Nature Revealed Through the Built Environment: Re-envisioning the Clifford A. Phaneuf Environmental Center

James W. Fiore Jr.
University of Massachusetts Amherst

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NATURE REVEALED THROUGH THE BUILT ENVIRONMENT:
RE-ENVISIONING THE CLIFFORD A. PHANEUF ENVIRONMENTAL CENTER

A Thesis Presented

By

JAMES W. FIORE JR.

Submitted to the Graduate School of the
University of Massachusetts Amherst in partial fulfillment
of the requirements for the degree of

MASTER OF ARCHITECTURE

May 2011

Architecture + Design Program
Department of Art, Architecture and Art History
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RE-ENVISIONING THE CLIFFORD A. PHANEUF ENVIRONMENTAL CENTER

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Approved as to style and content by:

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Joseph Krupczynski, Chair

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Chair, Department of Art, Architecture,
and Art History
DEDICATION

To the children living in the city of Springfield, Massachusetts: may you learn to value and nurture the natural places carefully conserved and woven between the built environment. To the educators of our children: may you foster a greater awareness of the natural world of which we are a part. To the architect: may you learn to merge both built and natural into a coherent whole in order to help us live more harmoniously with our ecosystems.
ACKNOWLEDGEMENTS

I would like to thank my professors who guided me through the thesis process, David Dillon, Kathleen Lugosch, and Joseph Krupczynski. Many eyes and voices critiqued my work along the way, to them I am grateful. Most of all, my family’s support was needed to get through this time in my life. Thank you all.
ABSTRACT

NATURE REVEALED THROUGH THE BUILT ENVIRONMENT: RE-ENVISIONING THE CLIFFORD A. PHANEUF ENVIRONMENTAL CENTER

MAY 2011

JAMES W. FIORE JR., B.F.A., UNIVERSITY OF MASSACHUSETTS AMHERST

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Directed by: Joseph Krupczynski

The Clifford A. Phaneuf Environmental Center is home to ECOS, The Environmental Center for Our Schools, in Springfield Massachusetts. The ECOS program provides a chance for elementary and middle school students in Springfield public schools to experience and learn about the natural world. The built environment provides opportunities to teach about ecosystems and human connections to nature. A new design for the Clifford A. Phaneuf Environmental Center will teach students about the natural world experientially through the building’s own connections to the environment.
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INTRODUCTION

The built environment is often designed in a way that disguises its means of operation, so much so that modern humans grow up without intuitive knowledge of their environments. We are able to change the temperature of our homes with the push of a button, never able to gauge the real impact it has on our planet. Water is delivered and expelled from our buildings without acknowledgement of where it came from, where it will go, or how waste will be filtered from it. Even the way our buildings are assembled and the origin of their materials is a mystery to most people. Being disconnected from our ecosystem, our own homes, places of work and recreation, leaves a rift in our ability to understand the natural world of which we are a part. This is a problem, for only with clear comprehension of our environment can we learn to care for it.

In our hastily advancing world it is becoming increasingly necessary to teach students about the natural environment. Environmental education centers can fill this important role in our public school systems. An environmental education center is one where students are able to explore the natural environment and learn experientially. A student can be told of how bees gather nectar from flowers and accidentally pollinate them on their journey; but until that student witnesses the clumps of yellow powder sticking to the insect's hind legs, the lesson of how pollinators and flowering plants coevolved isn't truly learned (figure 1). Likewise, nothing makes the process of photosynthesis more clear than the ability to trace the path of a plant's leaves as they bend towards the sunlight over the course of a day.
The built environment also provides experiential opportunities to teach about human ecosystems and our connections to nature. For this reason the design of an environmental education building is equally as important as the curriculum it houses. The parts of the building should coalesce with the environment expressing their role at every opportunity to foster an awareness of place. An environmental education center should teach students about the natural world experientially through the building’s own connections to the environment. Through these connections students will recognize their role in nature. They will take this knowledge with them, process it, and apply it to their daily lives. They can then begin to understand the implications of their actions and become better stewards of their ecosystem and the earth as a whole.

This thesis will explore the various ways that buildings connect to nature, how those connections can operate as a sustainable part of an ecosystem, and the means of expressing and experiencing these connections in an educational context that reveals truths about nature.
PART 1

CONNECTIONS
“Long ago both orders and styles became empty rituals – they were never Architecture – they were merely forms cast upon the shores of time by the Spirit of Architecture in passing. Architecture is the living-spirit of building truly and beautifully.”

-Frank Lloyd Wright

Architecture is a site specific art. Architects have been writing about the ways buildings connect with site as early as Vitruvius, in the first century B.C.E. In Vitruvius’s *Ten Books on Architecture* several chapters are written specifically on the siting of settlements and various building types. This first century architectural scholar continually wrote about water, sunlight, wind, and other natural (as well as supernatural) forces and their relationship to buildings and cities. “If our designs... are to be correct, we must... take note of the... climates in which they are built. One style... seems appropriate to build in Egypt, another in Spain, a different kind in Pontus, one still different in Rome... This is because one part of the earth is directly under the sun's course, another is far away from it, while another lies midway between these two... it is obvious that designs for houses ought similarly to conform to the nature of the country and to diversities of climate.” While Vitruvius may not have had the same scientific understanding of the sun and other natural occurrences as we do today, he accurately perceived his relationship to nature through the lenses available to him at the time (figure 2).

Vitruvius’s respect for site continues to be a guiding principal in architecture today. The classical orders he documented (figure 3), themselves having origins in
natural forms, dominated architecture until the twentieth century when the ideas of Louis Sullivan, Frank Lloyd Wright, and other American architects began to propagate and be expanded upon throughout the architectural world. Louis Sullivan began experimenting with natural forms in buildings in the late nineteenth century in hopes of discovering an architecture that was truly American. He sought to accomplish this through the study of flowers and other plant forms found throughout the American landscape (figure 4). Sullivan integrated the forms he found into the decoration of his buildings, rather than relying upon the classical orders set forth in ancient times. Sullivan’s disciple, Frank Lloyd Wright, continued to develop Sullivan’s ideas. Sullivan’s treatise was “form follows function” but for Wright form and function were one and the same. Furthermore, where Sullivan utilized natural forms within architectural compositions ornately, Wright developed an architecture that was visually integrated into nature itself.

In 1910 Wright wrote in his polemic Organic Architecture “...it is quite impossible to consider the building as one thing...and its setting and environment still another.” Wright’s life’s work embodied this premise and culminated in the mid 1930’s with his most famous building, Falling Water (figure 5). In Falling Water, Wright chose to make the home of Edgar J. Kaufmann merge with a water fall, in the very place where the Kaufmann family loved to picnic. Rather than positioning the home in view of the water fall, Wright’s design engages the site and becomes part of nature, growing out of the waterfall itself like some sort of magnificent rock formation.

Falling water was partially a response to the modernist movement of which Le Corbusier, author of Towards a New Architecture (1920), was a leading figure. Le
Corbusier approached the relationship of architecture and site from a different perspective than that of Wright. He chose to place his buildings on pilotis, hovering above the landscape, defining architecture as separate from site, and seeming to suggest the same of man and nature. Much like Wright, the ideas that Le Corbusier set forth were fully embodied in the design of a private residence. In Le Corbusier’s design for Villa Savoye (built 1929), Le Corbusier’s *Five Points Towards a New Architecture* were fully realized (figure 6).

In whatever manner an architect chooses to engage site, the fact remains that site cannot be disregarded. Site is the canvas upon which architecture is composed and architecture imbeds upon its canvas new meaning. Before architects begin designing, they often undergo a series of site analyses, looking deeply at a site through a variety of lenses. Some of these lenses are scientific, such as geological surveys, solar analysis, and the study of weather patterns. Others are investigative procedures, such as interviewing clients, photographing the site, and studying the demographics or history of a region.

An architect will often choose to view a site through a spiritual or artistic lens rooted in tradition, philosophy, or theory. Fēng shui, for instance, is a systematic method of site selection developed by Chinese mystics in which the practitioner traces the path of chi through a landscape’s contours. Another example of a more poetic lens is the *Genius Loci*, or spirit of a place. The *Genius Loci* has been a presiding idea in design throughout Western history, possibly dating back to ancient Egypt. Alexander Pope, a romantic poet of eighteenth century England, expressed his affinity for the idea in verse.
To build, to plant, whatever you intend,
To rear the Column, or the Arch to bend,
To swell the Terras, or to sink the Grot;
In all, let Nature never be forgot.
Consult the Genius of the Place in all
That tells the waters or to rise, or fall....
Joins willing woods, and varies shades from shades
Now Breaks, or now directs, th'intending Lines;
Paints as you plant, and as you work, Designs.
- Alexander Pope

The goal of site analysis is to find ways to connect building to place. These connections guide the architect’s design process but they are not always apparent to the end user of a building. Revealing site/building connections can help a building’s inhabitants to better understand their environment as well as the architect’s intentions. This chapter will explore various site conditions and environmental factors, ways in which buildings make connections to these conditions in an expressive manner, and how these methods can be applied in an educational context to reveal truths about nature to the users of a building.
NOTES


2 “Vitruvius advises the prospective builder to seek a spot that is neither too high (where exposure to wind is a problem) nor too low (where it may be subject to the “poisonous breath of the creatures of the marshes”). He cautioned that a site can be intrinsically unhealthy and recommended that the builder slaughter an animal that had grazed on it and examine its liver for signs of disease.” - Pollan, Michael. A Place of My Own: The Architecture of Daydreams. (New York: Penguin Group, 2008). p. 31.

3 “If our designs for private houses are to be correct, we must at the outset take note of the countries and climates in which they are built. One style of house seems appropriate to build in Egypt, another in Spain, a different kind in Pontus, one still different in Rome, and so on with lands and countries of other characteristics. This is because one part of the earth is directly under the sun's course, another is far away from it, while another lies midway between these two. Hence, as the position of the heaven with regard to a given tract on the earth leads naturally to different characteristics, owing to the inclination of the circle of the zodiac and the course of the sun, it is obvious that designs for houses ought similarly to conform to the nature of the country and to diversities of climate.” – Vitruvius, Translated by Morgan, Morris Hicky, Ph.D., LL.D. Ten Books on Architecture. (Agathon Associates, 2007). Book VI, Chapter 1, Section 1: On Climate as Determining the Style of the House. http://www.bostonleadershipbuilders.com/vitruvius/book06.htm#1

4 “In Organic Architecture then, it is quite impossible to consider the building as one thing, its furnishings another and its setting and environment still another. The Spirit in which these buildings are conceived sees all these together at work as one thing. All are to be studiously foreseen and provided for in the nature of the structure.” (Wright, Frank Lloyd Organic Architecture) - Conrads, Ulrich. Programs and Manifestoes on 20th-Century Architecture. (Cambridge: The MIT Press, 1971). p. 25.

5 “Pilotis. A French term for a pile or support. It was adopted and canonized by Le Corbusier for the cylindrical concrete stilts or pillars he used to carry a building, raising it to first floor level and leaving the ground floor free and open.” - Penguin Reference. Dictionary of Architecture & Landscape Architecture. (New York: Penguin Group, 1999). p. 438.

6 “They rise directly from the floor...and elevate the ground floor. The rooms are thereby removed from the dampness of the soil; they have light and air; the building plot is left to the garden, which consequently passes under the house.” (Le Corbusier Five Points Towards a New Architecture) - Conrads, Ulrich. Programs and Manifestoes on 20th-Century Architecture. (Cambridge: The MIT Press, 1971). p. 99.

7 “…the Chinese had been the only culture to devise a systematic method of site selection. But fêng shui sounded very arcane to me…” (p.32) “‘Chi’ is the Chinese word for the earth spirit, or cosmic breath, which flows in invisible (but predictable) currents over the face of the earth, following both the natural and manmade contours of the landscape.” (p.44) - Pollan, Michael. A Place of My Own: The Architecture of Daydreams. (New York: Penguin Group, 2008). p. 32, p.43 - 48.


9 “The most pertinent advice I found was in the garden literature of the eighteenth century in England, when for a brief moment, some of the best minds of the culture, Alexander Pope to Horace Walpole to Joseph Addison, turned their attention to landscape design.” (p. 32 – 33) “…the romantic designers...worked to make every prospect in their gardens look ‘natural’.” (p.33) Pollan, Michael. A Place of My Own: The Architecture of Daydreams. (New York: Penguin Group, 2008). p. 32 - 33.

figure 1. Pollen.


figure 2. Diagram of the Winds.
Vitruvius, Book I, Chapter 6, Section 9 “Those who know names for very many winds will perhaps be surprised at our setting forth that there are only eight.”

figure 3. The Classical Orders.
An evolution of style: Doric, Ionic, and Corinthian

Drawing from Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers: Encyclopedia, or a systematic dictionary of the sciences, arts, and crafts, Volume 18. 18th Century.
http://hellenicperiod.blogspot.com/2010/10/greek-classic-order.html
figure 4. Sullivan’s Natural Ornamentation.
Ornamentation like this was utilized in Louis Sullivan’s work, such as the Guarantee Building. The subtitle on this plate reads “The aspect of freedom is beginning to appear”.

figure 5. Falling Water.
Perspective drawing of Edgar J. Kaufmann House, also known as “Falling Water”.

