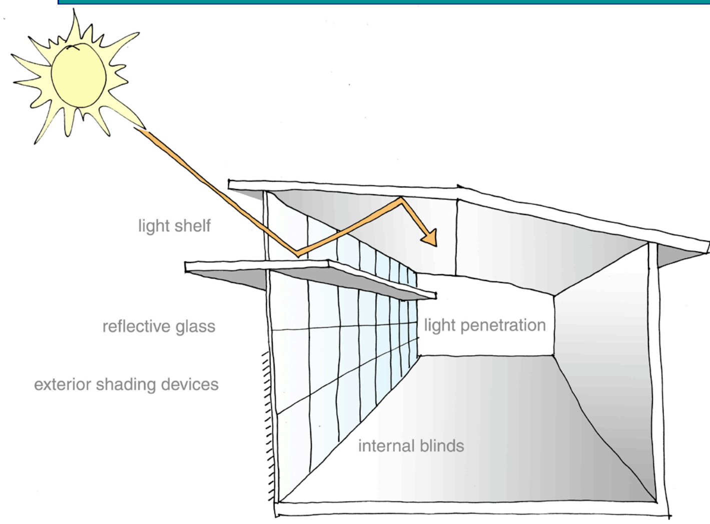
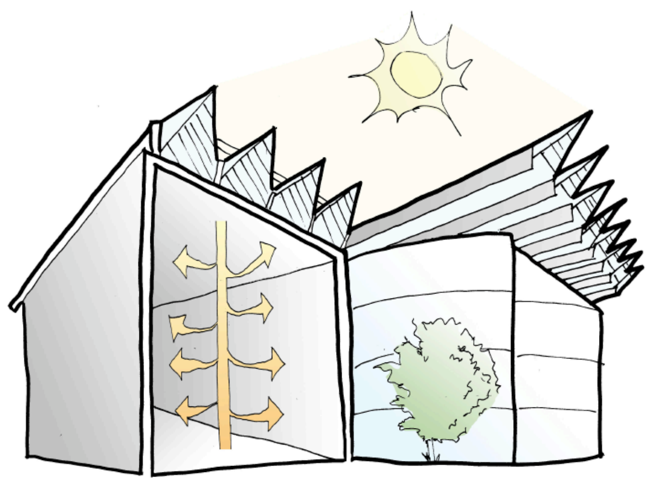
Sustainable Library Design





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1. INTRODUCTION

> "We are ecologically interdependent with the whole of the natural environment; we are socially, culturally, and economically interdependent with all of humanity; Sustainability in the context of this interdependence, requires partnership, equity, and balance among all parties."
>
> Declaration of Interdependence for a Sustainable Future, UIA/AIA World Congress of Architects, Chicago, 1993

Prior to the germ theory of medicine, it was considered essential to health to be exposed to fresh air and daylight, for there was little else known to prevent infection or disease. In years following, medicine began to focus on increasingly sophisticated technology, abandoning experiential evidence of the benefits of contact with nature. As medicine and hospitals changed to meet this attitude shift, patients became further and further removed from the outdoors or any sign of it. As the strengths and shortcomings of technology have been revealed in practice, we have become aware that there lies a necessary balance between technology and nature. Studies conducted in the past two decades have shown a link between patient recovery rates and contact with nature. As a result, the medical community (along with the medical insurance community) is experiencing a shift towards balance between technology and nature, western and eastern medicine, aggressive medical treatments and holistic treatment.

This is a change that parallels that of the design and construction of buildings. Architects are coming back to an ideological middle ground between advanced technology and traditional systems. For many years, architects have relied on mechanical systems to solve the indoor environmental and energy use problems that their aesthetically centered designs created. As a culture, we are coming face to face with the limitations of the technology that we have placed so much faith in. We are finding a need for using that technology appropriately, and in a way that supports design that is wisely collaborative with the laws of nature. Rather than suggest that we return to a primitive state, this shift suggests that we take inspiration from nature's design to use technology wisely to support design informed by thousands of years of experience.

It is essential to keep in mind that sustainable architecture is no different, in theory, from intelligent architecture. The challenge of building with minimal impact on resources provides architects with an opportunity to redirect their focus on elegantly simple design solutions, responsive to site, climate, and culture.

2. WHY ARE WE CONCERNED ABOUT BUILDINGS AND ENVIRONMENTAL IMPACT?

According to the US Green Building Council, commercial, institutional and residential buildings and operations account for 30-40% of total energy use, 50-60% of total electricity use, 35-40% of municipal solid waste, 25-30% of wood and raw materials use, and 25% of water consumption. Since buildings represent such a large part of the consumption of earth's resources, an enormous opportunity for significantly reducing our environmental impact lies in our ability to optimize the energy and resource efficiency of the buildings we live and work in.

In the United States we spend, on average, 90% of our time indoors. It follows naturally that we would want to make those spaces comfortable and healthy places to live, providing us with a connection to the outdoors when we are unable to be out in it. In the energy crisis of the 1970's, many architects and engineers responded to the need to reduce flows of energy (in the form of heat) in and out of buildings by dramatically reducing window area, and effectively closing off any connection to daylight, views, or other source of natural diurnal rhythm. We have learned that shutting out daylight increases the lighting load of a building and balances out any benefit derived from increased heating load in winter or cooling load in summer that might have resulted from a window's thermal passage.

For some it is helpful to imagine the sum of resources available on the Earth, in the form of materials, solar energy, wind and water. These are all resources that we harness for our use. By imagining the sum of those resources that exist on a single building site, a designer can imagine what amount of materials, energy, and waste are appropriate for use.

When considering energy, this is called a 'solar budget' or 'energy budget.' You can determine the total amount of sunlight available on a site that can be translated by current photovoltaic technology into usable energy using that light. Once you know how much energy is available to that site, you then have a guideline for the maximum amount of energy you should design your system to use. For a library's level of energy consumption, this is typically not that great a challenge. The next step would be to consider the feasibility of actually harnessing solar power for the building's use, whether an onsite renewable source or through a green energy program offered by utilities.

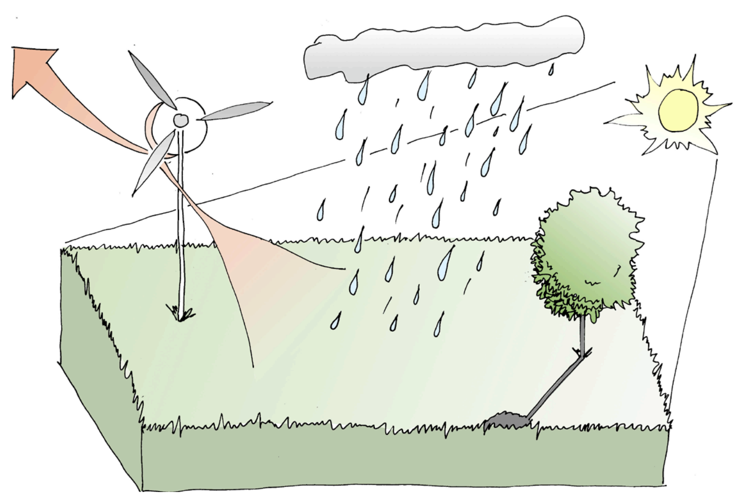


Figure 1: Wind, Water and Solar Budget

A design team could also create an energy budget based upon the amount of wind that travels across a site. Wind strong enough for effective power generation isn't as universal as the practicality of solar – but for a particularly windy site, it would be worth a study to determine the amount of energy that could be gathered using that renewable source.

