Making Your Hotel Green

The global hospitality industry is in a unique environmental position. Tourism operators often rely extensively on locating near unique environments to attract tourists and generate income. Unfortunately, hotel developments that accommodate these tourists have become the nodes for environmental degradation due to inefficient building design and wasteful operating practices. Thus, hotel operators find themselves in the role of damaging the resource that sustains their business.

What is a Green Building?
CITY OF SAN JOSE

A "green" building can be defined as any building that is sited, designed, constructed, operated, and maintained for the health and well-being of the occupants, while minimizing impact on the environment.

"Green building" refers to those practices that promote occupant health and comfort while minimizing negative impacts on the environment. There are different degrees of "greenness." Often, it is necessary to strike a balance between many different, sometimes conflicting, green options based on the particular conditions of a given project. For example, proper strategy for a sustainable retrofit project may differ from that of new construction design.

Green building practices offer an opportunity to create environmentally sound and resource-efficient buildings by using an integrated approach to design. Green buildings promote resource conservation by including design features which encourage energy efficiency, use of renewable energy, and encourage water conservation. By promoting resource conservation, green building design creates healthy and comfortable environments, reduces operation and maintenance costs, considers environmental impacts of building construction and retrofit, and concentrates on waste minimization. In the interim, green building design addresses such issues as historical preservation and access to public transportation and other community infrastructure systems. The entire life cycle of the building and its components is considered, as well as the building's economic and environmental impact and performance.

UNIVERSITY OF BERKELEY, CALIFORNIA

A Berkeley “green” building can be defined as a building that is sited, designed, constructed, and operated to maximize present and future beneficial impacts on the environment.

ENERGYBUILDER.COM

Green Buildings are really resource efficient buildings and are very energy efficient, utilize construction materials wisely -- including recycled, renewable, and reused resources to the maximum extent practical -- are designed, constructed and commissioned to ensure they are healthy for their occupants, are typically more comfortable and easier to live with due to lower operating and owning costs, and are good for the planet. The overall environmental impact of new building and community development and the choices made when we either reuse or demolish existing structures is very important.

ENVIRONMENTAL BUILDING NEWS

Buildings have a tremendous impact on the environment--both during construction and through their operation. 'Green building' is a loosely defined collection of land-use, building design, and construction strategies that reduces these environmental impacts. Benefits of building green include:

- reduced energy consumption,
- protection of ecosystems, and

- occupant health.

CHECKLIST

*Utilize the information on this web site to convert your hotel operation from a waste producer into an efficient environmental conserver.

*Comment, contribute, critique, and interact with the information and users on this web site.

REFERENCES

Joseph, Alexander T.
YourHomePlanet.com, Calgary, Canada 2002

Roodman, David M. and Nicholas Lenssen
World Watch Paper #124 - "A Building Revolution: How Ecology and Health Concerns Are Transforming Construction" 1995

WEB RESOURCES

EcoLodgical Design Tool for the Hospitality Industry
http://ecolodgical.yourhomeplanet.com

What is a Green Building?
http://www.buildinggreen.com/about/whatsgb.html

ENVIRONMENTAL DESIGN ELEMENT

The Key Problems

World population is increasing while per capita consumption (and the corresponding waste) is increasing. The current economical model is not sustainable and certainly is not sustainable with another 3 billion people and global per capita consumption equal to current western standards.

As a global community, we face a number of challenges

1. Population Growth

Based on data from the United Nations, global population is estimated to reach 9.4 billion by 2050. The problem is that if

FIGURE 1: World population growth projections.

Source: United Nations (U.N.) Population Division, World Population Prospects 1950-2050 (The 1996 Revision), on diskette (U.N., New York, 1996).

2. Resouce Consumption

Based on the global ecological footprint calculations, the average global citizen requires 2.1 hectares of the planet to provide for the resources consumed. Unfortunately, this means we are already consuming at a rate that is unsustainable. If we factor in the population growth and a provision to allow everyone to consume at a rate equal to the current global average, then it will be impossible to sustain the global population and our society as it is currently organized.

FIGURE 2: Ecological footprints of various nations.

Source:

3. Waste Production

At present our global system is built on the premise of cradle-to-grave resource consumption. Thus the raw resources used to produce the ‘consumable’ products that surround us are used only once and then deposited in our environment. To return society to a …

FIGURE 3: Waste per capita of various nations.

Source:

CHECKLIST

*Understand the two main environmental issues that can be applied to every situation to achieve economic and environmental benefits. Resource Consumption and Waste Elimination.

WEB RESOURCES
Population Connection
http://www.zpg.org

United Nations Population Information Network
http://www.un.org/popin

ENVIRONMENTAL DESIGN ELEMENT

Population Growth

World population growth is projected to reach 9 billion or a 50% increase in the coming 50 years. The question is, “If the planet’s ecosystem is already stressed, than what will an extra 3 billion human beings mean for the biosphere?”

Although little can be done in hotel design and operation to influence world population growth, instead developers, operators, and designers can focus on the two main environmental impacts that result from human population growth - resource consumption and the resulting waste.

CHECKLIST

*Plan and set environmental targets with population growth in mind. Forecast resource consumption over the life-cycle of the building.

ENVIRONMENTAL DESIGN ELEMENT

Resource Consumption

World resource consumption is already above sustainable rates. Currently, we are consuming resources as if we had access to more than one planet. Although a reduction is already necessary, many project that we will require a Factor 10 reduction (90%) in resource consumption by 2050 in order to allow for an extra 3 billion people and to allow for developing populations to achieve the western nations standard of living.

Nearly every activity consumes resources and thus opportunities to conserve abound.

Energy is the most common form of resource conservation. Energy conserving practices are well documented, can be employed quickly, and are easily quantified as to the benefits and payback periods.

Other forms of resource conservation that are not as common include water conservation, and reducing material consumption in the design and operation of the hotel. Indirect forms of resource conservation include converting fleet vehicles to alternative fuel sources, recycling, and providing education opportunities to clients, contractors, and guests.

Resource conserving strategies and practices ultimately conserve our environment and often produce economic benefits as well.

CHECKLIST

*Attempt to reduce all resouce consumption by at least a Factor of Four (75% reduction).

ENVIRONMENTAL DESIGN ELEMENT

The Concept of Waste

Waste by definition equates to an inefficient use or resources.

If we are to restore balance to our world, the concept of waste must be eliminated. What is considered to be “waste” in one system must be considered as “food” in another. And, in the process, the concept of “scarcity” must be converted to “abundance.” Natural, healthy systems have no problem creating food from waste. Our bodies do it all the time. Organisms stay healthy by consuming only what they need to maintain balance and by casting out only what is needed for nourishment by other systems.

CHECKLIST

*Reduce and ultimately eliminate waste in the hotel design and operation.

REFERENCES

Alexander, Christopher et. al.
A Pattern Language</u>, Oxford University Press 1977

ENVIRONMENTAL DESIGN ELEMENT

Biomimicry

Conventional industrial practices are based on 250 years of technological innovation that is based upon a heat-beat-treat philosophy. As well, many synthetic materials are developed in laboratories in complete ignorance to the plethora of natural technology and materials that have evolved over 4.5 billion years in nature.

Nature as Model - Biomimicry is a new science that studies nature's models and then imitates or takes inspiration from these designs and processes to solve human problems, e.g., a solar cell inspired by a leaf.

Nature as Mentor - Biomimicry uses an ecological standard to judge the "rightness" of our innovations. After 3.8 billion years of evolution, nature has learned: What works. What is appropriate. What lasts.

Nature as Measure - Biomimicry is a new way of viewing and valuing nature. It introduces an era based not on what we can extract from the natural world, but on what we can learn from it.

Excerpt from http://www.biomimicry.org

Two examples in nature that can directly applied to environmental design:

Every organic being that is eventually recycled into the web of life

Cradle-to-cradle green design-products that will be designed up front to be used, reused, and then fully recycled. Centerpiece of a no-waste economy.

Marshes

Constructed wetlands-sewage treatment facilities that clean a community's water while doubling as a wildlife refuge.

CHECKLIST

*Look to the natural world for the best answers to common design and operation problems.

WEB RESOURCES

International Initiative for Sustainable Built Environment
http://greenbuilding.ca/iisbe/start/iisbe.htm

SUSTAINABILITY - Ideas towards the goal
http://student.ocad.on.ca/student/1998_1999/sam_fleming

Alberta Sustainable Home/Office - Sustainable Water Systems
http://www.ecobuildings.net/resources/ash_sustainable_watersystems.pdf

ECO Audio/Video
http://www.ecomall.com/biz/real.htm

ECOTECT: The complete environmental design tool.
http://www.ecotect.com

Environmental Building News
http://www.BuildingGreen.com

Google: Alternative Architecture Group
http://groups.google.com/groups?hl=en&group=alt.architecture.alternative

Great Buildings Online
http://www.greatbuildings.com

Green Building Conferences
http://www.greenbuilder.com/conference

Green Building Statistics
http://www.sustainable.doe.gov/buildings/gbintro.shtml

MILLENNIUM DEBATE – Family uses Body Heat as Insulation Against Fuel Bills.
http://www.millennium-debate.org/tel3jan.htm

NAHB Research Center - Guide to Developing Green Building Programs http://www.nahbrc.org/tertiaryR.asp?TrackID=&CategoryID=1802&DocumentID=2598

Sustainable Sources
http://www.greenbuilder.com

Thailand Environmental Institute
http://www.tei.or.th

The Natural Step
http://www.naturalstep.org

The State of Green Building -- 2001
http://www.housingzone.com/green

U.S. Census Bureau: Current Construction Reports
http://www.census.gov/prod/www/abs/c20.html

WBDG - Whole Building Design Guide
http://www.wbdg.org

World Resources Institute - Green Office
http://www.wri.org/office

WorldWatch Institute
http://www.worldwatch.org

YourHomePlanet = Environmental Building Design & Green Construction Portal
http://www.yourhomeplanet.com

ENVIRONMENTAL DESIGN ELEMENT

Design

Most building operators are limited in their ability improve environmental performance of their buildings due to poor building design. It is critical to understand that choices made at the design stage impact the economic and environmental costs of construction, operation, and the efficiency of the occupants to carry out their jobs.

CHECKLIST

WEB RESOURCES

Green Building Information Council
http://www.greenbuilding.ca

ENVIRONMENTAL DESIGN ELEMENT

Retrofit/Renovation

Every building can be improved through retrofits of equipment and renovations in design. Retrofits offer a means to improve efficiency at a reasonable cost and payback period. Unfortunately, renovations to building components and structure is often economically unfeasible due to the poor choices made at the design stage.

The majority of hotel owners are in a situation where a new building is not a possibility

CHECKLIST

WEB RESOURCES

Arches Hotel, Bristol, UK
http://www.arches-hotel.co.uk

Ayo Udayana Eco-Hotel / Lodge
http://www.bali-hotels.co.uk/eco-lodge.html

Bosque del Cabo Wilderness Camp
http://www.hvsecoservices.com/bosque.htm

Bucuti Beach Resort
http://www.bucuti.com

Confifi Group Hotels
http://www.confifigrouphotels.com

Habitat Suites
http://www.habitatsuites.com

Hilton Tokyo
http://www.hilton.com/hotels/TYOHITW/index.html

Kandalama Hotel - Awards
http://xasia.lk/kandalama/Kandalama_Hotel/Awards/body_awards.html

La Milpa Field Station
http://www.hvsecoservices.com/milpa.htm

Lapa Rios Rainforest Ecolodge on Osa Peninsula
http://www.laparios.com

Scandic Hotels
http://www.scandic-hotels.com/br/30/30index.html

Scandic Hotels analysis by Natstep.org
http://www.naturalstep.org/publications/cases/case_scandic.pdf

Sheraton Rittenhouse Square Hotel
http://www.sheratonrittenhouse.com

The Benjamin
http://www.thebenjamin.com

The Colony Hotel
http://www.colonyhotel.com

The Deer Park
http://www.lanka.net/deerpark

The Fairmont Jasper Park Lodge
http://www.fairmont.com/FA/en/CDA/Home/Hotels/AboutHotel/CDHotelHomePage/0,2993,property%25255Fseq%253D100104,00.html

The Lodge at Chaa Creek, Adventure Center, Rainforest Reserve and Spa
http://www.chaacreek.com/home.html

ENVIRONMENTAL DESIGN ELEMENT

Operation

Ideally a building would be designed for maximum environmental efficiency from the onset, however the majority of building owners and operators are faced with the task of optimizing a poorly designed inefficient building.

CHECKLIST

WEB RESOURCES

Ayo Udayana eco-Hotel / Lodge
http://www.travelideas.net/bali.hotels/eco-lodge.html

Banff Park Lodge Resort Hotel and Conference Centre in Banff National Park, Canada
http://www.banffparklodge.com

Berkshire Inns - The Yankee and Chambery Inns
http://www.berkshireinns.com

Environmental Good Practice
http://www.emcentre.com/unepweb/tec_case/hotel_55/material/m2.htm

ENVIRONMENTAL DESIGN ELEMENT

Setting Goals

Environmental building design and operation is a complex topic with numerous interrelated issues. A well-defined process and approach to the issues is extremely useful to all involved.

Develop a Vision Statement that includes the environmental principles of the project and the integrated design approach.
Establish environmental design goals that the vision statement requires.
Determine environmental criteria that will assist the design to meet the environmental goals.

CHECKLIST

*Set environmental goals for any project.

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ENVIRONMENTAL DESIGN ELEMENT

2 or More Sites to Choose From

Conventional building developers often consider the site as irrelevant to the building. All that is required is enough flat space to place the building. However, the characteristics of the site should influence the design and ultimately the operating efficiency of the building.

Ideally, two or more sites should be examined for all criteria including environmental such that the specific project occupies an optimum space.

CHECKLIST

*When building new, always consider more than one site.

ENVIRONMENTAL DESIGN ELEMENT

Minimizing Ecological Footprint

At current global consumption levels, the human population requires the resources of 4 planets to sustain our standard of living. And this unsustainable lifestyle is largely the result of a minority few in the western world.

Minimize the overall ecological footprint of the project. An ecological footprint is the combined environmental impacts of the project including the construction, operation, and decommissioning.

CHECKLIST

*Continually seek to minimize the ecological footprint of any design or hotel operation.

WEB RESOURCES

Calculate your Ecological Footprint
http://www.earthday.net/footprint/index.asp

Ecological Footprints
http://www.ire.ubc.ca/ecoresearch/ecoftpr.html

Ecological Footprints of Nations
http://www.ecouncil.ac.cr/rio/focus/report/english/footprint

ENVIRONMENTAL DESIGN ELEMENT

Forming a Design Team

Many building design teams consist only of the architect, the owner, and an engineer. This narrow perspective seriously limits the ability for any environmental design initiative from being implemented.

Assemble an interdisciplinary design team before the site selection process. That includes client, users if possible, engineers, landscapers, maintenance staff, etc.