This drawing of Frank Lloyd Wright’s most famous work illustrates his ability to merge site and building into one cohesive composition.

figure 6. Villa Savoye. 1929.
Le Corbusier’s Five Points Towards a New Architecture:
1. The Supports (building elevated by the *pilotis*)
2. The Roof Gardens
3. The Free Designing of the Ground Plan (elimination of load-bearing walls)
4. The horizontal windows (uninterrupted views of nature)
5. Free Design of the Façade (supporting façade eliminated by *pilotis*)

*Image Source:* Irene Ngoc Ta, ARCH 1201: Villa Savoye (Le Corbusier),
“A great American poet once asked the architect, ‘What slice of the sun does your building have? What light enters your room?’ – as if to say the sun never knew how great it is until it struck the side of a building.”

-Louis Kahn

Our tiny planet travels around the sun in an ellipse once every year and one quarter day, spinning on its axis all the while, creating the day and the night. As one side of the planet faces towards the sun in the morning, the other side of the planet is experiencing the darkness of night. “So is the earth closer to the sun in the summer, is that why we have seasons?” asks an inquiring student. “Actually,” replies the instructor “the earth is closer to the sun during the winter, but this is not why we have seasons, we have seasons due to the earth’s axis” (figure 7). This explanation often serves only to confuse students. A young student may be able to go home and tell their parents, “We have seasons because of the earth’s axis,” but knowing the meaning of this is another thing entirely.

Students learn about the natural world through experiencing it. This is why the concept of night and day is easily grasped, we experience it daily. “Why is it night?” “Because the earth has turned away from the sun.” Seasons happen slowly in the life of a young person, and our built environment is constructed to augment the natural world for our comfort. How then, can we design an instructional building that teaches, through experience, our relationship to the sun? Can a building teach us how to utilize the sun’s free energy whenever possible, instead of the fossil fuels which damage our environment? Many buildings utilize passive and active solar
technologies, but experiencing these buildings over a course of time (such as living or working in the building) is the only way to begin to learn about the sun from them. Is it possible to design an instructional building that can teach about our relationship to the sun in a single visit?
NOTES

Figure 7. Earth’s Axis.
Louis Kahn (1901-1974) utilized natural light as if it were a building material. In all of his architectural works, great attention was paid to the way sunlight enters a space. Kahn understood how natural light can allow us to see volume and space in a more dynamic way. “...Natural light has all the moods of the time of the day, the seasons of the year, [which] year for year and day for day are different from the day preceding.” Natural light connects us to the world outside of the buildings we inhabit. For Louis Kahn, this was an important factor in designing the Kimbell Art Museum in Fort Worth, Texas. “...the cloud that passes over gives the room a feeling of association with the person that is in it, knowing that there is life outside of the room...”

Designing a museum with natural light is a challenge because paintings and other works of art can fade over time from exposure to the sun’s ultra violet rays. For this reason, Kahn knew that the sun’s light needed to be filtered and reflected to give the light a more subtle and luminous quality. The Kimbell Art Museum was designed as a series of extruded cycloid vaulted spaces. At the top of each concrete vault a sliver of light is allowed to penetrate through a semi-circular tube of glass that runs...
along the full length of the roof. The sun’s light is then reflected onto the vaulted ceilings by way of suspended curved metal screens (figure 8), bathing the room in a beautifully diffused natural light which Kahn described as having “the luminosity of silver.”

Kahn also allowed light to penetrate the museum at the ends of each space where the concrete vaults meet with the non-structural travertine walls. In these places, a slice of glass lets in the sun while revealing the truth about the relationship between the concrete structure and the travertine (figure 9). “I put glass between the structure members and the members which are not of structure because the joint is the beginning of ornament... Ornament is the adoration of the joint.”

Louis Kahn was an architect ahead of his time. In well designed architecture today it is common practice to utilize natural light whenever possible. This is because we now understand how sun light helps to make spaces healthier. Day-lighting is also a strategy to conserve energy. Through Kahn’s work can understand that there are many kinds of light and a multitude of strategies for lighting a space with the sun. The poetry of his architecture prevails as precedents architects return to again and again, in hopes of lighting new spaces in ways that connect us to the world outside of our buildings.
NOTES

3 “So light, this great maker of presences, can never be... brought forth by the single moment in light which the electric bulb has. And natural light has all the moods of the time of the day, the seasons of the year, [which] year for year and day for day are different from the day preceding.” – Kahn, Louis. (compiled by Johnson, Nell E.). *Light Is The Theme*. (Fort Worth, Texas: Kimbell Art Foundation, 1975). p. 18.
4 “And the cloud that passes over gives the room a feeling of association with the person that is in it, knowing that there is life outside of the room, and it reflects the life-giving that a painting does because I think a work of art is a giver of life.” – Kahn, Louis. (compiled by Johnson, Nell E.). *Light Is The Theme*. (Fort Worth, Texas: Kimbell Art Foundation, 1975). p. 18.
5 “…I am designing an art museum in Texas. Here I felt that the light in the rooms structured in concrete will have the luminosity of silver. I know that rooms for the paintings and objects that fade should only modestly be given natural light. The scheme of enclosure of the museum is a succession of cycloid vaults each of a single span [100] feet long and [23] feet wide, each forming the rooms with a narrow slit to the sky, with a mirrored shape to spread natural light on the side of the vault. This light will give a glow of silver to the room without touching the objects directly, yet give the comforting feeling of knowing the time of day.” – Kahn, Louis. (compiled by Johnson, Nell E.). *Light Is The Theme*. (Fort Worth, Texas: Kimbell Art Foundation, 1975).  p. 15.
6 “I put glass between the structure members and the members which are not of structure because the joint is the beginning of ornament. And that must be distinguished from decoration which is simply applied. Ornament is the adoration of the joint.” – Kahn, Louis. (compiled by Johnson, Nell E.). *Light Is The Theme*. (Fort Worth, Texas: Kimbell Art Foundation, 1975). p. 43.

photo by edlifeguard09: October 18, 2008.
http://www.flickr.com/photos/25261787@N03/2994767792/in/photostream

The travertine walls serve a non-structural purpose, while the concrete vaults, columns, and beams support the building. Kahn marked the difference between these two materials by placing glass between them. Allowing light to highlight their purposes.

original photo by edlifeguard09: October 18, 2008.
http://www.flickr.com/photos/25261787@N03/2994744840/in/photostream
The Visitor Activity Center at Pocono Environmental Education Center (PEEC) is a simple shed style building,\(^1\) designed to be what project architect Alex Kachel calls a “passive solar machine”.\(^2\) To maximize heat gain during winter months and provide daylighting (figure 10), the Visitor Activity Center has south, east, and west façades composed almost entirely of glass with thermally broken aluminum mullions.\(^3\)

The south facing façade is the expression of the sun/building connection. It opens the door for instruction about the path of the earth around the sun, the seasons of the year, and how the sun affects our lives. Through The Visitor Activity Center’s orientation, a dialogue is opened regarding the essentialness of the sun to our environment.

The southern, as well as eastern and western, glazing does more than just open the room to dialogue; it opens the room to nature. PEEC’s Visitor Activity Center looks out to a beautiful forest of pine trees, immersing visitors in the forest, while being secure within the warmth of the passive solar building.\(^4\) When a student has a meal in this multi-purpose facility, or plays a game here, he or she can see that they are a part of the natural world.

The profile of the Visitor Activity Center’s roof is engineered to maximize solar heat gain during winter months while blocking out harsh summer rays (figure 11). A core of darkly tinted concrete (figure 12) runs through the building along the north
side of the assembly hall. In an expression of purpose, the concrete barring wall continues outside the building, framing the north side of the covered porches that flank the building to the east and west. The darkened concrete within the building provides thermal mass, as does the concrete floor.

Thermal mass serves to keep the temperature within the building consistent. As the sun’s rays are absorbed by the dark concrete during the day, heat is slowly released as it is needed, because heat moves naturally from where it is hot to where it is cooler. Thermal mass also helps to absorb high temperatures during the warmer months so that the building does not overheat.

In a similar fashion to the concrete wall, the roof of the building also extends gracefully towards the east and west. This is to ensure the rays of the sun do not enter the building from any side to heat the building during the cooling season (figure 12).

The Visitor Activity Center is also interactive in its connection to the environment. In order to cool the building or ensure warm air stays inside, windows and fans must be manually operated (figure 13). These systems are “teachable moments in the center’s daily curriculum”. In this way visitors learn to care for their own comfort. Perhaps students will take this lesson home and open a window the next time they are hot instead of turning on the air conditioner.
NOTES


4 “This main gathering space has been designed to take advantage of all the natural world has to offer: the warmth of the sun, prevailing breezes, natural light and views of the forest to the south.” - Bohlin Cywinski Jackson. Visitor Activity Center, www.BCJ.com. http://www.bcj.com/public/projects/project/88.html

5 “Warm air escapes out of high-set windows on the south side; this circulation is aided by ceiling fans on the hottest days. The architects explored computer controls for the windows, but PEEC’s administration vetoed any automatic systems, preferring to make manual temperature-tuning of windows and fans teachable moments in the center’s daily curriculum.” - Gragg, Randy. Pocono Environmental Education Center Dingman’s Ferry, Pennsylvania. Greensource. July. 2008. Pg. 96 – 99.
figure 10. Day Lighting.
The Visitor Activity Center is day-lit in all seasons, due to the building’s utilization of south, east, and west glazing.

Diagrams showing the passive heating and cooling strategies utilized in the Visitor Activity Center by Bohlin Cywinski Jackson.

Large roof overhangs block south, east, and west sun in the summer, while allowing the sun to enter and warm the building in the winter. Darkly tinted concrete masonry units (cmu) increase the wall’s ability to absorb and retain heat.

Operable windows (highlighted in red) allow warm air to rise and escape from above and cool breezes to blow in from the east and west, below. Ceiling fans serve to increase cooling when needed.

The Blue Ridge Parkway Destination Center is a place for visitors to learn about the Blue Ridge Parkway, a 469 mile drive connecting the Shenandoah National Park in Virginia to the Great Smoky Mountains National Park in Western North Carolina.\(^1\) The Destination Center features a large exhibition space, a 70 seat high-definition theatre, an interactive map called the “I-Wall”, and several integrated environmental systems designed by the architects at Lord, Aeck, & Sargent (an Atlanta firm).

To capture the warmth of the sun during the heating season, the architects decided to integrate Trombe walls into the building’s design. The Trombe wall was popularized in the 1960s by engineer Felix Trombe and architect Jacques Michel. The technology quickly caught on in passive solar house design and developed a stigma as a cliché used in “early hippie houses.” For the design of the Destination Center the architects at LAS have reinvented the Trombe wall “in a modern context.”\(^2\)

A Trombe wall is essentially “a thermal collector insulated by air and covered by glazing.”\(^3\) The thermal collector is usually a heavy mass wall, in this case concrete. The sun heats the small air space between the glass and the thermal collector. The trapped heat can then be “transferred into the building through vents or indirectly,” such as conductively through the mass itself. Trombe walls are an alternative to thermal-mass walls,\(^4\) such as the one at PEEC’s Visitor Activity Center.

The Blue Ridge Parkway Destination Center boasts 12 Trombe walls (2 are two stories high) which form a zigzagging south-east elevation (figure 14).\(^5\) The
Trombe walls themselves face south, while the glazed spaces in between allow for views out to the forest and for eastern light to enter into the exhibit hall (figure 15). To optimize the Trombe walls, they were designed using computational-fluid dynamics (CFD), a technology that has long been in use in the aerospace and defense industries. The Pennsylvania State University's Applied Research Laboratory used “historical data on local weather conditions” to create a CFD model which predicts the future performance of the building.6 The resulting building uses “75 percent less energy than a comparable conventionally designed facility.”7

Air flows dynamically in and out of the spaces between the 8-inch-thick poured-concrete walls and the exterior glazing. In the winter, cool air from within the building flows in through vents at the bottom of the concrete walls (figure 16). The cool air enters into the hollow cores, heats as the sun floods through the glazing, and rises (by natural convection) back into the building through vents at the top of the walls. In the summer, exterior vents can be opened to allow excess heat to escape from the building (figure 17).8 The Trombe walls are designed with an overhang to provide shade in the summer, preventing the building from overheating (figure 18).9

The Trombe walls are not merely applied to the Destination Center, they are integrated into the design, serving multiple purposes. The Trombe walls are part of the building’s structural system. They help to hold up the roof and brace the building laterally. Inside the Destination Center, the concrete walls are used to mount presentation panels, creating a dynamically arrayed exhibition marked with views of nature through the eastern glazing (figure 16). The walls also express themselves poetically on the exterior, leading visitors to inquire about the building’s unique, saw-toothed façade (figure 17).10 The Blue Ridge Parkway Destination Center allows
visitors to experience the benefits of utilizing the free heat of the sun. This integrated building by Lord, Aeck & Sargent allows the public to see how environmentally conscious design can be implemented in beautiful and innovative ways.
NOTES


4 “…engineer Felix Trombe and architect Jacques Michel popularized the Trombe wall...in the 1960s... Trombe walls were quickly embraced by the passive-solar housing movement of the era, and now, “When you think Trombe you think early hippie houses,” says Vikram Sami, a senior building performance analyst with Atlanta’s Lord, Aeck & Sargent. “We are reinventing it in a modern context.” - Sokol, David. Off the Wall: Trombe walls at a visitor’s center bask in the sunshine. Greensource. December. 2008.