In addition to energy budgets, design teams interested in creating a building that doesn't use more than its share of water could calculate the amount of water that falls or flows through a site. This is more challenging in some areas of California than in others – but at the very least, it creates an awareness of the disparity between available resources and those that are planned for use. For further ideas about strategies for making the best use of available water, read the section on water efficiency (Section 6.2) below.

This resource budgeting gives design teams a good tool for gauging the relative impact of their design compared against a tree, for example, which is not capable of using resources beyond what falls directly upon it or under it.

3. WHY SHOULD LIBRARIES BE SUSTAINABLE BUILDINGS?

As Winston Churchill once said, "we shape our buildings and thereafter they shape us." Libraries serve as symbols of the attitudes and values of their creators and can serve to extend those attitudes and values to future generations of occupants and visitors. Communities with the opportunity to build a new library or update an existing library should prioritize sustainable design measures. Sustainably designed libraries would be built to last, to flexibly respond to changing functional demands, to provide an environment that is inspiring and safe, as well as to perform efficiently, providing great financial value to the community that supported its creation.

As we come to learn more about the psycho-physiological effects that buildings can have upon us, the importance of the health of libraries becomes ever clearer. Numerous studies have shown that strategies we use to reduce a building's environmental impact have ancillary benefits for improved occupant health and energy efficiency.

The architectural firm Heschong Mahone conducted a study of the effect of daylighting on student performance and found that students who took their lessons in classrooms with more natural light scored as much as 25 percent higher on standardized tests than other students in the same school district. In her research into the connection between green building strategies and occupant well-being, Judith Heerwagen, PhD has found that, "much of the green building literature focuses on air quality and physical health, thereby ignoring the other dimensions that are equally as important. Ironically, many of the prominent features of green buildings are likely to have their greatest impact on cognitive and psychosocial well-being. For instance, contact with nature and sunlight penetration has been found to enhance emotional functioning. Positive emotions, in turn, are associated with creativity and cognitive "flow," a state of high task engagement."

Given that there is evidence to demonstrate a connection between green building strategies and occupant cognitive performance, library designers should be conscious of the opportunities inherent in those strategies for creating a quality space for occupants at the same time as delivering a building optimized for resource and energy efficiency.

Whether an historic renovation, an adaptive reuse, or new construction, a library that is built with the intent to limit its impact upon the environment and community can serve to mark this time when our ways of thinking about resources are changing, much in the way libraries have always served as landmarks in their communities.

4. UNDERSTANDING SUSTAINABLE DESIGN IN THE LARGER CONTEXT

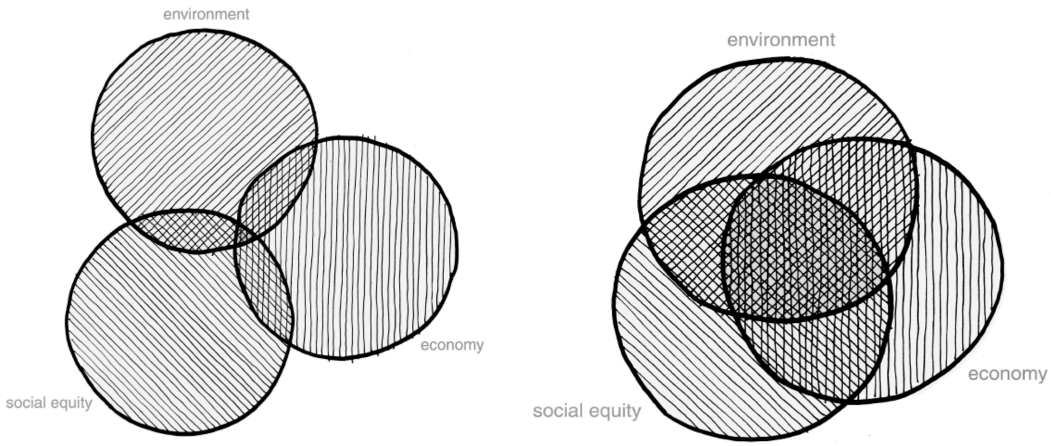
Historically, sustainability has referred to that which is economically sustainable. In the past several decades, further focus has been placed on environmental and social aspects of sustainability. Several theories have been developed to explain how caring for all three aspects will be essential for our survival.

4.1 The Triple Bottom Line

The triple bottom line encourages organizations to broaden the focus of their goal setting and self-evaluation to include not only economic value but also social and environmental value – and impact. The three parts represent society, the economy and the environment. *SustainAbility's* John Elkington writes that, "Society depends on the economy - and the economy depends on the global ecosystem, whose health represents the ultimate bottom line. The three lines are not stable; they are in constant flux, due to social, political, economic, and environmental pressures, cycles, and conflicts."

The idea of the three intersecting spheres of Economy, Environment and Social Equity is not unique to a single theorist. Many individuals have created variations on this same theme - perhaps a sign of its usefulness as a visual. By pursuing strategies that achieve positive results for all three of the spheres, an organization can optimize its overall benefit.

One organization that has used this model as part of their purchasing policy is College Housing Northwest. They call the three intersecting spheres the sustainability nexus, and prioritize purchasing products and services that provide for the greatest intersection of the three spheres of concern.



Figures 2 and 3: Overlapping spheres of economic, environmental and social sustainability. In the figure on the left, the action represented by the darkest area does not show significant consideration of all spheres. In the figure on the right, the action taken has met the needs of much of each sphere, representing a more sustainable choice. A completely sustainable action would appear as a single sphere, with all needs being met equally.

4.2 The Natural Step

The Natural Step began with a Swedish Oncologist, who had noticed rising cancer rates in children, who do not display lifestyle factors that typically cause cancer. He took this to mean that more than likely the causes of these cancers were not linked to lifestyle but rather to environmental factors that he discovered such as atmospheric and indoor environmental toxicity, and bioaccumulation of toxic materials such as DDT and PCB's in mother's milk.

He developed, along with about 50 other European scientists, the four system conditions, a set of conditions outside of which we will not be able to sustain ourselves as a species.

The four system conditions:

- Substances from the Earth's crust must not systematically increase in the biosphere.
- Substances produced by society must not systematically increase in nature.
- The physical basis for the productivity and diversity of nature must not be systematically deteriorated.
- There needs to be fair and efficient use of resources with respect to meeting human needs.

The Natural Step is a big picture theory of principle rather than detail. Rather than providing a prescriptive approach, it provides a compass for decision-making. To learn more about the Natural Step, visit the Natural Step US's website at www.tns.org.

4.3 McDonough Braungart Design Chemistry

The McDonough Braungart Design Chemistry, or MBDC, developed by Architect William McDonough and German Chemist, Michael Braungart, describes sustainability, similarly to the Triple Bottom line, as being made up of a balance of three considerations; ecology, equity, and economy. When too much attention is focused on one part of the triangle, the others become imbalanced. In an ideal situation, all three areas would be considered with equal weight.