CHECKLIST

*Prior to the design phase of any project, form a team that includes all aspects of the project.

WEB RESOURCES
Pre Design Process
http://www.sustainabledesignguide.umn.edu/MSDG/predesign.html

ENVIRONMENTAL DESIGN ELEMENT

Collecting Data

A site is more than space to place a building. Numerous qualities and quantities of a site can be measured in order to determine the adequacy of a site and to compare with other potential sites.

The purpose of collecting data is to identify the assets and liabilities of each site. Each of the potential sites should be assessed in a similar manner.

Analyze all the proposed sites to determine site characteristics that will influence building design. Study how the solar altitude, microclimate, and the topography will affect design (i.e. solar orientation, wind loading, floor elevations, potential for passive solar/daylighting)

Consider the climatic zone of the site. Each climatic zone (cold, temperate, hot-dry, hot-humid) have design strategies to maximize the overall design (i.e. passive solar vs. shading, deciduous vs. coniferous vegetation).

Perform soil and groundwater testing. Avoid building on soils that are contaminated with agricultural or industrial chemical residues. Establishing a clean source of groundwater is important if the building is to be self-sufficient. contaminated groundwater is a likely indication of nearby pollution that may impact the building operation environmentally and economically.

Test soil suitability for bearing strength, additional slope structures, and infiltration. Test the native soil for bearing, compaction, and infiltration capacity. Assess the added cost of importing fill to the site to make the soil suitable for development.

Evaluate ecosystems for existence of wetlands and endangered species. Assess and identify any areas that may not suit building development or require special preservation or restoration.

Examine existing vegetation to inventory significant plant populations. Denote vegetation that may require special protection during construction. Identify species and populations such that the landscape designers can later mitigate any damaged areas with original elements.

Avoid stream channels, flood plains, wetlands, steep erodible slopes, and mature vegetation. Evaluate whether the interstitial spaces (i.e. between channels, plains, etc.) are enough for the proposed building footprint.

Map all natural hazard potentials. Disclude the site if there is evidence of significant past disturbances (i.e. 100-year flood level, slopes prone to slides, wind-damage, avalanche potential). Consider discluding a site if it is within the 100-year flood level (many jurisdictions provide or require the purchase of flood insurance for development within the 500-year flood level).

Diagram existing pedestrian and vehicular movement and parking to identify patterns. Determine whether existing patterns fit the proposed design plan. Take advantage of existing patterns to reduce environmental impacts and infrastructure costs, or consider a different site.

Review the potential of utilizing existing local transportation resources. Attempt to share existing infrastructure (i.e. parking facilities, shuttle buses) with neighbouring developments to reduce overall costs and increase site efficiency.

Analyse site for existing utility and transportation infrastructure and capacity. Identify any need for increased capacity or upgrades and denote costs (the need for additional infrastructure may discount the site). Examine potential of integration with building design.

Identify any construction restraints and requirements that the site necessitates.

Observe the architectural style of the area. Attempt to incorporate some elements of the community's architectural fabric in the design of the building and landscape (i.e. materials, colours). Utilize historically compatible building types where appropriate.

Review site's cultural resources for possible restoration. Discuss the potential of including existing resources within the building plan and design.

Analyze the site's existing air quality. Determine the existing outdoor air quality and analyze how the proposed building will affect air quality. Observe diurnal wind patterns and investigate potential ventilation intake/outtake orientations and locations.

CHECKLIST

*Visit each site and collect as much data from as many perspectives as possible to allow for a good assessment by the entire design team.

WEB RESOURCES

Environmental Impact of Siting
http://www.sustainable.doe.gov/buildings/envirimp.shtml

ENVIRONMENTAL DESIGN ELEMENT

Assessing Data

Accurate and effective data assessment of sites provides the basis for efficient design choices.

For each potential site, analyze impacts of proposed design. Identify alternative designs for each site that mitigate site-specific impacts. Utilize the entire design team to compare the assets and liabilities of each site. Evaluate and decide based on all criteria, environmental, social, and economic.

Identify topographic and hydrological impacts of proposed design. Note potential mitigation measures required or alter design.

Develop general area takeoff and overall building footprint compatibility with site. Design the building for the site not vice versa.

Identify alternative site design concepts to minimise resource costs and disruption. Remain flexible to take advantage of all site assets in the design.

Review financial implications of site development, building, and projected maintenance costs. Accounting for all life-cycle costs leads to an optimum choice.

Develop matrix of use and site compatibility index. Use the matrix to easily identify key assets and liabilities of each site.

Evaluate project site selection, based on all criteria.

CHECKLIST

*The entire design team should assess the site(s) data to determine the optimal site to choose and to identify all the assets and liabilities of each site.

ENVIRONMENTAL DESIGN ELEMENT

Avoidance of Virgin or Signifcant Land

Virgin land in its natural state is a non-renewable resource. Top soil in the Great Plains can require a thousand years to develop. Unfortunately, virgin land is still being consumed by urban sprawl and development while empty previously developed land remains vacant within the existing urban environment.

It is important to avoid choosing and developing virgin landscapes.

CHECKLIST

*Avoid using or damaging virgin land whenever possible.

ENVIRONMENTAL DESIGN ELEMENT

Brownfield/Urban Redevelopment

Numerous opportunities exist to redevelop land and/or buildings within the existing urban landscape.

Whether to increase density or to avoid further damaging suburban land, it is a prudent choice to select land that has already had some form of human development upon it before tearing up new land on the city's boundaries.

During the selection process, give preference to urban redevelopment sites and sites that have previously been damaged environmentally.

Select urban sites that can be redeveloped. Avoid developing virgin land whenever possible to minimize habitat destruction.

Select brownfield or previously damaged sites when mitigation strategies can be implemented. Investigate potential economic incentives and land improvement funding available. Avoid sites that have unrepairable damage.

Encourage in-fill and mixed-use development. Development that mixes residential and commercial space decreases the need for automobiles.

CHECKLIST

*Consider utilizing brownfield land or redeveloping an urban lot to avoid damaging virgin ecosystems.

ENVIRONMENTAL DESIGN ELEMENT

Access to Sunlight

Sunlight is the most important free energy source (heat, electricity, light) available to a building. Unfortunately, the majority of buildings do not even consider its potential benefits.

Locate your building on a site where ample sunlight is available. Know where the sun rises and sets in order to capitalize on natural lighting.

CHECKLIST

*Access to sunlight is the most critical siting issue for mid to high latitude locations.

ENVIRONMENTAL DESIGN ELEMENT

Access to Alternative/Public Transportation

A significant consumer of resources and producer of air pollutants and greenhouse gases are automobiles. These impacts can be mitigated by providing occupants with less polluting alternatives such as bicycles, buses, and alternative-fuel vehicles.

Site the building to take into account available public transportation for employees and guests. Provide preferred parking stalls for car pool vehicles and easy security for bicycles with change and shower facilities in house. By locating nearby public transportation corridors, the designer may be able to decrease the size of parking lot, and provide a better working environment for the staff. Proximity to recreational corridors or pathways is also an asset for guest recreation.

Support reduction of vehicle miles travelled. Support and design for ease of use of mass-transit. Reduce parking capacity and encourage car-pooling. Consider facilities (i.e. showers, locks) for cyclists.

Identify and use existing vehicular transportation networks to minimize the need for new infrastructure. Reduces construction, operating, and maintenance costs. Reduces non-permeable surfaces.

Consider increased use of telecommuting strategies. Evaluate the cost benefits including deferred building components, operations, and maintenance.

Consolidate service, pedestrian, and automobile paths. Thereby reducing paving area, centralizing runoff, and increasing efficiency of paths.

CHECKLIST

*Consider the proximity to the urban infrastructure (public transportation, utilities, etc.) when selecting the best site for the building.

WEB RESOURCES

Carpooling
http://www.carpooling.ca

ENVIRONMENTAL DESIGN ELEMENT

Sediment and Erosion Control

Unless a building is suspended on stilts, a building ultimately rests on a landscape. The building alters water cycles by concentrating precipitation runoff which can cause erosion of the surface soils.

Controlling erosion and excess sediment produced during the construction phase is paramount to avoiding environmental impacts on water and air quality especially in areas where heavy precipitation is common.

Develop a plan for both the construction phase and the operation phase. Utilise silt fencing and sediment traps, phase construction accordingly, stabilise steep slopes, and maintain vegetated ground cover.

CHECKLIST

*Minimize the site erosion potential by retaining surface soils and vegetation as much as possible. Put in place measures to control any sediment or erosion expected from the building.

ENVIRONMENTAL DESIGN ELEMENT

Stormwater Management

It has been a common practice to employ engineer stormwater solutions in any building design.

It is important to limit the disruption of natural water flows through the site. This can be achieved by minimizing storm water runoff, increasing infiltration, and reducing the amount of contaminants available to pollute the water.

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WEB RESOURCES
The Stormwater Manager's Resource Center
http://www.stormwatercenter.net

ENVIRONMENTAL DESIGN ELEMENT

Soil and Soil Ammendments

Soil is more than dirt, it is a complex ecosystem that includes organisms that decompose organic and inorganic materials, stores and filters water runoff, and provides habitat for numerous species.

Although not readily apparent, the soil plays an integral role in mitigating surface impacts of storm water runoff and the success of vegetation growth and overall landscaping of the site. Protecting the soil is of most concern during the design and construction phase.

Involve a qualified site-design professional on the design team early in the project.

Obtain and evaluate the chemical and physical characteristics of the site soils.

Amend the soil in planting areas according to professional advice.

Protect the soil during construction. Design for minimal grading. Stockpile and replace existing topsoil when grading is necessary. Avoid the movement of heavy equipment over site. Remediate compacted soil after construction with tillage, etc.

Carefully design for grading and excavation. Design building with site in mind. Utilize sites strengths (i.e. existing topography, drainage patterns) and direct storm water to planted areas to minimize irrigation requirements.

Follow all applicable erosion-control regulations. Avoid exposed soil and mitigate potential erosion where necessary and/or required by regulations.

Stabilize soil during and after construction. Utilize natural means where possible (i.e. straw bail dams, jute netting, hydroseeding).

Use bioengineering. Interwoven woody cuttings reduce the potential for full-scale washouts more common to rigid constructions.

Instruct operators to schedule soil-maintenance tasks. To be done in conjunction with other planting and site vegetation maintenance activities.

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ENVIRONMENTAL DESIGN ELEMENT

Vegetation and Grounds Management

Vegetation is the natural extension of the soil ecosystem on a site. It can provide summer shade, wind protection, and a low-maintenance landscape that is adapted to the local environment. Unfortunately, the common practice is to remove the existing landscape cover and replace with a generic, water and maintenance-intensive lawn.

The existing vegetation should be viewed as an asset to enhance design (i.e. natural shading, reduced landscape construction and maintenance) and reduce impacts of the development (i.e. reduced storm water runoff, increased infiltration).

Include an ecologically knowledgeable landscape architect as an integral member of the design team.

Preserve existing vegetation, especially native plants. Avoid fencing off property where possible to make landscape available to community increasing project integration. Decrease paving and monoculture lawns. Avoid replacing mature trees with young seedlings.

Protect existing plants during construction. Delineate the “drip line” around trees and demark or fence off areas to avoid damage. Contain heavy equipment and stockpiling areas to predefined areas.

Design new plantings as diverse communities of species well adapted to the site. Plant native or drought resistant species (less maintenance and water) of varying ages. Select vegetation that attracts wildlife. Avoid invasive species and monocultures (same species, same age).

Follow XeriscapeTM (water-efficient) principles.

Use vegetation to mitigate climate and existing site conditions. Deciduous trees provide shade during summer and allow solar gains in winter. Coniferous trees provide year round shade and wind protection (wind protection = a distance 3 times tree height). Noise mitigation requires at least a 75-metre band of vegetation.

Hire a reputable nursery or contractor to supply and install plants. This avoids contractors that pilfer plants and plant out of season.

Employ integrated pest management (IPM) against insects and weeds. Avoid synthetic chemical pest management (pesticides, herbicides, insecticides, biocides, etc.) in preference for natural, organic products.

Use mulching, alternative mowing, and composting to maintain vegetation health. Avoid synthetic fertilizers. Recommend manual-push mowers rather than powered types. Design for and utilize on site composting for landscape nutrient supplementation.

Compile and follow a seasonal maintenance task list. Regular maintenance is key to maintaining a healthy landscape.

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WEB RESOURCES

04-11-99 Improve Your Lawn, Environment and Conserve Water
http://gardening.wsu.edu/column/04-11-99.htm

Care for the Environment While Caring for Your Lawn
http://www.magicouncil.org/carefor.htm

Clean Air Gardening, push reel mowers, composters, garden tools
http://www.cleanairgardening.com

Google: Permaculture Group
http://groups.google.com/groups?hl=en&group=own.eco.permaculture

Healthy Lawn Healthy Environment
http://www.epa.gov/oppfead1/Publications/lawncare.pdf

ENVIRONMENTAL DESIGN ELEMENT

Landscape Design to Reduce Heat Islands

Common building design removes existing mature vegetation (shade) and replaces it with juvenile plants and groundcover. Common building materials typically have significant thermal mass. The combination provides an excellent location for passive solar absorption which can be a significant problem in the urban environment that can increase air conditioning costs.

A heat island is the result of a surface that has absorbed solar radiation during daylight hours which then gives off heat to the adjacent air. Since dense materials like concrete and asphalt have greater thermal capacities than adjacent (natural vegetation cover) surfaces, they can store more energy from the sun and thus become hotter surfaces. This heat is distributed to the air whenever the surface slab is hotter than the air. This occurs after mid-morning until potentially late into the evening.

Conventional buildings typically have dark coloured roofs and are surrounded by asphalt or roadways. The black (low albedo or good heat absorption capabilities) thermal mass coupled with the clearing of trees on a site (reducing shade) increases ambient temperatures. This can be beneficial for cold-climate buildings (passive solar gains) but costly in temperate to hot climates (increased cooling loads).

Harness solar energy, airflow patterns, natural water sources, and the insulating quality of landforms for building temperature control. Waterbodies are effective heat sinks (in cold-climates as winter heat sources, in hot-climates as air-cooling). Landforms can also play an important role consider colour and orientation.

Use existing vegetation to moderate weather conditions and provide protection for native wildlife. Green space not only forms necessary connections between parcels of habitat, but also provides shade and the cooling aspects of transpiration.

Design access roads, landscaping, and ancillary structures to channel wind toward main buildings for cooling, or away from them to reduce heat loss.

CHECKLIST

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WEB RESOURCES

Heat Island Group: Projects of the Heat Island Group
http://eetd.lbl.gov/HeatIsland/PROJECTS

ENVIRONMENTAL DESIGN ELEMENT

Pervious and Impervious Surfaces

A natural landscape absorbs precipitation and filters rainwater. Whereas impervious surfaces such as asphalt parking lots and cement walkways limit absorption, concentrate runoff, and produce pollution.