7 “The project also involved state-of-the-art computational analysis to optimize the passive solar design.” “Lord, Aeck & Sargent called on Pennsylvania State University's Applied Research Laboratory to study the air movement and heat-transfer performance of the Trombe walls. The laboratory took historical data on local weather conditions and created a computational fluid dynamics (CFD) model to predict future performance. CFD has long been used in the aerospace and defense industries; it’s now becoming more common in high-tech architectural applications.” - Moffitt, Debra. Appalachian Suncatcher. Architecture Week. July, 16. 2008. http://www.architectureweek.com/2008/0716/environment_2-1.html


10 “...But they also are the lateral bracing system and the vertical structure to hold up the roof. They're used as exhibit panels — the concrete walls go to the inside...” - Moffitt, Debra. Appalachian Suncatcher. Architecture Week. July, 16. 2008. http://www.architectureweek.com/2008/0716/environment_2-1.html

“Trombe walls...accomplish multiple tasks... Sami also points out that the walls serve as structural columns and laterally brace the building, and exhibition designers use the walls for mounting their presentations. Meanwhile, Lord, Aeck & Sargent principal John Starr, AIA, notes that the walls fulfill an aesthetic ambition. “We wanted the building’s systems to be expressed as beauty and poetry,” he says.” - Sokol, David. Off the Wall: Trombe walls at a visitor’s center bask in the sunshine. Greensource. December. 2008.
Figure 14. Destination Center Floor Plan.

Floor plan of the Blue Ridge Parkway Destination Center by Lord, Aeck & Sargent. Note the unique, zigzagging Trombe wall design.


Architecture Week, July 16, 2008.

Moffitt, Debra. Appalachian Sun catcher.


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figure 15. East Facing Glass.
East facing glass (highlighted in red) between the trombe walls allows for views out to nature and while letting in eastern light.

figure 16. Trombe Wall Interior Vents.
Cool air flows in through vents at the bottom of the trombe walls (highlighted in red). It is then heated by the sun within the hollow core as it rises and reenters the building.

figure 17. Trombe Wall Exterior Vents.
Operable exterior vents (highlighted in red) allow for hot air to escape from the Trombe walls during the cooling season.

The Queens Botanical Garden Visitor Center is designed with acknowledgement of our connection to the sun. The Visitor Center is composed of “three roof systems.” Each roof responds to the environment in different ways (figure 19). One is a rainwater channeling canopy above the entry plaza, another is a gently sloped green roof populated by native plants, and the main building is sheltered by “a flat roof with an integrated photovoltaic (PV) array”.

Photovoltaic arrays allow us to harvest the sun’s free energy and utilize it in the form of electricity. BKSK Architects recognized the importance of this technology in their building design. Unfortunately, the array is laid flat on the main building’s roof. Solar panels that are laid flat do not allow for maximum electricity generation. The rule of thumb to maximize the efficiency of a solar panel is to face the panel south at an angle equal to the latitude of the location. It is also important to be aware of anything that might cast a shadow over the PV panel. Due to its location, the photovoltaic array at the QBG Visitor Center is virtually invisible to visitors. Educating the public about solar energy was apparently not the mission of this building, but it seems like a missed opportunity.

Green roofs are incredibly sustainable and have much to teach us about our connection to the natural world. The green roof that covers the 180-seat, day-lit auditorium (figure 20) at QBG provides insulation which reduces the heating and cooling loads of the building. Green roofs diminish “the amount of heat reflected back into the city, reducing the urban heat-island effect.” — Stuart Gaffin, an associate

Project: Queens Botanical Garden Visitor Center
Location: Flushing, New York
Architects: BKSK Architects
Completed: September 2007
research scientist at the Center for Climate Systems Research of Columbia University” and several of his students measured the temperatures of the various roof systems of the QBG Visitor Center. On the same summer day, the administration building’s flat black weatherproofing membrane was 170 degrees; The water-collection roof (white PVC) was 115 degrees; and the green roof (covered with various native plants) was 85 degrees, “which was the ambient temperature that day.” The Visitor Center “is planning to install instrumentation that [will] record temperature and moisture levels continuously at various points on the roof. The data should help determine which plant species best achieve the roof’s goals.”3 By making these devices legible to the public, the building can provide learning opportunities about the ways native plants can help reduce the heat of the sun. Visitors are already able to access the roof and explore the variety of indigenous species planted there (figure 21).

Penguin Reference’s Dictionary of Architecture & Landscape Architecture defines brise-soeil as “a sun break or check; now frequently an arrangement of horizontal lines or vertical fins, used in hot climates to shade the window openings.”4 QBG Visitor Center’s main building utilizes a horizontal wooden brise-soeil to transform the quality of the light inside (figure 22). The goal of this shading device is to reduce the heating load of the building while allowing views of the gardens outside and letting in indirect natural light. One disadvantage to this system has been low winter sunlight penetrating directly through the brise-soeil, casting glare on work surfaces. This problem is being remedied “with the addition of interior shades that will give occupants individual control over day-lighting conditions.”5 The brise-soleil also produces a rich visual texture on the exterior of the building.6
QBG’s new building has three roof systems: a folded canopy that shelters an entry plaza and directs rainwater; a sloped green roof planted with sedum, grasses, and perennial flowers; and a flat roof with an integrated photovoltaic array.” - Gonchar, Joann. Setting Down Roots: A new building raises a botanical garden’s profile as an institution focused on environmental stewardship. Greensource. April. 2008.


Perhaps the most talked-about function of green roofs is diminishing the amount of heat reflected back into the city, reducing the “urban heat-island effect.” At Souder’s behest, Stuart Gaffin, an associate research scientist at the Center for Climate Systems Research of Columbia University, came out to the new building last summer with several students. They took the temperature of the administration building’s roof, made of a black weatherproofing membrane: 170 degrees. The water-collection roof over the plaza is white PVC; that was 115 degrees. By contrast, the green roof came in at 85 degrees, which was the ambient temperature that day. So the effect, Souder says, “is pretty dramatic.” Now she is planning to install instrumentation that would record temperature and moisture levels continuously at various points on the roof. The data should help determine which plant species best achieve the roof’s goals. It’s hard to think of a better mission for a botanical garden.” - Bernstein, Fred A. A Garden Blooms in Queens: One of New York’s Lesser-Known Botanical Gardens Emerges as a Leader in Sustainable Design. Metropolis Magazine. February. 2008. http://www.metropolismag.com/story/20080220/a-garden-blooms-in-queens

The offices are bright and pleasant and offer views from the southeast side of the building, over the sheltered entry terrace and into the garden beyond. Motion sensors and a daylight dimming system control electric lights, while exterior brises-soleil, made of the same cedar as the cladding, modulate most of the sunlight coming through the generous windows. However, direct low winter sunlight does penetrate the shading devices, creating glare on work surfaces. Luckily, this problem will soon be rectified with the addition of interior shades that will give occupants individual control over daylighting conditions.” - Gonchar, Joann. Setting Down Roots: A new building raises a botanical garden’s profile as an institution focused on environmental stewardship. Greensource. April. 2008.

“Behind the plaza is the main building, with the brises-soleil creating complex shadows. To Brown, one of the project’s great strengths is showing that “environmental initiatives can generate aesthetic richness.” - Bernstein, Fred A. A Garden Blooms in Queens: One of New York’s Lesser-Known Botanical Gardens Emerges as a Leader in Sustainable Design. Metropolis Magazine. February. 2008. http://www.metropolismag.com/story/20080220/a-garden-blooms-in-queens
**figure 19. Three Roofs.**
The Queens Botanical Garden Visitor Center by BKSK Architects is composed of three separately roofed structures.

The auditorium beneath the green roof at the QBG Visitor Center is day-lit “by a skylight and a 30 foot long slot window.”

http://www.metropolismag.com/story/20080220/a-garden-blooms-in-queens
figure 21. Green Roof.
Visitors exploring the green roof above the auditorium at the QBG Visitor Center. Note the dramatic water collection roof in the background.

http://www.metropolismag.com/story/20080220/a-garden-blooms-in-queens
figure 22. Brise-Soeil.

Above: brise-soeil, composed of black-locust wood, seen from inside the building.
Below: cantilevered conference room, shaded by the brise-soeil, as seen from the exterior.

A fountain brings us peace, joy, and restful sensuality and reaches the epitome of its very essence when by its power to bewitch it will stir dreams of distant worlds.¹

-Luis Barragán

Water is one of nature's most dramatic elements. From the majesty of a cascading waterfall to the depression of an autumn rain storm, water can inspire awe and change our moods. Water is essential to all life and seemingly abundant. From space we can see how water covers the majority of the Earth’s surface. Despite water’s apparent abundance, less than 1% of the earth’s water is fresh and available for our use.² Our connection to water is undeniable, yet those of us who live in regions where water is plentiful hardly think about it at all.

The built environment has been designed to deliver clean, potable water at the turn of a knob. A warm shower in the morning is a luxury many of us could hardly stand to live without. In many parts of the world it is painfully apparent how precious water is, but in the North Eastern United States it is a commodity that we often take for granted. Proper building design can help us remember that we are connected to water. Environmentally conscious design can remind us how precious this resource is.
NOTES

2 The Omega Institute. Omega Center for Sustainable Living (OCSL) – Introduction.
http://vimeo.com/3296474
“Every drop is a line of silver spreading rings of silver to the edge, where they fall to the ground... Barragán had learned from water and borrowed what he liked best.”

- Louis Kahn

For Luis Barragán (1902 -1988) water was an essential architectural component. Whether in the form of a fountain, a single stream of water, or a swimming pool within a home, water was the focus of Barragán’s greatest works. Something from Barragán’s soul was expressed through water and its relationship to form, light, color, and figure. To him, water represented the boundary between reality and the transcendent.

At Los Clubes, a sub-division designed by Luis Barragán outside of Mexico City, only the horse can cross this boundary. For the horse, unlike man, does not involve itself in worrying about the future. Death is not loaming in wait for the horse. “The horse is the innocent element through which form reveals itself, to show its truth.” The subdivision is designed for travel on horse back, for horses, and for people who love horses. The main resting ground for horses and riders at Los Clubes is La Fuente de los Amantes.

La Fuente de los Amantes means the Lovers’ Fountain. The lovers are represented by two weather beaten wooden troughs, standing upright, no longer
needed for their former purpose (figure 23). Instead, a brilliant pool now quenches the thirst of traveling horses. The two lovers are also manifest in the planar stucco walls that surround the pool. The feminine lover, a pink wall, wraps around the pool (figure 24), forming the boundaries of the space in conjunction with the water. The masculine lover is the center piece of the space, the fountain (figure 25). The rust brown fountain appears as if it were once a single wall, but when the horses called for water the wall split apart, rotating perpendicular to itself, revealing a horizontal continuum filled with water that poured to the cobblestone ground, allowing the horses to drink.5

On a functional level, Barragán was expressing multiple purposes in his use of the fountain at Los Clubes. The fountain satisfies the physical need for the horses to drink while serving as an aesthetic point of interest to travelers. On a poetic level, the fountain is elegantly simple. It instantly makes the beauty and essentialness of water clear to its visitors. Luis Barragán utilized water like an architect would any other building material. In its reflection we see its potential within the landscape, dividing reality from the transcendent.
NOTES

3 “…The horse is the innocent element through which form reveals itself to show its truth. The liquid is the manifestation of form and of time, of a time that the water distills from the bowels of the plane from which it gushes…” - Martinez, Antonio Riggen. Luis Barragan: Mexico’s Modern Master, 1902-1988. (New York: The Monacelli Press, 1996). Pg. 42.
4 “The centerpiece of the landscaping program is a fountain called the Fuente de Los Clubes, also known as the Fuente de los Amantes (Lovers’ Fountain).” – Portugal, Armando Salas. Photographs of the Architecture of Luis Barragan. (New York: Rizzoli International Publications, Inc., 1992). Pg. 120.
5 “Only horses could enter into this mirror of water, in reality a fountain of life composed of two elements: a level that evoked the feminine component and a prismatic structure, a symbol of the masculine presence, from which water flows in a horizontal continuum. In the shallow water reserved for the horses are two mute witnesses, two troughs corroded by time resting on cobblestones over which the water flows.” - Martinez, Antonio Riggen. Luis Barragan: Mexico’s Modern Master, 1902-1988. (New York: The Monacelli Press, 1996). Pg. 226.
figure 23. Two Troughs.
Two weather beaten troughs, representing the two lovers, stand at the waters edge.


figure 24. Pink Wall.
Plan view of La Fuente de los Amantes showing how the pink wall wraps around the fountain, creating the space where the horses drink.

figure 25. La Fuente de los Amantes.

photo by Esparta Palma:
http://www.flickr.com/photos/esparta/3573608700/sizes/l/in/photostream
According to the Queens Botanical Garden (QBG) director of capital projects, the diverse community of Flushing, New York sees the QBG as its own backyard. The grounds are used continuously for a variety of activities, such as Tai Chi, picnics, nature walks, and school trips. Given the community's strong ties to the garden, it was important to include them in the design process. This was accomplished through a series of public meetings. “A strong desire for a scheme that prominently featured water emerged...from these sessions.” For the residents of Flushing, New York, water has a cultural significance. The theme of water tied in well with the institution's mission to “demonstrate environmental stewardship, promote sustainability, and celebrate the rich cultural connections between people and plants.” Fred A. Bernstein stated in the February, 2008 issue of Metropolis Magazine, “If water represents continuity and cycles of life, recycling technologies give new meaning to those ancient concepts.”

