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Case Studies: Sustainable Design Buildings in Iowa

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CASE STUDIES:
SUSTAINABLE DESIGN BUILDINGS IN IOWA

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A. Introduction

The area of sustainable design in the discipline of architecture has grown substantially in the last ten years. Based on the commonly accepted interpretation, sustainability means "living in such a way as to meet the needs of the present without compromising the ability of future generations to meet the needs of the future" (Spiegel & Meadows, 1999). This definition presents a three pronged approach to design, including a social concept, considering the needs of the unborn; an environmental concept, concerning pollution and resource management; and an economic concept, evaluating the limits of consumption on economic capital. (Spiegel & Meadows, 1999)

Interestingly though, these ideals toward design are not the recent brilliant workings of human minds. Instead it is a return to the ideas of belonging to, relying on, and working with the earth. The Industrial Revolution gave humans the ability to conquer nature through, in the case of architecture, air conditioning, electrical lights, and heat. However, these conveniences and others destroy nature and deplete our natural resources.

Humans have a history of "localized" collapses, where humans depleted their resources, forcing them to move on to a different place or die out. "But for the first time in human history, we have the opportunity to have a world-wide collapse" (Kibert, 1999, p. 56). We can no longer manage or react to environmental pollution and resource depletion. If the Industrial Revolution taught us one thing, it is that waste costs money. Something you have purchased, but cannot sell or use is lost profit, it is waste (Spiegel & Meadows, 1999). Collectively buildings, in their construction and operation, make up a significant percentage – 40 percent – of the world's energy usage. (Spiegel & Meadows, 1999)

As for physical waste, it is easier and more cost-effective to prevent waste than to clean after the fact. The law of conservation of matter states that matter can be neither created nor destroyed. Instead it goes through a cyclical transformation and nothing ever gets "thrown away" (McDonough). Sustainable design of buildings seeks to counteract this waste. It does this, not through rejecting technology, but embracing our abilities as humans to maximize resources through innovative technologies. Sustainable technologies "are those that depend upon preventive and clean technology. These must be commercially available, economically compatible, and environmentally and socially acceptable," (Campbell, et.al., 1997, p87). Clean technologies are the most economic approach to the future.

Not only should these buildings reflect a concern for the environment and economics but also for the people that spend 90% of their life inside a building. Sustainable buildings are "located and constructed in a sustainable manner that is designed to allow its occupants to live, work, and play in a sustainable manner" (Spiegel & Meadows, 1999). In order to evaluate the success of sustainable efforts in buildings, evaluative criteria are now in existence and continue to be refined in the form of Leadership in Energy and Environmental Design (LEED) certification.

B. Purpose of Research

As an adaptive and innovative design trend, the area of sustainable design is continually morphing to meet the needs of society. This research will attempt to evaluate the most current buildings in Iowa that meet standards set forth by LEED in order to enhance awareness and understanding of the sustainable design movement. The purpose of this research is to provide insight to the investigator and other designers regarding the use and effectiveness of current LEED-worthy projects in Iowa.

C. Research Questions

This research study evaluated sustainable materials/features used in three buildings. There were three areas of examination that materials were evaluated with.

Material Source

- How did the material use the resources that are readily and locally available?
- Were the solutions in keeping with the traditions of the local culture, existing climate, and environmental surroundings?

Recycled Content

- What was the amount of recycled content in the material?
- Was there a possibility of this material being reused after its current life cycle?

Durability and Ease of Maintenance

- How well did the material withstand use?
- Did this material require any maintenance beyond standard cleaning?

D. Methodology

The study design was a case study approach. The investigator looked at specific buildings and conducted an in-depth analysis of each. Methods used to learn about each building included interviews, surveys, and archival search. The study used interviews to first list all sustainable products/materials used in the building and also how those products were currently performing. This included questions regarding the exact benefits of the products in addition to the users' opinions of these products. A written survey was given to employees currently working in the building and consisted of questions regarding the sustainable materials that they experienced on a daily basis. Finally, archival research was used to supplement as well as compare information regarding the sustainable materials. This information was found primarily using MSDS (Material Safety Data Sheets).

E. Results

As a preface to this section of the case study it should be noted that no one element dominates a building's ability to be sustainable, rather it is only through the integration and interdependency of the systems that the building as a whole can be called sustainably designed. Thus those listed in the case studies are merely a discussion of parts to the building's whole.

Results

Case Study 1:

Center for Energy and Environmental Education (CEEE)
Cedar Falls, Iowa

Case Study: #1

Center for Energy and Environmental Education (CEEE)
University of Northern Iowa
Cedar Falls, IA

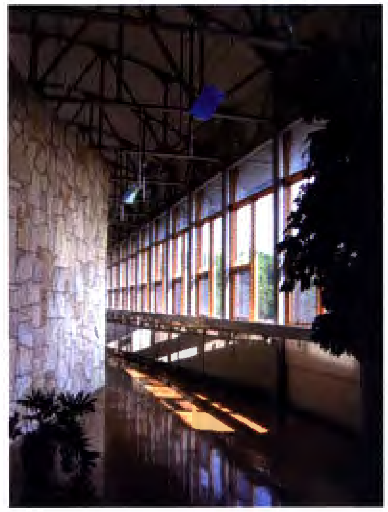
29,300 sq ft
Open: August 1994
Architect: Wells, Woodburn, O'Neill of Des Moines, Iowa
Energy Consultants: Weidt Group of Minnetonka, Minnesota

Overall Description of Building:

The Center for Energy and Environmental Education (CEEE, pronounced *C triple E*) was designed as an educational building focusing on said areas. The CEEE's mission is to "promote greater understanding and awareness about issues related to energy and the environment" (CEEE Facility), and its efforts extend beyond the university setting. The CEEE seeks to reach K-12 students, current and future educators, small businesses, and aid various energy and environmentally minded organizations. Programs and other information can be found at their website (CEEE Facility).

The main floor of the building contains two classrooms holding approximately thirty students each as well as a rotunda, and small lecture hall. The upper level holds the administrative offices of the building as well as a conference room and resource library.

The CEEE sits on the South side of the University of Northern Iowa's campus, a relatively remote location in respect to the concentrated area of main campus. The orientation places the building's long axis from East to West providing a large southern exposure. The north side looks toward central campus and the south side faced, then a prairie grass field, now a construction site. The building is divided by a large masonry wall forming a distinct north and south side to the building. This wall extends beyond the primary building shell and as it intersects the pedestrian path, creates a gateway between campus to upperclassmen housing. As the gateway suggests, the building sits at an intersection of industrialized campus and the more nature enhanced path to the housing units. This transition is highlighted by the conscious choice of materials for the exterior façade. They are, on the north side, metal and concrete, while the south side is composed of wood and brick.



This image was taken on the upper level of the CEEE looking East. This walkway connects the offices of the upper floor. The windows shown face south. On the left is an image of the limestone wall from the nearby Maquoketa Valley. The floors are a polished and stained concrete.

Notice the warm colors and off-white ceiling color. The exposed trusses give an industrialized, modern feel to the curved, wing shaped roof.

This image faces east and depicts one of the two traditional classrooms in the building. Note the large expanse of windows on the south side and exposed ductwork.

The ceiling is wood planks stained in a warm golden shade. One can see the indirect fluorescent light fixtures suspended from the ceiling.

Inside, the interior finishes exude a respect of nature by use of neutral brown tones in the stained concrete, furniture selection, wood, and red brick. Elements of metal are introduced as accents through the use of brushed metal chairs and exposed ductwork and trusses. The lecture hall is the main exception to the building's color scheme through its use of white and gray. The north wall is structurally and aesthetically unpainted, gray, concrete block. Painted room dividers are white and the seating is done in shades of gray.

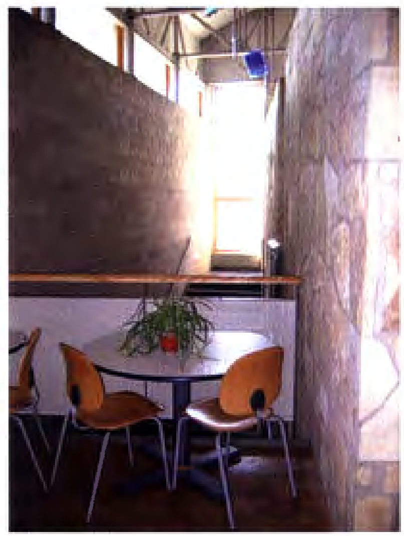
The CEEE's planning and subsequent construction, predate the formation of the *Leadership in Energy and Environmental Design (LEED)* rating system. However, the architects' ideals and goals were similar to those later set by LEED. Those environmental goals set by the CEEE architects were: to reduce energy consumption, select appropriate building materials, reduce the building's impact on the site, and to provide a healthy and productive human environment.

This image is looking toward one of the classrooms. Note the prismatic panels on the column and the recycling container, left, as well as a trash container, right.

Description of Sustainable Elements within the building:

Daylighting and overall lighting system

The integration of natural sunlight to illuminate the interiors was a primary objective for the building. The two-story southern façade is composed primarily of windows which flood the public rotunda and the classrooms with light. The higher windows allow for a deep penetration of light that cannot be achieved with a single story window wall. On the second floor, the offices also utilize windows to their greatest light potential on the north side. There was, however, one main office that was not going to receive the amount of natural light desired, and for this space the architects added a direct skylight to the ceiling design. The only space not daylit is the mechanical room.



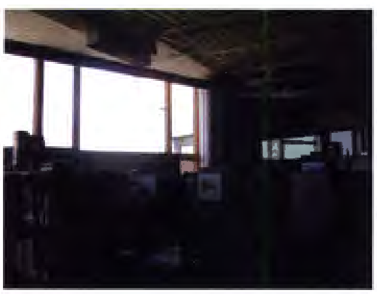
This image was taken on the upper level of the CEEE looking West. Notice the Maquoketa limestone wall on the right and, concrete block on the left. Tall, but narrow west window at the top of the staircase, illuminates the entire length of the staircase with the help of the clerestory windows along the south wall.

Of note is the railing. The wood is in a curved wing fashion, mimicking the ceiling curve. Also, notice the perforated metal railing panel. This helps to delineate space while allowing light to pass through.

The initial design called for an even greater expanse of windows than is currently found in the building. Through analysis, however, the architects found that they had to reduce the expanse to lessen the amount of *radiant heat gain* from sunlight. DOE 2.1 was the simulation program used to analyze the building and its features, and that subsequently lead to the change in design.