McDonough and Braungart have spent much of their time trying to help the design industry transform its thinking to setting its sights on "eco-effectiveness" as opposed to efficiency. When we describe a system as efficient, we are focusing on avoided damage. Eco-effectiveness is not merely the avoidance of negative change, but creating positive change and effect through design. McDonough asks: "How's your relationship with your spouse? Sustainable? Oh, I'm sorry! I would hope the answer was at least sustaining, better yet would be restorative!"

The McDonough-Braungart Design Chemistry describes five steps to Eco-Effectiveness to help the market transition from its current unsustainable practices to ones that are sustainable and regenerative – taking into account that the change cannot happen overnight. In order to be economically viable, a significant change in design or practice must be understanding of the limitations imposed upon the organization seeking to make the change. If a group were to set out to design a completely sustainable building right away, it would be impossible, due to the rest of the supporting markets/industries not being prepared yet to offer products produced entirely sustainably. So much of the success of a building's effort to be sustainable is dependent upon the transformation of the marketplace to one where sustainable products are available. The MBDC is one of a number of initiatives seeking to close the gap between design and product sustainability – between the consumers and the producers of goods and services.

Economy, Community, Environment: without considering the success of all three, we will not succeed in sustaining ourselves. At a building level, what does this mean?

5. INTRODUCTION TO THE USGBC

The US Green Building Council is a national non-profit organization, founded in 1993, to promote "the design, construction, and operation of buildings that are environmentally responsible, profitable, and healthy places to live and work." The USGBC is concerned with educating the public about green building, and with creating a standard for measuring a building's greenness. Before the USGBC, and without a consistent means of measurement, the potential for *greenwashing* was great. [Green washing is the practice of covering up aspects of a product or service that is unsustainable, by distracting consumers with a claim that it has some attribute that is environmentally preferable.] Many could claim that they had a green building, and there was no system in place for one to measure that claim.

In 1995, the USGBC began to develop the LEED™ rating system as a response to the need for defining what a green building is, and as a means for design teams to determine sustainable design goals, determine strategies for meeting those goals, and to track progress and success against those goals. So it offers a definition of successful resource and energy efficient design, as well as pushing designers to raise the bar on their own work.

Prior to LEED™'s release, there were other systems in place for measuring a building's environmental performance, including BREEAM in the UK, and BEPAC in Canada; but none were based on building standards already in use in the United States. So, as the many creators of LEED™ began, they kept in mind the importance of creating a system that applies equally to all states, and using standards already in use by the construction industry, in order to reduce the burden of documentation.

LEED™ is currently in its second version, Version 1.0 being the Pilot version under which only 12 projects were certified. The pilot projects helped the program administrators identify the weaknesses of the system in order to make improvements for Version 2.0. LEED™ version 2.0 is intended for use by new commercial, institutional, or high-rise residential projects only. Future versions will have more broad applicability to Tenant Improvement and Existing Building projects, with Version 3.0 anticipated for release in 2005.

Site, Water, Energy, Materials, and Indoor Environmental Quality. These are the five impact categories the LEED™ credits are organized under. This is not to suggest that these areas are unrelated, or that some credits do not impact more than one category, but rather that they can be principally connected to one or another most simply, because of it's place in the design process, regulatory context, or the standards that are referenced to document the credit.

There are a total of 69 points available, 64 of which fall under the five impact areas. Four of the other five points are available to projects that can demonstrate that they have innovated outside the rating system's criteria. And the last point is available by having an individual on the design team who is certified to be a LEED™ accredited professional, having passed the exam proving proficiency with all aspects of applying the rating system.

Points	Section
14	Sustainable sites
5	Water efficiency
17	Energy and atmosphere
13	Materials and resources
15	Indoor environmental quality
64	**Total**
4	Design Process and Innovation
1	LEED Accredited Professional
69	**Total points available**

In addition to the 69 points, there are seven prerequisites without which a project cannot be certified. Measures were identified as prerequisites that were so fundamental to green building that the creators of LEED™ felt them to be inalienable qualities of a building designed to be energy and resource efficient.

The points that a project earns determine what level rating it receives. The four levels are certified, silver, gold and platinum. The lowest possible score that a project can receive and be certified is 26, which is less than half the total number of points available. The LEED™ Version 2.0 Rating System text is available for download from: www.leedbuilding.org[1]

LEED™ Certified	26 – 32 points
Silver Level	33 – 38 points
Gold Level	39 – 51 points
Platinum Level	52 + points

6. AREAS OF IMPACT

6.1 Sustainable Sites

In many cases, a site has already been selected for a building before the design team is assembled. The library staff may not have the input of architects in the selection process. In fact, in many cases, the library staff may have no input in the site selection process either. It is as essential to select an appropriate site for construction, as it is to treat that site with care once design and construction begin. LEED™ considers not only environmental, but community and economic concerns in crediting a building with a wisely selected site.

The USGBC has ascribed value to eliminating sites from consideration that are of environmental value greater than the building that would fill it. They have also prioritized the selection of sites which would encourage alternative transportation modes, or that would fill in unused urban space (taking pressure off of undeveloped land without existing infrastructure), or that would utilize and restore land that is labeled a brownfield for contamination.

For more detail on site selection, see “Site Selection for Libraries” on the Libris Design website at www.librisdesign.org.

LEED™ gives credit to projects that not only do not harm the land they rest on, but which actually make improvements to water, soil, and habitat. There are many simple things that you can do with your library design to improve its site. You will see that some of the strategies that arise are ones that are beneficial to other areas of impact (water, energy, materials, and indoor environmental quality)

[1] *LEED™ is a registered trademark of the USGBC

6.1.1 Strategies

Alternative transportation - A library can encourage the use of alternative transportation modes by providing facilities for bicyclists to store bicycles safely and to shower/change once they arrive to work. The facility can encourage the use of alternative fuel vehicles by providing electric car recharging stations. The City of Santa Monica, by providing free public access to recharging stations around the city, has created the opportunity for people to make that choice as a consumer. Libraries can also limit automobile use by reducing available parking, and providing preferred parking for carpools and vanpools.

Reducing direct site impact – Maximize open space on the site, restoring as much of that open space to native vegetation and potential habitat as possible. During construction, the contractors can limit their staging areas to areas close to the actual building footprint to limit compaction.

Microclimate – Limit libraries' impact on the microclimate by reducing the amount of heat-absorbing and radiating materials on the site and on the roof. Try to pave as little as possible, and to shade as much of the paved area as possible. Parking can be put underground or made a pervious surface that can absorb storm water and retain little heat. A strategy that can reduce roof temperatures and reduce the necessity of handling and treating storm water runoff is the use of a vegetated roof, or green roof. This type of roofing can also provide benefits to building users when it is treated as a public green space.

Storm water – When a building is placed on a site, more water runs off that area of land than would have previously. In a state where water is a precious resource, consider storing that water for use in landscaping, mechanical systems, or in the flushing of toilets, where potable water isn't required. This can reduce water consumption as well, relating to the following area of impact, water efficiency.