Anytime impervious surfaces are applied to a site, impacts occur due to reduced vegetation, increased runoff, and increased solar heating. Careful attention must be paid to the alteration of the site water cycle that impervious paving may cause.

Limit paving areas to the strict minimum for their intended purpose. Specify smaller parking stalls (i.e. 2.8m by 5.6m rather than 3m by 6m).

Carefully distinguish between light-vehicular, heavy-vehicular, and pedestrian paving. Avoid using vehicular paving when not needed. Specify alternative materials (permeable interlocking block, gravel: See Water-permeable or Porous Paving below) rather than non-renewable, energy intensive pavement.

Use water-permeable or “porous” paving. By removing the fine elements of concrete and asphalt, water is allowed to percolate into the soil. Select porous paving or alternatives (i.e. block-lattices, masonry pavers on sand).

Design paving to serve dual purposes. For example, placing a parking lot over top of a gravel reservoir designed to handle stormwater volumes.

Design to minimize runoff. Curbs focus runoff, increasing water volume and erosion capability. Designing for infiltration of runoff as close to source (subterranean gutters, curbless roadways) is most cost effective.

For light-duty roads and paths, stabilize without pavement. Crushed stone or brick (potentially reclaimed from old building) can be an effective porous road surface.

Locate pavement where solar heat gain is desirable. Be aware that dark coloured pavement absorbs and slowly releases large amounts of solar heat (beneficial in cold climates) and light coloured pavement can introduce severe glare on sunny days (but minimizes solar heating).

CHECKLIST

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WEB RESOURCES

Cellular Concrete
http://www.cellular-concrete.com

Environmental Building News - Paving without Asphalt or Concrete
http://www.buildinggreen.com/products/road_oyl.html

PolyPavement: Natural Soil Pavement - Liquid Soil Solidifier
http://www.polypavement.com

ENVIRONMENTAL DESIGN ELEMENT

Outdoor Public Amenities

The modern western lifestyle isolates humans from the environment from which they evolved. Increased interaction with the natural environment provided by the surrounding building site encourages an awareness of the wonderfully complex but fragile world in which we live.

Allowing occupants to utilize the outdoor space surrounding the building enhances the connection between architecture and nature.

A well-designed building takes advantage of the site to provide shaded areas for eating and relaxation, connecting corridors between buildings, and easy, safe access routes to adjacent buildings on neighbouring properties. All executed in a manner as to retain the original vegetation communities intact.

Modify microclimates to maximize human comfort in the use of outdoor public amenities such as plazas, sitting areas, and rest areas. Regulate sun and wind and be conscious of seasonal variation in weather.

Consider sustainable site materials for public amenities. Specify recycled or reclaimed materials with low life cycle costs. Consider surface albedo to avoid severe glare.

Specify sustainable site construction methods. Avoid unnecessary site disruption.

Develop sequential staging to minimize site disruption.

CHECKLIST

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ENVIRONMENTAL DESIGN ELEMENT

Pre Design/Life Cycle Analysis

Due to the current market framework, it is often the case that the client that is commissioning a building is often a different client than the one who will operate the building and pay the lifetime of maintenance and operating costs. This dichotomy tends to prevent the designer from specifying increased environmental capital costs in the construction phase because builders often don't take into account the long-term costs of operating the building.

Green building techniques will lower energy costs, lower water costs, lower site-clearing costs, lower landfill dumping fees, lower overall material costs, and create fewer employee health problems resulting from poor indoor air quality (Sustainable Building Technical Manual 1996). Environmental design features incorporated early during the design stage will easily pay for themselves in years of operational savings and increased return on investment. It is critical that the entire design team be involved and co-ordinate a holistic, whole building design approach that not only takes full advantage of environmental strategies and technologies, but maximizes the synergies between them as well.

CHECKLIST

*Create a design and construction team that utilises the whole-building integrated design approach. Select team members from all aspects of the project (site planning, operations) who believe in the environmental goals of the building and who are committed to contributing beyond the bounds of their disciplines.

*Select a team leader and encourage communication and integration among team members. Their role is to integrate the design process and facilitate communication between all involved.

*Establish a vision statement that embraces sustainable principles and an integrated design approach. Involve the entire design team and client such that all agree and believe in the statement of goals.

*Establish the project's green building goals, developed from the vision statement. These should emanate from the client or owner. The goals can be broad ideas (i.e. energy efficiency, waste minimization).

*Establish green design criteria. Develop specific criteria from goals set above.

*Set priorities for the project design criteria. Prioritizing will allow for decisions to be made when compromises are required.

*Develop a building program detailing the project's green building requirements. The program defines how the client and the designers expect the building to perform.

*Review any laws or standards that apply to the building project. Pay particular attention to environmental regulations.

*Research green projects that are complete or are about to be completed. Focus on projects that are similar is scale and geographic locale.

*Develop partnering strategies. Identify programs, neighbours, businesses, and/or community organizations where synergistic benefits may be available.

WEB RESOURCES

Advanced Building Technologies
http://www.advancedbuildings.org/

ENVIRONMENTAL DESIGN ELEMENT

The Design Method

Implementing environmental elements during the design stage reduces inefficient operating costs, and future renovation costs. Their successful integration is necessary to achieve optimum building performance. One method of handling the diversity of environmental design considerations during the building design phase is suggested below.
Utilize the following method for each design step as a guide:
Confirm environmental design criteria
Develop environmental solutions
Evaluate environmental solutions
Check cost
Integrate systems
Refine environmental solutions
Check cost
Document environmental materials and systems
Verify material test data (i.e. MSDS)

CHECKLIST

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*Check cost

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*Refine environmental solutions

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*Verify material test data (i.e. MSDS)

WEB RESOURCES

21Design Energy Efficiency Building Design Tools

http://www.21design.com/index.html

ENVIRONMENTAL DESIGN ELEMENT

Optimizing Each Element

design element content

CHECKLIST

*Optimize the energy, material, and operational efficiency of each building element.

ENVIRONMENTAL DESIGN ELEMENT

Optimizing All Elements

design element content

CHECKLIST

*Once each building element has been optimized in design and operation. Consider optimizing the efficiency of entire systems and the building as a whole.

ENVIRONMENTAL DESIGN ELEMENT

Climatic Considerations

The design team must consider the regional and microclimate of the site. Data collected during the site-planning phase can enhance the overall building design and optimize energy performance.

Assess the local climate (using typical meteorological-year data) to determine appropriate envelope materials and building designs. In hot-dry climates utilize materials with high thermal mass. In hot-humid climates utilize materials with low thermal mass. In cold climates utilize air tight, well-insulated walls.

Assess the site’s solar geometry. Identify benefits and/or costs of solar gains via roofs, walls, and windows depending on climate.

CHECKLIST

*Make adapting the building to the local climatic conditions the priority.

ENVIRONMENTAL DESIGN ELEMENT

Building Grounds

The building must be integrated with, rather than stand apart from the surrounding site. It is the design team's task to integrate the existing landscape and any exterior design elements with the building's architecture.
Co-ordinate building strategy with landscaping decisions. Involve the landscaping designers and maintenance staff to develop strategies for year round design optimization.
Reduce paved areas to lessen heat buildup around the building that will add to the load on the building envelope. Except in cases of cold climates where exterior heat islands may be useful; decrease paved area and avoid selecting dark colours. Be aware of glare potential on light coloured surfaces.

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ENVIRONMENTAL DESIGN ELEMENT

Human Scale Neighborhoods

Minimize automobile dependence.

CHECKLIST

*Minimize automobile dependence.

ENVIRONMENTAL DESIGN ELEMENT

Infrastructure

Consideration of existing infrastructure is important to minimize the costs of a poorly sited building. The design team can take advantage of existing infrastructure to minimize new development and additional equipment capacity.
Design the site plan to minimize road length, building footprint, and the actual ground area required for intended improvements. This will reduce length of utility connections.
Use gravity sewer systems wherever possible. Avoid the continuous power consumption that sewer pumps require.
Reuse chemical waste tanks and lines. Inspect existing infrastructure and avoid disposing of adequate tanks and lines.
Aggregate utility corridors when feasible. Utilize existing roads, trenches, and clearings before new land is cleared for trenching.

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ENVIRONMENTAL DESIGN ELEMENT

Building Form and Orientation

Since a typical building requires significant resources to maintain a comfortable interior environment, it only makes sense to take advantage of free light, energy and in many cases heat from the sun.

A building's form must be determined by its relationship to the sun and local climate, as much as aesthetics. Building's can take many forms from a hemisphere (igloo) to forms that maximize surface area like the Habitat building in Montreal, Canada built for the World Expo 1967. Each form has advantages and disadvantages.

Building Form

The igloo is a 'natural' example of the optimum building form. And it is no surprise that the elevated sleeping pad is located directly in the middle of the igloo either. Body heat from the occupants radiates outward and is reflected back toward the centre of the igloo and its occupants due to the hemispherical shape. This maximizes the radiant heat retention for the occupants.

As well, the shape of the igloo minimizes exterior surface area and thus minimizes heat loss from the shell of the igloo. As it turns out the igloo is the perfect design choice by the Inuit of the Arctic. This is also an example of biomimicry, or ethnomimicry.

Figure: Heating energy is dependent upon building form (surface area).

Source: http://www.oikos.com/esb/36/ bldgform.html

The most efficient building form with respect to minimizing heat loss is a hemisphere. The surface area of the sphere is equal to 2 X pi X radius squared. The surface area of the floor is pi X radius squared. This equates to a ratio of 2 (surface area to floor area).

A perfect square's ratio is 4 which means that an igloo has half the surface area of a square (where diameter equals wall length). This relationship continues as the shape becomes more complicated with an ever increasing amount of surface area. Note however, that in a temperate climate where heat loss is not an issue, surface area is not as significant with the exception of the added costs and resources that may be required to construct a building with a complicated form and surface area.

Building Orientation

It is always important to orient a building to optimize the effects of solar radiation. In equatorial and temperate locales, the designer must consider the impacts that direct sun may have on occupants and temperatures in the indoor environment. Large openings that allow for sunrise and sunset light to penetrate the building should be avoided (western and eastern facades) or sun control measures should be considered.

CHECKLIST

*Site and orient the building to take advantage of solar energy for passive and active solar systems. Maximize solar gains in winter (in cold climates) and minimize solar gains during summer. When photovoltaic panels are being used, maximize solar exposure.

*Site and orient the building so as to minimize the effects of winter wind turbulence upon the envelope. Consider all opportunities for infiltration of the building envelope.

*Plan site clearing and planting to take advantage of solar and topographic conditions. Determine the solar altitude and azimuths (dependent on latitude of site) and assess for what portion of the year that solar penetration through vegetation is desired. Use Walden sun path diagrams to assist with site clearing decisions.

*Minimize earthwork and clearing by aligning long buildings and parking lots with landscape contours; take up excess slope with a half-basement and staggered floor levels.

*Choose the most compact building footprint and shape that work with requirements for daylighting, solar heating and cooling, and function. The greater the ratio of floor area-to-building envelope area, the less heat exchange that will occur. In cold climates building envelope area should be minimized. In hot-dry climates the exterior surface area can be maximized to facilitate convective cooling.

*Minimize solar shadows. Avoid casting shadows on southern (or northern aspect in mid to high south latitudes) aspect of the building and adjacent buildings.

*Provide a north-wall design that minimizes heat loss. Apply insulation, air locks, extra glazing on windows, etc. to reduce heat loss.

*Provide a building-entrance orientation that maximises safety and ease of access. Consider protection from the elements (i.e. winter winds, early morning and late afternoon solar glare).

WEB RESOURCES

Compact Building Form Cuts Heat Loss
http://www.oikos.com/esb/36/ bldgform.html

ENVIRONMENTAL DESIGN ELEMENT

Thermal Efficiency

Insulating a building in any climate can have merits. In cold climates, insulation serves to reduce heating costs. In temperate and hot climates, insulation can serve to reduce air conditioning costs. It is often difficult and expensive to retrofit insulation in an existing building so identifying proper amounts at the design stage is critical. Minimization of thermal bridging is also important to achieve maximum benefits of insulation.
Determine the building function and amount of equipment that will be used. Determine internal heat gains from occupants and equipment when considering HVAC requirements.
In general, build walls, roofs, and floors of adequate thermal resistance to provide human comfort and energy efficiency.
Pay particular attention to roofs as they can receive excessive solar gains in summer and losses in winter.
Consider the reflectivity of the building envelope. In hot climates and when cooling loads are present, review the colour selection and reflectivity of exterior walls.
Prevent moisture buildup within the envelope. Place vapour barrier on the warm side of the wall when space heating is used to prevent moisture from condensing in the wall cavity.
Weatherstrip all doors and place sealing gaskets and latches on all operable windows. Prevent air leakage to avoid convective losses and unwanted infiltration.
Specify construction materials and details that reduce heat transfer. Prevent heat transfer through walls to maintain indoor environments.
Incorporate solar controls on the building exterior to reduce heat gain. Consider solar gains and losses through the roof and all exterior walls.

Consider the use of earth berms to reduce heat transmission and radiant heat loads on the building envelope. Sod roofs and buried exterior walls provide thermal mass that absorbs and controls solar gains.

CHECKLIST

*Determine the building function and amount of equipment that will be used. Determine internal heat gains from occupants and equipment when considering HVAC requirements.

*In general, build walls, roofs, and floors of adequate thermal resistance to provide human comfort and energy efficiency. Pay particular attention to roofs as they can receive excessive solar gains in summer and losses in winter.

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ENVIRONMENTAL DESIGN ELEMENT

Passive Solar

Heat and light from the sun is free and renewable. Ironically, the majority of buildings today are not designed to harness this free energy. Instead buildings are often constructed to block sunlight in favour of insulated, opaque partition walls.

DEFINITION

Passive solar design refers to the use of the sun's energy for the heating and cooling of living spaces. In this approach, the building itself or some element of it takes advantage of natural energy characteristics in materials and air created by exposure to the sun. Passive systems are simple, have few moving parts, and require minimal maintenance and require no mechanical systems.

Operable windows, thermal mass, and thermal chimneys are common elements found in passive design. Operable windows are simply windows that can be opened. Thermal mass refers to materials such as masonry and water that can store heat energy for extended time. Thermal mass will prevent rapid temperature fluctuations. Thermal chimneys create or reinforce the effect hot air rising to induce air movement for cooling purposes.

Wing walls are vertical exterior wall partitions placed perpendicular to adjoining windows to enhance ventilation through windows.

CONSIDERATIONS

Passive design is practiced throughout the world and has been shown to produce buildings with low energy costs, reduced maintenance, and superior comfort. Most of the literature pertaining to passive solar technology addresses heating concerns. This information is useful and relevant in our area; however, cooling issues, which are equally important in Austin, are less well documented. Key aspects of passive design include appropriate solar orientation, the use of thermal mass, and appropriate ventilation and window placement.