DOE 2.1 can be used at any stage of design from schematic to construction. The system works by entering thermal zones of the building and different variables such as insulation and window glazing to evaluate which parameters will improve energy efficiency while maintaining thermal comfort and cost-effectiveness. The program can predict hourly energy use and energy cost of a building. Yet, this program is not meant to be the sole source of information in regard to building design. Experience and judgment of the architect or engineer are still valuable additions to the design process. (DOE2) This program is still widely used for thermal simulation but is no longer supported by the US department of energy. (Techniques for Sustainable Design)

While sunlight is the main source of illumination in the building, it was necessary to still install electrical lighting as supplementary. The electrical lighting system in the classrooms include indirect fluorescent fixtures on a light sensor system. Only when the light levels from the windows are not adequate will the sensors activate the electric fixtures. And if desired, these sensors can be overridden with a switch. The fixtures are situated in three bays of four or five fixtures in each bay. Each fixture is then programmed to the senor so that the lights turn on in a stepped pattern. In other words, the lights closest to the windows might not be turned on while those farthest from the windows in the same bay might be turned on. The idea was to develop a way to light the space as evenly as possible using the least energy.



This image was taken inside the office and library space on the second floor. The lights are not on in this picture but the large northern windows allow adequate light to enter the space.

The white walls and ceiling help to reflect the light. Bouncing the light off the ceiling and back down into the work spaces.

This is another image of the same space. There is one fixture on above an interior office, seen in the center of the image.

Once again, clerestory windows are integrated among the interior spaces to allow light to flow from one room to another.

This image is from the lower floor looking east. Notice the large expanse of windows. Also of note is the slope of the ceiling described earlier as a wing shape. This slope can be seen through the window looking at the adjacent walkway and the ceiling of the primary space.

There are two classroom located to the right of this walkway.

This image faces west and shows door assemblies including side lights and transoms to once again let light penetrate from one area to another while creating sound and some visual barrier. One can also see the slope of the ceiling and the different bays of indirect fluorescent fixtures. There are three bays shown in this image. In this picture the lights are on. Small white boxes on the fixtures are the electronic devices that tell the fixture to go on or off according to either a switch in the classroom or the sensor.

There are certain spaces within the building where the designer put extra effort into ensuring a daylit space. For one, the interior restrooms have clerestory windows to allow natural illumination. Special attention was also paid to a rear hallway connecting the classrooms (shown left). It has a second story set of windows, but half is being covered by the second level walkway. The spaces closest to the northern walls would be quite dark as circumstances do not allow for much light to reach this space. The architects predicted this occurrence and integrated strategically placed openings in the second level walkway to allow light to flow into these otherwise dark corners. This happens in numerous locations in the building.

Thermal mass

The large stone wall that divides the building along the East/West axis was designed to be a *thermal mass* element as well as a unifying element. The architects pointed out that when inside the building, one is seldom disengaged from this beautiful element. The architects found this feature to also represent a symbolic sundial (Nordmeyer and McDougall, 2005). The wall can be seen in many of the images taken from inside the space reinforcing its role as a unifying element. Information on the wall's material is discussed a bit later. The wall's extrusion to the exterior helps to absorb warm or cool air, subsequently releasing that temperature slowly back into the space. Inside, the upper level of the wall is near southern facing windows to additionally help it absorb the low sun in the winter months.

On the lower level, the concrete floors and brick "wing" walls of the rotunda serve a similar purpose. As masonry elements they are shaded from direct sunlight in the summer months and collect the radiant heat from the low winter sun. One might also ask about the cement block composing the large north wall. While this masonry element will also retain a more constant heat as the other features mentioned do, its lack of sunlight on the North side makes it less effective as a passive heating element, but an effective passive cooling element.

This image was taken from the lower floor looking up to the offices on the second floor. Notice the overall height of the space. Also, note the punctures in the Maquoketa stone wall. These windows allow offices on the other side of the wall access to this abundant light.

Take note as well of how dark the lower level walkway seems. This space is actually adequately lit due to the gaps in the upper walkway seen and discussed at left.

This image was taken in the rotunda Exemplifing beauty and creativity in design, the ceiling has support beams radiating from the center. A central suspended light fixture illuminates the space in evening hours. The thin black pipes seen projecting from the outside to the center from the are arms of the building's sprinkler system.

User control of the environment

The architects made a conscious effort to include user controls within the building. Through the use of operable windows, window blinds, ceiling fans, and light switches, people can choose to use one system or the other.

While these features may not seem impressive, they can be an amenity to someone who wishes to have fresh air, or a breeze enter their workspace. Also, one often feels more comfortable knowing they have ability to change their environment, whether or not they choose to do so.

Material Selection

Masonry Features

Concrete block was used for walls on the north side of the building as well as a short wall on the south side. Concrete block is a sustainable material due to its structural longevity which in turn limits the operating cost of a building. Additionally, building with longevity in mind reduces the waste associated with demolition and construction. The amount of waste involved with both processes is considerable and must be evaluated. The block walls were left unpainted for specific reasons. In using unpainted concrete block as part of the overall design of the space, there is less maintenance on the building including, but not limited to, periodic painting. Paint can lower the indoor air quality and add to the operating costs of the building. Additionally, the unpainted wall can be disassembled and reused keeping much of its material integrity. However, this does not imply the structural integrity of the block itself would remain intact upon disassembly.

Similar to the concrete block wall, the concrete floors are incredibly durable. They need to be mainly swept with periodic waxing and buffing in polished concrete areas. The pebbled concrete floor finish is even more durable in that it needs no additional sealant after installation. Poured on site, this is a local material that can achieve a LEED point since it traveled less than 500 miles to reach its destination.

Other masonry materials used were brick and limestone. Brick is a highly durable material, requiring tuck pointing in time but generally maintenance free. It is often a beautiful color in its natural state without use of paint. The Maquoketa Limestone used for the central wall feature comes from the Maquoketa Valley, located in Iowa, and traveled less than 120 miles from the site.

This is an image of the brick wing walls in the rotunda. On them are pictures composed by elementary students pertaining to environmental topics.

This image is looking south on the upper floor. It is focused on a small square reflective piece seen in numerous photos as it is repeated throughout the building.

It is not a photovoltaic panel. It is instead purely decorative. These prismatic, reflective panels were added to bring a rainbow of color to an otherwise neutral palate.

Modular carpeting tiles

In the office spaces at the CEEE, modular carpet tiles are used. Modular carpet tiles come in standard square sizes, often in 12 inch by 12 inch squares. This method of buying carpet has allowed for flexible design solutions and a reduction in waste. Broadloom carpet often comes in 12 yard rolls and often creates a great deal of waste in the manufacturing and installation processes. Maintenance with carpet tiles is easier as well. Stains and damage to tiles can be easily solved by pulling up the tile and replacing it with a new tile. Also, this method allows easy access to any wiring or under-floor application.

Carpet manufacturers in recent years have made vast improvements to manufacturing processes, making carpeting and the processes used to create the carpet more sustainable. There are also many re-claimation programs available at the end of the carpet's useful life.

Copper Roof

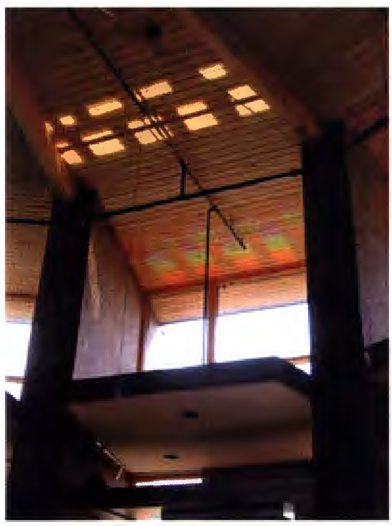
While copper is a beautiful and enduring material it is also a material that requires much mining for little meaningful substance. As the word mining suggests, techniques include large holes in the ground, hundreds of acres of tailings from which the ore is found and large piles of waste. Yet even this process has undergone a transformation of late. BHP Copper has developed an In-situ Mine where the copper is dissolved in a weak acid leach solution and pumped up to the surface and into recovery wells. This method, the article claims, leaves the surrounding habitat virtually intact.

Lessons Learned

Daylighting

The architects have learned that glazing areas over 20-25 percent of floor area is too high a ratio to balance daylighting and heating/cooling energy. The architects mentioned that "daylighting is like taking a sip off a fire hydrant," in that sunlight needs to be directed and manipulated in a way that supplies enough without impairing people's ability to work with glaring, distracting amounts of light. An example of this would be where the architects underestimated the effects of the direct skylight in the office space on the second floor. It allowed too much light and created glare for the employee working directly below. The skylight has since been retrofitted with a grill system to help diffuse the light entering the space. The architects have found 15 percent window to floor area a better daylighting measure.

Yet another feature of this space are the suspended ceiling pieces within each wing section. This helps to bounce the light back up onto the ceiling creating a more even distribution of light. On the top surface of these are additional prismatic squares. These capture the light and as seen in the third image, create colorful spots of light on the ceiling.



The architects also mentioned that the stepped light switching in the classroom was "overkill". An alternative method would to utilize a continuous dimming switching. This implies dimming the entire bay simultaneously. With the development of dimmable ballasts for fluorescent fixtures this method is much more applicable for today, and the energy use would be comparable.

There are also improvements being made constantly in luminaries. The research of new advancements and technologies is imperative to choosing the correct fixture and luminary for the job.

Building Use

Over time, the use of the building has evolved and will continue to evolve to meet the needs of the university. Currently, the building is home to the Physics Department as other buildings are remodeled. The classrooms now see double the amount of usage increasing the need for electric light in the late afternoon hours, especially in winter months.

Also computers, since the building opened ten years ago have become an integral part to every university building and classroom. The CEEE is no exception; it has its own computer lab where the computers not only use energy but also produce heat. This extra generated heat disrupts the equations the architects used when originally configuring the space. In addition, the use of daylighting techniques can be troublesome for computer screen use due to high frequency of glare. One suggestion is to place computer screens at a 90 degree angle to the window. Upon observation, the CEEE has made frequent use of manual window blinds to solve this problem.

Building Commissioning:

Due to the CEEE's change in use, the architects suggested it may be helpful to re-commission the space. Commissioning is a process of evaluating the heating, ventilation, and air conditioning (HVAC) of the building to ensure optimum operation and performance of these systems. Since building systems are integrated, deficiencies in one can result in less than optimal performance, by remedying these deficiencies the building can improve occupant comfort, energy savings, and building operation and maintenance. This process also ensures that the building system performance meets the design intent.

This image, from inside one of the classrooms gives a feel for the scale of the room. Notice the clerestory window in the upper left corner allowing light to transfer from space to space. Also in the upper-center of the photo, a white, square protrusion from the wall is a light sensor connected to the electric lights. Notice how unobtrusive its appearance in the room.

Banners hang from the second floor railing can be seen from the lower rotunda. They advertise local environmental programs.

"Recent studies indicate that on average the operating costs of a commissioned building range from 8-20 percent below that of a non-commissioned building" (Building Commissioning). This investment can result in reduced operating costs for the life of the building and eliminate the need for costly capital improvements (Commissioning Guide).