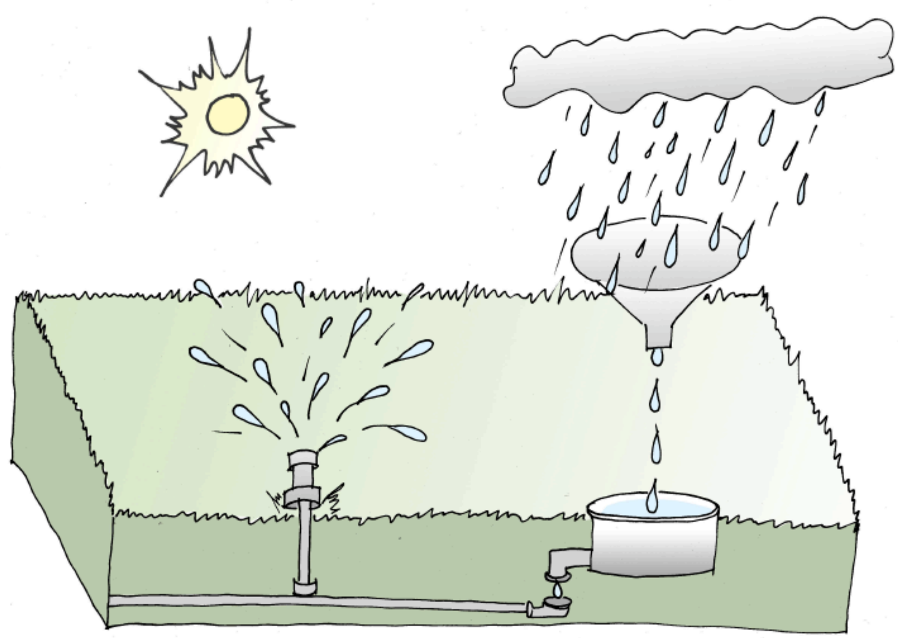


Figure 4: Collection, Storage, and Reuse of Storm water

Night sky – polluting the night sky with excessive exterior lighting and poor control over interior lights can result in the disturbance of nocturnal animal habitat surrounding the building, and can disturb neighbors, and can contribute to a larger area problem of a night sky that is orange instead of starry.

6.2 Water Efficiency

Californians are reminded regularly of the precious nature of water as a resource. Water has a more political history in California than in just about any other state. Cities such as Los Angeles and San Diego owe their existence to the political and business dealings of a few in the early days with a very specific agenda for development of cities and agriculture in this state, which could not sustain itself without the infrastructure set in motion nearly a century ago. The droughts that Californians economize through, remind us that infrastructure can only go so far to serve a growing population in a desert.

Like energy crises, water shortages also remind us of the importance of conservation and wise use. Strategies for reducing consumption of potable water are not unfamiliar to most Californians; but perhaps many do not realize, within the regulatory context of a drought, that conservation doesn't necessarily require sacrifice of quality of life.

6.2.1 Strategies

Landscape - One of the facets of a building that can consume enormous quantities of water is the landscape. Many public entities are set on having the conventional institutional appearance of a lawn with non-native shrubs. The benefits of using drought-tolerant native species have begun to reveal themselves through the popularity of xeriscaping – landscaping with plants that are adapted to their environment without the need of much irrigation, pest control, or maintenance. By selecting drought-tolerant plants, a designer opens up the possibility of using recaptured site water for irrigation, even in an arid climate with little annual rainfall. By recapturing site water with an efficient irrigation system; the use of potable water can be entirely eliminated for landscape purposes.

Efficient fixtures – While not acceptable in some cities, alternative plumbing fixtures like waterless urinals can dramatically reduce consumption rates for public buildings. Waterless urinals also require less plumbing, and less maintenance, which can reduce first cost and life cycle cost for owners. Sensor faucets and gray water plumbing systems can reduce consumption as well.

Alternative wastewater treatment – Look into living machine technology as well as constructed wetlands, for treating the building's wastewater on site. Municipalities can consider treating the facility's gray water through reuse at one level, or have a demonstration system for sewage waste like the city of Arcata, CA.

All of these strategies can be utilized while not requiring building users to alter their behavior. In some cases, as with the native landscape, the strategies can serve to educate the community and connect the occupants with their immediate bioregion.

6.3 Energy and Atmosphere

Energy efficiency is often placed as the top priority for those considering greening their building or product, because of the broad range of impacts that energy production has on the environment, economy and global social equity. Because of the Carbon Dioxide (CO2) produced in the production of energy in coal power plants, and the toxic waste generated by nuclear power, power production is named as one of the greatest polluters of our atmosphere and biosphere, contributing greatly to global warming, water pollution, and human toxicity. This is incredibly important once you realize that this is an impact that goes far beyond the user and could have implications for cultures completely unassociated with its cause.

In addition to CO^2 emissions, there are the issues of diminishing fossil fuel resources, and the impacts associated with the extraction, delivery, and processing of those resources. The USGBC promotes not only reducing a building's dependence upon energy, but in improving the sources of what energy it does consume. LEED™ promotes the use of onsite alternative energy sources as well as the brokering for green power to use for the building – options available to a deregulated market such as California's.

In addition to energy use, this section of LEED™ is concerned with reducing the use of Ozone Depleting Materials in the HVAC&R systems of buildings, and with setting in place a commissioning plan to ensure that the building and its systems function as intended in design. For more about commissioning, see the Bonneville Power Administration's Building Commissioning Guidelines at www.bpa.gov.

Title 24 - Because LEED™ measures energy performance using the Energy Cost Budget method and ASHRAE/IESNA Standard 90.1-1999, which compares a design case against a base case, many Californians were complaining that they were at a point disadvantage. The state's Title 24 – 2001, which creates a particularly high base case, could make it more challenging to achieve the energy savings than could be achieved in other areas of the country. There has been an amendment made to LEED™ Version 2.0 that helps to interpolate Title 24 results with those of ASHRAE.

6.3.1 Strategies

There is an important relationship between the strategies that are effective in reducing the energy consumption of a building and ones that will be effective in improving the Indoor Environmental Quality. It will be important to not compromise daylight and views for lessened solar gain. In many cases there are strategies that can optimize both energy and environment.

Envelope Design – Rather than seeking to simply reduce glazing area, think about designing your glass to make maximum use of the type of light and solar gain you want to benefit from and eliminate that which you do not want. In the case of the Phoenix Central Library, this consisted of having glazing only on the North and South sides of the building, eliminating the deleterious effects of the extremely powerful rays of low sun at sunrise and sunset. There are exterior shading devices to ward off direct rays, to diffuse daylight, to bring light further into the interior, while maintaining any thermal gain from the mass of the shading devices on the exterior of the building, effectively keeping the re-radiation of that heat away from the interior.

Heating, Ventilation, and Air Conditioning – Strategies that reduce energy use of mechanical systems can be passive – using effective envelope design natural ventilation strategies in the design of spaces – as well as active – relying on developing technologies such as underfloor air or displacement ventilation. Due to the specific environmental parameters that a library environment must maintain in order to sustain the physical condition of the books, relying entirely on natural ventilation strategies might be viable in only a few select environments with steady temperatures that wouldn't threaten the library's treasures. If natural ventilation is ruled out, consider the feasibility of using the physics of the stack effect (where hot air rises, pulling cool air upward) in favor of drawing cool air through the space more easily. This strategy would be most viable in concert with a displacement ventilation system that relies on creating layers of temperature in a space with very low velocities of air being pushed by the mechanical system. This type of ventilation also generates very little stirring of particulate matter, lowering the amount of airborne dust. This strategy would be very much in line with a thermally comfortable environment as well as an effectively ventilated space, two concerns for Indoor Air Quality.