Consideration of high humidity is a key issue in Austin. For example, a basic passive cooling strategy is to permit cooler night air to ventilate a house and cool down the thermal mass (this can be brick, stone, or concrete walls or floors, or large water containers) inside the house. The thermal mass will absorb heat during the day; however, excessive humidity will reduce the cooling effect from the cooler thermal mass. Interior design elements of a home in our region also play a strong role in the effectiveness of passive cooling. For example, carpets, drapes, and fabric-covered furniture will absorb moisture from humid air, forcing the air conditioner to work harder to remove humidity.

As a design approach, passive solar design can take many forms. It can be integrated to greater or lesser degrees in a building. Key considerations regarding passive design are determined by the characteristics of the building site. The most effective designs are based on specific understanding of a building site's wind patterns, terrain, vegetation, solar exposure and other factors often requiring professional architectural services. However, a basic understanding of these issues can have a significant effect on the energy performance of a building.

Solar energy in the form of heat and light is freely available in nearly all locations. In regions where heating is required, design for efficient use of passive solar energy. A building must first be oriented properly (See Sustainable Siting) to take maximum advantage of the solar energy. In locales that require air conditioning, the designer should attempt to minimize solar heat infiltration while allowing for maximum daylighting.Every opportunity should be made to harness “free” solar energy in the form of heat and light. The design team must also pay particular attention to reducing excessive solar heating especially in temperate and hot climates.

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WEB RESOURCES

Passive & active solar architecture
http://mhathwar.tripod.com/thesis/solar/solar_architecture.htm

Passive solar design software - solacalc
http://ourworld.compuserve.com/homepages/dacPc/solacalc.htm

Thermal Solar Collectors, Solar Controller
http://www.thermomax.com

ENVIRONMENTAL DESIGN ELEMENT

Passive Solar Heating

Passive Solar Heating:
Analyse building thermal-load patterns. Seek strategies that deliver daylight and solar heat when the building requires it. Integrate passive solar heating with daylight design. They are complimentary strategies.

Design the building's floor plan to optimize passive solar heating. Windows should face within 15 degrees of true south to take advantage of solar heating.
Identify appropriate locations for exposure to beam sunlight. Shorter occupancy spaces (i.e. atrium, lobby, hallways) can tolerate direct solar gains. Offices where people work for extended periods of time must include measures to disperse direct sunlight and heat (i.e. clerestory windows, light shelves, window tinting).
Avoid glare from low sun angles. Be aware of early morning and late afternoon solar exposure that penetrates deeper into interior spaces. Orient work stations north-south so that partition walls block low angled light.
Locate thermal mass so that it will be illuminated by low winter sun angles. In cold climates, take advantage of low solar angles when space heating is required in winter. The thermal mass will remain in the shade during summer.

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ENVIRONMENTAL DESIGN ELEMENT

Passive Solar Cooling

In temperate and hot climates, solar heat infiltrating the building has typically been the most costly thing to mitigate (i.e. air conditioning). However, effective passive solar cooling design can eliminate much of this conventional operating cost with proper building design. Passive solar cooling can reduce or even eliminate the need for air conditioning in homes. At its simplest, passive cooling includes overhangs for south-facing windows, few windows on the west, shade trees, thermal mass and cross ventilation. Some of the same strategies that help to heat a home in the winter also cool it in the summer. Consider preventing excess solar heat from entering the building envelope. A variety of design strategies are listed below.
Design buildings for cooling load avoidance. Utilize appropriate window glazing and shading devices to avoid the need for mechanical cooling.
Choose one or more shading strategies including: fixed shading devices as part of building design (porches, overhangs, extrusions), trees or other vegetation that provide seasonal shading, awnings that can be extended or removed, operable shades or blinds. In general, limit east and west glazings to avoid low solar angle exposure.
Consider other cooling strategies including: taking advantage of natural ventilation, radiative cooling in regions that have significant differences in day and night temperatures, ground coupled cooling, and dehumidification in humid climates.

CHECKLIST

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WEB RESOURCES

Demonstration of Energy Savings of Cool Roofs
http://eande.lbl.gov/EA/Reports/40673/ExecSummary.html

Fan and Pad Greenhouse Evaporative Cooling Systems
http://edis.ifas.ufl.edu/BODY_AE069

Green Roofs
http://www.greenroofs.com

Natural Home Cooling
http://eartheasy.com/live_naturalcooling.htm

ENVIRONMENTAL DESIGN ELEMENT

Thermal Mass

Storing passive solar energy can assist both heating and cooling strategies. Storing heat allows for “free” heating to be used during night hours. Absorbing heat and storing it also decreases the maximum interior temperatures during the hottest times of the day thereby reducing daytime temperature peaks.

CHECKLIST

*Utilize thermal mass effectively inconjunction with exterior partition insulation to minimize interior air conditioning loads.

ENVIRONMENTAL DESIGN ELEMENT

Overhangs

Too often in the past have buildings been designed for daylighting or passive solar without taking into account the potential impacts of direct sunlight penetrating the building when heating is not required. Unfortunately, many designers have avoided daylighting design because of these bad experiences. However, proper design of fenestration and roof overhangs can mitigate these problems.

Passive solar design works by utilizing overhangs to shade a house during the heat of the summer and allow sunlight to penetrate the interior of the house during the winter.

CHECKLIST

*Design adequate overhangs and shade structures to interior exposure to excessive direct lighting and passive solar gains.

WEB RESOURCES

Passive Solar Design Guidelines for Northern New Mexico
http://www.nmsea.org/Curriculum/Courses/Passive_Solar_Design/Guidelines/Guidelines.htm#Obstructions%20to%20Solar

ENVIRONMENTAL DESIGN ELEMENT

Active Solar

If you want to heat your building with solar energy, you will need to decide whether you want an "active" or a "passive" system. A passive system does not use a mechanical device to distribute solar heat from a collector. An example of a passive system for space heating is a sunspace or solar greenhouse on the south side of the house. Although passive systems are simpler, they may be impractical for a variety of reasons (for example, building an effective sunspace may not be possible).

Active solar heating systems consist of collectors that collect and absorb solar radiation and electric fans or pumps to transfer and distribute the solar heat in a fluid (liquid or air) from the collectors. They may have a storage system to provide heat when the sun is not shining. An active system may be more flexible than a passive system in terms of siting and installation.

Choosing the appropriate solar energy system depends on factors such as the site, design, and heating needs of your house. Local covenants may restrict your options; for example homeowner associations may not allow you to install solar collectors on certain parts of your house. If you are unsure about what type of solar energy system to install, contact a solar energy specialist or engineer. No matter what system you choose, you should learn about it before making a purchase. Active systems employ mechanical and/or electrical means of harnessing and/or using passive solar energy. Harnessing this “free” energy is one of the simplest ways to improve environmental performance and reduce costs of building operation.

Determine if the climate and building usage is appropriate for an active solar collection system. This will depend on solar availability and planned uses of system.

Determine the financial feasibility of an active solar system. Consider the lifecycle costs of both solar and mechanical systems for up-front costs, operation costs, and maintenance.

Determine an appropriate location for solar collectors on or near the building. Locate solar collectors to maximize exposure to sun (dependent upon latitude and seasonal usage). Avoid shading from vegetation or adjacent structures. Select locations that reduce chances of vandalism. Be conscious of and mediate potential low angle glare from solar panels.

Design collectors to withstand all weather conditions. Specify glass that can withstand severe precipitation (i.e. hail, ice storms) and supporting structures that can withstand extreme wind events.

Design and locate collectors to maintain a clean surface and facilitate cleaning. Design structures that can hold maintenance staff.

Minimize heat losses from the system. Locate collectors near storage systems. Insulate distribution lines.

Avoid over-designing to ensure the longevity of an active solar system. Minimize controls and maintenance. Maximize accessibility to collectors, distribution lines, and storage systems.

CHECKLIST

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*Determine the financial feasibility of an active solar system. Consider the life
cycle costs of both solar and mechanical systems for up-front costs, operation costs, and maintenance.

*Determine an appropriate location for solar collectors on or near the building. Locate solar collectors to maximize exposure to sun (dependent upon latitude and seasonal usage). Avoid shading from vegetation or adjacent structures. Select locations that reduce chances of vandalism. Be conscious of and mediate potential low angle glare from solar panels.

*Design collectors to withstand all weather conditions. Specify glass that can withstand severe precipitation (i.e. hail, ice storms) and supporting structures that can withstand extreme wind events.

*Design and locate collectors to maintain a clean surface and facilitate cleaning. Design structures that can hold maintenance staff.

*Minimize heat losses from the system. Locate collectors near storage systems. Insulate distribution lines.

*Avoid over-designing to ensure the longevity of an active solar system. Minimize controls and maintenance. Maximize accessibility to collectors, distribution lines, and storage systems.

ENVIRONMENTAL DESIGN ELEMENT

Active Solar Heating

When building heating is required, temperate and hot climates may be able to rely 100% on solar heating. A variety of design strategies are indicated below.
Select an active solar heating system and collection medium appropriate for the building's heating and cooling systems. Water based systems tend to work well with water-based HVAC systems and similarly air-based systems work best with central air distribution HVAC systems.
Evaluate water-based collectors. They offer the ability to transfer heat to water-storage, water-distribution, and air-distribution systems.
Consider air-based systems. Air-based systems avoid the problems of leaks, are more easily maintained, but require more area to collect as much heat.
Consider ventilation air preheat systems. In cold climates, simple solar preheating devices are inexpensive, cost efficient, and easy to maintain.

CHECKLIST

*Select an active solar heating system and collection medium appropriate for the building's heating and cooling systems. Water based systems tend to work well with water-based HVAC systems and similarly air-based systems work best with central air distribution HVAC systems.

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*Consider ventilation air preheat systems. In cold climates, simple solar preheating devices are inexpensive, cost efficient, and easy to maintain.

ENVIRONMENTAL DESIGN ELEMENT

Active Solar Hot Water

In temperate and hot climates, hot water production can utilize ‘free’ solar energy in whole or in part. At minimum a supplemental solar hot water heating system should be mandatory and a part of every new building design.

Select the type of solar hot water heater according to climate, cost, and operations and maintenance preferences. Potential systems include: thermosyphon systems which rely on natural convection to distribute collected heat to storage tank located above collectors; direct-circulation systems that pump water or other medium to collectors when solar heating is available; drain-down systems utilize heat exchangers to heat potable water and can be drained during cold seasons when freezing would cause damage; indirect water-heating systems which use a freeze-protected liquid as the collecting medium and heat exchangers; air systems that use air as the storage medium and heat exchangers.

Consider a pre-heat or full-temperature system. Utilizing active solar heating to preheat water can be cost-effective installing a gas or electric backup to boost temperatures of the water to required levels.

For systems using water as a collection medium, consider the following issues: prevent stagnation that can lead to excessive heating and expansion of medium resulting in damage to the system; provide freeze protection when climate warrants it; avoid calcification and corrosion which can reduce flow rates and overall efficiency of system (creates insulating layer); plan for leaks in the system; select a heat-storage system for maximum efficiency and flexibility; minimize pumps and pump energy required.

CHECKLIST

*Select the type of solar hot water heater according to climate, cost, and operations and maintenance preferences. Potential systems include: thermosyphon systems which rely on natural convection to distribute collected heat to storage tank located above collectors; direct-circulation systems that pump water or other medium to collectors when solar heating is available; drain-down systems utilize heat exchangers to heat potable water and can be drained during cold seasons when freezing would cause damage; indirect water-heating systems which use a freeze-protected liquid as the collecting medium and heat exchangers; air systems that use air as the storage medium and heat exchangers.

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WEB RESOURCES

Solar Water Heating - Revolutionary Design - Fireball 2001
http://www.solarroofs.com

Tankless Water Heaters by Controlled Energy Corporation
http://www.controlledenergy.com

Tanksplash
http://www.rainwatercollection.com

The Chilipepper Hot Water Appliance
http://www.chilipepperapp.com

ENVIRONMENTAL DESIGN ELEMENT

Design Process

Today, there is increasing evidence that daylight is essential for the health, well being and productivity of individuals. Although productivity is often difficult to quantify, clinical disorders, such as daylight deprivation and seasonal affective disorder (commonly called SAD), are directly linked to a person's lack of light. By carefully designing window specifications for either commercial or residential buildings, architects can contribute to the increased productivity and psychological health of building occupants.

Through the years, daylight has played an invaluable role in the lighting of buildings. Until the industrial revolution, workers generally spent a large amount of time outdoors or within close proximity to daylight. Not until this century, when electric lights became commonplace, has daylighting been neglected in most buildings.

Allowing natural, “free” daylight to permeate the building’s façade and light interior spaces should be the main goal of the designer. Natural daylight provides a less expensive means of lighting and a healthier (See Indoor Environmental Quality: Lighting Quality) indoor environment. It is important however to consider the impacts of morning and evening low angle sun and daytime heating on the indoor environment.

A recent study indicates that typical people are exposed total daylight levels of greater than 2000 lux for only 90 minutes each day (Savides, 1986). Light exposure is important to the inner time keeping of humans. Through evolution, man has adapted to rhythms such as body temperature to provide him with explicit knowledge of external time (Terman, et al, 1987). The loss of this connection can contribute to fatigue, insomnia, and SAD. Another study of Russian and Czechoslovakian literature indicated that occupants of windowless factories were more subject to headaches, faintness and sickness that similar occupants of factories with windows (Plant, 1970). However, with today's advanced window technology, combined with efficient electric lighting, we can now design cost-effective, healthy buildings, that help to minimize these effects.

Daylight, a full-spectrum light source, most closely matches the visual response that, through evolution, humans have come to compare with all other light. Daylight provides continually changing values, brightness and contrasts to the workplace, allowing the human eye to constantly adjust. This adjustment reduces eye fatigue. The human eye is capable of adjusting to high levels of luminance without producing discomfort (AIA, 1993). However, reflections and brightness need to be controlled in relation to the task or design program.

Windows provide outside contact

Windows are the best means of providing points of contact with the outside environment. Short- and long-range views allow the eye to change focus, provide a connection to the natural world, and to assist in knowing time and weather and provide orientation. The lack of a physical connection is a major source of occupant dissatisfaction in offices. Studies show that many European countries now require that workers be within 27 feet of a window. Switzerland and the Scandinavian countries go a step further. They require that windows also be operable (Loftness, et al, 1993). To offset the problem of overburdening a mechanical system with open windows, automatic sensors are placed within the air diffusers in individual offices. These sense, through a change in air pressure, that a windows is open. They then cut off heat flow to the room so that the heating system is not working against an open window.

With reduced reports of headaches, fatigue and seasonal disorders through increased daylight, worker productivity is bound to increase. Wages and salaries can represent about 95 percent of all costs of a typical office building (Ternoey, et al, 1984). Reduced sickness and absenteeism and the increased performance would, therefore, more than offset any increased initial costs or life cycle costs (Robbins, 1986) associated with providing more workers visual access to windows.