Survey Results

Employees of this facility have worked within the office for anywhere from 3 years to eleven years. Their job descriptions include, project director, custodian, office staff, manager, and director. Only one out of those surveyed was consulted during the design process and that person's involvement started at the beginning of the design process and included committee work and meeting with architects. That same person was involved in the selection of sustainable materials and features. No other employee surveyed was involved with this phase.

Those surveyed describe their area as spacious with great insulated windows, carpet tiles on the floor, large work spaces, a beautiful limestone wall, and varying but satisfactory light levels. When asked whether or not a certain feature was sustainable there were mixed responses. Some were even unsure as to the sustainable nature of a material. The categories of flooring, work surface, fabric, furniture had mixed answers. Those responding were most unsure about the sustainable aspects of their work-surfaces. However all knew that the lighting was a sustainable feature.

All enjoy working with these materials, including the janitor, and all enjoy the way the materials look. All surveyed would recommend these products. When asked for what reasons they would recommend these materials, the answers varied and included the lighting's energy efficiency and the ability to recycle used fluorescent bulbs. One stated that the environment was a comfortable, odor free, low maintenance environment. Another mentioned that "the materials are naturally beautiful and require far less maintenance to ensure the provision of bright, cheerful, working environments". Overall, the sustainable feature those surveyed liked the best was unanimously the lighting. The colors and the work-surfaces were also mentioned as well-liked.

There were few problems experienced with these sustainable features. The most pertinent problem would be that the high double-pane windows are difficult to clean from outside. Stains can be seen on fabric and scratches have, over time, appeared on furniture and work-surfaces.

There are specific things that those surveyed would like to change. Those items include having better temperature control, and the desire to add more daylight in the auditorium space or at least more efficient lighting in this area. They would also like to replace the lighting and windows with newer, better technology.

Results

Case Study 2:

Conard Environmental Research Area,
Environmental Education Center
Grinnell, Iowa

Case Study #2

Conard Environmental Research Area (CERA), Environmental Education Center (EEC)
CERA, (pronounced *sara*), is the area of land and the EEC is the building.
Grinnell CollegeGrinnell, Iowa

7500 sq ft with an adjacent 1900 sq ft maintenance shed
Opened April 2005
Project Architect: Jan Behounek of Holabird and Root

Overall Description of Building:

In 1968, 365 acres of land were acquired by Grinnell College 20 miles south and west of Grinnell, Iowa. It was named after college faculty member and botanist, Henry S. Conard. Soon after acquiring the land, "a system of all-weather roads, a laboratory for 24 students, an apartment for the manager, and a 14-acre pond" were constructed (www.grinnell.edu). At that time, forty-five acres of cropland were planted with prairie grasses and in 1987 an additional 80 acres of prairie grass was added to CERA.

"The Environmental Education Center was a part of Phase II of the Noyce Science Center Renovation/Construction Project." During discussions regarding the needs for the renovation, CERA was discussed as needing a better equipped facility at which to collect specimens, teach classes, and carry out the functions of CERA. The EEC is located alongside a preexisting, all-weather road at the crest of a valley on the North end of the property. The building is long and narrow with its main facades facing north and south. The north side houses the main entrance to the building and is punctuated by clerestory windows. The south side is dramatically different with an expansive window wall and large overhang looking out over the beautiful prairie that is CERA. On the East end of the building is the EEC's greenhouse. Fully automated, this greenhouse is a perfect place for growing and experimenting with native Iowa plant species.

This image is of the North façade. The building arcs slightly with a concave curve on the north and a convex curve on the south, seen in the image below. The main entrance to the building from the road can be seen in the middle of the building.

Notice the asymmetrical window placement. While somewhat unusual from the exterior can be best understood from knowledge of the interior functions adjacent to this wall. Offices, a kitchen, restrooms and mechanical room line this wall.

The gravel road, seen in the foreground, serves as both a parking area and access road.

This second image allows you to see the beautiful window wall and the large overhang on the south side of the building.

Notice that only a small concrete deck area was poured to minimize the footprint of the building.

Also, the building is only one story, keeping the building low-lying kept with the feel of the surrounding prairie.

The main areas of the building consist of two classrooms holding approximately 24 students each. One serves as a lecture room and the other, a laboratory setting. Also included in the building is an office, kitchen, and greenhouse. A central hallway acts not only as a traffic center but also as an exhibit space with two large display cases. One of the display cases holds the interactive kiosk which is also online. This kiosk helps visitors to learn about the sustainable features of the building as well as track energy and water usage.

This image is of the west façade. The building is quite narrow on the east and west ends with a minimal amount of windows. The cistern mentioned earlier is located just off the north west corner of the building.

The interior finishes consist primarily of stained and waxed concrete floors with an exposed, painted metal ceiling. The walls are either concrete block or painted stud walls. Colors are warm earth tones in browns and reds. The classroom and lab have Formica countertop surfaces and hard caster, un-upholstered seating. The furniture in the office is a wheat board material, golden brown in color. Acoustical ceiling tiles are also wheat board.

The greenhouse pictured here is on the East end of the building. Once again the building itself has little window area facing this direction.

It was decided from the beginning that the CERA EEC would seek LEED Certification upon completion of the project. A budget was established early on and cost estimates were completed at each stage of the design. (Jan) After the initial schematic designs were completed it was realized that the project was over budget. For this reason there were some sustainable features that were removed from the project. The largest feature that was eliminated was the green roof. Alone, this part of the project was estimated at two million dollars (Jan). However, the roof to the EEC as it now stands, is structurally able to support a *green roof* should the college choose to add it at a later time.

Description of Sustainable Elements within the building:

Building Site

In designing the building, architect and scientists wanted the center to blend in with the prairie surroundings from the exterior and create as little *footprint* as possible. While choosing the orientation of the building they chose to place it so that its long axis was in an East, West direction. This directional orientation helps to maximize natural light without glare and heat gain that can come with the direct light of an East or West facing window.

The overall view from inside the space was important to the college. It needed to evoke a sense of awe that is necessary for individuals to connect with nature, to internalize concern, and to express interest in preserving it. For this reason the crest overlooking the valley was an ideal location to capture this natural beauty.

Another variable in choosing this particular site was access to an existing roadway. Given that the ideals behind CERA are to promote a natural landscape and creature habitat, great concern was given to the effects of building at any location in CERA. By placing the site on an existing roadway they were able to avoid the damaging effects of creating a new road to a pristine site.

This wasn't the only concern for the managers of CERA. The view was spectacular, but it was one of the only views that CERA had which didn't involve any buildings, roads, or electrical lines, and the managers were hoping to preserve this. Another major concern was the rainwater runoff. Adjacent to the building is a river and also a pond. These waterways are easily contaminated and so extra care was taken to reduce harm to these areas. The building site was a complicated decision for CERA managers and the architects, but a compromise was reached.

South Overhang

With an expansive window wall on the south face, it was important to the building's energy efficiency to shade this area in the summer time from the high, hot sun. The solution in this instance was a large overhang. When planning an overhang it is useful to obtain information regarding sun patterns; for example, in the Midwest the sun rises very high in the summer and substantially lower in the winter months. This data can help designers calculate the extension distance from the building needed to prevent this hot sun from affecting the interior building. Yet in the winter, this same heating effect is desired, therefore the extension needs to be both deep enough and shallow enough for both effects to occur.

Water Management

Sustainable design can and should start from the earliest schematic designs. With the CERA EEC, efforts were taken during construction to prevent storm water pollution. By using silt stock around the entire site the storm water could be filtered before it reached the prairie land.
(www.cera.grinnell)

One of the interesting features of this building is its lack of landscaping. The native grasses and flowers compliment the building.

Also, pictured here is the overhang on the north side, or lack thereof. A large overhang is not needed on this side of the building because of its orientation.

This image shows the main entrance on the north side with focus on the concrete facing block and drain spout coming off of the roof. There is actually a green tube that is somewhat difficult to see in this image at the base of the drain spout. This connects the drain spout to the cistern located about 30 yards away.

Also of interest is the opening at the down spout. This opening was designed to prevent the down spout from freezing and cracking. For this feature to work best it must be at a proper slope to prevent any rain from escaping during a heavy downpour.

CERA wanted to integrate water management into their building design as well. Again, this was to minimize the impact of the building on the surrounding area. Their solution was to create a closed loop system between the runoff from the roof through closed drain spouts and into an underground cistern. This cistern collects, filters, and holds the water for gray water use in the building's toilets, lavatories, faucets, and sprinkler system. The collection of rainwater prevents water that has accumulated debris from the rooftop of the building from transferring that debris and potentially harming the surrounding vegetation.

According to a graph on the interactive kiosk, the building uses on average, approximately 6,500 gallons less than a typical building. While the graph does not note the variables that equate the two buildings or where the quantities came from, it is apparent that the CERA EEC building uses far less water than a typical building that does not have a water management system. The interactive kiosk also notes that the cistern holds enough water to flush each of the four toilets in the building nineteen times. (CERA Kiosk)

Due to the cistern's small size and its integration into the overall design of the building from the beginning, reduces much added cost associated with such a water management system. The small additional, initial cost with this system was overlooked as it will most likely save the building money long-term by reducing the need for well water.

Energy Efficiency

CERA EEC utilizes a geo-thermal heat pump to heat and also help cool the building. This particular system includes a series of 30 pipes, located under the parking lot. This particular location was again chosen as it was already disrupted land and not a pristine site. Since the earth several feet below the surface remains a constant temperature year round this knowledge combined with technology can be used to heat or cool the building. The water filled pipes pick up the cool or warmth of the ground, relative to the outside air, and return heated or cooled water back into the building. At the same time air is forced through the heat pump over the surface of the water coil mounted in the heat pump. (CERA Kisok). Geothermal systems, like this one, are responsible for an average of 0.2 lbs of CO_2 emissions per kilowatt used. This figure is 85% less than natural gas and 90% less than coal and oil. (CERA Kiosk)

This image is highlighting the display case in the hallway. This is the western end of the central hallway. On this end is a very special feature to the building.

The black screen that can be seen on the left side of the picture is the interactive kiosk the building maintains. Visitors can learn about the green systems that are implemented in the building through an easy to navigate format.

This image is of the east classroom. It is set up in more of a lecture setting opposed to the laboratory setting of the other classroom.

The finishes in this space are similar to the rest of the building. White walls and a white ceiling help to diffuse the light evenly into the space by bouncing light off into other parts of the room.