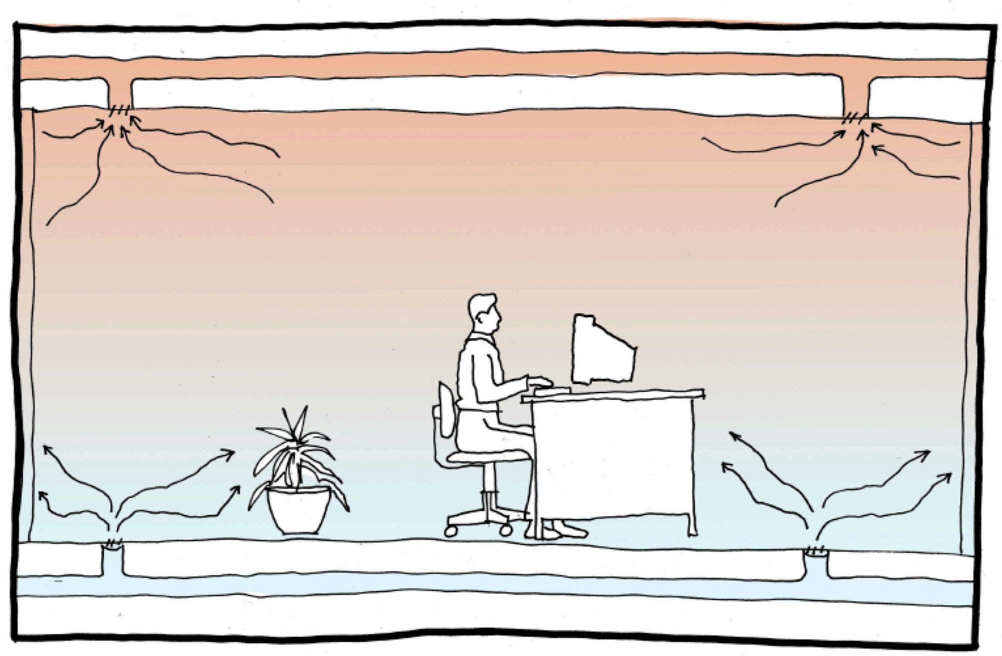


Figure 5: Displacement Ventilation makes best use of zones of use in a space, placing the fresh air where it is needed, near the occupants – using the natural stratification of air temperatures to its advantage.

Water Heating – For a building type such as a library with relatively low demand for hot water, the use of solar water heaters could be of tremendous life cycle cost benefit. If the facility is to be constructed in an area with a reasonable amount of sunshine, this strategy should be studied for feasibility. Also consider the life cycle cost feasibility of an on-demand water heating system which doesn't require any energy use during times when hot water is not being used. A regular tank heater costs more to operate since you are maintaining the temperature of an entire tank of water, whether or not there is demand for it. Heated water can also be considered for an HVAC strategy of using radiant heating through plumbed slab floors.

Lighting – Daylighting is a passive strategy which can improve the indoor environmental quality of a library – but it is a measure which will not reap energy savings unless there is a daylight sensor to control the lights in day lit spaces. Using photosensors in day lit spaces to control dimmable ballasts will allow a system to work without being actively operated by occupants. The importance of dimmable ballasts is in the way that the system operates on a cloudy day. Without dimming, lights might go off and then on and then off and on again in response to changes in light level. With dimming lights, the change would still be in response to ambient light levels, but it would be subtle and not distracting to occupants, as well as consuming less energy in the turning off and on.

6.4 Materials

Did you know that for every 10 lb. laptop made, the amount of waste created in its construction totals 40,000 lbs. (20 tons)? The materials we buy can be much more than they seem.

Every material that is used in the construction of a building has a history. Armed with some knowledge about what materials are the most consumptive over their life cycles, consumers can make wise choices that can influence the markets to change to suit their preferences.

6.4.1 What makes a building material Green?

There are a number of different lists of criteria to define whether a building material is preferable environmentally. Ultimately, after consulting these lists to see what sorts of considerations need to be taken into account, it is up to the consumer to define what their values tell them is most important. Water efficiency is likely to be far more important to someone living in the desert than to someone living in a water rich environment. It will be important too for you to hear why different groups place priority on different criteria before you choose what is the most significant for you.

Some of the most common aspects of a product's environmental performance that are considered by consumers include:

- Energy efficient and with low embodied energy
- Made of renewable materials
- Made of post-consumer recycled materials
- Made of post-industrial recycled materials
- Made of certified wood
- Healthy for indoor air – low voc
- Healthy for the atmosphere – no CFCs or HCFCs used in manufacturing
- Non-toxic in use, production, or at end of useful life
- Made of salvaged materials
- Recyclable at end of useful life

- Simple to install without dangerous adhesives, etc.
- Made near to the building site – low transportation impacts
- Efficient/resourceful/reusable packaging

One of the most significant barriers to successfully building green is to not have access to accurate environmental product data. It is a dangerous problem for consumers and specifiers. The consumer has to be incredibly savvy to differentiate a legitimately healthy product from that which is merely *greenwashed*. Many "green" products hang their hat on single attribute environmental claims, like, "contains 10% recycled material," or "made with wood from sustainably managed forests." A word to the wise: If a product 'contains' 10% recycled material, that means that one of the materials that make up the product could be 10% recycled, and there could be as little as less than 1% recycled content in the total product. Be aware that many manufacturers will attempt to skew the perceptions of consumers as long as there aren't simpler ways to identify the environmental impact of a product.

There are a few laws to protect consumers. The Federal Trade Commission has ruled that manufacturers can make only one environmental product claim. If they make more than one claim, they have to be able to back that up with third-party verified evidence that their claim is legitimate. You can read more about these protections at www.sustainableproducts.com.

There are a number of groups that are trying to promote the use of Life Cycle Assessment (LCA) to evaluate the environmental impact of products. LCA looks at the impact of a product through its entire life cycle, from cradle to grave, and generates a score (for lack of a better word) to show that product's performance against a series of criteria like ozone depletion or toxicity. The US government has invested a considerable amount of funding in the development of an LCA tool, called BEES, designed specifically for the US building materials market. To learn more about LCA, visit www.sppcoalition.org, or www.lcacenter.org

6.4.2 Simplification of systems and Reduction of Use

What is the most sustainable material? Perhaps it is the material that is never used.

When considering whether a building should be of new construction or a renovation project, keep in mind that for every material that can be simply reused, the impacts associated with its extraction, manufacture, delivery, installation, and eventual disposal are eliminated. In addition, simplifying systems that are either unnecessary or redundant can both lower first cost and environmental impact. For example, if a concrete slab floor is already being poured – consider the possibility of a stained and sealed concrete floor being an acceptable finish, rather than adding all of the various materials associated with a carpet or tile system.

6.4.3 LEED™ Materials Credits

LEED™ gives credit to projects that show that they have reduced the resource consumption of the building by specifying products that are renewable, recycled, salvaged, certified wood, or that are low-emitting materials. This impact category of LEED™ also is concerned with appropriate waste management during construction of the building and during operation of the building. By putting an advanced plan into place for the effective recycling and salvage of building materials during construction, projects can reduce significantly the burden placed on landfills, as well as reducing the demand for raw materials for use in new materials.

