-year, 24-hour (SCS Type II) event and pass the 10- and 100-year, 24-hour (SCS Type II) events. In addition to the stormwater strategies, all landscape plantings are native and adaptable species to the project's climate. No irrigation system was installed or required for the site's vegetation, including the green roof.

ENERGY EFFICIENCY

The energy design approach of the King Pavilion project followed a three-step process: minimize building loads, select efficient systems, measure and operate efficiently.

Following this simple process can reduce a building's energy consumption by 20–40% per year, when compared to a code baseline. Economically speaking, such energy savings can be a considerable cost advantage to a building's operational budget. For example, a facility spending $1.00 square foot/per year will see energy savings translate to significant cost savings. Thinking beyond operational costs, such reductions also have a direct environmental impact—including a reduction in carbon emissions, as well as a reduced dependence on non-renewable resources.

The most important design consideration is minimizing building loads. This must be accomplished early in the design process. Key characteristics include building orientation, proportion of spaces, and the fenestration patterns of the building's envelope. These fundamental decisions dramatically increase a building's performance, and are a necessary first step in bio-climatic design. For the King Pavilion project, care was taken to "tune" each building façade independently. As an example, glazing with North exposure was specified to provide as much daylight as possible by utilizing a high visible transmittance value. In contrast, West glazing was specified with a ceramic frit, to limit solar heat gain and solar glare. The design utilized a continuous clerestory window ribbon to provide uniform daylighting patterns around the perimeter of the building, and a central light monitor was used to provide daylighting deep into the core spaces of the building. The result, all occupied spaces exceed daylight targets—in other words, the project saves a good amount of energy by not needing to operate electric lights during the day.

To complete the second step in the process, the project team selected efficient mechanical systems and controls to optimize the building's performance. The projects team worked together with an energy consultant to provide considerable analysis of multiple system configurations. This analysis allowed the project team to make informed decisions on selection of mechanical and electrical systems. The pavilion utilizes operable windows in the studios as well as in the light monitor to allow natural ventilation in the building on days that make sense. As part of the teaching tool, the building occupants—the students and faculty—control these systems. The design also utilizes daylight sensors and continuously dimming ballasts to help maximize the efficiency of daylight harvesting. The result, the King Pavilion project costs 42% less to operate when compared to a code compliant building.

Working within the existing context of the site, the King Pavilion's orientation is atypical for a high performance facility. For this reason, the proportion of spaces and the building's fenestration patterns were critical to the success of the project. Care was given to maximizing daylight penetration, while balancing the amount of glazing to eliminate glare and optimize the insulation value of the building envelope.

Facilities must not only be designed for energy efficiency, they must also be operated efficiently. Tracking a facility's energy performance is one method to ensure ongoing performance. Beyond initial design, holistic sustainable thinking anticipates the operation and maintenance of a facility. The King Pavilion design includes a sophisticated measurement and verification (M&V) system that allows building occupants to track and trend the performance of the end use sources of energy, including domestic hot water, interior lighting, ventilation, heating and cooling, and plug loads. This allows the building occupants to learn how their interaction with the building systems impacts daily consumption. It will also allow building operators to monitor and improve the building's performance over time.

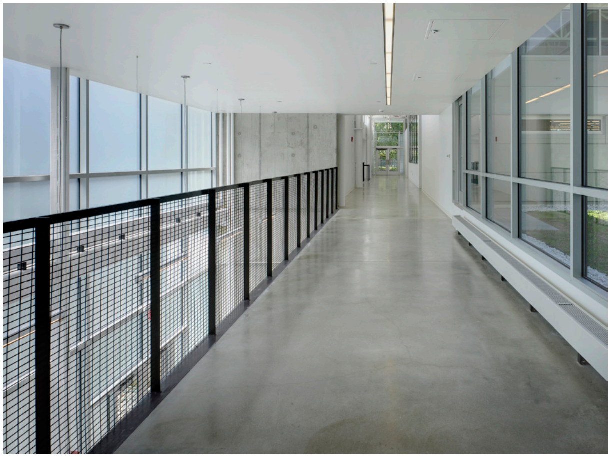
MATERIAL CONSERVATION

The selection and use of materials in the design of the King Pavilion express several fundamental concepts: material reuse, life cycle costs, and waste management.