Building Materials

During construction a waste management plan reduced the impacts of waste disposal by diverting construction, demolition, and land clearing debris from landfill disposal. Wood, steel, cardboard, and paper were sorted and taken to recycling centers. A local farmer utilized soil and debris that was removed during sitework for field mulch. "These strategies resulted in a 75% reduction of all construction, demolition, and land clearing debris going to landfills." (CERA Kiosk) Overall, "18% of the building materials contain post-consumer and post industrial content. 50% of all materials were manufactured locally, within a 500 mile radius. 46% of the materials manufactured locally were also harvested and extracted locally." (CERA Kiosk)

The ground face concrete block used on the exterior walls is a material containing up to 40% post-industrial recycled content. The concrete block is made in Illinois (within a 500 mile radius and considered a "local material" by LEED), which was a big selling point for the material. (Jan)

The concrete block is a very durable material, able to withstand climate and time. This is an important aspect of sustainability because it will not likely need replacing and requires very little maintenance over time in comparison to wood siding which requires a great deal of maintenance over time. Often materials are chosen as a compromise, either it will last a long time or it can be easily recycled. (Jan)

The cement floors were an important aspect to the overall design of the building and needed to respond well to the demands that the CERA project puts forth. That is much dirt, pebbles, and various other prairie debris would come into the building. Durability was actually the main criteria for all materials in the building and the flooring needed to be especially durable. With the cement floors only light maintenance is needed and will likely not need replacing. In all the material is very conducive to the type of functions that take place within the building. (Jan)

Added cost is a concern for many considering the use of sustainable materials. However, the choices made regarding building materials mentioned above were little to no additional cost. That said, the shredded wheat acoustical tiles,

This image was taken directly inside the main entrance, looking through the doors to the north exterior. This image helps to see the colors and size of the cement block better.

Also of interest is the metal grate on the floor suspended over a drain area. The grate sets on a recessed ledge so that the surface is flush with the adjacent floor finish.

The grate then serves to remove excess dirt, water, and other debris from people's shoes as they walk in the door. Amount of debris entering the space can be a major concern given the type of work and experiments that are done literally in the field. This removal of dirt and other debris also helps the overall indoor air quality of the building.

casework from certified forests, and substrate from wheat board all have cost implications, but with the size of the building it was not a significant additional cost overall. (Jan)

Windows

"CERA center saves on cooling costs by using a high performance glazing curtain wall system to reduce solar heat gain." Painted walls, ceilings, and beams, in addition to their placement, were carefully chosen to minimize glare and to maximize reflected light. "Daylight buildings have ample light even on the cloudiest days. A completely overcast sky provides about 5,000 foot-candles of light, ten times the needed amount to light the typical building." (CERA Kiosk) A high performance glazing day light system introduces twice as much light per unit of heat than the most efficient artificial lights.

Overall, fewer windows were designed into the north side is as it is typically the colder façade. With these factors in mind the less frequently used spaces were intentionally designed along this side. To reduce cost, high performance glazing was utilized on the south side, but minimal on the few east and west windows as their size would not adversely affect the carefully monitored heat system.

This image gives an even better feel of what the beam structure looks like as a painted finish as well as the texture of the ceiling.

Also shown in this photograph is a light sensor. This one is suspended from the ceiling as opposed to the one others in the building that are mounted to the wall .

This hallway connects the north side of the building to the south side without passing through the classrooms. This also helps to act as sound control when the classrooms close their doors to the hallway, the dead space between helps to absorb the sound.

However, the amount of noise generated from inside the two rooms is too great for this area to be very effective in reducing that noise.

This image shows the concrete flooring and the surrounding wall finishes.

Acoustical tile panels are found almost everywhere, however, few have seen the wheat board acoustical tile panels. Similar to their traditional counterparts, these panels serve to absorb the sounds that a concrete floor and flat painted walls of a hallway can produce. At the same time they add a unique texture to the ceiling.

Fluorescent light fixtures can be seen as part of the overall lighting plan in the building. The central hallway where this picture was taken gets some light from the north and south side windows however, this comes through doorways and is limited in amount. The hallway also has exits on either end and these doors have windows and side lights that allow additional light into this area.

Along with the glazing, operable blinds were integrated into the window and lighting design. The blinds allow users to minimize glare and allow more light to enter when needed. The blinds played another interesting role in this particular design. CERA managers worried that a glass window wall would increase the chances of birds flying into the windows and injuring or killing themselves. While the architects felt that a one story building is less likely to have birds fly into it, they explored different solutions. One solution could have been adding a subtle pattern to the windows. In the end, the blinds were the least expensive and most functional way to prevent this occurrence by obstructing the path and making the window more noticeable to birds. (Jan)

The windows were not produced in Iowa and not within the 500 mile local radius as set by the LEED standards. However the windows were chosen as the best glass available due to budget constraints and the desired low-e shading coefficient. The life cycle of the glass was not discussed when choosing this material, as it was again intended to last the lifetime of the building which they hoped to be many decades even centuries long. (Jan)

The windows are not operable, which, as discussed in a previous case study, can be a desirable quality. The opposing argument to operable windows in this building was that climate control is imperative to scientific research. The old building had humidity issues that were detrimental to the work done within the building (Jan). In order to operate this building at its highest efficiency while maintaining the climatic integrity, it was better to have non-operable windows. Also, when using an automated climate system it is easiest to always have that environment automated as opposed to controlled by the user. Another variable to this situation might be the amount of use the building receives. For example, if the building was left unoccupied with an open window for large amounts of time, the temperature outside and inside can fluctuate, possibly making the building uncomfortable to the next visitor to the building.

These images help to show the expansive windows and the ample amounts of light. They begin at desk height and extend to the ceiling beams. The higher the windows the better penetration the light entering is able to achieve.

Notice the large window shades that are operable by the users of the space.

The overall lighting plan in this building was to daylight as many spaces as possible. However it is also necessary to add electric fixtures to the space for evening hour work or just a very dark day. For this reason the electric lights are programmed to a light sensor, shown in the middle of the photograph. The sensor tells the lights to turn on or off
These lights can also be switched on or off if desired. Switching the lights off would disable the light sensor and subsequent lighting changes.

Indoor Air quality (IAQ):

Just inside the exterior doors, a metal grate can be found. Known as a form of walk-off mat, it helps to rid some of the dirt from user's shoes resulting in better overall indoor air quality. Without some method of removing dirt, particles from shoes and clothing can enter the air and the air ventilation system resulting in a lower degree of IAQ (Jan).

"Volatile Organic Compounds (VOC) contribute to smog and air pollution and can have negative effects on the health of building occupants. The use of low VOC paints, adhesives, and sealants at CERA contribute to improved IAQ by reducing the quantity of indoor air contaminants that are odorous, potentially irritating, and/or harmful to the comfort and overall well being of installers and occupants.

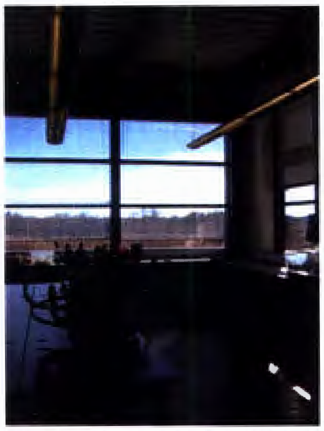
In 1996 the Environmental Protection Agency (EPA), listed IAQ as fourth on the list of high cancer risks. Noting as well, that health risks are five times higher when breathing indoor air than outdoor air (Spiegel, Meadows, 1999). Higher demands on ventilation systems and filtration systems have decreased this problem, but there are still areas of improvement to be made.

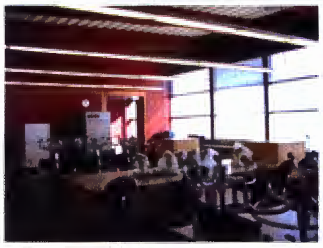
This image was taken in the office of the building. The furniture including desk, file cabinets, and a small table is made of wheat board. The staff that works in the building mentioned how when the furniture came it had a very distinct and wonderful smell to it.

During construction of the facility a construction IAQ management plan was established to protect materials and ensure that the indoor air was free of residual construction debris at the time of building occupancy. This included assurance that materials stored on site or absorptive materials were protected from moisture damage. Additionally, all mechanical filtration media were replaced prior to the building opening, and a two-week flush-out of the mechanical system was conducted with 100% outside air." (CERA Kiosk)

Millwork and Casework

The millwork and laboratory casework substrate used in the building is made of wheat straw, a *rapidly renewable* material. All kitchen, laboratory casework, and display case wood are from certified forests, certified by the Forest Stewardship Council. Use of certified wood encourages responsible forestry practices that are environmentally responsible, socially beneficial, and economically viable. This accounts for 40% of the wood in the building.





These three photographs are from inside the west classroom. This class room serves as a laboratory space.

The finishes, while nondescript upon first glance are actually very important. As a laboratory space in a praire there is much dirt and grime that comes in on people's clothes. To reduce the amount of maintenance a smooth concrete floor was used for easy clean-up. Also the chairs are plastic without upholstery. Once again reducing maintenance.

The table tops are also of interest. As some of the work involves looking at or collecting dirt or insects the users needed a surface that would allow them to focus on specimens. This becomes more difficult if the surface is either dark in color or speckled. For this reason they went with a solid color, light surface material.

In the last two pictures you are able to get an overall feel for the large rooms. Notice the floors again and the exposed structural beams, painted red, and the corrugated metal ceiling. Suspended light fixtures hang from the ceiling to offer additional light when needed.

The finishes feel very appropriate for the type of work that takes place in this space, however, a problem has arisen. When these two classrooms are filled with students the space becomes very loud, very quickly. Much of this is due to the fact that the space does not have any sound absorbing materials such as carpet or upholstered furniture that would normally help control the noise level in a room.

To solve this problem the architect is looking at adding acoustical panel "clouds" within the room. These would hang between the light fixtures at the same suspension height to help control noise.

Survey Results

Those surveyed have been employed at Grinnell College anywhere from 3 months to 14 years, with most over 5 years. Their job responsibilities include lab assistant, manager, field technician, summer intern, and director of field station. Most (4 out of 5) were consulted during the design process and most at the beginning with one joining discussions somewhere in the middle. Over half of those surveyed were involved in the selection of sustainable features/ materials. They were consulted when choosing the furniture, ceiling tiles, flooring, exterior concrete block and roof type. One participant commented that much of the faculty's input was aimed at making the building "greener" than the architects were proposing.

When asked to describe their workspace many commented on the large rooms, moveable furniture, and large windows with a beautiful view. One participant commented that the finishes felt too industrial and cold. Another mentioned the noise level in the space was overwhelming.

When asked to indicate which materials/features were sustainable, the entire group recognized that the lighting and the furniture were sustainable. Since there was no fabric in the space, this question is not applicable. Most surveyed were confident that the flooring and work-surfaces were sustainable while there were still one or two who were unsure.