Check the "Further Information" page for links to additional sources of information about green building materials.

6.5 Indoor Environmental Quality

This aspect of green building is one that is influenced not only by the science of physiological response to environmental factors, but also our psychological response – recognizing the link between the physical and emotional. Studies have shown that people's psycho-physiological response to a natural environment is conducive to improved ability to focus, to be productive, to maintain health and to heal.

> "We need to create environments that sustain all life – including humans and their seemingly unique aesthetic, physiological, psychological, and spiritual needs. Aesthetics, beauty, health, well-being, and quality of life are as important to sustainable design as are reducing waste, energy consumption, and environmental impacts."
>
> Mary Guzowski, from Daylighting for Sustainable Design

An indoor environment that is not only safe, but healthy and inspiring for occupants will take several environmental factors into consideration: fresh air, light, views or connection to the outdoors, thermal comfort, and the ability of the occupant to control their environment. As a building type, libraries have no intrinsic limitation to achieving any of the above goals. Not only that, but libraries are an apt opportunity for providing a rich indoor environment that is inviting, safe, and conducive to concentration.

Several cases have shown that by providing occupants of a building with a healthy indoor environment, building owners can actually reduce their risk of liability, reduce absenteeism and improve worker productivity. Sick Building Syndrome, multiple chemical sensitivity, and legionnaire's disease have been brought to public attention in the past several years. In some cases, individuals have had to abandon homes where mold spores in the building materials were threatening their health. The US Environmental Protection Agency lost a $1 million lawsuit over employees with sick building syndrome and multiple chemical sensitivity caused by the work environment in their new offices in Washington DC. These cases, and the studies by Judith Heerwagen, mentioned earlier, are causing people to take notice of the importance of indoor air quality.

So what are some steps that can be taken to improve the indoor air quality of a library?

Make sure that the effective delivery of fresh air is a priority to the design team. This is essential, but will not in and of itself create a healthy environment. If materials have been selected for the interiors that offgas dangerous chemicals, then the movement of air may not be enough.

You must also be sure to isolate any sources of chemicals that could be hazardous to occupants. This includes separating copiers into spaces that can be properly ventilated so that the ozone from the copiers does not affect the entire library. This will also include keeping the pollutants from the streets, sidewalks, and parking lots out of the library by having effective walk-off mats at all main entryways.

In any public space, the mechanical system cannot respond to increasing occupancy rates without having some means for feedback. By providing CO^2 sensors in all occupied spaces, the mechanical system can "know" when there are more people needing more fresh air in a space and respond by increasing the rate of outside air into the ventilation.

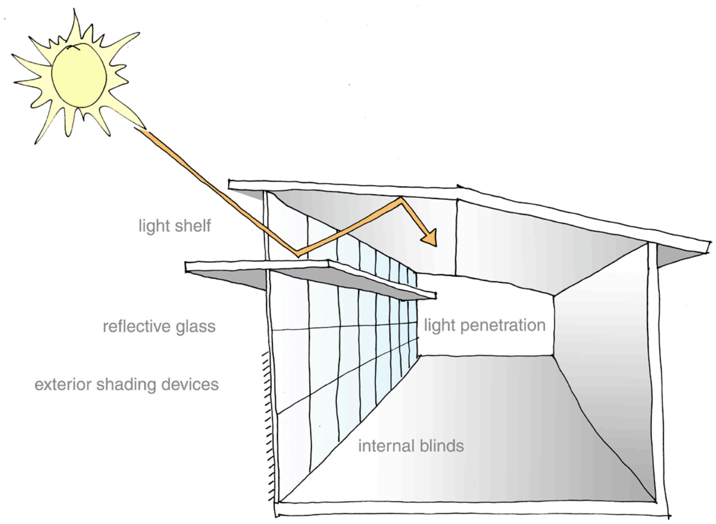


Figure 6: Exterior and Interior shading devices to optimize daylighting

In addition to these health and safety concerns, there are psycho-physiological needs for daylight and views as a means for connecting to the outdoors and our internal clock that relies on cues from the environment. These are needs that hadn't been taken seriously until the research of Roger Ulrich and others has shown their importance to our health and productivity. This is research that is still being deepened and authenticated, and is considered by some skeptics to be soft science. Whether validated by hard science or not, we all have an intuitive sense for the difference between a space that heals and inspires us and a space that distracts us or makes us feel uncomfortable. The qualities of those spaces that work for us will continue to reveal themselves as we investigate the spaces we live and work in.

7. INTEGRATED DESIGN TEAM APPROACH

Albert Einstein once said that one couldn't create a solution with the same thinking that created the problem. You have to imagine a new process, a new approach – only then can innovation find its voice. In the world of the design and construction of buildings, there is certainly a "way" of doing things that has stayed too long as a guest. At this gathering of professionals that is a design team, each person is a wallflower, standing at the edge of the room, doing their own thing. When members of a team aren't communicating, there is no room for helping one another think through a concept, there is little of the free exchange of ideas that constitutes creativity.

Many in the design profession attempting to change their practices to be more sustainable are looking to deepen the partnerships of design team members, opening up the channels of communication early on, ensuring that all stakeholders in the end product have the opportunity to influence the project. There are a number of practices that help teams achieve this. One of the most effective means is the EcoCharrette. The AIA has written a definitive guide to the EcoCharrette, but it may end up being an expression of the design team, the end user, the client, or even the community. The Charrette has a long history in architecture – an energetic exchange of design ideas/solutions, consisting of drawings, discussions, brainstorms, and setting of goals. The EcoCharrette takes that concept and puts it to work as a means for setting a precedent for a project – so that all stakeholders are using the same compass to guide their work, and so that goals are set and clearly stated. EcoCharrettes are an opportunity to educate, to inspire, and to innovate solutions.

You can contact your local office of the American Institute of Architects to get a copy of the AIA guidelines for planning and running an EcoCharrette: Environmental Design Charrette Workbook, AIA Press, 1996.

The reason for emphasizing the EcoCharrette here is to advocate their use, certainly, but also as a metaphor for the integrated design team in which all team members are partnering together in the solution. Whether or not your project chooses to use the EcoCharrette as a tool, there can be a partnering of individual groups with an open collaborative approach. The sorts of people that should be involved in this process include: the owner, the occupant, the architect, the engineers, the landscape architect, the contractor, city or county representatives, and even groups like public utilities who often have incentives for green building strategies.

8. CASE STUDIES

8.1 Phoenix Central Library; Phoenix, Arizona

Architect: Will Bruder, DWL Architecture

Completed: 1995

The Phoenix Central Library is located in downtown Phoenix, and is constructed of tilt-up concrete walls to the East and West and Glass curtain walls to the North and South. The East and West walls are clad with copper mesh, which provides shade to the thermal mass of concrete. The North and South walls each have exterior shading device systems designed to respond to the challenges of those orientations. The ground floor of the library has a shallow pool of water over which air is drawn to assist the cooling of the interior. The interior is effectively daylit, with skylights designed to deflect any direct sunlight penetration that might harm the books.