According to Joan Krevlin, the lead designer of the QBG Visitor Center and partner at BKSK Architects, “The building helps to tell the story of the site.” Above the entry plaza, 12 red columns reach at various angles to support a 3,000-square-foot zinc-clad water-collection roof (figure 26). Here water is collected and kept from running off into the city’s over utilized sewer system. Instead of mixing with the city’s waste, storm water goes into the building’s rainwater-recycling system. On a rainy day, water can be seen cascading off the roof above the plaza (figure 27). From the roof, water pours into a “cleansing biotope” (figure 28) that naturally filters...
the water by using “three kinds of swamp grasses along with sand and gravel”. The cleansed rainwater is pumped underground to a fountain (figure 29) by the main gate of the gardens to greet arriving visitors. The water then travels across the site, under a series of bridges, engages a constructed wetland, and pours into a water channel that runs between the main building and the partially submerged auditorium building (figure 30). The water finally arrives back in the biotope, where it begins its journey again. “If there’s been a drought, the streambed will be empty,” Krevlin explained in Bernstein’s article. By allowing the water channel to be feed by the rain, visitors are able see how weather affects the site. They can make connection to their own use of water by watching this natural process take place over time. Perhaps visitors will be signaled to conserve water in times of drought when they witness the dried up streambed.

The QBG Visitor Center is conscious of conserving water in other ways as well. The buildings feature a gray-water recycling system that utilizes a constructed wetland to cleanse used shower water and recycle it through the toilets. The gray water system reduces the building’s “potable water consumption by 55%”. A composting restroom is available in the eastern wing of the administration building. Composting toilets use no water at all and, in time, the compost they produce can be used to fertilize the surrounding gardens. Waterless urinals also help to reduce the building’s use of this valuable resource. Plants on the green roof absorb storm water, and the soils of the green roof retain what the plants don’t absorb. “Additional runoff [from the green roof] enters the building’s rainwater-recycling system (described above).
NOTES

1 “The neighborhood is one of the city’s most ethnically diverse, with a larger Chinese population than Manhattan’s Chinatown. It is also home to many Koreans and Latinos. “This community sees the garden as its backyard,” explains Jennifer Ward Souder, QBG director of capital projects. Nearby residents visit regularly, using the grounds to practice Tai Chi, for walks, or to enjoy a picnic lunch. So before beginning the design process in earnest in the late 1990s, administrators held a series of public meetings to gather input from the community. A strong desire for a scheme that prominently featured water emerged as a priority from these sessions. Though the residents were primarily interested in water’s aesthetic benefits and its cultural associations, their wishes nevertheless dovetailed with the institution’s mission to “demonstrate environmental stewardship, promote sustainability, and celebrate the rich cultural connections between people and plants.” - Gonchar, Joann. Setting Down Roots: A new building raises a botanical garden’s profile as an institution focused on environmental stewardship. Greensource. April. 2008.

2 “Eight years ago, making the building green was only one of the garden’s priorities. Another was responding to Queens’s diversity—the borough is a melting pot, with particularly large Asian and Latino communities in the neighborhoods surrounding the garden. Some 75 percent of its visitors speak a language other than Eng-lish at home. Every morning a large Chinese contingent uses the grounds for the meditative martial art Tai Chi. “We thought those were two very different missions,” Krevlin says, recalling her initial response to the cultural and environmental mandates. But as the design process got under way, garden officials began meeting with community members to learn about their cultures’ responses to landscape. “Every time we had an event that year, we had drawings out, and we would talk about the ideas and get people’s input,” says Jennifer Ward Souder, director of capital projects. “And what we found out was that every culture had some significant relationship to water.” Soon the garden was looking at ways to incorporate water features into the design of the new building. Souder, Krevlin, and the garden’s executive director, Susan Lacerte, realized that the very features that would draw residents could also become exemplars of sustainability. If water represents continuity and cycles of life, recycling technologies give new meaning to those ancient concepts.” - Bernstein, Fred A. A Garden Blooms in Queens: One of New York’s Lesser-Known Botanical Gardens Emerges as a Leader in Sustainable Design. Metropolis Magazine. February. 2008. http://www.metropolismag.com/story/20080220/a-garden-blooms-in-queens


5 “After it is filtered in the “cleansing biotope,” rainwater is pumped into a fountain near the garden’s main gate. From there, the water flows through a channel that traverses the site on its way back to the biotope.” - Gonchar, Joann. Setting Down Roots: A new building raises a botanical garden’s profile as an institution focused on environmental stewardship. Greensource. April. 2008.

“After being filtered by a biotope (consisting of three kinds of swamp grasses, along with sand and gravel), rainwater is pumped into the fountain.” - Bernstein, Fred A. A Garden Blooms in Queens: One
“On a wet day visitors can watch rain collect on the gull-shaped roof over the outdoor plaza, then spill into a pond that naturally filters the water before it starts a picturesque journey across the site. But this is no mere “water feature.” Conditions in the streambed will reflect past and present weather conditions. “If there’s been a drought, the streambed will be empty,” says BSKS partner Joan Krevlin, the lead designer. “The building helps to tell the story of the site.” - Bernstein, Fred A. A Garden Blooms in Queens: One of New York’s Lesser-Known Botanical Gardens Emerges as a Leader in Sustainable Design. Metropolis Magazine. February. 2008. http://www.metropolismag.com/story/20080220/a-garden-blooms-in-queens


figure 26. Below the Canopy.
Visitors enjoy a relaxing afternoon beneath the QBG Visitor Center’s water collection canopy.

figure 27. Cascading Water.
A rainy day at the QBG Visitor Center reveals the purpose of the expressively shaped canopy above the entry plaza.

Figure 28. Site Plan for the QBG Visitor Center.

Fountain

Cleansing biotope


Original drawing by BKSK Architects: Architecture Week, Northeastern Building Types
figure 29. Fountain.
The fountain near the main gates of the Queens Botanical Garden.

http://www.metropolismag.com/story/20080220/a-garden-blooms-in-queens
figure 30. Channel.
A channel of water runs between the green-roofed auditorium building and the wood clad administration building.

Mercer Slough is a beloved 320 acre forested wetland in the heart of the city of Bellevue, Washington. The Pacific Science Center and the city of Bellevue have offered classes to young students at Mercer Slough since 1993. The original education center was housed in a retrofitted parks property known as the Sullivan House (figure 31). This barn roofed facility was only able to accommodate about 8,000 students each year and was not outfitted with the correct lighting or other equipment needed to carry out lesson plans properly. The new Mercer Slough Environmental Education Center (MSEEC) incorporates the Sullivan House (figure 32) and is capable of serving 20,000 visitors per year. Further phases of the project will accommodate up to 40,000.¹

It was critical that Mercer Slough’s new environmental education center leave a small foot print on its site and not disrupt the wetlands that it was being built to immerse visitors in. This was accomplished by building several small buildings on the site and elevating them on piers (figure 33). By not disrupting the natural contours of the site, the architects were able to let the ground below (and the plants that inhabit it) become the buildings’ storm-water management system.² Impact on the site was further reduced by placing the footings of the supporting piers in dense clay patches where trees have been unable to grow. By doing this, most of the site’s trees were preserved. The trees were then able to become a natural ventilation system for the buildings.³ This eco-conscious design allowed the buildings to be immersed in the tree canopy above the wetland. Boardwalks link buildings,
interpretive areas, and overlooks allowing visitors to experience the slough and not impact it negatively.4

On site parking was dealt with in a similar fashion. Rain water run off from large parking lots can be a serious problem in terms of erosion and ground water contamination from oil and other car related fluids. Instead of paving a vast parking area, the architects “chose to weave smaller pockets of parking into the gaps in the trees”. By doing this, the total parking area was kept to a minimum. The architects believe this strategy will also encourage the use of alternative transportation.5

Rain falling on the shed roofs at MSEEC is guided softly to the wetlands below. From the buildings’ metal roofs, rain water is directed along visible gutters that run parallel to the boardwalk’s railings (figure 34). Here visitors are able to view the gushing water and interact with it if they desire. From the interactive gutter system, the storm-water falls into soil retaining gabion walls (figure 35). The wire enclosed rock walls filter the storm-water before it gently touches ground, preventing the water from eroding the earth below and disrupting the ecosystem.6 “Farther down the line, bioswales and compost-amended filter strips provide additional lines of defense to remove sediments and contamination from runoff before it reaches the slough,” explained Andrea Ward in her December, 2009 GreenSource article. The ability to visualize and interact with the MSEEC’s storm-water system connects visitors to their environment in a memorable way. The thoughtfulness of this design will help to preserve Mercer Slough for many generations.
NOTES

1 “Started in 1993, the center has become a playground of sort for tens of thousands of children from around the region. Annually, 8,000 students and parents visit the nature center. With its expansion, the center expects to serve up to 20,000 annually and start offering programs to preschoolers, Brinkley said. This is a joint project between Seattle's Pacific Science Center, which runs the nature center, and the city of Bellevue, which owns the land.” – Vinh, Tan. Mercer Slough Environmental Education Center Expands. The Seattle Times. October 9, 2008. http://seattletimes.nwsource.com/html/outdoors/2008241596_nwwmercerslough09.html

2 “Pacific Science Center and the city of Bellevue have offered classes at Mercer Slough for the past 15 years. However, the original education center was the Sullivan House, a retrofitted Parks property that could only accommodate 8,000 students each year. Once all phases of the new expansion are complete, the center will be able to welcome as many as 40,000 school children, teachers and families each year.” – Bellevue Reporter. Mercer Slough Environmental Education Center receives another award. (BellevueReporter.com). November 22, 2009. http://www.pnwlocalnews.com/east_king/bel/news/70706592.html

3 “Dense deposits of clay in the soil left pockets where trees would not grow, creating open spaces in the canopy where the buildings could be placed, and allowing the team to leave nearly all the existing trees standing—a move that would also prove critical to the objective of ventilating the buildings naturally.” - Ward, Andrea. Teaching in Trees: Mercer Slough Environmental Education Center, Bellevue Washington. Greensource. November and December. 2009. Pg. 110 – 115.

4 “Rather than compromising the site by creating a conventional single-building facility (which would have required grading and filling), or limiting the educational mission by choosing a different location, the team broadened their thinking about the site into three dimensions. The result is a unique collection of seven shed-style buildings, elevated above the forest floor and threaded through open spaces in the forest canopy, connected by aerial boardwalks that traverse the upper story of the woodland without disturbing the ecosystem on the ground.” - Ward, Andrea. Teaching in Trees: Mercer Slough Environmental Education Center, Bellevue Washington. Greensource. November and December. 2009. Pg. 110 – 115.

5 “This parking area, just a few feet above the slough, represents another stormwater-conscious strategy: Rather than clear and pave a larger parking area, the team chose to weave smaller pockets of parking into the gaps in the trees, keeping the total parking area to a minimum and encouraging the use of alternative transportation.” - Ward, Andrea. Teaching in Trees: Mercer Slough Environmental Education Center, Bellevue Washington. Greensource. November and December. 2009. Pg. 110 – 115.

6 “All soil retention is done with gabion walls—rock fill enmeshed in wire enclosure—through which stormwater is filtered. Rain that falls on the building roofs is directed to the gabion walls through gutters installed along the boardwalk railings, where they become a prominent and sometimes interactive display of the stormwater-management efforts.” - Ward, Andrea. Teaching in Trees: Mercer Slough Environmental Education Center, Bellevue Washington. Greensource. November and December. 2009. Pg. 110 – 115.
figure 31. The Sullivan House.
The original home of the Mercer Slough Environmental Education Center.

photo by Nate Cormier: http://www.flickr.com/photos/ncormier/3205324020/
sizes/l/in/set-72157603330103312
figure 32. MSEEC Site Model.

Note: The white building is the Sullivan House.

photo by Nate Cormier: http://www.flickr.com/photos/ncormier/3204987527/
sizes/l/in/set-72157603330103312
figure 33. Structural Piers.
Section and photograph illustrating the structural piers that elevate MSEEC above the forest floor.

sectional drawing by Jones + Jones: http://www.flickr.com/photos/premiersips/5219476774/sizes/z/in/set-72157625500929970
figure 34. Rain Gutters.
Rain gutters run along the railings at MSEEC.

photo by Nate Cormier: http://www.flickr.com/photos/ncormier/2982132268/sizes/l/in/set-721576033330103312
figure 35. Gabion Walls.
Rain water is directed to gabion walls in order to prevent erosion.

original photo by Nate Cormier: http://www.flickr.com/photos/ncormier/2981302459/sizes/l/in/set-72157603330103312
The Omega Center for Sustainable Living (OCSL) is “an education center on how we can understand our connection to nature... on how we live on the earth,” according to Skip Bakus, executive director of the Omega Institute. OCSL is a 6,250 square foot facility in Rhinebeck, New York that processes all of the waste water (as much as 52,000 gallons per day) used by the Omega Institute. The Omega institute is a nonprofit organization that offers “educational experiences that inspire an integrated approach to personal and social change.” Rather than constructing a conventional sewage treatment plant, the Omega Institute looked to nature to inspire the design of their new facility. The Omega Institute had to rethink the idea of waste water. According to Bakus, “if its waste water we’re not understanding the full ecological process.”