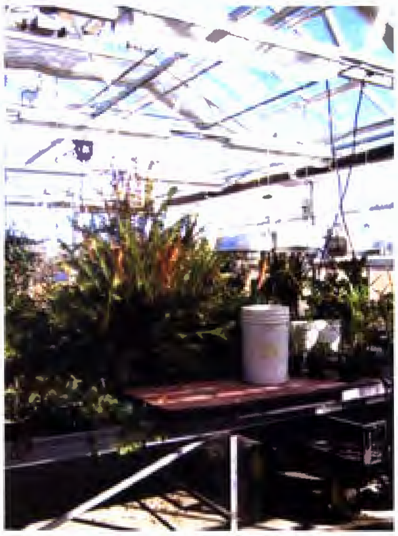
Those surveyed enjoy working in the space and commented on the nice smell the wheat board brought to the space. Most enjoy how the materials looked, but one did comment that the style could be improved. And all would recommend using the materials and features to others. When asked to elaborate on their answer, many felt they should be used because they were first and foremost sustainable. Participants also felt that the furniture and finishes were comfortable and functional for their purposes. However, some participants wished that the materials could be a bit more aesthetically pleasing while maintaining their sustainability.

There were mixed responses when asked if the users experienced any problems with the materials or features. Comments made in response to this question included the concern that there seemed to be issues with the sealant that was used on the concrete floors, noting that the concrete floors quickly absorbed water while mopping. Also it was noted that the exterior door jamb paint will stick the door shut. The users had noticed scratches or stains on the finishes. Those included marks on the floor, work-surfaces, and office furniture

When asked if the users would like to change anything about their workspace they commented on the lack of colors, acoustical problems, and desire to change table orientation.

These images were taken inside the attached greenhouse. The entrance is connected to the main building and a door is available to separate the spaces when desired.

The space is temperature controlled by an automated system that can be set at a desired temperature. Among the systems that moderate the temperature includes automated shades that open and close as needed. This material can be seen rolled up in the trusses. Fans also help to maintain temperature.



One dilemma that the EEC encountered was how sophisticated the automated system could be. When set at a specific temperature the system worked constantly to keep the greenhouse at that temperature the entire day. This was an ineffective use of energy as plants do not require an exact temperature for optimum health.

The solution came very easily. Temperature was programmed as a range as opposed to a specific temperature, allowing the space to fluctuate throughout the day yet avoiding extremes that would detract from optimum growing conditions.

Future Changes:

The most immediate concern of the space is the acoustics. With so many hard surface materials it takes very little for noise levels to exceed a tolerable amount in a classroom setting. When this dilemma was conveyed to the project architect, she mentioned that this problem was anticipated and that an easily installed solution would most likely soon follow. The solution would come as an acoustical panel cloud. That is, instead of a traditional suspended grid system that can be seen in the hallway, these would be suspended in between the lighting creating smaller areas of acoustical panels. This solution should accomplish the goal of reducing noise levels as well as maintain the industrial look of the building.

Early in the project a Green Roof was eliminated from the plans. However, the roof was still built to be able to withstand the additional weight of the green roof. In this way, the college will be able to someday place a prairie on the roof to help the building blend in with its surroundings.

Results

Case Study 3:

Spatial Designs
Mason City, Iowa

Case Study #3

Spatial Designs
Mason City, Iowa

3,000 sq. ft.
Opened June 2004
Architect: Thomas Hurd of Spatial Designs

This first image faces south and the north façade of Spatial Designs. Parking is available for visitors and the current entrance is just left of center in this image. The north and south faces are the longer of the four sided building. With few windows on the north and east sides and no windows facing west.

Overall Description of Building:

Spatial Designs is a small architectural firm housed in an unassuming concrete building. The small 3,000 sq ft building is nestled in among other corporate chain businesses. From the current road access it does not look particularly inviting, but this side wasn't intended as the main entrance. The building's site was strategically chosen near a not-yet developed roadway. So that in the future, access to the building will come from a southern direction. A short walk around the building and it becomes obvious that this was the desired entrance from the conception of the project.

A small pond separates the future parking lot from the building and is connected by a bridge. The southern façade contains many large windows with "wing" projections from the building. Upon entering, the reception is on the right hand side, and directly in front is the conference room. An office can be seen through a window cut-out in a dividing wall. There is another office further down the hallway and a printing/filing room can be seen through another cut-out in a space dividing wall. Bathrooms, a small mechanical room, and garage compose the remaining spaces of the building.

This photo shows the southern façade on a sunny summer day. The retention pond to the front of the building helps with storm water runoff. The bridge connects the land to the south of the building to the intended front entrance.

Notice also on the roof the sixteen photovoltaic panels angled to catch the sun's energy.

The owner and architect of the building Thomas Hurd wanted to design this space not only because he strongly believes in sustainable design, but also because he wanted it to be a working promotion for clients to see how sustainable design attributes looked, worked, and saved money. The company also wishes it to be a research area where new products can be explored and developed.

The initial additional cost for building the Spatial Design office with renewable features was 15% while the sustainable efforts were minimal. This is in reference to the equipment needed to produce renewable energy including photovoltaic panels and wind turbines. The sustainable efforts would include the choice of enduring materials such as concrete block.

Description of Sustainable Elements within the building:

Renewable Energy:

Spatial Designs prides itself on the integration of renewable energy methods to help the building carry out day-to-day operations. Ultimately, their goal is to be completely energy self-sufficient. In order to help them achieve this goal they have integrated two primary means of energy production, those are wind turbines and photovoltaic panels.

Two 40 foot wind turbines are located next to each other on the southern side of the building. These two capture the majority of the energy needed for the building. Sixteen photovoltaic panels are located on the southern roof face. These function as supplementary to the wind turbines.

The energy captured by the wind turbines and photovoltaic panels are either directly used by the building or they are stored in batteries within the small mechanical room. When the batteries are anything but full, the solar panels are instructed to bring in solar energy to supplement. This dialogue is carried out through a computer system that monitors the input and output of energy. The wind turbines do not have this dialogue; they will continue to turn even if the batteries are full. As a result of these efforts, the building produces 90% of its own power and uses approximately two thirds less power than a building of comparable size.

Energy minimization efforts:

Many efforts were taken to help minimize energy use of the building. In regard to heating and cooling costs, the use of small east windows and no west windows helps to keep low, direct sunlight out of the space. Limiting direct sunlight helps to reduce the radiant heat gain of the building. Strategically placed deciduous trees help to shade the building in the summer while allowing the sunlight to reach the building in the winter. Lastly, the use of high quality insulation helps to avoid fluctuating temperatures.

This image shows the wind turbines as well as the photovoltaic panels on the roof.

This image is of the computer based system that helps monitor and control the functions of the wind turbines and photovoltaic panels. Overall it is a very compact system.

Additionally, Spatial Designs chose a smaller air conditioning unit because of the small size of the space. They simply didn't need one any bigger than what they have. Another way they keep costs down is to run a dehumidifier instead of the air conditioning. Often it is the humidity that makes the space uncomfortable, not the temperature.

Retention Pond

The 10,000 gallon retention pond, located on the South side of the building, acts as a control for storm-water runoff and a natural air cooling device. The general area where the building was built was prone to flooding due to the large amounts of asphalt and other water impervious materials. The retention pond helps reduce chances of this occurring in the future. The system works by directing rain water toward two corners of the roof, where it waterfalls from the building, into the pond. Stones directly beneath the roof overhang help to catch and channel the water toward the pond.

During growing seasons Spatial Designs uses water from the retention pond to irrigate surrounding vegetation powered by energy produced from the wind turbine and photovoltaic panels. Also, in the summer when the office has the windows open a breeze will flow over the pond, naturally cooling the air before reaching the building. Overall, they estimate saving 25,000 gallons of city water per year through the retention pond as well as through low-flow toilets and faucets in the restrooms.

Tornado safe shelter

A unique feature of the Spatial Designs office is the tornado shelter, wonderfully concealed as a conference room. 100 tons of pre-stressed concrete were used to build the tornado shelter. The walls are reinforced concrete block that adds dimension and texture to the interior and exterior wall. To reduce the overall cost of the room, the concrete ceiling was made into forms on the ground and then lifted onto the ceiling. The most imperative aspect to the tornado shelter is the door. Considered the most crucial factor in creating a tornado storm shelter, they are required to resist impact from flying debris as well as maintain a proper locking mechanism. Interestingly though, the door is also required to have the proper hardware to allow for easy exit in case of fire. The massive concrete structure also helps to serve as a thermal mass within the space. This feature was discussed in length in previous case studies.

Iowa is one of many states prone to tornados. In a one story, basement-less building there would be few places of refuge in the event of a tornado. This factor in combination with the ability to showcase an example of such a structure were motivating factors in the addition of the space to the overall design of the building.

The retention pond, highlighted in this first photograph is surrounded by stones to help water run into the pond as well as to allow the pond to expand without hurting surrounding vegetation.

The employees of Spatial Designs enjoy the waterfall effect that results from the rain falling from the roof into the pond. They mentioned that with very heavy rains, the water creates a fascinating water spiral on its way to the pond.

This image looks from the front entrance into the conference room. Notice the square concrete block used to form the walls of this tornado safe room. The painted block inherently creates texture and interest to the wall.

The door has a sophisticated locking mechanism to complete the room's ability to withstand tornado forces.

Daylighting

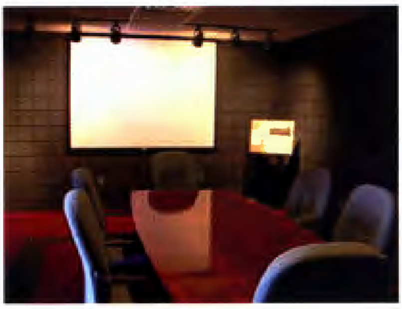
Wing walls projecting from the building's exterior serve multiple purposes. First, they help to control the amount of direct light let into the building during late afternoon and early morning in the summertime. By helping to disrupt direct sun, the building can reduce the amount of glare experienced as well as limit radiant heat gain. Conversely, these wing walls do not prevent direct sun in the winter months helping to heat the building in the winter. Their projection from the building also helps to separate one office from the next. The view is disrupted which allows employees to experience privacy and a sense of territoriality.

Carefully developed, the wing projection from the exterior wall was based on sun angle documentation. This information combined with the overhang of the roof gave the final projection depth. For the upper area that did not necessarily need to be present they chose to angle it at the same angle as the roofline, 30 degrees. Spatial Designs chose to do this to keep their façade aesthetically pleasing.

One advantage of having a one story building is Spatial Design's ability to take advantage of the light-diffusing qualities of snow and water from the pond. These features help to catch direct sunlight, bounce it off the ceiling, and subsequently onto the worksurfaces. This effect is very desirable as the diffused light enables illumination without distracting amounts of light.