The NMB Bank Headquarters in The Netherlands was designed by architect Ton Alberts of Alberts and Van Huut, to heavily rely on daylight. No desk may be more than 23 feet from a window. Window louvers bounce daylight deep into the space. Inside the bank, wood windows are used to bring the light from one area into another, thereby giving all workers access to daylight, even when they are located in interior spaces.

The bank has seen a significant drop in employee absenteeism, which is attributed to the attractive work environment (Browning, 1992). Each tower of NMB Bank is punctuated by a glass-roofed atrium, allowing a generous use of plants to help bring the outside in.

Enhanced spatial relationships, both within a building and to the outside, are also positive attributes of daylighting. Natural light is the best source of good color rendering, making people and colors look more realistic than they do in electric light. Daylight adds a dimension of expansiveness to spaces and can help to define shapes and tasks. This attribute of daylight is especially critical to the elderly. As the baby boomers age, sensory loss will become a significant issue which designers must face. Common eye problems associated with aging include slower adaptation to light level changes, increased difficulty with glare and requirements for higher illumination levels (Noell, 1992). Contrast between window openings and surrounding wall surfaces can be reduced by proper shading of windows, splaying of window jambs, and proper interior lighting.

When designing a daylit building, the designer must carefully consider the visual tasks to be performed in a space and the needs of the occupants. Glazing choices and the location and design of window openings then are carefully chosen and detailed. With the variety of window types available, fading, overheating and glare can be controlled. Generally, using glass that is clear in color and has a high visible transmittance is desirable. Shading coefficients will vary according to climate, orientation and the thermal needs of the building.

Way Station, a mental health facility in Frederick, Md., uses daylighting to create an aesthetically pleasing and healing environment that helps promote wellness of people with serious mental illness. "Members" and staff of the center comment that the building makes them feel great and that they love that daylight is available in almost every room. The Way Station uses light monitors, tracking daylight collectors, and finely-tuned window strategies to enhance the positive qualities of light. The daylighting techniques are part of an overall strategy that results in an energy cost savings of more than two thirds.

As architects and designers explore the inclusion of daylighting into their designs, the availability of high performance windows with diversity of characteristics to accommodate specific functions will be necessary. Jacob Liberman, Ph.D., states, "When we speak about health, balance and physiological regulation, we are referring to the function of the body's major health keepers; the nervous system and the endocrine system. These major control centers of the body are directly stimulated and regulated by light, to an extent far beyond what modern science, until recently, has been willing to accept."The design team must balance the need for natural, daylight to penetrate the building envelope, while avoiding excess heating and unwanted morning and evening glare on eastern and western facades.

Establish daylighting performance objectives and requirements. These objectives may be developed during the pre-design phase (See 2.1 – Design Elements: Pre-Design).

Analyze lighting performance needs using the following procedure: perform a solar path analysis for the site, perform preliminary aperture-optimization strategies, determine and design illumination levels for various programs, perform a preliminary life-cycle cost-benefit analysis.

Establish basic daylighting parameters as part of the building design including: location, shape, and orientation of building; fenestration design objectives; energy-efficient artificial illumination systems; preliminary life cycle cost analysis of daylighting systems; optimal effective aperture of toplighting strategies; lighting control strategies.

Specify details for lighting systems and products including: glazing materials, finishes, shading systems location and type, control systems.

Confirm that specified practices and materials are installed properly. Monitor direct sunlight penetration. Observe that seals are correctly installed on all skylights. Observe final calibration of lighting control systems.

Ensure that the building's daylighting features are in place and maintained for optimum performance including: control systems, maintenance schedule, and education for occupants.

CHECKLIST

*Ensure entire design team is aware of and includes daylighting features in the hotel design.

WEB RESOURCES

Daylighting Collaborative Website
http://www.daylighting.org

Daylighting Decisions - Tools for an Informed Approach
http://www.lightforum.com/design/daylight1.html

Daylighting for Commercial, Institutional, and Industrial Buildings
http://www.eren.doe.gov/consumerinfo/refbriefs/cb4.html

Daylighting Offers Great Opportunities
http://www.nwwda.org/articles/designlab_daylighting.html

Daylighting Productivity Study
http://www.innovativedesign.net/paper.htm

Daylighting: Measuring the Performance of Light Shelves and
http://www.fsec.ucf.edu/~bdac/pubs/PF340/PF340.html

Genelux: a daylighting and lighting design tool on the internet
http://genelux.entpe.fr

Natural Daylighting
http://energy.sourceguides.com/businesses/byP/light/NaturalDaylighting/NaturalDaylighting.shtml

Tips for Daylighting with Windows
http://eande.lbl.gov/btp/pub/designguide

ENVIRONMENTAL DESIGN ELEMENT

Daylighting Systems

Complete integration of daylighting strategies and systems with other lighting and energy systems is necessary to optimize energy efficiency and permit overall success with daylighting design.
Avoid direct sunlight and excessive brightness on critical task areas. Evenly distribute light in interior spaces (i.e. light shelves, clerestories). Avoid placing workstations and computer screens adjacent to windows.
Bring the daylight in at a high location. Utilize windows, skylights, roof monitors, and clerestories. Consider colour and reflectance of ceiling members.
Diffuse and distribute the daylight using: vegetation, draperies, screens, translucent shades, light shelves, and light scattering glazing.
Bounce the daylight off of surrounding surfaces. Use light shelves, louvers, blinds, and vertical baffles to distribute light.
Integrate daylight with other building systems and strategies.
Maintain a favourable room aspect ratio – the ratio of ceiling height and window height to depth of room from window. See diagram to the right.
Establish an appropriate building footprint. The ideal building depth is limited by the dimension required for a double-loaded corridor (exterior window/wall-daylit room-corridor-daylit room-exterior window/wall).

Specify the appropriate room reflectivity (surface reflectance).
Rely on clerestories in addition to windows. They allow light to penetrate deeper into a space.
Consider a sawtooth roof form to provide uniform illumination over a larger area.
Design roof monitors and skylights to provide lighting of interior spaces. Skylights are efficient in that they usually have 180-degree view of the sky.
Use sloped or curved ceiling planes. Ceiling planes are the simplest mechanism of distributing light in a space.
Optimize overhangs based on window height and latitude (solar altitude). Consider seasonal benefits and drawbacks with permanent overhangs.
Incorporate light shelves with windows where appropriate.
Employ baffles, louvers, and reflectors as appropriate in conjunction with any of the above-mentioned strategies for solar control.
Integrate daylighting with luminous ceiling systems.
Consider solar shade and awning systems.
Consider optical venetian blind systems.
Consider advanced light-shelf systems. See figure to the right.
Consider advanced systems such as active concentrating heliostats, passive collimating systems, and high-performance optical skylights.
Consider light-pipe distribution. They are effective at delivering natural daylight to interior spaces without exterior partition walls.
Consider spectrally selective glazings, which filter certain wavelengths (i.e. infrared) allowing for maximum daylighting while maintaining energy efficiency.
Consider switchable glazings for differing seasonal conditions. Photochromic glass darkens at predetermined intensity levels. Thermochromic glass becomes translucent at predetermined temperatures. Electrochromic glass darkens when an electrical current is applied. Liquid crystals become clear when an electrical current is applied and are translucent otherwise.

CHECKLIST

*Avoid direct sunlight and excessive brightness on critical task areas. Evenly distribute light in interior spaces (i.e. light shelves, clerestories). Avoid placing workstations and computer screens adjacent to windows.

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RELATED PRODUCTS

Sun Tube Skylights
http://www.solatube.com

Sun Tube Skylights
http://www.sunpipe.com

ENVIRONMENTAL DESIGN ELEMENT

Fenestration and Form

design element content

CHECKLIST

*Ensure proper orientation of the building and resulting fenestration to prevent excessive heat loss or gains.

ENVIRONMENTAL DESIGN ELEMENT

Artificial Lighting

Any building that will be occupied outside of the daylight hours will require some form of artificial lighting. Efficient design of ancillary lighting combined with effective daylighting integration will ensure maximum energy efficiency.
Integrate lighting controls to respond to available daylight.
Ensure good control-system design.
Integrate daylight controls with other control strategies.

CHECKLIST

*Integrate lighting controls to respond to available daylight.

*Ensure good control-system design.

*Integrate daylight controls with other control strategies.

ENVIRONMENTAL DESIGN ELEMENT

Design Process

Once the daylighting design is complete, then artificial or supplemental lighting is needed for proper light distribution and off daylight hours.
Include the entire design team in the design of building massing, orientation, and envelope to achieve greater daylighting contribution.
Incorporate the most energy-efficient technology for lamps, fixtures, and control equipment.
Consider all lighting functions including the ambient system, task lights, emergency and 24-hour lighting, exterior lights, exit lights, and public-area lights.
Use sophisticated design analysis, including computer simulation, for system design.
Consider using the guidelines of the Illuminating Engineering Society (IES). IES guidelines are helpful for designing outdoor lighting.
Design for specific visual tasks. Consider lower ambient lighting levels in exchange for more directed task lighting.
Consider task-lighting systems that reduce general overhead light levels.
Match the quality of light to the visual task lighting requirement. Quality is more important than quantity.
Improve lighting design and energy efficiency by performing several key activities in the early phases of architectural space planning. Co-ordinate the lighting plan with furniture layout. Design for daylighting to be available in hallways, lounges, and areas of recreation. Group occupants with similar tasks together so that unoccupied areas require less lighting.
Improve room-cavity optics. Utilize high reflectance walls and light colours to enhance daylighting.
Provide effective lighting control. Use sensors that automatically adjust artificial lighting with daylighting available. Allow occupants to adjust lighting levels.
Consider improved task lighting products.
Convert existing light fixtures. In many cases, more efficient fixtures are available.

CHECKLIST

*Include the entire design team in the design of building massing, orientation, and envelope to achieve greater daylighting contribution.

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*Consider improved task lighting products.

*Convert existing light fixtures. In many cases, more efficient fixtures are available.

ENVIRONMENTAL DESIGN ELEMENT

Light Fixtures

New technology is available and many contemporary lighting fixtures are being replaced by energy efficient fluorescent fixtures and task lighting. Consider retrofitting exit signs to energy efficient fixtures.
Specify efficient lamps for the intended use. Select T8 fluorescent lamps; compact fluorescent lamps; lower wattage, high colour rendering lamps; compact reflector HID lamps; halogen lamps with infrared reflectors; sulphur bulbs.
Use efficient exit signs. Exit signs are available that use little or no electricity.
Use electronic ballasts. They are 10-20% more efficient than most magnetic-coil ballasts.
Improve optical control. Improve task lighting while lowering overall ambient lighting levels.

CHECKLIST

*Specify efficient lamps for the intended use. Select T8 fluorescent lamps; compact fluorescent lamps; lower wattage, high colour rendering lamps; compact reflector HID lamps; halogen lamps with infrared reflectors; sulphur bulbs.

*Use efficient exit signs. Exit signs are available that use little or no electricity.

*Use electronic ballasts. They are 10-20% more efficient than most magnetic-coil ballasts.

*Improve optical control. Improve task lighting while lowering overall ambient lighting levels.

ENVIRONMENTAL DESIGN ELEMENT

Light Pollution

A source of pollution that is rarely identified or discussed until recently, but present in nearly all hotel developments, light often impacts the access to the night sky and alters nocturnal environments (i.e. turtles reproduction habitat on beaches). Although outdoor lighting may be important for personal and property security, exterior lighting should be controlled to minimize environmental impacts. Exterior lights should be turned off or set on timers to turn off when not needed, especially after guests go to bed. Lights that are required all night should be placed in a manner to achieve their task without excess lighting.

Direct lighting to specific tasks. Avoid lighting areas that do not require it.

Use lighting controls to turn lights off when not needed. Timers and motion sensors increase energy efficiency.

CHECKLIST

*Direct lighting to specific tasks. Avoid lighting areas that do not require it.

*Use lighting controls to turn lights off when not needed. Timers and motion sensors increase energy efficiency.

WEB RESOURCES

International Dark-Sky Association

http://www.darksky.org

ENVIRONMENTAL DESIGN ELEMENT

PreDesign

As one of the largest building operating costs in tropical locales, the HVAC system must be designed with optimum performance in mind. As noted above (See Design Elements: Passive Solar), one of the largest factors determining HVAC systems is the heat transfer performance of the building envelope. A building designed to efficiently deal with outdoor temperatures and passive solar energy may be able to greatly reduce these HVAC operating costs. It is important to reiterate that proper design eliminates a lifetime of high operating expenses and/or costly renovations cost at a future date.Achieving an efficient HVAC design involves an awareness of all other building systems and the expertise of the entire design team. Integration with all other building systems is priority.

Develop a conceptual model that illustrates projected energy use and sources. Be sure the entire design team has input at this stage.

Use the following approach in performing the analysis of different systems. Explore passive solar strategies and non-energy intensive HVAC and lighting opportunities. Consider the building envelope when examining HVAC strategies. Consider the building orientation and footprint. Consider thermal mass appropriately placed. Optimize energy benefits of glazing through appropriate selection, placing, and design of the building façade. Consider daylighting strategies to reduce HVAC requirements. Consider shading devices. Control unwanted infiltration. Consider increased insulation levels. Reduce internal heat gains.

Design the HVAC system and consider potential options for energy efficiency.

Improve control systems by using computer software programs and sensors to operate building in accordance with occupancy patterns.

Develop accurate pricing. Taking into account life cycle costing.

CHECKLIST

*Develop a conceptual model that illustrates projected energy use and sources. Be sure the entire design team has input at this stage.

*Use the following approach in performing the analysis of different systems. Explore passive solar strategies and non-energy intensive HVAC and lighting opportunities. Consider the building envelope when examining HVAC strategies. Consider the building orientation and footprint. Consider thermal mass appropriately placed. Optimize energy benefits of glazing through appropriate selection, placing, and design of the building façade. Consider daylighting strategies to reduce HVAC requirements. Consider shading devices. Control unwanted infiltration. Consider increased insulation levels. Reduce internal heat gains.

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*Develop accurate pricing. Taking into account life cycle costing.

WEB RESOURCES

ASRAE - American Society of Heating Refrigeration and Air-Conditioning Engineers
http://www.ashrae.org

ENVIRONMENTAL DESIGN ELEMENT

Design Process

Proper HVAC design and minimization of unwanted heat transfer to the interior environment will ensure years of efficient building performance.
Define the project design criteria. They should reflect the building’s use, occupancy patterns, density, passive solar opportunities, office equipment, lighting levels, comfort ranges, and space specific needs.
Use advanced design methods. Utilize up-to-date software and avoid oversizing systems.
Design for part-load efficiency. Specify equipment that remains efficient over a wide range of operating conditions.
Optimize system efficiency. Give priority to overall system efficiency rather than individual components.
Design for flexibility. Consider a change in occupancy or new technology and how easy the system can be reconfigured.