The water used at the Omega Institute comes from deep wells beneath the 195 acre site. In order to recharge this precious aquifer, a closed loop system that replicates natural processes had to be developed, in part by Dr. John Todd. The three day reclamation cycle begins when all of the water from tanks located throughout Omega’s campus (which hold “waste” water from toilets, showers, and sinks) flows to the Eco Machine™. The campus is located uphill from the Eco Machine™, so the delivery system is gravity feed and uses very little energy.

Solid settlement tanks are the first stop in the Eco Machine™. In these tanks solids settle out of the water and become a sludge that is injected with microorganisms to accelerate the decomposition process. The water then flows into...
one of two 6,000 gallon equalization tanks. Here the flow of water is balanced, so as not to flood the system. The equalization tanks allow for the water to be evenly released over the course of a day, despite ebbs and flows in water usage.\textsuperscript{10}

From the equalization tanks, water flows into two 5,000 gallon anoxic tanks located beneath the ground next to a constructed wetland. Within these tanks anaerobic bacteria and other micro-organism thrive in a low oxygen environment. These naturally occurring organisms “digest ammonia, phosphorus, nitrogen, potassium, and many other substances in the water”.\textsuperscript{11}

By this time the water is ready to begin its journey back into the natural environment. The water moves through a splitter box and divides evenly into two constructed wetlands, each about the size of a basketball court (figure 36). At this point the water is no longer confined to controlled tanks. The water flows beneath the rubber lined, three foot deep, gravel filled wetlands and is purified by over 8,000 plants. While some of the water is absorbed by the plants and some begins to evaporate, microorganisms and native plants continue the cleansing process and harvest nutrients from the water. The processed “waste” water then “flows via gravity” to two more constructed wetlands below. By the time the water is ready to leave the wetland stage of the process “there is a 75 percent increase in the water's clarity and a 90 percent reduction in the water's odor,” according to the Omega Institute.\textsuperscript{12}

Water from the constructed wetlands is then pumped into one of two “highly oxygenated aerated lagoons” located within the building (figure 37). Here water flows through a series of four, ten foot deep cells, populated by hundreds of species of plants, fungi, algae, and snails and billions of microorganisms. The vast array of
species work to convert “ammonia into nitrates and toxins into harmless base elements”. The water is also treated with ultra violet light from the sun that enters the room containing the lagoons through a south facing, floor to ceiling, glass curtain wall and solar tracking sky-lights. Within the building, visitors can watch as the water flows through the aerobic environment, but they shouldn’t touch the water. Although it looks clear, smells good, and is healthy for the plants and animals within the water, the water is not yet safe to touch.\textsuperscript{13}

After being cleansed by the aerated lagoons, two steps remain before the water at the Omega Institute reenters the aquifer. First it is pumped to a recirculating sand filter where “sand and microorganisms absorb and digest any remaining particulates and small amounts of nitrates that may still be present” in the water. At this point the water is safe for human consumption; however state regulations prevent this water from being used for potable purposes. In order to comply with the law and to fully complete this closed loop cycle, the filtered water is “pumped to two dispersal fields under Omega’s parking lot, each about the size of a basketball court.” From here the water is released back into the groundwater table. As the water flows 250 to 300 feet beneath the campus it is purified further by nature, trickling deep into the aquifer, to be pumped up again through Omega’s deep wells and begin the cycle again.\textsuperscript{14}
NOTES

1 The Omega Institute. Earth Day 2009 at Omega: Step Lightly on the Earth! http://www.youtube.com/watch?v=Ekt7NasAlXM&feature=related
3 The Omega Institute. Why Design Now?: Eco-Machine at the Omega Center for Sustainable Living. http://www.youtube.com/watch?v=McUTzdVwRHw
4 “As a nonprofit organization, Omega offers diverse and innovative educational experiences that inspire an integrated approach to personal and social change.” - The Omega Institute. About Omega. http://www.eomega.org/omega/about/?content=LINK&source=WEB.OM.HM
5 The Omega Institute. Skip Backus “OCSL Site Tour 3”. http://vimeo.com/5249322
7 The Omega Institute. Why Design Now?: Eco-Machine at the Omega Center for Sustainable Living. http://www.youtube.com/watch?v=McUTzdVwRHw
8 “From various tanks located throughout campus, wastewater flows into multiple solid settlement tanks.” - The Omega Institute. Settlement Tanks & Equalization Tanks—OCSL. http://www.eomega.org/omega/about/ocls/settlement-tanks
9 “All the water from Omega’s campus, including water used in toilets, showers, and sinks, flows to the Eco Machine™, where it is purified by microscopic algae, fungi, bacteria, plants, and snails. This natural water reclamation process cleans the water using zero chemicals. In large dispersal fields under the parking lot, the purified water is returned to the aquifer deep beneath campus.” - The Omega Institute. Eco Machine™—OCSL. http://www.eomega.org/omega/about/ocls/eco-machine
10 “Solid settlement tanks are the first step in the Eco Machine™ process at the Omega Center for Sustainable Living… wastewater flows into multiple solid settlement tanks. All solids settle out in the tanks as sludge and are injected with microorganisms to accelerate decomposition. The remaining wastewater flows out of the solid settlement tanks to the equalization tanks… Two 6,000 gallon tanks equalize the flow of water over 24 hours. This helps balance out natural surges in water use on campus (typically in the morning and early evening), evenly releasing water to the anoxic tanks… Without the equalization tanks, the Eco Machine™, and the Omega Center for Sustainable Living, would need to have been designed and built at a much larger scale. By using equalization tanks, we were able to build the smallest facility possible, greatly reducing the carbon footprint of the Omega Center for Sustainable Living.” - The Omega Institute. Settlement Tanks & Equalization Tanks—OCSL. http://www.eomega.org/omega/about/ocls/settlement-tanks
11 “Step 3 in the Eco Machine™ at the OCSL is the anoxic tanks. Two 5,000 gallon tanks are located underground, right next to the constructed wetlands at the OCSL. Here, naturally occurring microbial organisms use the wastewater stream as food. They begin to digest ammonia, phosphorus, nitrogen, potassium, and many other substances in the water. This process happens with very little oxygen (called either anaerobic or anoxic)...” - The Omega Institute. Anoxic Tanks—OCSL. http://www.eomega.org/omega/about/ocls/anoxic-tanks
12 “There are four constructed wetlands in the Eco Machine™…each the size of a basketball court. They are three feet deep, lined with rubber, and completely filled with gravel. About two inches beneath the gravel is wastewater, which flows from the anoxic tanks, to the splitter box, to the upper two constructed wetlands. The wetlands use microorganisms and native plants, including cattails and bulrushes, to reduce biochemical oxygen demand, remove odorous gases, continue the denitrification process, and harvest nutrients such as phosphorus. As the wastewater flows through the wetlands, the microorganisms and plants are fed. Once the wastewater is processed in the upper two constructed wetlands, it flows via gravity to the bottom two constructed wetlands. In total… There is a 75 percent increase in the water's clarity and a 90 percent reduction in the water's odor by the time it is ready to leave the wetlands... However, not all the water that enters the wetlands travels to the aerated lagoons. The plants absorb some of the water during the purification process in the constructed wetlands, and some of the water evaporates - The Omega Institute. Constructed Wetlands—OCSL. http://www.eomega.org/omega/about/ocls/wetlands
13 “…the water is pumped into two highly oxygenated aerated lagoons ...The aerated lagoons are divided into four cells, each 10 feet deep. At this stage, the water looks and smells clean, but it's not safe to touch. The plants, fungi, algae, snails, and other microorganisms of the aerated lagoons are
busy converting ammonia into nitrates and toxins into harmless base elements.” - The Omega Institute. Aerated Lagoons —OCSL. http://www.eomega.org/omega/about/ocsl/lagoons

14 “...the water is sent to a recirculating sand filter. There, sand and microorganisms absorb and digest any remaining particulates and small amounts of nitrates that may still be present, and provide a final "polishing" to the water. After the water has moved through the recirculating sand filter, it meets advanced wastewater standards and is as clean as water from your kitchen faucet at home. However, due to state regulations, we cannot use the water for potable purposes. After the water has been through the recirculating sand filter, it is pumped to two dispersal fields under Omega's parking lot, each about the size of a basketball court. In the dispersal fields, the reclaimed water is released back into the groundwater table, located below the surface. The reclaimed water is further purified by nature as it trickles down to the aquifer that sits 250-300 feet beneath campus... Omega completes a closed hydrological loop in our water use. We draw water from deep wells that tap the aquifer; use the water in sinks, toilets, and showers...” - The Omega Institute. Recirculating Sand Filter & Dispersal Fields —OCSL. http://www.eomega.org/omega/about/ocsl/filters
figure 36. Constructed Wetlands.
The constructed wetlands in front of the Omega Center for Sustainable Living.

photo by Farshid Assassi: BNIM Architects.
http://www.bnim.com/work/omega-center-sustainable-living
figure 37. Aerated Lagoons.
The aerated lagoons within the building are bathed in sunlight.

photo by Farshid Assassi: BNIM Architects.
http://www.bnim.com/work/omega-center-sustainable-living
“...each pebble in the chinks of the cellar-wall beneath us holds thousands of thousands of years locked up in it, since first the ancient oceans sifted it and inner earth baked it and thickening continents began to squeeze it into rock.”¹

-Gannet, Wright, Winslow

Building materials have a story to tell. They can speak of a building’s genesis. They may even allude to a building’s future. Materials are capable of articulating the relationship between the built and natural environments. Building materials can also tell us lies.

The palette of materials an architect chooses to work with has further implications than simply the look of a building. Building materials today come to the United States from as far away as China. Shipping materials over great distances impacts our planet’s atmosphere, oceans, and land in devastating ways.

Reusing materials, using recycled materials, and using sustainably obtained local materials are all ways to reduce the impact a building’s construction has on the earth. In an educational context, reducing our impact on the earth through our material choices is an important goal. A sustainably designed building can set an example to students about the choices they make when purchasing other types of products. Do I really need that brand new bicycle, or should I fix up my brother’s old bike instead? Should I buy the apples from my local farm stand or the apples grown on the other side of the country?
A bit of pavement from Pompei, a fragment from the pyramids, is prized because man’s touch was on it 2000 or thrice 2000 years ago; but each pebble in the chinks of the cellar-wall beneath us holds thousands of thousands of years locked up in it, since first the ancient oceans sifted it and inner earth baked it and thickening continents began to squeeze it into rock.” Bolon, Nelson, Seidel. The Nature of Frank Lloyd Wright. (Chicago and London: The University of Chicago Press, 1988). pg. 7; Essay by: Connors, Joseph, Wright on Nature and The Machine: Original text from: William C. Gannett, Frank Lloyd Wright, and William Winslow, The House Beautiful (River Forest, Ill.: Auvergne Press, 1896-97)
"In all the crafts the nature of materials is emancipated by the Machine and the artist is freed from bondage to the old post-and-lintel form... A modern building may reasonably be a plastic whole – an integral matter of three dimensions: a child of the imagination more free than of yore, owing nothing to orders or styles."\(^1\)

- Frank Lloyd Wright

When Frank Lloyd Wright (1867 – 1959) built Taliesin, his country estate in Wisconsin\(^2\), he was dreaming of his Welsh ancestors and the agrarian life style he grew up loving. He designed his home to face towards the valley he and his family had once farmed (figure 38).\(^3\) Over the course of his young life, Wright spent time in the hills where he was to build his estate, taking in the aesthetics of the nature that surrounded him. And when he thought of where he was to live, upon leaving his conventional life in the suburbs of Oak Park, he thought again of the landscapes of his childhood. He returned to the hill where he was to grow his new home. He saw the landscape again, this time with the eyes of an accomplished architect. Large rock outcroppings in the landscape appeared to Wright as the form that was to inspire his home. Thus he gave the place he was to build the name Taliesin, a Welsh word meaning shining brow, and wrapped the building around the hill in such a manner as to not to diminish the qualities of the hill, but rather to make it greater (figure 39).\(^4\)
The building materials Wright employed came from the site itself and the surrounding hillside. For Wright it was sacrilegious to stucco over a brick wall or to paint upon oak boards. He wanted materials to maintain their natural qualities, to be truthful, to evoke the natural world, to make the building and its inhabitants become one with the site. Wright “deeply believed that the closer man associated himself with nature, the greater his personal, spiritual, and even physical well-being grew and expanded.” And so he examined the way the landscape was composed, with stone and trees upon the rocky earth, and the stone and wood of the site became the material palette for Taliesin.