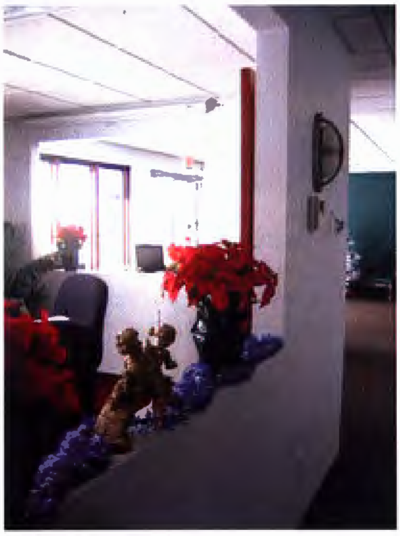
Operable Windows

Spatial Designs chose to include operable windows into the design of the building. Operable windows are generally more expensive than non-operable, yet the appeal of being able to open the windows when one would like, is desirable. The building does have air conditioning, but on a perfect day, employees at Spatial Designs will open the windows. Still, allergies and humidity prevent the windows from being open for much of the warm weather months.



As seen in this image, the impressive tornado shelter seamlessly becomes a functional conference room.

Of interest in this photograph are the wing walls. Designed to reduce low sun angles from entering the building, one can also see how they help to create separate viewing areas, increasing privacy.



Another method used to maximize the amount of sunlight each area received was to add openings to the dividing walls, described earlier as "cut-outs". These help to provide ample amounts of daylight to the spaces that do not have windows or those with small windows.

Sustainable Materials

Walls are sustainable wood covered with EFIS. Spatial Designs chose to include VCT tiles in the restrooms. VCT is made from recycled plastics and vinyl's. When the bridge across the pond was built, Spatial Designs looked into a sustainable material for the decking. The choice was a material called Trax from DuPont, a recycled plastic material. Initially, the product cost was three times more than regular decking material, however the material should last fifty years compared to wood decking's fifteen year life span. Also the plastic has far less maintenance involved compared to its wood counterpart.

One crucial element that arose during the interview with the architects was that they attempted to choose the best product that was available at the time for the building. Much sustainable advancement in interior finishes has emerged in recent years. However, it would be neither sustainable nor cost efficient for Spatial Designs to replace the material, simply to ensure a green building.

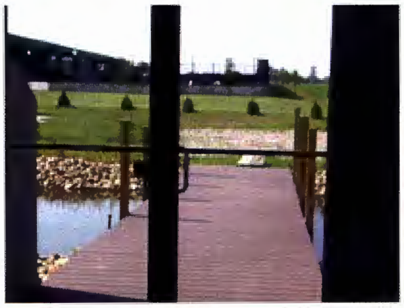
Survey Results

The few employees at Spatial Designs have all been at this location for approximately the same amount of time which is about 3 years. Their responsibilities range from office staff to owner and architect. As they designed their own building, all were involved with every step of the process.

They describe their work space as that which has southern windows that allow daylight to enter with provided additional task lights if needed. However the daylit areas have anywhere from 20 – 200 footcandles on a given day.

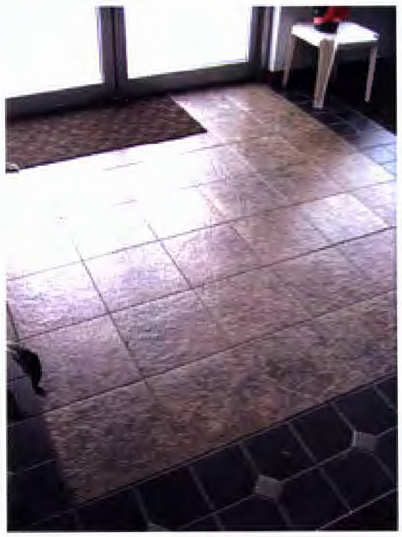
Participants listed the sustainable materials in their space as flooring and lighting. Participants enjoy working with these materials and enjoy the way they look. They would recommend the use of sustainable products to others.

The most appealing aspect of their workspace is the lighting. Changes within the space would only be to upgrade to improve the building's energy efficiency and to come closer to reaching the goal of self-sufficiency.



The bridge in this image serves as a grand entrance to the building. The material is a non-slip surface made of recycled plastics.

Just beyond the bridge is the future parking lot site. They hope to use a grass paved lot using a plastic honeycomb shaped material that reinforces the vegetation, protecting it from vehicle damage. Boundary indicators would be provided to help people familiarize themselves with the area in which to park.



Upon entering the building a tiled entry area helps to keep dirt out of the adjacent carpet. This easy to clean and sustainable material also helps to absorb radiant heat in the winter acting as a passive heating element.

Future Changes:

Self-Sufficiency

Spatial Designs has, from the beginning, strived to create a space where they could be energy, self-sufficient. This includes maintaining their current equipment as well as evaluating the options of upgrading old equipment to investing in new, renewable energy producing equipment. One area that has been discussed is hydrogen power. No plans were made at the time of interview to actively pursue this venture.

Efforts to share renewable energy.

Since Spatial Designs often runs their building with energy to spare, there have been attempts at sharing this energy with others. Exploration into the option of selling back energy to the local energy company resulted in a 28 page form and a $350.00 fee before dialogue could begin. (Hurd) The company then had up to 18 months to give an answer. The extra equipment that would be needed to sell back this energy would cost around $1000 dollars. Spatial Designs decided against this option.

Another option might be to share the extra energy with neighboring buildings. However, many of the buildings surrounding Spatial Designs are corporate chains that often do not entertain ideas from small businesses.

This image faces northwest. There is actually no windows on the west wall. The cement stone of the conference room is also pictured.

Color of the finishes were thoughtfully chosen. It was necessary for the space to reflect light in order to maximize the natural light that entered through the windows. Therefore many surfaces were white. Below one can see that many walls were painted white as well as utilizing white ceiling tiles.

There is a car wash adjacent to Spatial Designs that has communicated with them on this topic. However it would take a wind turbine that produced three times as much as their current wind turbine model, to produce only 25% energy needs. Yet, discussions are in the works on how this car wash and other businesses like it can reduce their energy costs.

Spatial Designs has found that people are aware of sustainable design options but that they don't think it will work for them. "People are willing to pay 35,000 for a car that will depreciate as soon as it leaves the dealer's lot, but they are not so willing to invest 35,000 into a wind turbine that will pay-for itself and even make money for the company over time." (Hurd)

Publicity

Spatial Designs strives to promote the benefits of sustainable design from both the ecological and economical standpoint. The company discovered first hand the hurdles that progressive designing encounters. Spatial Designs had to go through many bankers and insurance agencies before they found someone to approve their work on this building. They feel that the more buildings that are constructed in this manner will allow for better understanding and support in these financial and (approved for permit) arenas. This will then effect willingness to adopt these practices.

F. Discussion

The CEEE, CERA EEC, and Spatial Designs represent the beginning trend toward sustainable design in Iowa. They are exemplary products of an innovative and thorough design process. Upon beginning research into this area it soon became apparent that buildings seeking LEED certification in Iowa are primarily institutional facilities in the areas of education and municipal buildings. One would venture to say that a privately owned business such as Spatial Designs is a rarity in its commitment to sustainable design as it is clearly those institutions that have the opportunity to think beyond the bottom line and toward a greater ideal that are leading the sustainable efforts in Iowa. This observation could be explained by three main themes that were apparent within the case studies but require more explanation. Those include interpretations of sustainability, investment and funding opportunities, and the LEED certification processes.

Interpretations of sustainability:

Many when approached with the subject of sustainability initially require an explanation of what sustainable design is. Often terms that are used to help individuals visualize are words like "green" or "environmentally friendly". This can sometimes provoke ideas of "trash art" or the use of discarded material as building material or decoration. A recent example is the "Beer Can House" in Houston, Texas (Beer Can House) where the facades are adorned entirely with beer cans and pull tabs. Another example might be the use of old rubber tires as planters. While instances such as these hold a special place in some hearts, it is not exclusively the efforts toward sustainable design as is apparent in the images used in the case studies.

From a purely business standpoint, it would make very little sense for exclusive promotion of this sustainable endeavor. Instead, manufacturers are developing ways to harvest raw materials and manufacture products that are sustainable, aesthetically pleasing, and perform well. By creating products that are more widely acceptable to market segments they increase their chances of receiving a worthwhile return on investment. Also strong evidence that green products work can be seen in the mainstream acceptance of such products. This acceptance would be impossible if the products themselves did not perform (Spiegel, Meadows, 1999)

This end result can be achieved in two ways. One option is to include the utilization of recycled content of post-industrial or post-consumer content. As mentioned in the case studies, the CERA EEC ground face block utilized 40% post-industrial recycled content. Carpet manufacturers can be found on the other end with much post-consumer recycled content in their processes. The other option for sustainable manufacturing is the development of new technologies that are cleaner, are designed to be reintroduced into the manufacturing process at the end of their useful life as a product, or both. It is known that for some products excess processing can diminish their integrity as a product and continuous reintegration into manufacturing would not be possible. Aluminum for example, is often used for auto body applications, yet when combined with other metals for different applications, the quality and value of the aluminum decreases making it unsuitable for this particular application (Auto Companies). Instead manufacturers must design sustainably from the beginning to ensure complete reintroduction of materials into product cycles which will enable them to compete in sustainable product markets.

Along this same topic a theme that became apparent through researching these buildings was the difficulty of choosing interior materials. Designers often found themselves choosing between a finish that was sustainably manufactured and that which is enduring. Ideally a product would contain both qualities, but time is required for manufacturers to adjust to these market demands. In time it is hoped that there will no longer be the question of sustainably designed products. Instead, the consumer market will demand sustainable design from so many arenas that the entirety of the manufacturing businesses will change to accommodate this demand.

Investment and Funding Opportunities:

Institutional settings such as universities often draw through proposal processes a qualified pool of designers sometimes not available to small businesses or developers. These institutional buildings are also quite concerned with maximizing the use of tax-payers dollars by building with longevity in mind. This is often unlike the small business owner or mid-size developers who often through necessity, need the design process to take place very quickly in order to begin making a return on their investment. The simple fact, however, remains that new, innovative design takes more time due to research and creative processes which also implies

One striking event took place during this study. A building in Iowa that was, at the time this paper was written, seeking LEED certification (it is unsure what level of certification they were applying for) was contacted by the investigator. Responses of disinterest in participating in the study were numerous and varied, but one stood out. That statement was one indicating that the users of the building knew nothing about the LEED certification process and they would have no useful information to contribute. Whether this statement was entirely true was not the basis of concern; it was rather that the users of the building did not understand the importance of the building in which they worked and did not wish to promote its innovative qualities. Those who operate sustainable buildings need to be advocates for sustainable design and firstly advocates to the building's users.

After knowledge about LEED certification is established there remain hurdles to be overcome. A thorough application and review process takes place before certification is awarded. While this is admirable given the need to ensure a favorable reputation of the LEED certification, it is a complex matter for architects and designers wanting to certify for the first time. The United States Green Building Council encourages those interested, to contact a LEED accredited professional to assist in this process and even more encouraged to integrate the accredited professional into the design team as early as possible. If brought in from an outside firm, this advising could incur substantial additional costs to the project.