When discussing the built environment, the restoration or adaptive reuse of existing facilities is perhaps the most responsible choice that can be made by a project team. If a project team is faced with a situation that requires new construction, opportunities to salvage and reuse existing materials should be looked for as often as possible. Such strategies will reduce the amount of construction waste from demolition activities, help preserve the historic context of a place, reduce the demand for virgin resources and products, and potentially reduce a project's construction schedule and material costs.

The King Pavilion project is site specific; design decisions grew from the context of the existing plaza. The footprint of the pavilion is set on several of the existing plaza's retaining walls. These site walls were repurposed as foundation walls in the new structure of the addition. An elevated circulation bridge was

FIGURE 11. This image shows the existing concrete circulation bridge on the right that was salvaged and repurposed as the main circulation corridor connection the King Pavilion with the existing college of design center (left).



also salvaged and reused in the pavilion design. A portion of the concrete bridge was enclosed with a high performance glazing system, and now serves as the main circulation link between the addition and the existing design center. These decisions were respectful of the site's material pallet, led to a sensitive physical connection between the pavilion addition and the existing building, and also successfully demonstrate the concept of material reuse in a new teaching environment.

When evaluating the selection of new materials and finishes, life cycle cost assessments are now required on most public projects, including higher education institutions, federal building projects, and even local school districts. Life cycle cost assessments look at all of the costs associated with a product or system. Traditionally, products and systems have been evaluated by looking only at the costs associated with one point in time, the first costs—what the purchase price is. In contrast, life cycle assessment looks at the cost associated with multiple points in time; first costs, maintenance costs, replacement costs, disposal costs, etc. In other words, in addition to the material and installation costs of a product or system, LCCAs report the operations, maintenance, and replacement costs of a system over its life expectancy.

As an example, when comparing flooring systems terrazzo and polished concrete have a higher first cost then VCT or carpet. However, when you look at the LCC over 30 years, terrazzo and polished concrete provide considerable operational savings. Beyond the cost savings to the building owner, the extended life cycle of these products also eliminates construction waste associated with replacement and disposal, as well as eliminating the carbon footprint associated with transportation, delivery, and manufacturing of replacement products.

Reusing materials and selecting materials with long life expectancy helps to reduce waste associated with the design and construction of facilities. Even with a very efficient design, most construction projects will still have a large amount of waste. Implementing a comprehensive construction waste management plan during the construction phase is one way to help reduce this waste. A Waste Management Plan (WMP) can redirect a majority of construction waste away from landfills. This waste can be recycled into products, repurposed to lower grade products, or used for a variety of alternative purposes including: energy recovery plants, alternative daily cover, or as soil amendment. The construction process for the King Pavilion included a comprehensive construction waste management plan. Over 90% of construction waste was diverted from the landfill and repurposed. This was accomplished through the cooperation of multiple parties, including construction and demolition debris recyclers, material salvage companies, a local recovery power plant, and specific product manufacturers with reclaim programs.

Some additional material facts relating to the King Pavilion project:

The Pavilion was constructed with over 40% regional materials (materials from within 500 miles) and over 30% of the building's materials are comprised of recycled content. 100% of wood products are Forest Stewardship Council (FSC) certified, and the project also utilized rapidly renewable material when available. For example, the team replaced traditional batt insulation with cotton batt insulation made from recycled blue jeans. Several selected products were made from nearly 100% recycled content. They include; Bradmar solid plastic partitions, PaperStone solid surface counters, and Sierra-Pine SDF casework.