The stones used to construct the building’s walls were quarried just over the adjacent hill, and reassembled to mimic the stones’ natural state (figure 40). The stones were layered, as they were within the rough ledges of the quarry, making the walls feel as though they grew out of the site itself. Wright taught the local stone masons to build the walls in this way, with their natural edges protruding. The masons “were soon as interested as sculptors fashioning a statue.” In this way, Wright made artists out of his laborers.

The stone walls of Taliesin ride low across the landscape, grounding the building, except where massive chimneys of stone rise through the roof, signaling the places within for gathering. Upon the native stone, lighter walls were framed in wood and plastered on the exterior for protection from the elements. To maintain a natural and indigenous quality, Wright utilized sands from the river in the valley below within the plaster. This gave the walls the same color as the river beds. Finish wood on the exterior of the building and the wooden shingles of the roof were allowed to weather (figure 41), “silver gray like the tree branches”.

80
Wright devised an architecture in harmony with nature one hundred years ago. Taliesin was his testing ground. It grew in all directions across the hill-side throughout Wright’s life time, like the runners of a plant. Wright led the way, teaching us how to build and design in ways that truly seem natural. Architects of the twenty first century have begun again to build on these organic principals in order to compose buildings in a sustainable way, creating atmospheres that foster an awareness of our place in the environment.
“But in the country estate he began building in Wisconsin in the summer of that year [1911], on the land that his Welsh forefathers had settled in the previous century, Wright found the liberation from convention he had been searching for.” – Bolon, Nelson, Seidel, The Nature of Frank Lloyd Wright. (Chicago and London: The University of Chicago Press, 1988), pg. 34; Essay by: Levine, Neil, Frank Lloyd Wright's Own Houses and His Changing Concept of Representation


“He redirected the masons to imitate the ‘pattern’ of rough ledges, or strata, of rock as they were ‘exposed’ in the quarry located just over the next hill.” - Bolon, Nelson, Seidel, The Nature of Frank Lloyd Wright (Chicago and London: The University of Chicago Press, 1988), pg. 38 - 39; Essay by: Levine, Neil, Frank Lloyd Wright's Own Houses and His Changing Concept of Representation.

“Talisien was to be a combination of stone and wood as they met in the aspect of the hills around about. The lines of the hills were the lines of the roofs. The slopes of the hills their slopes, the plastered surfaces of the light wood-walls, set back into shade beneath broad eaves, were like the flat stretches of sand in the river below and the same color, for that is where the material that covered them came from. The finished wood outside was the color of gray tree trunks, in violet light. The shingles of the roof surfaces were left to weather, silver-gray like the tree branches spreading below them.” - Wright, Frank Lloyd. Frank Lloyd Wright: Writings and Buildings. (New York: Horizon Press, 1960). Pg. 177. Taliesin.
figure 38. The Valley Below Taliesin.
The valley below Taliesin, where Frank Lloyd Wright grew up.

photo by Jessamine: http://www.flickr.com/photos/jessamine/3021681652/
sizes/z/in/photostream
figure 39. Taliesin Hill.
Wright designed Taliesin in such a way that the building did not sit upon a hill, rather it wrapped around it. The resulting courtyard is the hill top itself.

photo by Jessamine:
http://www.flickr.com/photos/jessamine/3021697752/sizes/z/in/set-72157608854398558
The stones used to construct Taliesin were reassembled to mimic the way they appeared in the ledges of the quarry nearby.

photo by Jessamine:
http://www.flickr.com/photos/jessamine/3021684462/sizes/z/in/set-72157608854398558
figure 41. Taliesin Wood.
Weathered wood mullions rise like tree trunks from stone walls, giving the building a natural quality.

photo by Jessamine:
http://www.flickr.com/photos/jessamine/3021652562/sizes/z/in/
set-72157608854398558
Adaptive reuse is “the process of adapting old structures for new purposes.”¹

By using existing structures, and changing them to meet new needs, architecture can connect us with the history of a site in interesting ways while conserving large quantities of building materials. Acquiring, shipping, and putting together new building materials can use up vast amounts of resources and energy. In many ways, the most ecologically sustainable building is the one that is already built. The Barn at Fallingwater, as redesigned by Bohlin Cywinski Jackson (BCJ), is an adaptive reuse project that recognizes the impact building materials can have on our environment. The construction of the Barn at Fallingwater utilized an existing structure, reused materials from the original building, employed reclaimed materials, explored new renewable resources, and recycled 81% of the project’s construction debris.²

The existing structure was a 19th century barn with a 20th century addition, added on by Edgar J. Kaufmann, the owner of F. L. Wright’s master piece, Fallingwater. The 19th century “bank barn” is built into the side of a hill in order for both levels to be accessible from grade. This portion of the building was constructed using heavy-timber. In contrast, the Kaufmann addition (built as a dairy barn) was framed using dimensional lumber. BCJ’s redesign of the building serves as an interpretive center for Bear Run, a 5,000-acre nature reserve owned by the Western Pennsylvania Conservancy (WPC). Adaptive reuse of this building is perfectly in line with WPC’s mission: "Saving the places we care about by connecting people to the
natural world." In renovating the barn, stewardship of the natural environment and preserving “the artifacts of the cultural landscape” were highly import to the WPC.

The materials added to the barn help to bring new meaning to the building, as well as recall its agrarian past. A rustic trellis of mountain laurel and red cedar signals those approaching the barn towards two entrances. The organic form of the wooden trellis echoes the surrounding forested landscape (figure 42). The first entrance is marked by a sliding barn door on the exterior of the renovated 1940s dairy barn (figure 43). Entering through a pair of double doors, visitors are greeted by a massive hearth, built of local fieldstone (figure 44). Walking around the hearth, to either side, allows entry into a multi-purpose assembly and exhibit space (figure 45). While renovating this room, finish materials added in the 1970s were removed revealing glazed terra cotta wainscoting from the 1940s. The terra cotta was retained and incorporated into the new design, along with glass block windows that were also found in the building. The original concrete floor was restored and red cedar from the ceiling was reused as a wall finish. Another material used to finish the walls is sunflower seed composite board, a new product manufactured by Phenix Biocomposites in Mankato, Minnesota. One and a half inch thick, 4 by 8 straw bale panels (figure 46) were applied to the underside of the roof to provide thermal insulation and sound absorption.

If those approaching the Barn at Fallingwater choose to continue past the first entrance and continue walking beneath the naturalistic portico, they will pass between the former dairy barn and a fifty foot high historically restored silo before arriving at the entry way to the former bank barn. Here they will be able to view the operable brise-soeil which protects the “office windows from the western sun” (figure
Inside, the original heavy timber frame has been preserved and kept visible (figure 48). The structure serves as a beautiful reminder of the resilience of wood when used as a structural material. To the right are the offices with storage space towards the back of the barn, imbedded into the hillside. The carpets used to finish the office floors are made of recycled materials and produce no off-gassing. The paints used within the building are also designed to not off-gas volatile organic compounds. Siding from another barn owned by WPC was reclaimed and used to finish the interior walls of the office suite.

On the second floor of the former bank barn is the building’s most dramatic space. “The grand upper level... is used as a seasonal area for exhibits, lectures, and other social functions.” This space was left virtually untouched by the architects at BCJ. The barn’s uninsulated wallboards have been left as-is to allow air and light to circulate freely through the second story walls. “…light filters through gaps between the boards, bouncing off the glossy floor and suffusing this space with a transcendental glow (figure 49).” The maple floor in this unprogrammed, 5,000 square foot space was reclaimed from a convent in Pittsburgh by the construction manager. The room has four oversized sliding doors that open to the east during warm months.

The Barn at Fallingwater is a lesson in preservation and ecology. It teaches us that the things we need are closer than we think. It acknowledges the value of historic structures, but looks beyond mere nostalgia. The materials of this building coalesce to express beautiful visions of the site’s agrarian past and its sustainable future.
NOTES

1 Adaptive reuse is conventionally defined as “the process of adapting old structures for new purposes.” - adaptivereuse.net. Adaptive Reuse. http://adaptivereuse.net/about-adaptive-reuse

2 “During the construction process, 81% of the construction debris was recycled.” - Fallingwater.org. About the Barn at Fallingwater: Green Building.

3 “The Barn at Fallingwater is an adaptive reuse of a 19th century heavy-timber barn and its 20th century addition, framed in dimension lumber. The 19th century structure is a bank barn, built into the side of a hill so that two levels can be accessed directly from grade level. It serves as an interpretive portal for the Western Pennsylvania Conservancy's 5,000-acre Bear Run nature reserve… It manifests the Conservancy's mission statement: "Saving the places we care about by connecting people to the natural world." - The American Institute of Architects. AIA/COTE Top Ten Green Projects: The Barn at Fallingwater. April 25. 2005. http://www.aiatopten.org/hpb/overview.cfm?ProjectID=453


5 “To attract attention to the barn’s entrance, Mountain Laurel and Red Cedar were combined to create a rustic trellis across the Route 381 elevation.” - Fallingwater.org. About the Barn at Fallingwater: Building and Site Features. http://www.fallingwater.org/51/building-and-site-features

6 “Multi-purpose assembly and exhibit space occupies the 1940s dairy barn addition. Removal of 1970s renovation finishes revealed glazed terra cotta wainscoting from the period when the Kaufmanns lived at Fallingwater and operated a modern, scientific dairy… A chimney mass of local fieldstone anchors the space for formal presentations, while screening the room from the exterior entrance.” - Bohlin Cywinski Jackson. The Barn at Fallingwater. http://www.bcj.com/public/projects/project/56.html

7 “In the multipurpose room various materials were retained from the 1940s-milking parlor including glazed tile block walls, a concrete floor, glass blocks windows, and red cedar, which was part of the 1960s ceiling.” - Fallingwater.org. About the Barn at Fallingwater: Green Building. http://www.fallingwater.org/52/green-building

8 “Phenix Biocomposites of Mankato, Minnesota manufactures a product from sunflower seed composite called Dakota Burl. It is used on walls in the multipurpose room and some cabinetry.” - Fallingwater.org. About the Barn at Fallingwater: Green Building. http://www.fallingwater.org/52/green-building

9 “A renewable resource, 4 by 8 straw panels (1 ½ inches thick) from Bio Fab LLC in Redding, CA were used as sound absorptive wall finish in several areas of the building.” - Fallingwater.org. About the Barn at Fallingwater: Green Building. http://www.fallingwater.org/52/green-building


11 “The barn’s heavy timber frame construction has been retained and is visible in the office suite... Preservation of the fiftyfoot plus silo was determined to be critical to maintaining the barn’s historic integrity. The badly deteriorated tiles were repaired and preserved.” - Fallingwater.org. About the Barn at Fallingwater: Building and Site Features. http://www.fallingwater.org/51/building-and-site-features


13 “The office carpet (a Bigelow brand) is made from recycled products. Both paint (PPG’s Pure Performance) and the carpet have little or no offgassing... In the office suite, barn board from a building on WPC property was recycled for interior finishes.” - Fallingwater.org. About the Barn at Fallingwater: Green Building. http://www.fallingwater.org/52/green-building
“The grand upper level of the original bank barn is used as a seasonal area for exhibits, lectures, and other social functions.” - The American Institute of Architects. AIA/COTE Top Ten Green Projects: The Barn at Fallingwater. April 25. 2005.
http://www.aiatopten.org/hpb/overview.cfm?ProjectID=453

“Bohlin Cywinski Jackson left the older barn’s main space, a 5,000-square-foot room, untouched, preserving its barnlike character with unfinished, uninsulated wallboards that allow air and light to circulate freely... Once considered a problem, the unprogrammed large space is now the project’s selling point... Even on rainy days, light filters through gaps between the boards, bouncing off the glossy floor and suffusing this space with a transcendential glow.” – Murdock, James. Bohlin Cywinski Jackson employ creative renovation on an old barn used by the Western Pennsylvania Conservancy. Architectural Record. January. 2005.


figure 42. Rustic Trellis.
A rustic trellis calls attention to the building’s points of entry.

figure 43. Dairy Barn Entrance.
The entrance to the multi-purpose assembly/exhibit space.

figure 44. Field Stone Chimney.
A massive chimney built of local field stone recalls the spirit of Frank Lloyd Wright.

photo by Nic Lehoux: Bohlin Cywinski Jackson. The Barn at Falling Water.
figure 45. Multi-Purpose Space.
The large space within the former dairy barn is a mix new and old materials.

*photo by Nic Lehoux: Bohlin Cywinski Jackson. The Barn at Falling Water.*
figure 46. Straw Bale Panels.  
Left: Straw-bale panels were also utilized in the walls of the former bank barn. 
Right: The operable brise-soeil protects the office from harsh western sunlight.

photos by Nic Lehoux: Bohlin Cywinski Jackson. The Barn at Falling Water. 
figure 48. Heavy Timber.
The original heavy timber frame may look distressed, but it is still a durable and reliable structure.

figure 49. Fractured Light.
The large unprogrammed space on the second floor is given a mystical appeal by the fractured light entering through the barn walls.

photo by AzyxA: http://www.flickr.com/photos/azyxa/5152073197/sizes/z/in/photostream
The Visitor Activity Center at PEEC has a very interesting northern façade. The north facing exterior wall is shingled using the treads of tires found near the building’s site (figure 50). For the architects at BCJ, this was an opportunity to turn trash into a façade that is not only beautiful, but also extremely useful in its ability to shed water. By way of the architects’ consciousness and willingness to reuse abandoned materials, a wall that might have otherwise been very solid and ordinary became a wonderful teaching moment. The tire tread cladding provides a chance for visitors to learn about the importance of reusing and recycling.