Additionally, along the process of designing a building, filling out paperwork, and spending time researching sustainable building practices there are the fees associated with the certification. Fees for certification are grouped by building size, under 50,000 square feet is a flat fee, 50,000-500,000 is based on square feet, and over 500,000 is also a flat rate, (USGBC). A registration fee, fee for reference guides, and fees for any credits appealed after review are also additional costs to the certification fee. Overall, for buildings such as Spatial Design's 3,000 square foot building, certification comes with an unreasonable price tag. Having mentioned all this, an important aspect to remember is the need to promote sustainable buildings. Whether through the LEED Certification process or through active advocacy in the community, the news must reach everyday people.

The next step in sustainable materials is not necessarily to continue to improve current methods but to affect materials through the smallest of particles. Nanotechnology, the science of manipulating matter at a molecular level, is the next step in the area of sustainable design. Scientists are looking to produce textiles that feel like cotton and perform like vinyl, integrate photovoltaic panels into textures instead of a solid glass panel, and create self-cleaning tiles. (Rewi, 2006) In this way, we can create clean processes, reducing waste and harmful substances through manufacturing; enhance performance, limiting maintenance and necessity for harmful chemical treatments; and "upcycle", by enabling materials to constantly re-enter the manufacturing system repeatedly while maintaining performance integrity.

G. Conclusion

1: Sustainable Attribute Comparison

Sustainable Area	Specific Features	Buildings portraying the features		
		CEEE	CERA	Spatial Designs
Passive solar heating/cooling				
	Thermal Mass	X	X	X
	Overhang		X	
	South primary window façade	X	X	X
	Few East/West windows	X	X	X
	Wing walls			X
	Window blinds	X	X	X
Indoor air quality		X	X	
	Little use of paint and adhesives	X	X	X
	Materials need little chemical treatments	X	X	X
	Walk off mat	X	X	
	Air cleanout prior to occupancy		X	
	Operable windows	X		X
Local materials				
	Materials within 500 mile radius of site			
Safety and welfare				
	Tornado Shelter			X
Water management				
	Retention pond			X
	Cistern		X	
	Low-flow fixtures		X	X
	Management during construction		X	
Energy efficiency				
	Light sensors	X	X	
	Daylighting methods	X	X	X
	Adequate HVAC system		X	X
	Thermal heating		X	
Renewable energy				
	Photovoltaics	X		X
	Wind turbines			X
Materials w/ recycled content				
	Plastic decking			X
	VCT			X
	Ground face block		X	
	Ceramic Tile	X	X	
Renewable materials				
	Wood	X	X	X
	Rapidly renewable materials		X	
Education				
	Community activities	X		X
	Tours	X	X	X
	Informational kiosk		X	
	Website	X	X	

The above table strives to concisely compare the sustainable material and features of the three case studies. While it seems as though one building may have many more qualities than another, there also seemed to be a degree of depth achieved in some categories while others were simple applications requiring much less design. Therefore while some buildings may have numerous and various attributes, others have few but with far reaching effects. A better assessment of a building's sustainability may be to investigate each feature to strive to determine the wide benefits of such a feature. However, this goal is beyond the scope of this study.

Sustainable design has begun a reasonable start in Iowa, a state often embracing the familiar and hesitant toward change. However, Iowans love their land and the fresh smelling air; for this reason they can, and many have already, become passionate about saving the integrity of their state's environment. The buildings listed in this study represent those already passionate about sustainable design and committed to its promotion in addition to other similar endeavors.

Sustainable development occurs within a dynamic and evolving set of interlocking systems that are never in a static equilibrium (Campbell, et.al., 1997). "Change is the norm, not the exception," (Campbell, et.al., 1997, p.8). The managers of these buildings are aware that there will always be the need for improvements as space needs change. Commitment is necessary to ensure that occupants receive full information about how to get the best use of the space and that the building is operating as it was designed. However, investors, tax payers, and home owners are aware that frequent change and updating can be a costly endeavor. Yet, if improvements are put through a sustainable design criterion, a solution that will be best for the environment, economy, and people will become apparent. This remains true even if that solution is to not make adjustments at this time.

These buildings represent the beginning of the sustainable design movement within the state of Iowa. The managers and employees that work at these buildings understand the importance of their efforts and the need for their continued efforts toward publicity. Familiarity can breed acceptance and acceptance can change the world. "Due to today's increased complexity and interrelatedness, no building can be constructed as a microcosm. Every building must consider the impact it will have on the environment into which it will be placed, locally and globally." (Spiegel & Meadows, 1999. p.1)

Through the identification and investigation of three admirable LEED-worthy buildings in Iowa a greater sense of knowledge and awareness has been achieved for the investigator and, it is hoped, for other design enthusiasts. Each building had a different approach to the concept of sustainable design through their use of materials and sustainable features. These materials' and features' performance, effectiveness, appropriateness, locality, and recyclability were discussed within the case studies. This gives the investigator and other designers the ability to compare the buildings with one another while appreciating individuality and focus of the overall building design. Based on observation and employee surveys these buildings create positive, beautiful places to work and learn. It is hoped that these buildings will help to catch the imagination of and inspire the next set of design professionals and those commissioning designs.

H. Sources

Auto companies launch aluminum sheet recycling (2003). *Advanced Materials & Processes*, Feb 2003 v161 i2 p19(1).

Beer Can House, Kirby, D., Smith, K., Wilkins, M., (2006). http://www.roadsideamerica.com/attract/TXHOUbeer.html

Building Commissioning, updated 07-01-99. http://sustainable.state.fl.us/fdi/edesign/resource/totalbcx/

Campbell, C. Lee; Evans, Victoria; Heck, Walter W.; Lee, Si Duk; Lee, Victor S.; Muschett, F. Douglas; Shen, Thomas T.; Warrant, John L.; (1997). *Principles of Sustainable Development*: Delray Beach, FL., St. Lucie Press.

CEEE Facility, retrieved 10-19-05: http://www.uni.edu/ceee/facility/index.html.

CERA Kiosk, retrieved 02-09-06. http://cera.grinnell.greentouchscreen.com/kiosk_resolution.swf

Commissioning Guide, updated 03-21-05 by Mike MacDonald. http://eber.ed.ornl.gov/commercialproducts/retrocx.htm

DOE2, retrieved 02-27-06. http://gundog.lbl.gov/dirsoft/d2whatis.html

Karlen, M., Benya, J., (2004). *Lighting Design Basics:* Hoboken, NJ, John Wiley & Sons.

Kibert, Charles J (editor) (1999). *Reshaping the Built Environment: Ecology, Ethics, and Economics:* Washington, DC, Island Press.

Kline, John (retrieved 03-15-06). *Copper mining in a cotton field?* http://www.copper.org/environment/casestudies/cottonfield.html

McDonough, William, Braungart, Michael, (2002). *Cradle to Cradle: Remaking the way we make things*: New York, NY, North Point Press.

Nordmeyer, Kevin and McDougall Tom, *Iowa's first green building: Presentation and guided tour,* April 2005. (Available from University of Northern Iowa, Cedar Falls, IA 50614).

Passive solar design: Increase energy efficiency and comfort in homes by incorporating passive solar design features, Office of Building Technology, State and Community Programs Energy Efficiency and Renewable Energy, US Department of Energy,

Rewi, Adrienne J., (2006). Mind over matter. *Perspective, Spring 2006,* pgs 14-22.

Spiegel, R.; Meadows, D.; (1999). *Green building materials: A guide to product selection and specification*: New York, NY, John Wiley & Sons, Inc.

Techniques for Sustainable Design, , Alspach, P., O'Leary, M., retrieved 02-27-06. http://www.sasakigreen.com/events/handout1.pdf

Terminology, retrieved 02-27-06: http://www.idec.org/greendesign/terminology.html

USGBC, US Green Building Council, (2006). http://www.usgbc.org/DisplayPage.aspx?CategoryID=19

Appendix 1

Glossary

Appendix 1: Glossary

BLUE: term used to in reference to the idea of cool, clean, unpolluted air or water

BROWN: term used to stimulate ideas of dirty, barren, polluted areas. Used in reference to contaminated sites, for example "brownfields"

BUILDING ENVELOPE: The entire perimeter of a building enclosed by its roof, walls, and foundation. Properly designed, the envelope can minimize temperature gain or loss and moisture infiltration.

CAPTURED RAINWATER: Through the use of appropriate roofing materials and gutter systems, rainwater can be harvested or collected then stored for future non-potable use such as showers and hand washing (See also Graywater & Harvested Rainwater)

CLEAN TECHNOLOGY: uses less fuel or alternative fuels to produce energy and generate little or no waste for industry, agriculture, and transportation. (p86,2)

CONSTRUCTION WASTE MANAGEMENT PROGRAM (CWMP): A plan that diverts construction debris from landfills through conscientious plans to recycle, salvage, and reuse. For best results, this type of plan should also eliminate packaging of materials when possible and be carefully monitored or audited by the contractor.

COMMISSIONING: A quality process for achieving, validating and documenting that the facility and its systems are planned, designed, installed, tested and capable of being operated and maintained to perform in conformity with the design intent. (www.sustainable.state.fl.us)

DAYLIGHTING: Natural daylight introduced into interior spaces and controlled specifically to reduce levels of electric lighting, minimize glare and optimize lighting quality.

EMBODIED ENERGY: Energy required to extract, manufacture, transport to jobsite, assemble materials and components, and complete the installation.

ENERGY EFFICIENT: products and systems that use less energy to perform as well as or better than standard products. While some have higher up-front costs, energy-efficient products cost less to operate over their lifetime.

FOOTCANDLE: Developed over 300 years ago, the science of lighting was based on candlelight. The foot-candle is the amount of light striking a surface 1 foot away from a candle. Still used today, and generally referenced to indicate the average light level requirement measured in the horizontal plane at desk height. (Karlen, Benya, 2004)

FOOTPRINT: Area of land directly and perpetually affected by a building, often in regard to the shell of the building disregarding the overall height.

FLUSH OUT: To help ensure the indoor air quality, mechanical systems are operated for a minimum of two weeks using 100 percent outside air at the end of construction and prior to building occupancy.

FLY ASH: By-product of coal burning that increases the strength of concrete.

GEOTHERMAL ENERGY: Energy from rock and or water that is heated by contact with molten rock deep in the earth's core (i.e. magma) the heat can be extracted and used for space heating or generate electricity.

GREEN: adjective meaning "environmentally friendly"

GREEN ROOF: an extension of the existing roof which involves a high quality water proofing and root repellant system, a drainage system, filter cloth, a lightweight growing medium and plants. (www.greenroofs.net)

GREY WATER: Wastewater captured from sinks, washbasins, bathtubs, showers and clothes washers; can be collected and treated for re-use such as the flushing of toilets or watering of landscape.