CHECKLIST

*Define the project design criteria. They should reflect the building’s use, occupancy patterns, density, passive solar opportunities, office equipment, lighting levels, comfort ranges, and space specific needs.

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ENVIRONMENTAL DESIGN ELEMENT

Control Systems

Control systems allow the designer to automate and integrate building systems. Design the control systems to allow operators to adjust the system components and fine-tune performance.
Design a building management control system.
Train building engineers to use the control system for greater comfort and efficiency.
Integrate the operation of all components and install a centralized computer interface throughout the project.
Consider that the HVAC control systems include the following functions: comfort control (temperature, humidity), scheduled operation, sequenced modes of operation, alarms and system reporting, lighting and daylighting integration, maintenance management, indoor air quality management, remote monitoring and adjustment, commissioning flexibility.

CHECKLIST

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*Integrate the operation of all components and install a centralized computer interface throughout the project.

*Consider that the HVAC control systems include the following functions: comfort control (temperature, humidity), scheduled operation, sequenced modes of operation, alarms and system reporting, lighting and daylighting integration, maintenance management, indoor air quality management, remote monitoring and adjustment, commissioning flexibility.

ENVIRONMENTAL DESIGN ELEMENT

Air Delivery Systems

Energy efficient strategies are necessary to optimize air delivery and adequate ventilation.
Use variable air volume systems. These systems remain efficient during partial loading.
Avoid reheating for zone temperature control. Consider dedicated perimeter heating and room return air for heating to minimize outdoor-air reheat penalty.
Reduce duct system pressure losses. Due to proportion of energy used to distribute air using fans, efficient duct design is integral.
Reduce duct leakage and thermal losses by specifying low-leakage sealing methods and good insulation.
Consider proper air distribution to deliver conditioned air to the occupied space. Select appropriate diffusers for the task.
Use low face velocity coils and filters. Reducing velocity across impediments reduces energy losses.
Use cold air systems. This reduces airflow requirements and fan energy usage.
Design equipment and ductwork with smooth internal surfaces. This minimizes friction losses and reduces dust and microbial buildup.

CHECKLIST

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ENVIRONMENTAL DESIGN ELEMENT

Central Equipment

Advances in efficiency and alternative plant technology allow the designer to do more with less. Ensure proper sizing of equipment to avoid additional costs of unnecessary systems.
Evaluate chiller selection. Open-drive compressors save energy by not directing compressor motor heat into refrigerant flow. Consider evaporative cooling equipment.
Evaluate a multiple chiller system with units of varying size. Or a chiller system with variable-speed drives to maintain efficiency through a range of operating loads.
Consider desiccant dehumidification in cases of significant latent load or in humid environments.
Consider absorption cooling that changes energy source from electricity to less expensive gas.
Consider thermal energy storage to effectively manage diurnal and seasonal loads.
Evaluate hydronic-pumping systems.
Evaluate heat exchangers. Select heat exchangers with low approach temperatures and reduced pressure drops.
Consider other heating system equipment and enhancements including: using condensing boilers, matching output temperatures to the load, using temperature reset strategies, selecting equipment that maintains efficiency under partial loading.
Evaluate heat recovery options. Especially in cases when heating and cooling loads occur simultaneously.

CHECKLIST

*Evaluate chiller selection. Open-drive compressors save energy by not directing compressor motor heat into refrigerant flow. Consider evaporative cooling equipment.

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*Consider absorption cooling that changes energy source from electricity to less expensive gas.

*Consider thermal energy storage to effectively manage diurnal and seasonal loads.

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*Evaluate heat recovery options. Especially in cases when heating and cooling loads occur simultaneously.

ENVIRONMENTAL DESIGN ELEMENT

Efficiency Enhancement Options with HVAC

Consider further enhancement options for HVAC systems to improve energy efficiency.
Consider additional improvements to energy efficiency including: higher efficiency motors, variable-speed drives, mechanical drive efficiency, direct digital control systems, advanced control strategies (i.e. system optimization, dynamic system control, integrated lighting and HVAC control, and variable-airvolume (VAV) box airflow tracking).
Undertake independent system testing, adjustment, and balancing to improve efficiencies and comfort.

CHECKLIST

*Consider additional improvements to energy efficiency including: higher efficiency motors, variable-speed drives, mechanical drive efficiency, direct digital control systems, advanced control strategies (i.e. system optimization, dynamic system control, integrated lighting and HVAC control, and variable-air
volume (VAV) box airflow tracking).

*Undertake independent system testing, adjustment, and balancing to improve efficiencies and comfort.

ENVIRONMENTAL DESIGN ELEMENT

Minimum Energy Performance

Design the building to exceed the local standard (and or the ASHRAE or international standard, whichever is higher) set for energy use. Strategies implemented during the design stage are less expensive than retrofit approaches at a future date. A building designed efficient from the start will save money on the reduced size of the power plant and will provide a lifetime of operational cost savings.

CHECKLIST

*Exceed the energy efficiency of average buildings in its class and locality.

ENVIRONMENTAL DESIGN ELEMENT

Optimize Energy Performance

Take the minimum energy performance standard as a starting point and seek overall building energy performance that sets a new standard. Every effort should be made to optimize individual systems and components; as well as the integration of entire systems for maximum performance.
Optimize each system individually. Then integrate systems for maximum optimization.

CHECKLIST

*Optimize each system individually. Then integrate systems for maximum optimization.

ENVIRONMENTAL DESIGN ELEMENT

Balance Energy Performance and IAQ

Consider indoor air quality and ventilation when seeking optimum building energy efficiency. Adequate indoor air quality must not be compromised by lack of proper ventilation. Design of the HVAC systems must employ energy efficient strategies that do not compromise IAQ.

Begin the design process with the goal of maximizing IAQ performance and energy efficiency.

Include dedicated ventilation systems. This will help to ensure adequate air exchanges.

Consider heat recovery options. Air-to-air heat exchangers are effective and energy efficient. Avoid mixing exhaust air with fresh air intake.

Reduce pollutants. Avoid using products that off gas and increase ventilation in areas adequately to ensure good air quality.

Institute ventilation demand strategies. Consider using control systems that modify ventilation rates based on occupancy, carbon dioxide levels, and VOC concentrations.

Consider diffuser selection. Appropriate diffuser selection and placement will ensure adequate microenvironments for occupants.

Consider under floor air-distribution. In milder, low-humidity environments floor air-distribution takes advantage of naturally buoyant warm air thus requiring less fan energy for distribution and circulation.

Perform a pre-occupancy flushout. Be sure to replace flushed out air with fresh outdoor air.

Consider the use of evaporative cooling equipment. Particularly in dry climates, evaporative cooling equipment can be very efficient and cost-effective.

CHECKLIST

*Begin the design process with the goal of maximizing IAQ performance and energy efficiency.

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ENVIRONMENTAL DESIGN ELEMENT

Measurement and Verification

Without ongoing data collection, the operating staff haven’t the means to assess building system performance, nor set and meet targets for better performance. Install meters to assist operators to maintain the building at peak performance status.
Install meters or other data collecting devices to measure and verify system performance.

CHECKLIST

*Install meters or other data collecting devices to measure and verify system performance.

ENVIRONMENTAL DESIGN ELEMENT

Other Design Issues

Other design strategies related to environmental performance of the building are indicated below.
Design the building with common material modules in mind. Efficient dimensions reduce waste and labour time.

CHECKLIST

*Design the building with common material modules in mind. Efficient dimensions reduce waste and labour time.

ENVIRONMENTAL DESIGN ELEMENT

Doors and Windows

Any openings in the building envelope are potential energy “leaks” if not designed properly. Many new, advanced technologies are available to allow the design team maximize transparent openings while avoiding the heat transfer penalty.
Size and position doors, windows, and vents in the envelope based on careful consideration of daylighting, heating, and ventilating strategies.
Shade openings in the envelope during hot weather to reduce the penetration of direct sunlight to the interior of the building. Utilize overhangs or deciduous trees to shade southern façade during summer.
Select double or triple glazed windows with as high and R-value as possible and proper shading coefficients within the project’s financial guidelines. Higher r-values minimize heat transfer (i.e. tropical heat into the building, or interior heat out into the cold outdoors).
Select the proper glazing for windows, where appropriate. The objective is to allow as much daylight in, while preventing either heat loss in cold climates or heat gain in hot climates.

CHECKLIST

*Size and position doors, windows, and vents in the envelope based on careful consideration of daylighting, heating, and ventilating strategies.

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WEB RESOURCES

Accurate Dorwin - Windows | Doors | Commercial | Residential
http://www.accuratedorwin.com

Efficient Windows Collaborative (EWC)
http://www.efficientwindows.org

High Performance Window and Curtain Wall Systems
http://www.visionwall.com

Southwall - Heat Mirror Windows
http://www.southwall.com/products/heatmirror.html

Thermotech Windows Ltd.
http://www.thermotechwindows.com

ENVIRONMENTAL DESIGN ELEMENT

Entry Vestibules

CHECKLIST

*Employe entry vestibules in design in order to minimize unwanted air mixing between interior and exterior spaces.

ENVIRONMENTAL DESIGN ELEMENT

Building Manual

Create a Building Maintenance Manual for the client. It will help to assure the continuing high performance of the building's systems and reduce costs for maintenance.

CHECKLIST

*Create a Building Maintenance Manual for the client.

ENVIRONMENTAL DESIGN ELEMENT

Design for Decommissioning

CHECKLIST

*Design any project or building with the ultimate decommisioning in mind.
*When fastening materials together, utilize strategies that allow for easy disassembly.

ENVIRONMENTAL DESIGN ELEMENT

Heat Recovery

Since valuable energy is used to heat interior spaces (temperate and cold locales) and water, the energy used to generate that heat should be used to the maximum. Heat recovery devices should be considered for all instances where heating (or air conditioning) is used.
Consider heat recovery on all wastewater piping.
Consider utilizing earth-tubes to preheat or pre-cool HVAC intake air.

CHECKLIST

*Consider heat recovery on all wastewater piping.

*Consider utilizing earth-tubes to preheat or pre-cool HVAC intake air.

ENVIRONMENTAL DESIGN ELEMENT

Writing Specs

Providing education and directing purchasers and contractors as to the environmental objectives of the project within the building specifications will execute many environmental targets set out in the pre-design phase.
Division 1, which addresses broad administrative and procedural issues, should clearly indicate the broad green considerations for design and construction, identify the owner’s commitment, and require the contractor’s participation.
For CSI Division 2 through 16, communication of green requirements can be improved by identifying them in separate Articles under each of the three main Parts.

CHECKLIST

*Division 1, which addresses broad administrative and procedural issues, should clearly indicate the broad green considerations for design and construction, identify the owner’s commitment, and require the contractor’s participation.

*For CSI Division 2 through 16, communication of green requirements can be improved by identifying them in separate Articles under each of the three main Parts.

ENVIRONMENTAL DESIGN ELEMENT

Writing a Building Manual

Nearly every household appliance has a operating manual. Even something as small as a toaster has an accompanying document gives instructions on operationand maintenance. Ironically, buildings rarely have operating manuals (beyond the mechanical plant equipment).

A building manual is an important document to be included in any new or renovated environmentally designed building. Without a detailed document describing the environmental goals, targets, and sytems, it may be impossible for a building operator to understand and manage the building for optimal environmental performance.

A building manual should include the following:

- Explanation of Environmental Goals and Priorities

- Description of Design Intentions and System Synergies
- Design details of each Environmental Component
- Operational details of each Environmental Component
- Maintenance details of each Environmental Component
- Any documents related to Environmental Certification

CHECKLIST

*Write a building manual and educate the operator on the maintenance of the environmental systems in use.

ENVIRONMENTAL DESIGN ELEMENT

Overview

A variety of issues need attention when selecting materials for a building. Each issue stands on its own merit and does not override any other issue. The design team should consider all issues in conjunction with environmental goals set out for the project.
Reduce material use, reuse, and recycle – in that order of priority.
Use new materials thoughtfully; consume the minimum for the purpose; avoid waste. Design building to utilize common dimensions of materials.
Perform and environmental-impact and cost analysis of all materials based on life-cycle principles.

CHECKLIST

*Reduce material use, reuse, and recycle – in that order of priority.

*Use new materials thoughtfully; consume the minimum for the purpose; avoid waste. Design building to utilize common dimensions of materials.

*Perform and environmental-impact and cost analysis of all materials based on life-cycle principles.

WEB RESOURCES

ATHENA Sustainable Materials Institute
http://www.athenasmi.ca

Environmental Home Center
http://www.built-e.com

Environmental Store - Sustainable Building Products
http://www.nwbuildnet.com

GreenSpec Products
http://www.greenspec.com

ENVIRONMENTAL DESIGN ELEMENT

Needed at all?

design element content

CHECKLIST

*Begin with the question, "Is this material or component really needed at all? Or is there an alternative that can reduce the total environmental impact."

ENVIRONMENTAL DESIGN ELEMENT

Building Reuse

When an existing structure is available, attempt to design the building to utilise the existing structure and materials. This will reduce the overall embodied energy of the development.
Utilize existing building structures whenever possible.

CHECKLIST

*Utilize existing building structures whenever possible.

ENVIRONMENTAL DESIGN ELEMENT

Resource Reuse

Select salvaged or recycled materials and components. This will reduce costs and lower overall embodied energy. Many large dimensional wood products are now only available through salvage businesses.
Salvage materials and components whenever possible. Specify reclaimed and salvaged materials whenever possible

CHECKLIST

*Salvage materials and components whenever possible. Specify reclaimed and salvaged materials whenever possible.

WEB RESOURCES
Used Building Materials Association
http://www.ubma.org

ENVIRONMENTAL DESIGN ELEMENT

Material Efficient

design element content

CHECKLIST

*Select design methods and strategies that reduce the overall consumption of resources and select materials that are the most efficient use.

ENVIRONMENTAL DESIGN ELEMENT

Recycled Content

Materials and components with recycled content reduce environmental impacts. Give preference to post-consumer recycled content over post-industrial content.
Specify minimum recycled content for materials and components.

CHECKLIST

*Specify minimum recycled content for materials and components.

ENVIRONMENTAL DESIGN ELEMENT

Natural vs Synthetic

design element content

CHECKLIST

*Whenever possible, select natural materials that use less synthetic chemicals, and can be returned to the natural environment without harm.

ENVIRONMENTAL DESIGN ELEMENT

Toxic?

Minimize or elimnate the use of treated lumber. Instead choose materials that are better suited to resist deterioration. If wood preservative is required seek out the least toxic or non-toxic alternatives.

CHECKLIST

*Minimize or elimnate the use of treated lumber. Instead choose materials that are better suited to resist deterioration. If wood preservative is required seek out the least toxic or non-toxic alternatives.