The process by which the wall was built helped to cleanse adjacent ecosystems. This is analogous to the how nature reuses waste to create new life. The treads were stripped from tires which were “collected by the park service along nearby roads.” MooRoof, a small family owned company out of British Columbia, traveled to the building site to strip the “sidewalls off the collected tires.” Marvin Malecha, a COTE award juror, praised the building’s green ingenuity saying, “This is how to mainstream Sam Mockbee.”

Samuel Mockbee (1944 – 2001) was the founder of Rural Studio, an Alabama architecture school program in which students design and build community related structures and houses for poor residents. Reclaimed materials are used in innovative ways to bring down the cost of many of these buildings. Perhaps the most famous building designed and constructed by the Rural Studio is Mason’s Bend
Community Center in New Bern, Alabama. For this design, four thesis students at the Rural Studio reused car windshields to create an elegant glass façade (figure 51).  

Mockbee and his students were not the first to institute the principal of reuse in building construction. Reusing materials is something architects and builders have been doing for centuries. For example, the great mosque in Cordoba, Spain (built 784 – 987 AD) reused many “elements from pre-Islamic buildings”, most notably columns and capitals (figure 52). This was also the case in many other buildings throughout the post Roman Empire. Remnants of Roman era buildings were reused and reused again in new and innovative ways by subsequent civilizations.

The architects at BCJ were conscious of the architectural history of building material reuse when they designed PEEC’s Visitor Activity Center. Their design for the building acknowledges the future. It recognizes the natural world, of which we are a part, is constantly changing. To account for this, the building was constructed with the ability to be easily disassembled incase a need arises for the building to be relocated or the building materials need to be reused for some other future purpose. All of the structural elements are bolted together, rather than welded or adhered in a more permanent way (figure 53). Glue-laminated wood posts and beams are utilized allowing for structural members to be made using smaller pieces of wood, reducing the need to harvest older trees. The bolts that connect the glue laminated structure are visible, providing opportunities for learning. Teachers are able to point out the building’s consciousness of nature’s uncertainty and visitors are able to learn about how the built environment is put together.
The north elevation nestles into the landscape and is literally clad in material from the site: treads stripped from tires collected by the park service along nearby roads. A huge hit with the public and the COTE award jurors, the material was serendipitous, says Kachel. The designers originally specified a material manufactured out of recycled tire treads, but the source company went out of business. A hasty Web search for an alternative discovered MooRoof, operated by two brothers from British Columbia who quickly drove cross-country in their diesel VW bus and set their portable machinery up on the site to strip sidewalls off the collected tires. “This project grows from the site,” said COTE juror Marvin Malecha, adding, “This is how to mainstream Sam Mockbee.” Even the furniture is recycled, salvaged from a nearby country club. - Gragg, Randy. Pocono Environmental Education Center Dingman’s Ferry, Pennsylvania. Greensource. July. 2008. Pg. 96 – 99.


“The Mosque of Cordoba, like so many other early hypostyle mosques, reused elements (especially columns and capitals) from pre-Islamic buildings. However, a number of major innovations transformed it into one of the great monuments of medieval architecture.” Ettinhausen, Grabar, Jenkins-Medina. Islamic Art and Architecture 650-1250. (New Haven and London: Yale University Press). Pg. 85.

figure 50. Tire Tread Cladding.
The northern façade of PEEC’s Visitor Activity Center is clad in tire treads salvaged from nearby roadways.

figure 51. Mason’s Bend Community Center.
The expressive glass wall of the Mason’s Bend Community Center was built using car windshields.

photo by Tim Hursley: www.timothyhursley.com

figure 52. Great Mosque in Cordoba.

photo by Sergei Pechenezhskiy: http://www.flickr.com/photos/pechenezhskiy/3969357111/sizes/z/in/photostream
Structurally, the center is a space frame of concrete, gluelams, trusses, and columns that can be easily disassembled should the building need to be moved or if it becomes obsolete.

**figure 53.** PEEC Exploded Axonometric.

Selecting environmentally sensitive building materials for the Queens Botanical Garden (QBG) Visitor Center was extremely important to the mission of the new building. In fact “more than 33% of the materials in the building, by cost, were harvested or manufactured within 500 miles of the project site.” The interior materials are kept simple and minimal. For example, many of the concrete floors are left unfinished because using no finish material at all, such as carpeting or tile, is more sustainable than using unnecessary materials. This attitude towards frugality can translate into an important lesson to visitors about consumerism. Often what we want and what we truly need are at odds with each other. Sometimes deciding not to buy something is the best decision for the health of our planet, no matter how sustainable a product may seem.

Black locust wood that was “harvested on Long Island and milled in Pennsylvania” was chosen for use on “the decks of the bridges crossing the water channel” as well as for the brises-soleil surrounding the administration building (figures 22 + 54). Originally BKSK Architects had selected an extremely dense Brazilian wood called ipe for these purposes. Although the ipe would have been “certified by the Forest Stewardship Council [FSC],” the distance the wood had to travel seemed to cancel out the fact that the forests where the ipe originated from were well managed. Another FSC certified, local wood, western red-cedar, was used as exterior cladding for the administration building (figure 54). The structure of the
auditorium was formed with reclaimed hemlock, leaving its imprint on the concrete walls.\textsuperscript{8}

Wood is one of the only truly renewable building materials we have. Well managed forests are healthy for our planet because trees sequester carbon dioxide. In fact, new growth forests sequester more carbon dioxide than old growth forests do, because young trees grow at a faster rate than old trees. The more we use wood from well managed forests in our construction, the more forests will be planted to maintain an adequate supply of wood. This is one of the reasons many architects are exploring new ways to use wood in building types that never used wood before.

1 “On the interior, the architects’ approach to sustainability was to use as few finishes as possible. For example, though some spaces have carpet tile, most floors are polished concrete.” - Gonchar, Joann. Setting Down Roots: A new building raises a botanical garden’s profile as an institution focused on environmental stewardship. Greensource. April. 2008.

2 “Souder also learned that LEED’s point system can have drawbacks. Some parts of the building have carpeting—designed by William McDonough and made of recycled material—because LEED bestows a point for the use of “sustainable” flooring materials. Without the checklist, the offices might have had no carpet, Souder says—surely a greener option.” - Bernstein, Fred A. A Garden Blooms in Queens: One of New York’s Lesser-Known Botanical Gardens Emerges as a Leader in Sustainable Design. Metropolis Magazine. February. 2008. http://www.metropolismag.com/story/20080220/a-garden-blooms-in-queens


5 “One of the project’s greatest assets was Souder’s desire to look beyond green labels. For the brises-soleil, BKSK had selected ipe, a Brazilian wood of unusually high density. But the fact that the wood was certified by the Forest Stewardship Council wasn’t enough for Souder. “I think certification is important,” she says, “but I also think the program isn’t perfect.” Satisfying herself about the wood’s sustainability, she says, would have required “visiting the forest myself and seeing how it’s managed.” But had she visited and come away impressed, she still would have been reluctant to use a tropical wood. “I don’t feel it’s necessary to ship something around the world,” she says. “Especially since this is a pretty important architectural element that people might want to replicate.” - Bernstein, Fred A. A Garden Blooms in Queens: One of New York’s Lesser-Known Botanical Gardens Emerges as a Leader in Sustainable Design. Metropolis Magazine. February. 2008. http://www.metropolismag.com/story/20080220/a-garden-blooms-in-queens

6 “The team even considered the source of wood used for construction processes: The formwork for the auditorium’s concrete structure was made of salvaged hemlock. Although the hemlock is not part of the completed building, its imprint can be read on the auditorium’s board-formed walls.” - Gonchar, Joann. Setting Down Roots: A new building raises a botanical garden’s profile as an institution focused on environmental stewardship. Greensource. April. 2008.
figure 54. Western Red Cedar. 
The QBG’s administration building is clad in western red cedar, with a black locust brises-soleil.

photo by Queens Museum of Art Immigrant Parks Collaborative: http://www.flickr.com/photos/qmaparks/2726479586/sizes/z/in/photostream
CHAPTER 8

CONCLUSION

The modernist architects of the twentieth century designed buildings that formally blurred the lines between the built and natural environments. Louis Kahn utilized natural light to enhance his architecture, believing the sun to be essential to all space making. Luis Barragán had a strong affinity for water and incorporated it dynamically into his striking architectural compositions. Frank Lloyd Wright employed materials from the sites of his buildings in ways that recall their genesis. These, and many other examples, point to how the modernist movement opened the doors to explore new ways of naturalizing architecture. Where before, nature in architecture was merely applied as a decoration, the modernists were able to generate new forms and methods that begin to grow the built environment from a site. They composed places that make us feel more a part of the natural world.

The great architects of the early twenty first century will be remembered for expanding on the ways architecture can connect us to the natural world. Their work begins to form a harmony with nature, akin to a living ecosystem. Through their buildings we can learn to live in ways that regenerate the natural environment. We are taught to reuse and recycle materials, conserve and regenerate our water, and utilize the free power that the sun provides to us all. As we learn to replicate and expand upon the processes of nature that these architects are designing with, a time may come when the there is no longer a need to distinguish between the built and natural environments.
PART 2

THE CLIFFORD A. PHANEUF ENVIRONMENTAL CENTER
The Clifford A. Phaneuf Environmental Center, in Springfield, Massachusetts’s Forest Park (figure 55), is home to the Environmental Center for Our Schools (ECOS).¹ The building sits on the northern edge of Porter Lake where residents of Springfield once ice-skated in the winter. The Warming House, as it was called then, was originally constructed in 1936² to replace an adjacent skate house just to the west (figure 56). The 5,200 square foot³ Warming House contained a large warming room (50’ x 30’), a restaurant (24’ x 15’), a shoe check room, bathrooms, and storage on the first floor (figure 57). The second floor was most likely used for administrative purposes. The building was framed in steel with wood stud walls and clad on the exterior with log siding, giving the building the appearance of a log cabin from the outside (figures 58 + 60).

“In 1970, the year of the first Earth Day,”⁴ ECOS was founded by Clifford A. Phaneuf and Lorraine Ide⁵, and the former warming house became home to the ECOS program. Clifford A. Phaneuf (born in 1923 and known as “Springfield’s father of environmental education”⁶) became the coordinator for ECOS in 1971 and continued to develop the program until his death in 1987.⁷ In June of 2008 the former skate house on Porter Lake was officially renamed the Clifford A. Phaneuf Environmental Center⁸ and a plaque to commemorate the visionary educator⁹ “was mounted above the fireplace” inside the building (figure 60). Phaneuf’s poem, “A Child Aks” is inscribed on this plaque.¹⁰
A CHILD ASKS

Please tell me teacher, what it’s like
to watch a swallow in its flight,
Or see an eagle soar so high
it fades into a cloudless sky.

Please tell me about a country road
along whose waysides wildflowers grow.
Or can you tell me why lichens die
just because we pollute the sky?

Describe to me a field of green,
with crystal dewdrops reflecting the sun’s gleam.
I’ve heard the elm tree was a majestic thing,
that reached further skyward every spring.

What was a picnic? Were they easy to hold?
The parking lot’s pavement is too hot or too cold.
Was there ever a place a child could look
into the bottom of a clear mountain brook?

Did ever wild animals live not in a cage?
Please tell me teacher, of that other age.
Tell me about the love affair
between the butterflies, the flowers, and the clean fresh air.

You’ll have to tell me, teacher,
because I can’t see...
None of these things
are left for me.

- Clifford A. Phaneuf
Today, and for the past 40 years, ECOS continues to educate children in Springfield’s public school system as well as students from private schools. Over 8,000 elementary and middle school students attend the ECOS program each year. Unfortunately, the building is in desperate need of repairs (figure 61). According to Eric Fisher’s May, 2010 report “floors are old and creaky, windows are broken, and a number of birds are now residents of the roof.” In 2008 ECOS was able to obtain $50,000 for a new boiler and bathroom renovations, but what the building truly needs is a total renovation.

That renovation may now be on the horizon. With a $75,000 grant from the city in 2010, ECOS Educator Burton D. Freedman (who has been advocating for the renovation for over a decade) has been able to begin working with Stephen Jablonski Architects on renovation and addition designs (figure 62). The new design will include photovoltaic arrays, retrofitting and re-insulating the aging building, and an attitude of “preserving the historic appearance of the building.” “[The students] should have a facility that teaches them as they’re in the facility, and in this case that’s not happening,” Freedman said in an interview for WGGB, where he also stated “the environmental center should be a showcase for green energy efficiency”.