HARVESTED RAINWATER: rainwater captured and used for indoor needs and/or irrigation. (See also Captured Rainwater)

INDOOR AIR QUALITY (IAQ): The supply and introduction of adequate air for ventilation and control of airborne contaminants, acceptable temperatures and relative humidity. Assessment of the indoor air to determine levels of molds, bacteria, viruses, and chemicals produced by off-gassing of products used in the building or carried into the building by the HVAC system.

LEED: The Leadership in Energy and Environmental Design (LEED) Building Rating System sets industry standards for green building design and developed by the US Green Building Council. Created to define "green building", recognize leadership, stimulate competition, raise consumer awareness, and transform the building market. (www.usgbc.org).

LIFE-CYCLE COST: The amortized annual cost of a product that includes first costs, but also extends to include installation, operating, maintenance and disposal costs over the product's lifetime.

NATURAL DAYLIGHTING: Use of daylight and often direct sunlight into a built environment.

PASSIVE SOLAR: Technology of heating and cooling a building naturally through the use of energy efficient materials and proper site placement of the structure.

PHOTOVOLATIC (PV): Solar panels (photocells) used to harness the sun's energy and convert it to electiricty that can be stored in batteries and/or used to power electrical systems. PV panels, now more affordable than in the past, are incorporated into building designs.

POST-CONSUMER: A material of finished product that served its intended use as a consumer item. It may be recycled and incorporated into building materials and identified as containing post-consumer recycled content or recovered material.

POST-INDUSTRIAL or PRE-CONSUMER: This refers to waste produced during the manufacturing process of virgin material and rerouted from one step in the process to the next. This does not refer to recycled material.

RADIANT HEAT: Flexible tubing is installed under flooring, behind walls, or above the ceiling to circulate warm water used as a heat source.

RADIANT HEAT GAIN: the transmittance of heat through the sun's radiation to a surface or object.

RAPIDLY RENEWABLE: Materials that are not depleted when used, but are typically harvested from fast growing sources (less than 10 years) and do not require unnecessary chemical support. These materials are also found to grow in high densities requiring less land. Examples include bamboo, flax, wheat, wool and certain types of wood.

RENEWABLE ENERGY: Energy harvested from sources that are not depleted when used, typically causing very low environmental impact. Examples include solar energy, hydroelectric power, and wind power.

RENEWABLE: A resource that is replenished through a relatively fast-acting natural process (e.g. sustainable reforesting for lumber production)

REPLENISHABLE: Energy harvested from the sun, wind, or water; materials from renewable sources (e.g., sustainable managed forests) or virtually inexhaustible ones (e.g. mud, clay, sand)

THERMAL MASS: Heat holding capacity of a material; heat is collected and stored (often using masonry or water), then slowly released.

VOLATILE ORGANIC COMPOUND (VOC): These highly evaporative substances are indoor air pollutants or chemical compounds that exist as noxious vapor or gases at normal temperatures and are carbon-based molecules typically used as solvents in products such as household cleaners, paints, inks, and dyes. Sources of VOCs include formaldehyde (a suspected carcinogen), xylene, toluene, benzene (a known carcinogen) and acetone.

WIND POWER: Energy generated through the use of a turbine that collects wind energy and converts it to electricity.

Appendix 2

Survey Results

Appendix 2: Survey Results

Survey Results #1: CEEE

Q1: How long have you been working for this office?
    5 years
    11 years
    6 years
    3-4 years
    11 years

Q2: What is your job responsibility?
    Project Director, Custodian, Office staff, Manager, Director

Q3: Were you consulted during the design process?
    1 yes, 4 no
    If yes: at what point in the design process did you become involved?
    Beginning

Q4: Were you involved in the selection of sustainable materials/features?
    1 yes, 4 no
    If yes: please describe your input:
    Participated in original comm.. work – met with architects

Q5: Please describe your work area
    Room – spacious with great window
    Flooring – carpet squares, very good
    Light levels – can vary and is excellent
    Deskspace – very good
    Long standing roof leak has finally been repaired!

My work area is the entire building that gets cleaned and surfaces that get disinfected. I care for many light fixtures, carpeted floors, cement floors, and tile floors. The CEEE is a very special custodial assignment I will take care of this building up to the year 2019.

Carpeted, spacious office with two spacious work stations, much natural light, huge window in office

The most important feature is the limestone wall, a beautiful natural accent that gives our space a very comfortable, natural feel. The wood also contributes to this. Although I work in an interior office, I have great daylighting and seldom turn on my office lights

I occupy the main office of CEEE. It is equipped with: large douple-pane, argon-insulated windows; motion-sensitive lighting with compact-fluorescent lamps; modular carpets; wooden and metal furniture, desks, and file cabinets.

Q6: Are any of these aspects in your work area a sustainable material/feature?
    Flooring: 4 yes, 1 unsure
    Work surface: 2 yes, 3 unsure
    Fabric: 2 yes, 2 unsure, 1 unmarked

Furniture: 3 yes, 2 unsure
Lighting: 5 yes
Note: not sure how you define "sustainable"

Q7: do you enjoy working with these materials?
All yes

Q8: Do you enjoy the way these materials look
All yes

Q9: would you recommend this materials' use to others thinking about designing a sustainable building?
All yes
Why?
Above factors
We use fluorescent bulbs that get recycled, cement block walls do not need to be painted
Lighting is more energy efficient
Very comfortable, odor free, low maintenance
They are durable, long lived; require far less maintenance than conventional materials; naturally attractive without frills; provide bright, cheerful working conditions; they are good for the envrionment

Q10: do you experience any problems with any of the materials?
Other, roof now fixed
No
No
Yes, copper on some areas has bubbled off, needs to be re-applied
Yes, high double-pane windows are difficult to clean from outside

Q11: Do you notice that the materials show any scratches, stains, or marks from use?
All yes
If yes: Please indicate the material(s) that show these marks
Fabric, chair
Flooring, worksurfaces
The copper patina is more attractive with stains! The wax on the concrete floor requires buffing to eliminate scratches
Some, but a lot less than conventional materials would show

Q12: Do you enjoy your workspace?
All yes, one Yes, absolutely

If yes: what feature(s) do you like the most?
Lighting, colors, worksurfaces, windows
Lighting, colors, work surfaces
Lighting, colors, work surfaces, large window
Lighting, wood and stone
Lighting, work surfaces, draft-free, simple and attractive

Q13: Would you like to change anything about your workspace?
All yes
If yes: which item(s) would you change
Temperature control

When I am in the building with a class I am in the lab. It is a large (24 x 36) room, concrete floors, many south facing windows with beautiful view of the prairie. Very high concrete ceiling, noise level is high, 24 lab chairs and 6 lab tables, perimeter of cabinets and blackboard

Painted walls, concrete floor (sealed) generous desk space (wheat straw) adequate fluorescent lighting and north facing windows

The desks and filing cabinets were made of some kind of wheat fibre (and smelled really good!!) and the tiles on the ceiling were also made of natural fibre.

The lab room where I teach accommodates 24 students, who can work at moveable tables or at work stations around the room's perimeter. To the south are large windows that overlook reconstructed prairie. To the north are a blackboard and projection screen

Q6: Are any of these aspects in your work area a sustainable material/feature?

Flooring: yes, yes (unsure), yes, unsure, unsure
Worksurfaces Yes, unsure (formica?), yes, yes, yes
Fabric n/a, n/a, n/a, n/a,
Furniture yes, yes (in the office but I don't work there very often), yes, yes, yes
Lighting yes, yes (the lights are automatic, dim near the windows and fluorescent), unsure, yes, yes

Q7: do you enjoy working with these materials?

4 yes, one n/a
Yes, the furniture in the office has a pleasant smell from the materials that are sustainable

Q8: Do you enjoy the way these materials look

All yes
Yes, I like the material but the style of it could be improved

Q9: would you recommend this materials' use to others thinking about designing a sustainable building?

All yes
Yes, for the most part

The furniture – chairs and desks are very comfortable, functional and cleanable; the lighting system works very well and the floor is fuctional, though not particularly aesthetically pleasing, maybe a little difficult to clean due to the sealant used.

They are sustainable and practical they could be a little more attractive without detracting from sustainability

They seem to be a sound and responsible alternative to other materials

It has a more natural feel to it

The materials are attractive, and function, and they make users feel good.

Q10: do you experience any problems with any of the materials?

2 yes, 3 no
May be some issues with the concrete floor due to the particular sealant used.

Exterior door jamb paint sticks the door shut (material malfunctions), (material is difficult to clean/maintain) the sealed concrete floors apparently absorb water very quickly when mopping, there is an odd smell associated with the wheat straw furniture

Q11: Do you notice that the materials show any scratches, stains, or marks from use?

2 yes, three no

If yes: Please indicate the material(s) that show these marks

Flooring, work surfaces, wheat board office furniture scratches

flooring

Q12: Do you enjoy your workspace?

All yes

Yes! The building is beautiful. The only draw back is the noise level

If yes: what feature(s) do you like the most?

Lighting, colors (in most spaces), worksurfaces,

Lighting, colors, worksurfaces, south facing windows

Lighting, work surfaces

Colors, work surfaces

Lighting

Q13: Would you like to change anything about your workspace?

3 yes, 2 no

If yes: which item(s) would you change

Colors in walls and office and restroom, small lab space.

Floor sealant and door paint.

Table orientation, but that's easy.

Survey Results #3: Spatial Designs

Q1: How long have you been working for this office?

3-4 years, 2-3 years

Q2: What is your job responsibility?

Office staff

owner

Q3: Were you consulted during the design process?

Yes

yes

If yes: at what point in the design process did you become involved?

Beginning

entirety

Q4: Were you involved in the selection of sustainable materials/features?

Yes

yes

If yes: please describe your input:

Lighting, flooring, VCT restrooms, decking on exterior bridge, daylighting an shades, board room, cabinetry

research, evaluation, selection

Q5: Please describe your work area

Low room lighting, daylighting and task lighting, work well for different tasks (ie) computer work vs material selection

Office with small conference area included, south windows for natural light, future deck outside, 20-200 footcandles lighting, gyp. Bd. Walls, carpet 2x2 lay in semi-recessed ceiling

Q6: Are any of these aspects in your work area a sustainable material/feature?

Flooring:	yes, yes
Worksurfaces	no, no
Fabric	no
Furniture	no
Lighting	yes

Q7: do you enjoy working with these materials?

Yes

yes

Q8: Do you enjoy the way these materials look

Yes

yes

Q9: would you recommend this materials' use to others thinking about designing a sustainable building?

Yes

yes

Cost sustainability, appearance

Q10: do you experience any problems with any of the materials?

No

no

Q11: Do you notice that the materials show any scratches, stains, or marks from use?

No, no

If yes: Please indicate the material(s) that show these marks

Q12: Do you enjoy your workspace

Yes, yes

If yes: what feature(s) do you like the most?

Lighting, colors,

lighting

Q13: Would you like to change anything about your workspace?

Yes, ongoing planned improvements

no

If yes: which item(s) would you change

Display of completed projects in reception area