ENVIRONMENTAL DESIGN ELEMENT

Local or Regional

Products that originate and/or are made from/with local materials and are manufactured locally generally have less environmental impacts. These products do not include the high environmental costs of transportation. Purchasing locally supports local workers and enhances the sustainability of the locality.
Specify local or regional materials that originated or were manufactured within 800 km of the construction site or building.

CHECKLIST

*Specify local or regional materials that originated or were manufactured within 800 km of the construction site or building.

ENVIRONMENTAL DESIGN ELEMENT

Recyclable

design element content

CHECKLIST

*Choose products and materials that can be recycled or at minimum downcycled. Avoid products and materials that are destinied for the landfill.

WEB RESOURCES

Waste Less - Recycled Content & Environmentally Friendly Products
http://www.rco.on.ca/wlts/products.htm

ENVIRONMENTAL DESIGN ELEMENT

Biodegradable

design element content

CHECKLIST

*Seek materials and products that rapidly biodegrade when disposed of into natural constituents.

ENVIRONMENTAL DESIGN ELEMENT

Impact Displacing

design element content

CHECKLIST

*Always select materials or products that minimize the overall environmental impact of the building by displacing other more harmful materials or products.

ENVIRONMENTAL DESIGN ELEMENT

Rapidly Renewable

Selecting components and finishes that contain rapidly renewable materials favours sustainable industries and avoids the use of products from endangered ecosystems such as old growth forests.
Specify products from rapidly renewable sources.

CHECKLIST

*Specify products from rapidly renewable sources.

ENVIRONMENTAL DESIGN ELEMENT

Certified Sustainable or Organic

design element content

CHECKLIST

*Where available, specify products that are certified harvested sustainably.

ENVIRONMENTAL DESIGN ELEMENT

Packaging

design element content

CHECKLIST

*Seek materials and products that have minimal packaging.
*Educate the manufacturer, distributor, and retailer to minimize packaging or demand a take-back policy for any packaging.

ENVIRONMENTAL DESIGN ELEMENT

Maintenance Required

design element content

CHECKLIST

*Compare the operational maintenance required on any material or product and choose materials or products with lowest lifetime maintenance.

ENVIRONMENTAL DESIGN ELEMENT

Health and IAQ Issues

Selecting materials is one of the most important steps to avoid indoor air quality problems.
Review emission levels from building products at the following stages: installation, occupancy, and maintenance and removal.
Consider these additional materials issues and effects: the sink effect (i.e. absorption of chemicals by materials), moisture and temperature, natural materials.

CHECKLIST

*Review emission levels from building products at the following stages: installation, occupancy, and maintenance and removal.

*Consider these additional materials issues and effects: the sink effect (i.e. absorption of chemicals by materials), moisture and temperature, natural materials.

ENVIRONMENTAL DESIGN ELEMENT

Life-cycle Cost

An accurate comparison of the land, water, air, and climactic impacts of various electricity generation options requires "life cycle" analyses, which examine the effects of producing and transporting fuel, building and subsequently decommissioning facilities, generating power, and treating and disposing of waste. For ease of comparison, some studies translate these diverse impacts into dollars, in keeping with past regulatory practices of attempting to identify the leastcost resource strategy. Such comparisons are controversial and, to some readers, unsatisfying, since many human health and environmental effects have no clear dollar cost.

CHECKLIST

*When comparing materials and products examine the life-cycle cost of the material including the environmental impacts of extraction, manufacture, distribution, construction, disposal.

ENVIRONMENTAL DESIGN ELEMENT

Embodied Energy

design element content

CHECKLIST

*Utilize embodied energy data to compare materials and products where available.

WEB RESOURCES

Embodied Energy Coefficients

http://www.arch.vuw.ac.nz/cbpr/embodied_energy/ files/ee-coefficients.pdf

ENVIRONMENTAL DESIGN ELEMENT

Common Building Materials

The following discussion identifies problems and solutions for each of the CSI building material categories.

CHECKLIST

ENVIRONMENTAL DESIGN ELEMENT

Concrete Issues (DIV3)

Resource efficient options:

-use fly-ash mixed with concrete up to 30% (may include ground blast-furnace slap from metal smelting operations);
-consider using palm tree husks;
-recycle crushed concrete, brick, and other masonry waste as a source of aggregates;
-utilize anti-corrosion agents such as epoxy coatings to reduce cracking and maintenance;
-use low-waste form work, recycle it, or incorporate form work into foundation design to serve as both structure and insulation value;
-when not in contact with earth or soil – consider eliminating air entrainment agents, plasticizers, water-reducing agents, sulphate resistant chemicals, curing agents (use water instead), calcium chloride; which will reduce costs.

CHECKLIST

WEB RESOURCES

Concrete Info by EcoDesign
http://www.ecodesign.bc.ca/Products/03/concrete.htm

Eco-Tech Foundations
http://www.eco-techfoundations.com

Neopor system - cellular lightweight concrete
http://www.neopor.com

ENVIRONMENTAL DESIGN ELEMENT

Concrete Alternatives and Solutions

CHECKLIST

ENVIRONMENTAL DESIGN ELEMENT

Masonry Issues (DIV4)

Resource efficient options:

-consider lightweight concrete blocks with expanded aggregates (i.e. pumice) that reduce weight and increase insulation value;

-select brick and block products with recycled content (i.e. sewage sludge and ash from incinerators and coal-burning plants);

-select glass blocks with recycled glass content.

CHECKLIST

ENVIRONMENTAL DESIGN ELEMENT

Masonry Alternatives and Solutions

CHECKLIST

ENVIRONMENTAL DESIGN ELEMENT

Metal Issues (DIV5)

Buildings utilize a variety of metals in construction.

Steel is a combination of metals that may include: manganese, silicon, carbon, sulphur, phosphorous, aluminum.

The raw materials for steel originate from sub-surface mines. Typically ores contain about 5 percent metal. Thus, significant rock waste or tailings are produced when exhuming these metals. The most significant environmental impact of this type of mining is acid generation from the oxidation of sulphide materials found frequently in metal mines. When present acid generation is an indefinite process that requires continual remediation.

Steel provides a high strength-to-weight ratio. Thus it forms the structure of many buildings. Although steel is essentially 100% recyclable indefinitely, the amount of recycled content in steel available in today's market can vary and rarely reaches the 100% level (NOTE: Statistics below based on US Market).

2 Methods of steel making

BOF or Basic Oxygen Furnace
– steel that requires drawability (appliances, sheets, pails, soup cans, etc.)
– uses 31.7% recycled steel (31.7% avg => 20.4% p.c. + 9.6% p.i.)

EAF or Electric Arc Furnace
- steel that requires strength (structural beams, rebar)
- uses 95.5% recycled steel (95.5% => 58.9% p.c. + 31.2% p.i.)

Source: Steel Recycling Institute 2001.

Thus, structural steel components have a high proportion of recycled content, whereas sheet metal has significantly less recycled content.

CHECKLIST

*Specify steel with verified recycled content of 30%+, do not specify for exterior framing due to thermal bridging;

*Aluminum with recycled content of 20%+;

*Select reclaimed beams and metalwork from salvagers.

WEB RESOURCES
Acid Mine Drainage
http://www.miningwatch.org/emcbc/mapping/amd_canada.htm

Steel Recycling Institute
http://www.recycle-steel.org/pub/leed.pdf

ENVIRONMENTAL DESIGN ELEMENT

Metal Alternatives and Solutions

CHECKLIST

ENVIRONMENTAL DESIGN ELEMENT

Wood Issues (DIV6)

Resource efficient options:

CHECKLIST

WEB RESOURCES

AllGreen® Medium Density Fiberboard
http://www.canfibre.com

American Bamboo Society
http://www.bamboo.org/abs

Antique flooring barn beams distressed wood heart pine
http://www.mountainlumber.com

EcoTimber, Quality Woods from Environmentally Sound Sources
http://www.ecotimber.com

Plastic Lumber Yard
http://www.plasticlumberyard.com

Reclaimed Wood
http://www.duluthtimber.com

Smart Wood - Certified Wood Product Company Listing
http://www.smartwood.org/product-finder/product-finder.html#plywood

StratSoy
http://www.ag.uiuc.edu/~stratsoy/new/commproducts.html

The Sustainable Forest Products Resource
http://www.forestworld.com

Treatedwood
http://www.treatedwood.com

Understory - Journal of the Certified Forest Products Council
http://www.greendesign.net/understory/index.html

Yahoo! Groups : Cordwood
http://groups.yahoo.com/group/cordwood

RELATED PRODUCTS

Reclaimed Old Growth Wood Flooring
http://www.ecotimber.com

ENVIRONMENTAL DESIGN ELEMENT

Wood Alternatives and Solutions

Not all wood fibre is the same. Choices can be made that reduce the environmental impact on the source ecosystems, reduce the distance required for transportation, and optimize the species type for durability and life cycle cost.

Health and pollution issues:

CHECKLIST

*Avoid using wood from old-growth forests.

*Consider choosing certified sustainably harvested wood products.

*Consider choosing rapidly renewable wood species (i.e. bamboo, cork).

*Consider wood products made from reclaimed or recyled wood waste (i.e. manufactured wood, finger jointed lumber, smaller dimension lumber).

*Consider reclaimed and salvaged wood products especially for larger dimension needs.

*Consider any glues used in manufactured wood products; water based, natural products are best without formaldehydes.

*Utilize structural sheathing to minimize needs for larger dimensional lumber.

ENVIRONMENTAL DESIGN ELEMENT

Plastic Issues and Alternatives

Common plastics that surround us today are made from non-renewable, fossil fuels. Although there are many types of plastics, the majority are non-biodegradable and will polute the environment for thousands of years to come. Fortunately, alternatives exist that allow plastics to be made from renewable agricultural crops like corn.

Figure: Plastic in the waste stream USA, 1999.

Source: http://www.ohiodnr.com/recycling/awareness/facts/plastics/plasticrecycling.htm

Plastics (resins) are typically divided into 7 categories: Poly-Ethylene Terephthalate (PET), High Density Polyethylene (HDPE), Polyvinyl Chloride (PVC), Low Density Polyethylene (LDPE), Polypropylene (PP), Polystyrene (PS), and other less common or composite plastics. At present, most municipalities only recycle plastics in the first and second categories as the other types are more costly to recycle.

Poly-Ethylene Terephthalate (PET) is perhaps the most environmental form of fossil fuel derived plastic as it can be recycled indefinitely. Soda bottles are made of this material and can be remanufactured into products such as fleece sweaters.

High Density Polyethylene (HDPE) is a plastic used to make milk containers and grocery bags. It can be down-cycled (i.e. cannot be recycled into the same product) to make products such as parking stops.

Polyvinyl Chloride (PVC) is a common plastic used in 70% of all building materials including piping, window frames, and vinyl siding. It is difficult to recycle and contains harmful constituents that can be released during use or when disposed in landfills. It is considered the plastic with the greatest potential health and environmental impacts. The PVC lifecycle (its production, use and disposal) results in the release of toxic, chlorine based chemicals. These toxins are building up in water, air and the food chain. The use of PVC compares unfavorably with other building materials in: air quality, embodied energy, recyclable and lifecycle toxicity impacts.

Low Density Polyethylene (LDPE) is used in food freezer bags, paint can lids, shrink wrap packaging and electrical wire casings. This plastic can be recycled similar to PETE plastics.

Polypropylene (PP) is used extensively in flooring products such as carpets. This type of plastic can be recycled although many products such as carpet include other materials that make it difficult to recycle.

Polystyrene (PS) is a common plastic used to make insulation products or packaging. It tends to disintegrate into smaller components and thus is extremely difficult to recycle or dispose of.

This category of plastics is the most difficult to recycle as it includes less common types of plastic and composite products like televisions and electronics that are difficult to separate.

CHECKLIST

*Avoid using fossil fuel based plastics and derivative products wherever possible.

*Seek alternative designs or use non-plastic substitutes where available.

WEB RESOURCES

Bioplastics
http://www.bioplastic.org

PVC - Polyvinyl Chloride
http://europa.eu.int/comm/environment/waste/pvc/index.htm

ENVIRONMENTAL DESIGN ELEMENT

Thermal Insulation and Moisture Protection (DIV7) - Issues

Resource efficient options:
-mineral-fibre is made primarily from basalt rock and steel mill slag, loose-fill, batts, and rigid board;
-glass-fibre is now available with 30%+ post consumer recycled glass content, loose-fill, batts, and rigid board;
-cellulose thermal insulation and acoustic sprayed coatings contain at least 70% post consumer recycled paper, does not settle after installation, may contain mineral fibre for fire retardancy and acoustic mediation;
-foamed polystyrene insulation is available with post consumer recycled content (See Table 3.3.1 above), expanded types are made with non-CFC gas, extruded types were made with CFCs – now with HCFCs, consider new varieties made without HCFCs;
-urethane foams, made with HCFCs, rigid board, and sprayed-in-place;
-vermiculite and perlite are naturally occurring materials, used in plaster mixtures, and loose-fill;
-spray-in-place foamed silicate mixture insulation is made from sodium silicate and magnesium oxychloride, used for fire retardancy, spray fill;
-strawbales…
-reflective film-radiant insulation, made from aluminium foil and metallized plastics, used to reduce radiant component of energy transfer, requires air space.

CHECKLIST

WEB RESOURCES

Appleseed Wool Corp., a wool-based products mill in North Central Ohio
http://www.appleseedwool.com

Bonded Logic and Ultra Touch Natural Cotton Insulation
http://www.bondedlogic.com

CIMA - Cellulose Insulation Manufacturers Association
http://www.cellulose.org

Cocoon Cellulose Insulation
http://www.cocooninsulation.com

Industry Leaders in natural fibre based thermal & acoustic insulation manufactured from a variety of fibres
http://www.woolbloc.co.nz

RELATED PRODUCTS

Cellulose Insulation
http://www.cellulose.org

ENVIRONMENTAL DESIGN ELEMENT

Thermal Insulation and Moisture Protection Alternatives and Solutions

-Health and pollution issues: precautions should be taken to avoid inhalation of insulation particles (especially glass-fibre), fumes from burning plastic insulation are particularly toxic and may be banned in some cases, consider using natural products w

CHECKLIST

ENVIRONMENTAL DESIGN ELEMENT

Cladding and Roofing - Issues

Resource efficient options:
-metal panels, made of galvanized steel and enamelled or anodized aluminium, durable and recyclable, little material to cover area, generally for pitched roofs and cladding;
-composite shingles, tiles, and panels, made of fibre-reinforced cement products (some coated with plastics, enamels, or thin metals), consider colour and resulting impacts on design HVAC;
-stucco, …;
-higher-quality asphalt shingles and fibreglass shingles, available with recycled content, consider colour and resulting impacts on design HVAC;
-torch-on roofing for flat or low pitch roofs, easy to repair, easy to install topsoil and sod on top (adding insulation), no recycling system available, easy to remove;

CHECKLIST

WEB RESOURCES
EcoStar Premium Roofing Premium Performance
http://www.ecostarinc.com

Slate Roofing
http://www.durableslate.com

RELATED PRODUCTS
Roofing Shingles
http://www.atlasroofing.com

ENVIRONMENTAL DESIGN ELEMENT

Cladding and Roofing Alternatives and Solutions

design element

CHECKLIST

ENVIRONMENTAL DESIGN ELEMENT

Sealants - Issues

Resource efficient options:
-selection of products with best durability and life span is optimum choice due to costs of replacing and damage resulting from sealant failure.