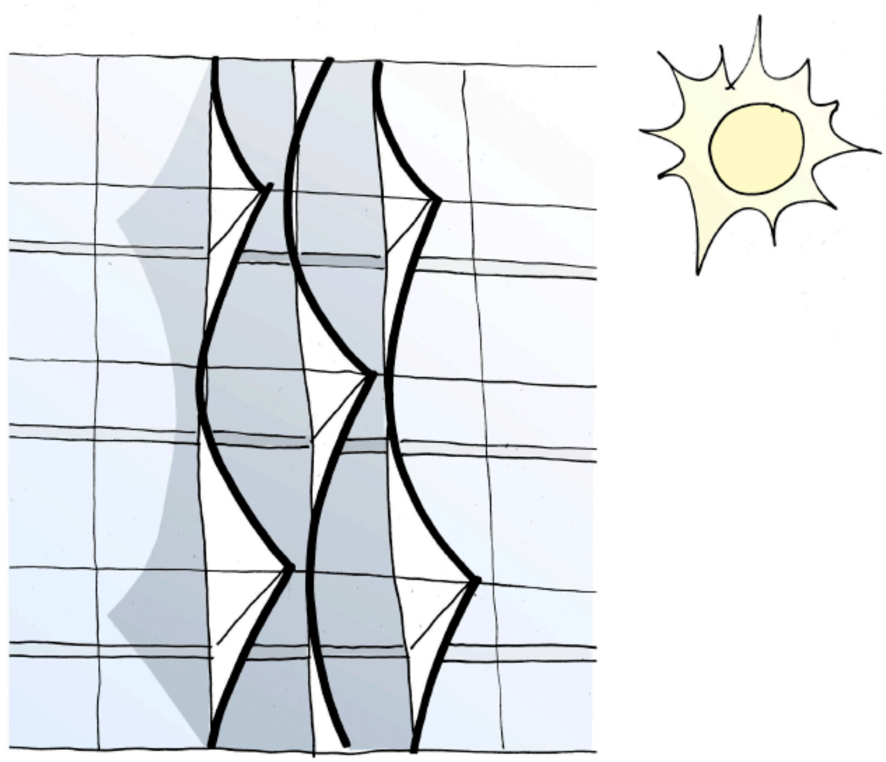


Figure 7: The sun at sunrise and sunset during summer in Phoenix is just north of true east and true west. These sunshades on the North face of the Phoenix library protect the books against direct sunlight and the interior from solar heat gain.

A Case Study of the building performed by students at Arizona State University:

http://www.caed.asu.edu/vitalsigns/c-index.html

8.2 Library at Mt. Angel Abbey; Mt. Angel, Oregon

Architect: Alvar Aalto

Completed: 1970

The feature for which this library is most known is its daylighting. Aalto made best use of the available light to this northern site – utilizing the north light to its full advantage. The curves of the monitors in the ceiling assist in the reduction of glare from the light and broadcast the light throughout the interior space.

The Abbey's official library website:

http://www.mtangel.edu/library/main/main.html

An independent review with numerous photos:

http://www.greatbuildings.com/buildings/Mount_Angel_Library.html

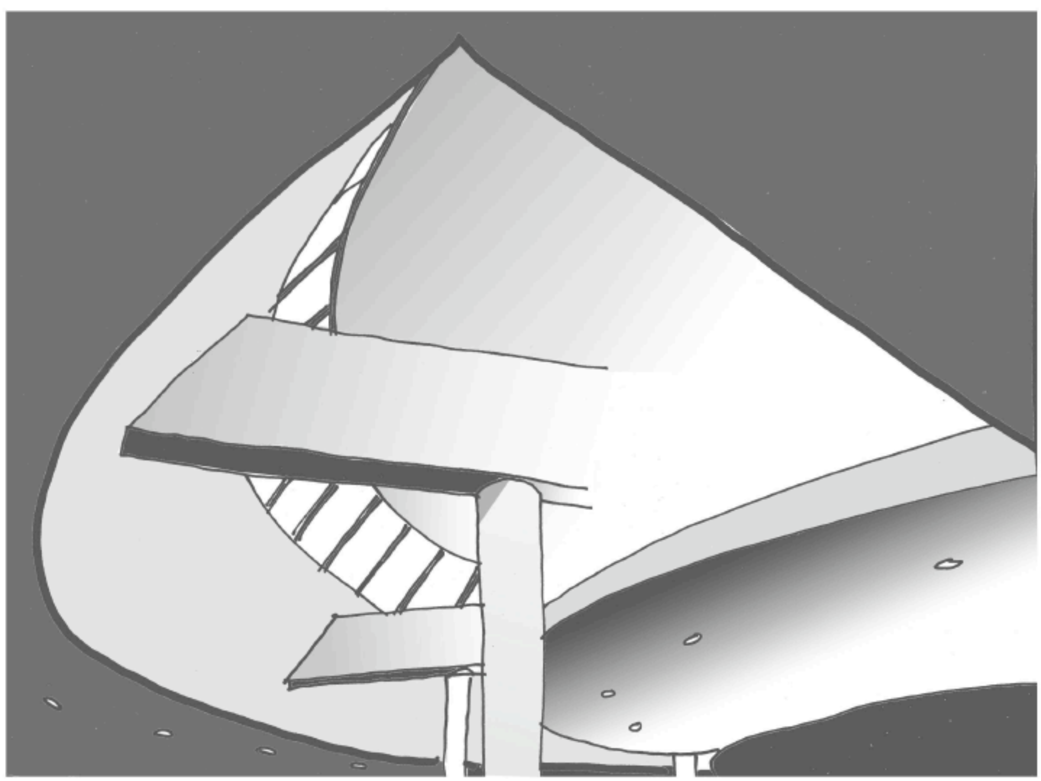


Figure 8: The skylights at the Mt. Angel Abbey Library make maximum use of already diffuse northern light by using a curved reflective surface to reduce glare even further. Natural light is also provided to the stacks away from the atrium with solar tubes.

8.3 Delft University of Technology Library; Delft, Netherlands

Architect: Mecanoo Architects

Completed: 1997

This enormous technical library houses approximately one million texts, under a tilted vegetated (green) roof. The daylighting is provided using enormous double-glazed curtain walls. Rising up through the massive library is a cone structure, which houses a number of study rooms. The cooling is provided using cold storage, a technique where cold is stored in a water table far below, and is then tapped for cold air in the summer.

Sources:

Ed Melet. Sustainable Architecture: Towards a Diverse Built Environment. Rotterdam: NAI Publishers, 1999.

Smart Architecture. http://www.smartarch.nl/smartgrid/items/014_library.html

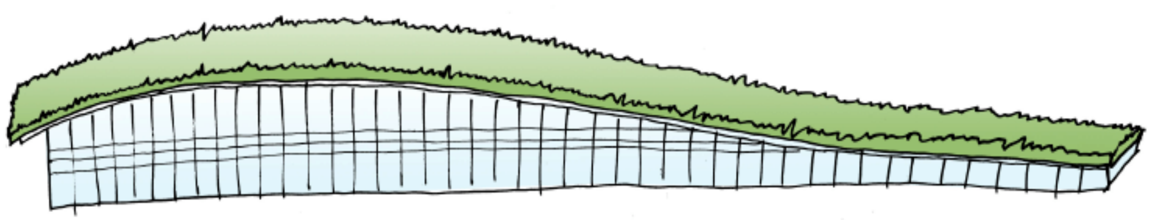


Figure 9: The slanted vegetated roof at the Delft University of Technology Library

8.4 Library and Cultural Center; Herten, Germany

Architect: Log I.D.