HUMAN ENVIRONMENT

This project is the antithesis to the refrigerated bubble of the typical office high-rise. The King Pavilion has no traditional air conditioning equipment and relies on natural ventilation and dehumidification for cooling in summer months. This is accomplished with a combination of design strategies: small, operable windows around the building parameter are opened to encourage cross ventilation, while at the same time the large roof top monitor windows are opened to create convection loops, allowing warm air to escape, and fresh air to be drawn into the building. The light monitor has an operable control accessible by all building occupants to provide purging/natural ventilation of the building's core spaces. Building occupants have the ability to control all operable windows and this control has both physical and psychological benefits. When students are working they feel a stronger connection to the outdoors, as they have plentiful fresh air and views to exterior spaces.

The Pavilion's fenestration patterns were designed to optimize daylight, as well as provide students with views to the outdoor environment that include discovery gardens and living lab space. Clerestory windows and a roof top light monitor all contribute to the project's daylight design. Continuous dimming ballasts are used to control light levels. Daylight levels of 30–50 foot-candles are achieved under overcast skies for all program spaces. This exceeds the LEED requirements for daylighting of 25 foot-candles. High and continuous clerestory bands and a high light monitor were used to achieve uniform daylighting to both levels of the building despite the challenges of a recessed site design. Lighting systems were selected for light quality as well as energy efficiency. Lighting control systems include photocells, occupancy cells, and solestrial clock/weather station. Each workstation/student desk includes task lighting. The lighting and electrical consumption is designed with the capacity to record and display in the building's measurement and verification system via a touch screen monitor.

Finally, the air quality was carefully considered. All interior finishes used in the building are low or no VOC. Recessed entry systems were installed at each entry to collect and control pollutants from entering the building. The building's air handler utilizes MERV 13 filtration to improve indoor air quality by removing new impurities caused by open windows or chemicals used in student projects. Moving from design to operation, ISU completed indoor air quality tests prior to occupancy to ensure the building met and exceeded LEED requirements. ISU has also implemented a green cleaning program to ensure the facility's indoor air quality will remain at a high level during ongoing operations and maintenance.

CONCLUSION

Sustainable design is not a new concept. The only thing that is new is our refreshed understanding of the importance and urgency in our current situation. Efficiencies in construction in these economic times are greatly valued. Reduction of our need for virgin materials, dependency on local economies, and an overall reduction in our greenhouse emissions from construction and transportation are all critical to our future environmental success. Following simple and fundamental concepts that were once common in the industry, such as daylight harvesting, rainwater harvesting, natural ventilation, and material selection are the beginning. Utilizing modern technologies for energy efficiencies, renewable energy, envelope performance, and intelligent system controls are all important strategies to help future facilities operate at the highest level of performance.

This project chose to utilize LEED as a rating system to judge the impacts of building. However, remember LEED is only a metric system—a measurement. There are many measurement metrics and rating systems available. What is important is not which system is selected, but that one is selected and selected early. Having a measuring stick in place will help communicate goals and performance targets to a project team. The USGBC and LEED have been on a meteoric rise, taking the building and construction industry to a place that it might not have otherwise reached. Their organization is still learning, still evolving. They are also students of green design, as are all of us.

We stand on the shoulders of giants. One giant is sustainability with a rich history of common sense mixed with technological advancements. Another giant is ingenuity with creative ideas and clever approaches, yet another giant is will and the will of people to change the world for better by combining learning with boldness.

ABOUT THE AUTHORS

Michael Andresen is a sustainable designer with RDG Planning & Design in Des Moines, and serves as a lecturer for the Iowa Department of Economic Development with a specific focus on sustainability. An alumnus of Iowa State, Michael received his BA in Architecture from the University in 2005. To date, Michael has managed the sustainable design process on nearly 2,000,000 square feet of new construction, including 12 LEED projects—two of which have achieved LEED Platinum Certification. Michael is a member of the U.S. Green Building Council (USGBC), a past chair of the Green Schools Advocacy Committee, and has been recognized as a sustainable content expert by the Green Building

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