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NOTES


4 “The building was constructed in the 1930s, but in 1970, the year of the first Earth Day, the former skate house became the home of the Environmental Center for Our Schools (ECOS) program of the Springfield Public Schools.” - McAuliffe, Michael. Springfield Seeks Funds to Enlarge Clifford A. Phaneuf Environmental Center in Forest Park. The Republican. 23 March. 2010. http://www.masslive.com/news/index.ssf/2010/03/springfield_seeks_funds_to_enl.html


14 “Floors are old and creaky, windows are broken, and a number of birds are now residents of the roof. Aside from a new boiler and some patches to the roof, little has been done to keep the building up-to-

14 “The City of Springfield and the School Department have committed $50,000 combined to refurbish the Clifford A. Phaneuf Environmental Center in Forest Park...” “Patrick J. Sullivan, city facilities director, said improvements will include new bathrooms and a boiler, and he is hopeful the city will win state funds for further renovations.” - Goldberg, Marla A. Springfield Honors Environmental Educator Clifford A. Phaneuf. The Republican. 11 June. 2008. http://www.masslive.com/news/index.ssf/2008/06/springfield_honors_environment.html


17 “...Burt Freedman, a teacher in the ECOS program. He's been fighting for renovations for over a decade, appealing to Springfield city leaders. While he's managed to win a few battles and get a few improvements for the classroom, he has something completely different in mind. A total renovation and expansion effort.” - Fisher, Eric. ECOS Classroom in Need of Upgrades. WGGB, ABC 40. 11 May. 2010. http://www.wggb.com/global/story.asp?s=12462545


19 The project would feature enlarging the 5,200-square-foot center, and among the improvements would be adding solar panels and more insulation while preserving the historic appearance of the building. Sullivan said the possibility of geothermal heating and cooling for the center is also being explored.” - McAuliffe, Michael. Springfield Seeks Funds to Enlarge Clifford A. Phaneuf Environmental Center in Forest Park. The Republican. 23 March. 2010. http://www.masslive.com/news/index.ssf/2010/03/springfield_seeks_funds_to_enl.html

20 “They (the students) should have a facility that teachers them as they're in the facility, and in this case that's not happening,' says Burt Freedman, a teacher in the ECOS program.” “The environmental center should be a showcase for green energy efficiency,’ says Freedman.” - Fisher, Eric. ECOS Classroom in Need of Upgrades. WGGB, ABC 40. 11 May. 2010. http://www.wggb.com/global/story.asp?s=12462545
figure 55. Forest Park.
A Brief History of the Clifford A. Phaneuf Environmental Center

In 1936 “The Warming House” was built to replace an adjacent ice skating house on Porter Lake.

The building is framed in steel with wood stud walls.

The exterior is clad with log siding, giving the building the appearance of a log cabin.

In 1970 the Environmental Center for Our Schools (ECOS) was founded by Clifford A. Phaneuf and Lorraine Ide.

Phaneuf became the coordinator for ECOS in 1971 and continued to develop the program until his death in 1987.

In 2008 the former skate house was renamed the Clifford A. Phaneuf Environmental Center.

Currently over 8,000 elementary and middle school students attend the ECOS program each year.
Figure 57. Warming House First Floor Plan.

Drawing by the Department of Streets and Engineering, Springfield, Massachusetts. 1935.
figure 58. Wall and Framing Sections.

Drawings by the Department of Streets and Engineering, Springfield, Massachusetts, 1935.
figure 59. The Clifford A. Phaneuf Environmental Center.
Photo of the Clifford A. Phaneuf Environmental Center on Porter Lake October, 2010.
figure 60. Commemorative Plaque.
“Clifford G. Phaneuf, of Sturbridge, grandson of the late Clifford A. Phaneuf, of Springfield, originator of the Environmental Center for Our Schools program, stands with a newly unveiled plaque renaming the former Porter Lake Skate House in Springfield’s Forest Park the Clifford A. Phaneuf Environmental Center.”


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The aging building is in desperate need of repairs. **Above:** log siding has fallen off the building. **Below:** Insect damage to the exterior.
A rendering of the proposed renovation by Stephen Jablonski Architects.

PART 3
RE-ENVISIONING THE CLIFFORD A. PHANEUF ENVIRONMENTAL CENTER
CHAPTER 9
INTRODUCTION

The existing facility for the Environmental Center for Our Schools (ECOS) is not a building that fosters an awareness of the natural or built environments. It is a building that hides the truth about its design under a façade of log siding, recalling something from our past in a purely nostalgic way. In fact, The Clifford A. Phaneuf Environmental Center was never designed to be an environmental center at all. A re-envisioning of this facility is greatly needed, one in which the building itself becomes a teaching tool.

Let us imagine a place on this site where students come to learn about and are immersed in nature. A place where they are taught to reuse and recycle materials, conserve and regenerate water, and utilize the free power that the sun provides. A place that makes connections to the natural world of which we are a part. Through these connections students will begin to recognize their role in nature. They will take this knowledge with them, process it, and apply it to their daily lives. They will begin to understand the implications of their actions and become better stewards of their ecosystem and the earth as a whole.
Design Process

The Clifford A. Phaneuf Environmental Center has been ill maintained for many years. For this reason, it is vital that a new facility be a building that is utilized by a greater population, continuously, for many types of activities. A new design for this building should be one that is greatly admired by those visiting Forest Park. It should be a destination; a place of desired repose.

Forest Park lacks a true visitor center. The Clifford A. Phaneuf Environmental Center is in a beautiful location, connected to nature trails, looking out to Porter Lake. It is a wonderful place to be. A new design for this building should house the functions of a visitor center. It should also be economically self sustaining. An assembly space could help accomplish this goal. By adding these functions to the program of the new ECOS’s facility, the Clifford A. Phaneuf Environmental Center will last for many generations.

Basic Program

Office

Classrooms

Assembly

Exhibition

To better understand the relationship between the building’s programmatic elements, I renamed each element (figure 63). The words associated with each element helped to promote a better understanding of the building’s program in terms of the learning process. I then began a series of diagrams utilizing these terms,
studying their relationships to one another (figure 64). A pair of diagrams emerged from the process. These diagrams, arranged on a gradient, speak to the program’s relationship to the site in terms of exterior and interior functions (figure 65) and public verses private spaces (figure 66).

Environmental systems should also serve as program for the design. By diagramming these processes, in term of their connections to the environment, another set of words began to emerge (figure 67). These words (collect/absorb, filter/reduce, reflect/divert) seemed to form a gradient similar to that of the programmatic diagrams. I utilized this gradient to create a new diagram that attempts to illustrate the interconnectedness of various environmental systems (figure 68).

A linear language surfaced from both sets of diagrams. I employed this language throughout my design process. I further developed the resulting programmatic arrangement through a series of sections which negotiated the building’s connections to sun and water, while keeping in mind the gradient developed in figure 68. Finally I developed a structural system and sustainable materials were chosen for the building.
figure 63. Program Renamed.
FIGURE 64. Relationship Diagram.
This diagram illustrates how groups come together to learn (coalesce), are taught (foster), display or teach what they’ve learned (express), and reflect on the lessons (process). This cycle begins again and the educator may improve on the lesson plan after processing the information. However, it is not always that straight forward.
Fostering an awareness of one's environment happens closest to nature, while the processing of information may need to take place someplace more discreet.
figure 66. Gradient Arrangement (public vs. private).
Places for people to coalesce should be public, inside and out of the building. Expression of nature should be a public aspect as well. Spaces to foster learning in students are not for the general public, but should be evident in the design. Educators need private spaces to process and develop lessons.
figure 67. Environmental Diagram 1.
Energy collection

Shading

Vegetation

Solar sterilization

Cistern retention

Root/Runoff collection

Filter/reduction

Purification

Erosion reduction

Water retention

Evaporation

Lake retention

Water cycle reentry

Heat/light reflection

Reflection pool

Metallic materials

Light colors

Figure 68. Environmental Diagram 2.
Sun

Figure 69 illustrates the building’s ability to be heated by passive solar means. Concrete floors and walls absorb the sun’s heat during heating season days and slowly release the heat as needed. An in-floor radiant heat system, (figure 73) preheated by the sun, provides added heat throughout the building when needed.

Figure 70 illustrates the various means of shading the building during season’s when heat is not needed. The classrooms are shaded with a large roof overhang, as well as a living shade. The living shade is a wooden trellis, over which vines grow in the spring and summer, blocking the sun. In the late fall the vines begin to die back and are pruned to allow the sun’s rays to enter and heat the classrooms. The office is shaded using light shelves that have been specially engineered to block direct summer sun and let in winter sunlight. Further cooling to the building is added by operable windows and ceiling fans that help the users of the building take advantage of natural air flows. These systems become teaching tools and part of the curriculum of the facility.

Figure 71 illustrates day-lighting within the office and exhibition space. Light shelves in the office block direct light, reflecting it to provide indirect light appropriate for working conditions. The sun light entering the exhibition space is reflected off of surfaces before being filtered through a wooden screen, giving the light a unique quality.

This building design also features a large photovoltaic array and solar hot water on a roof perfectly pitched to maximize solar gain (figure 73).
The red arrows indicate the directions of radiant heat flow. Concrete walls and floors absorb the sun’s heat, radiating it throughout the building section at winter solstice.

Figure 69. Passive Solar Heating.
Figure 70. Passive Cooling.

Ceiling fans and operable windows give the users of the building better control over their own comfort. Blue arrows indicate cool air flows into the building through operable windows, while red arrows indicate where hot air escapes.

The offices (left) utilize light shelves to block the sun during the summer. The classrooms (right) are shaded via a living shade and a large overhanging roof.
Light shelves in the office block direct light, reflecting it to provide indirect light appropriate for working conditions. The sun light entering the exhibition space is reflected off of surfaces before being filtered through a wooden screen, giving the light a unique quality.
Water

Figure 72 illustrates the building’s connections to water. The standing seam metal roof above the office diverts water to an extensive green roof above the office’s service core. This green roof filters the run off through a multitude of native plants and a deep gravel bed. The water that is not retained in the green roof system is collected in a cistern beneath the office entrance patio. This grey water is used to flush toilets within the building. It is also used to irrigate the green roofs and other plants on site in times of drought.

The strategy in the front of the building is to express storm water diversion by carefully guiding roof runoff into Porter Lake, cleansing it in the process, and avoiding erosion. The roof above the classrooms and the PV roof divert water to a long channel that runs between them. This water is joined by filtered water from an extensive green roof above the assembly space. The waters coalesce above the building’s portico and cascade down a series of rain chains in front of the assembly hall’s southern window. This is a visual moment for visitors on a rainy day to watch as the water clings to the rain chains and flows beneath their feet through grated slats filled with gravel. The water then enters a gravel filled rain garden, filled with native grasses and cattails that filter the water with their deep roots before it enters into Porter Lake.
Figure 72. Grey Water Collection + Storm Water Diversion.

Carefully guiding roof runoff into the lake, cleansing it in the process.

The strategy in the front of the building is to express storm water diversion by carefully guiding roof runoff into the lake, cleansing it in the process. The filtered grey water is then collected in a cistern and used to flush toilets and irrigate the green roofs and other plants on site. The standing seam metal (left) diverts water to an extensive green roof that filters the water. The filtered grey water is then collected in a cistern and used to flush toilets and irrigate the green roofs and other plants on site.
Material

**Figure 73** is an exploded axonometric diagram, showing the various materials and systems that make up the building’s design. The intensive green roofs consist of one foot of engineered soil and three inches of gravel. They can be planted with a multitude of native plant species due to intensive soil depth. The green roof above the exhibition and assembly spaces is suitable for recreation and accessible to the public. The roof above the office service core is not accessible, except for maintenance.

The other roofs of the facility are standing seam metal roofs. They are a light grey color in order to reflect the sun’s heat and reduce the cooling load of the building. These roofs are extremely durable, do not leak, and shed water incredibly well.

Wood is a major component of this building. Reclaimed wood siding will give the building’s exterior a rustic look, shed water well, and create teaching moments about the value of reusing materials. Forest Stewardship Council certified dimensional lumber is utilized in the building’s envelope because it is inexpensive, readily available, and can be obtained from local forests and mills. Glue-laminated beams allow the structure to maintain the aesthetic quality of wood, but be built using smaller trees from new growth forests.
Figure 73. Materials + Systems.

- Intensive Turf Roof
- Reclaimed Wood Siding
- Dimensional Lumber
- Concrete (Thermal Mass)
- Glulam Beams
- Photovoltaic Array
- Standing Seam Metal Roof
- Radiant Floor Heating
figure 74. Site Plan.
figure 75. First Floor Plan.
figure 76. Second Floor Plan.
figure 79. Portico.
figure 83. Office.
Figure 84. View From Across The Lake
Conclusion

This design for the Clifford A. Phaneuf Environmental Center attempts to illustrate the possibilities of what this facility could be. While there are many different ways this building could manifest, it is important that the design make meaningful connections to the environment. The design I am presenting here is for a new construction. That may not be the most economical choice; in fact it may not be the most environmentally friendly choice either. I have designed the building in this way to help those who read this thesis rethink the traditional; to look beyond historic preservation and retrofitting. Look instead to the example I am presenting here and to the precedents in this thesis. Imagine new ways to adapt this building in order to connect students to the diverse ecosystems Forest Park has to offer. Through these connections students will recognize their role in nature. They will take this knowledge with them and apply it to their daily lives. They will begin to understand the implications of their actions and become better stewards of their ecosystem and the earth as a whole.
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