Completed: 1994

This building is topped by a solar collector, which consists of a glazed roof that is raised above the building. Warm air is collected in this space, and in the winter when the warm air is needed for heating, it is pumped through a glazed rotunda in the interior, which is filled with plants. The oxygen generated by the plants in the rotunda enriches the air before it is passed through the rest of the interior. The glazed solar collector also contains solar water heaters between the glazing and the roof to provide hot water to the library.

Sources:

Ed Melet. Sustainable Architecture: Towards a Diverse Built Environment. Rotterdam: NAI Publishers, 1999.

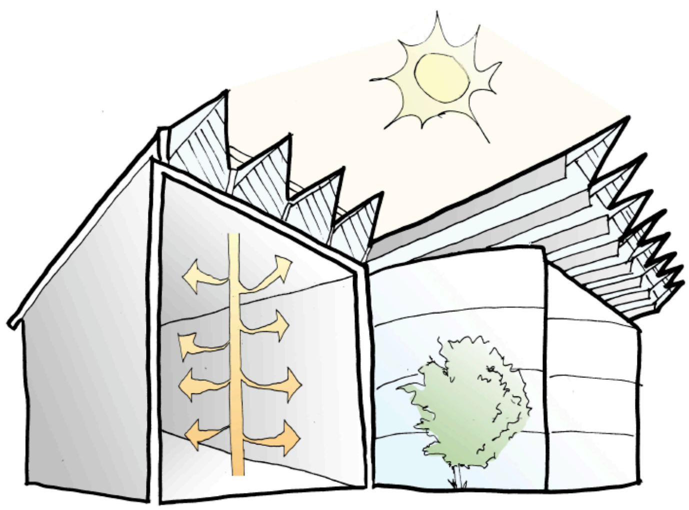


Figure 10: The solar collectors atop the Herten Library and Cultural Center provide warm air in the winter, stack effect to draw out warm air in the summer, and a location for the building's solar water heaters.

9. GLOSSARY OF SUSTAINABILITY TERMINOLOGY

HCFCs and CFCs	Hydro chlorofluorocarbons (HCFCs) and Chlorofluorocarbons (CFCs) are ozone-depleting substances that have historically been used as refrigerants and as blowing agents in the making of foam products. Some styrofoams have phased out the use of CFCs and HCFCs in response to the Montreal Protocol calling for immediate cessation of the production of CFCs and the eventual cessation of HCFCs (which, though harmful, are far less damaging than CFCs).
Low voc	A material that is low-voc emits low volumes of Volatile Organic Compounds, which are harmful to human health. VOCs are common in paints, primers, sealants, glues, and many other products containing chemicals.
Post-consumer recycled materials	Post-consumer recycled content is the percentage of waste material by weight available from consumer use incorporated into a building material.
Post-industrial recycled materials	Post-industrial recycled content is the percentage of waste material by weight available from industrial use incorporated into a building material. Post-industrial recycled materials are different from industrial scrap, a by-product of industrial processes that can be easily reused as a feedstock.
Renewable materials	Products that are made of raw materials that replenish themselves within a ten-year cycle. An example would be bamboo, which replenishes within one growing season, and can be used to make an alternative to wood flooring or paneling.

10. FURTHER SOURCES OF INFORMATION

General Green Building Information

US Green Building Council
1015 18th Street NW, Suite 805
Washington, DC 20036
(202) 828-7422
(202) 828-5110
www.usgbc.org

LEED™™
www.leedbuilding.org
On the LEED™ website, you can find links to all of the standards that are referenced in the LEED™ rating system.

General Publications

LEED™ Reference Guide, Version 2.0. US Green Building Council, June 2001.

Environmental Design and Construction: The Magazine for Successful Building – Economically and Environmentally. Troy, MI: Business New Publishing Company.

G.Z. Brown and Mark DeKay. Sun, Wind & Light: Architectural Design Strategies. New York: John Wiley & Sons, Inc, 2001.

Sandra F. Mendler and William Odell. The HOK Guidebook to Sustainable Design. New York: John Wiley & Sons, Inc, 2000.

Ed Melet. Sustainable Architecture: Towards a Diverse Built Environment. Rotterdam: NAI Publishers, 1999.

Process

EcoCharrette: Environmental Design Charrette Workbook, AIA Press, 1996.

Materials

Environmental Building News –periodical publication

Ross Spiegel and Dru Meadows. Green Building Materials: A Guide to Product Selection and Specification. New York: John Wiley & Sons, Inc, 1999.

Philosophy

Paul Hawken, Amory Lovins, L.Hunter Lovins. Natural Capitalism – Creating the Next Industrial Revolution. New York: Little, Brown and Company, 1999.

Janine Benyus. Biomimicry. New York: William Morrow and Co, Inc, 1998.

Societies, Organizations, Web Sites and Agencies

USGBC	US Green Building Council	*www.usgbc.org*
LEED	Leadership in Energy and Environmental Design	*www.leedbuilding.org*
CDI Harvard MIT	Online Resource for Innovation in Building Envelopes and Environmental Systems Harvard University's Center for Design Informatics	*www.buildingenvelopes.org*
CREST	Center for Renewable Energy and Sustainable Technology	*http://solstice.crest.org/index.html*

EREN	Department of Energy, Energy Efficiency and Renewable Energy Network	*www.eren.doe.gov*
	Natural Step US	*www.tns.org* *www.thenaturalstep.org*
	Triple Bottom Line	*http://www.sustainability.com/philosophy/triple-bottom/tbl-intro.asp*
	McDonough Braungart Design Chemistry	*www.mbdc.com*
	Sustainable Products Corporation	*www.sustainableproducts.com.*
CFPC	Certified Forest Products Council	*www.certifiedwood.org*
	Bonneville Power Administration's Building Commissioning Guidelines	*www.bpa.gov.*
BG	Building Green Publishers	*www.buildinggreen.com*
	Smart Architecture	*http://www.smartarch.nl*
Oikos	Oikos	*www.oikos.com*
SPPC	Sustainable Products Purchasers Coalition	*www.sppcoalition.org*
ASO	ASO College of Architecture and Environmental Design	*www.caed.asu.edu/*
		www.cacenter.org
		www.greatbuildings.com/buildings/

11. CONTRIBUTORS

The Author

Johanna Sands is an Associate with Zimmer Gunsul Frasca Partnership (ZGF), a national design firm specializing in architecture, interiors, and urban design. Johanna is responsible for coordinating the firm's Sustainable Design program, offering research and educational resources to all four offices as well as serving as an advisor to numerous architectural projects working to optimize environmental performance. She served as a member of the Building Materials Advisory Group to Oregon Governor Kitzhaber's Sustainable Suppliers Council. She contributes to the US Green Building Council's Educational Committee as well as to the LEED Materials and Resources Technical Advisory Group, and co-founded a national non-profit organization, the Sustainable Products Purchasers Coalition.

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