CHECKLIST

ENVIRONMENTAL DESIGN ELEMENT

Sealants Alternatives and Solutions

design element

CHECKLIST

ENVIRONMENTAL DESIGN ELEMENT

Gypsum Products Issues

CHECKLIST

*Gypsum board is available with post-consumer recycled gypsum content (typically 10-15%), paper facing can be made with recycled paper, gypsum board can be recycled if not contaminated with paint or adhesives.

RELATED PRODUCTS
Recycled Content Gypsum
http://www.bpb-celotex.com

ENVIRONMENTAL DESIGN ELEMENT

Gypsum Products Alternatives and Solutions

CHECKLIST

ENVIRONMENTAL DESIGN ELEMENT

Engineered or Composite Wood or Plastic Panels Issues

Resource efficient options:
-hardboards, made from wood fibre that is pressed and heated, typically no adhesive is required as natural lignin in wood bonds to form panels, resource efficient, durable, can be easily recycled;
-particleboard and medium-density fibreboard (MDF) panels, made from sawdust, wood chips which are pressed with glue, resource-efficient, potential source of off-gassing if not sealed;
-low-density fibreboards, made from paper and wood fibre, most panels don’t contain glue, resource efficient, recyclable;

-veneered wood panels (i.e. oriented strand board with hard wood facing), resource efficient, recyclable, may contain adhesives that can off-gas;
-recycled plastic panels, made from consumer product waste, resource efficient, potentially recyclable, may contain ingredients that can off-gas;
-vegetable-oil based plastics, made with coloured minerals, metal shavings, wood fibre, or plastic waste, reusable, resource efficient;
-fibre-reinforced cement boards, made from recycled fibre, resource efficient, reusable.

CHECKLIST

ENVIRONMENTAL DESIGN ELEMENT

Engineered or Composite Wood or Plastic Panels Alternatives and Solutio

CHECKLIST

ENVIRONMENTAL DESIGN ELEMENT

High Pressure Laminates Issues

Resource efficient options:
-made from laminating paper and colourants together with melamine (i.e. phenolic) resin, durable, products with recycled content not available as of yet.

CHECKLIST

ENVIRONMENTAL DESIGN ELEMENT

High Pressure Laminates Alternatives and Solutions

CHECKLIST

ENVIRONMENTAL DESIGN ELEMENT

Ceramics and Terrazzo Issues

Resource efficient options:
-local or regional ceramic products reduce impact of transportation;
-some ceramic products are available with recycled content (70% or more);

-terrazzo, made from cement and crushed stone, resource efficient.

CHECKLIST

ENVIRONMENTAL DESIGN ELEMENT

Ceramics and Terrazzo Alternatives and Solutions

CHECKLIST

ENVIRONMENTAL DESIGN ELEMENT

Wood Flooring Issues

Resource efficient options:
-salvaged solid-wood flooring, resource efficient, less expensive but increase cost of installation, requires sanding and refinishing;
-new wood flooring, made with veneers or laminates, resource efficient, may contain glues that can off-gas;
-domestic hardwoods (i.e. oak, maple, birch, ash, Australian eucalyptus, Scandinavian beech), most likely to come from sustainable sources, sustainable tropical hardwoods are also available;
-steel-track system using wedges to hold flooring down provides greatest reusability, nailing offers reusable potential, glue offers least reusability.

CHECKLIST

WEB RESOURCES
Aged Woods®-Rustic, wide plank antique flooring recycled from old barn wood.
http://www.agedwoods.com

Bamboo Flooring International
http://www.bamboo-flooring.com

Mesquite Hardwood Flooring Home Page
http://home.flash.net/~ccwdwrks

ENVIRONMENTAL DESIGN ELEMENT

Wood Flooring Alternatives and Solutions

CHECKLIST

ENVIRONMENTAL DESIGN ELEMENT

Resilient Flooring Issues

Resource efficient options:
-true linoleum products, made from linseed oil, cork, wood dust, or jute, highly durable, renewable materials;
-recycled rubber flooring, made from recycled tires and waste, resource efficient, good for high traffic areas.

CHECKLIST

WEB RESOURCES
Natural Home Products; Wool Carpet, Cork Flooring, Nontoxic Paint, Organic Cotton Bedding
http://www.naturalhomeproducts.com

ENVIRONMENTAL DESIGN ELEMENT

Resilient Flooring Alternatives and Solutions

CHECKLIST

ENVIRONMENTAL DESIGN ELEMENT

Carpets and Underpads Issues

Resource efficient options:
-polyester and nylon blended carpets, made with recycled content from PET soft-drink containers, varied performance and durability characteristics;
-high density, low-pile wool carpet, renewable material, inherent fire resistance, adequate durability;
-carpet tile and releasable roll carpet systems, longer life span potential, reusable or recyclable;
-nylon 6, high level of recyclability;
-carpet pad, made from sponge plastics and rubber, available with recycled content;
-carpet pad, made from natural jute or other products…

CHECKLIST

WEB RESOURCES
Colin Cambell & Sons Ltd.
http://www.colcam.com

Interface Carpet Tile
http://www.interfaceinc.com

Nature's Carpet
http://www.naturescarpet.com

RELATED PRODUCTS
Carpet Tile
http://www.millikencarpet.com

ENVIRONMENTAL DESIGN ELEMENT

Carpets and Underpads Alternatives and Solutions

CHECKLIST

ENVIRONMENTAL DESIGN ELEMENT

Finished Concrete Flooring Issues

Resource efficient options:
-See Paints below, proper sealing and waxing can prolong life.

CHECKLIST

ENVIRONMENTAL DESIGN ELEMENT

Finished Concrete Flooring Alternatives and Solutions

CHECKLIST

ENVIRONMENTAL DESIGN ELEMENT

Paint Issues

Paint is a common finish applied to buildings for a variety of reasons including preserving materials. Paint also offers a low-impact means to refurbish an interior or exterior surface, without having to remove and replace building materials. However, conventional paint causes significant pollution.

Indoor Air Quality
Conventional paints are the most significant producer of indoor air quality problems. This is a result of the fact that paint

begins as a liquid but must dry. The drying process involves the evaporation of liquid chemicals in the paint that enter the air as vapours. These chemicals often referred to as VOC's or volatile organic compounds are particularly harmful in the indoor environment.

CHECKLIST

*Identify and remediate any sources of lead paint in an existing building.

WEB RESOURCES

AFM - American Formulating Manufacturers
http://www.afmsafecoat.com

BioShield Natural Paints
http://www.bioshieldpaint.com

INSULADD - Insulating paints and additives reduce homeowners utility bills as much as 40%
http://www.insuladd.com

Livos Natural Paints
http://www.livos.com

Non Toxic Products
http://www.nwbuildnet.com

The Old Fashioned Milk Paint Co., Inc.
http://www.milkpaint.com

RELATED PRODUCTS

Insulating Paint
http://www.insuladd.com

Milk Paint
http://www.milkpaint.com

Natural Paints and Finishes
http://www.aurousa.com

Natural Paints, Stains, Finishes, and Cleaners
http://www.bioshieldpaint.com

ENVIRONMENTAL DESIGN ELEMENT

Paint Alternatives and Solutions

Alternatives to conventional paint products are becoming widely available. Low-VOC paint is the most common alternative and is cost comparable to conventional varieties.

Resource efficient options include:
-recycled paints, resource efficient
-solvent based paints
-low or no VOC paints
-low or no Biocide paints

-natural paint, made from all natural ingredients (i.e. citrus base), renewable, recyclable, compostable

CHECKLIST

*Avoid oil-based (fossil fuel; natural oil like citrus OK) paints.

*At minimum choose water-based paints.

*Seek low or no VOC paints whenever possible.

*Consider materials that do not require finishes, thus avoiding the continual maintenance of paint.

ENVIRONMENTAL DESIGN ELEMENT

Ceiling Tiles Issues

Resource efficient options:
-Ceiling tile, made from mineral fibre with added clay or gypsum fibres for fire retardency, reusable, recyclable.

CHECKLIST

ENVIRONMENTAL DESIGN ELEMENT

Ceiling Tiles Alternatives and Solutions

CHECKLIST

ENVIRONMENTAL DESIGN ELEMENT

Finishes - Specialties

Resource efficient options:
-demountable systems or office partitions, made with recycled content, significantly reduces waste due to change in floor plans;
-decking and patio products
-siding…

CHECKLIST

ENVIRONMENTAL DESIGN ELEMENT

Furniture Issues

Choice of furniture can be significant when measuring the environmental impact of a building over its life cycle.

Unfortunately, many furniture items contain numerous synthetic materials and chemicals, as well as natural materials sourced from disappearing ecosystems.

CHECKLIST

*

WEB RESOURCES

Baltix Furniture - Home of the EcoBUZZ
http://www.baltix.com

Natural Organic Chemical Free Home Products
http://www.nontoxic.com

Natural TREE Furniture
http://www.smithindustries.com

Returndesign
http://www.returdesign.com

ENVIRONMENTAL DESIGN ELEMENT

Furniture Alternatives and Solutions

Resource efficient options:
-used, refinished or reclaimed furniture, resource efficient;
-reconditioned furniture, resource efficient;
-furniture, made from steel, glass, and/or solid wood, reusable, recyclable;
-furniture, made from tropical hardwoods, durable, reusable, recyclable;
-upholstery and foams, previously made using CFCs, now available using HCFCs or other less harmful processes.

CHECKLIST

*Avoid purchasing any new furniture that uses products from old growth forests or tropical forests.

*Consider reclaiming furniture that has old growth or tropical hardwood.

*Avoid furniture products that use MDF or other manufactured wood that contain formaldehyde gluing agents.

*Consider furniture that uses smart design to minimize hardware.

ENVIRONMENTAL DESIGN ELEMENT

Straw Bale

History of Straw Bale

Agricultural materials have been used in construction for millennia. The earliest straw bale structure in North America was likely built in Bayard Nebraska in 1896. It was a ‘Nebraska-style’ load-bearing schoolhouse with a sod roof. These straw bale buildings were meant to be temporary shelter but once people lived in them they realized that the straw bale design afforded superior insulation and protection from the elements.

The first post and beam strawbale home was built in Alabama in 1936. Straw bale popularity waned however after World War II due mainly to the availability of other building materials such as timber and manufactured synthetic insulation products. The energy crisis of the 1970's revived interest in straw bale and led to Roger Welsch's 1974 seminal article, 'Baled Hay' in the journal Shelter.

The first permitted (bank-financed and insured as well) straw bale structure in the United States was built in 1991 in Tesuque, New Mexico by Virginia Carabelli. 'The Last Straw' newsletter began circulation this year as well by pioneer straw builders Matts Myhrman and Judy Knox. A permitted load-bearing straw bale structure followed in 1993. This was the same year of the first straw bale conference, 'Roots of Revival' in Arthur, Nebraska. The event attracted more than 50 design and construction enthusiasts.

Strawbale structures appeared in Canada as well, with significant work by Francois Tanguay in Quebec during the early 1980's. He along with Michel Bergeron and the Canada Mortgage and Housing Corporation conducted strength and heat conduction research that allowed for further funding and wider adoption by the building industry. They also experimented with straw fibres in place of steel rebar in concrete. Their work led to the formation of ArchiBio (Architecture Bioclimatique). They later taught workshops in France and were involved in a number of straw bale buildings in Europe. However they weren't the first as France's first straw bale building was commissioned in 1979. In the early 1990's a Fin designed and built a straw bale home without the knowledge that straw bale buildings existed.

In western Canada, a straw bale church built in the 1950's remains as a testament to the early Alberta pioneers of this building archetype. Jorg and Helen Ostrowski have led the straw bale initiative in Alberta with the design of a number of straw bale buildings including what maybe the first straw bale commercial building in North America (2000).

Straw bales have been used to make buildings in the Steppes of Russia since at least 1994, in Mexico since the early 1990's and in Guatemala in 1994. The technology has been spreading in Latin America with the aid of a variety of organizations including the 'Farmer to Farmer' program of the University of Arizona.

Benefits of Straw Bale Buildings

Straw bales are almost the ideal building material. Typically straw is treated as an agricultural waste product as it is slow to decay unlike nitrogen-rich hay. As a result, farmers often burn straw on the field as a means to remove it. This creates significant air pollution. Sacramento California suffers for a month each year as a million tons of straw are burnt in the valley releasing carbon monoxide and particulates that cause respiratory problems and cancer. This pollution is equal to the total amount produced annually by the state's electrical generation facilities combined. It is estimated that enough straw is incinerated each year in the U.S. to build 5 million 2000 square foot homes.

As a resource instead of a waste product, straw bales can be sustainably grown (ideally as perennial crop; intercropped in China) in low quality soil and are a biodegradable all natural material. Bales are durable, breathable, and provide significant thermal mass and sound attenuation. The R-value of straw bales is 3/inch (2.4 with grain) as compared to wood 1/inch, brick 0.2/inch, and fibre glass batt insulation 3/inch. The embodied energy of straw bales is approximately 1/50th of concrete (1 ton straw = 112,500 BTUs, 1 ton concrete = 5,800,000 BTUs). A typical straw bale wall has 1/30th the embodied energy of a timber frame wall. Straw bale construction requires non-specialized labour (basic skills can be learned in a 2-day workshop), minimal tools, and is a catalyst for social interaction and community involvement.

Details of Straw Bale Construction

Straw bales can be made from rice, wheat, rye, flax, barley, and oats. Halophytes (plants that grow in salt water) and recycled paper fibre may also be used. Bales that are bound with string (jute or polypropylene) are easier to work with than wire.

Straw bale walls are effective as load-bearing members and typically sustain 10,000 lbs/sq.ft. when bales are laying flat. Bales that are arranged on edge (see Figure below) are less effective as load-bearing members but are better insulation and thus preferred for straw bale infill insulation. Straw bale design is effective at absorbing seismic loads. With 8 out of

10 buildings worldwide constructed of earth, adobe, and stone, straw bale could significantly reduce the damage caused by earthquakes around the world.

Straw bales have exceptional fire resistance due to the lack of air circulation that penetrates the bales. Rodents are less a concern than once thought. More space is available for rodents in other building methods, and the seed of the straw, which attracts rodents has been removed. Termites prefer wood and can be deterred by termite shields, sand barriers, vapour barriers, diatomaceous earth and borax (also a good fire retardent).

Load-bearing designs are more difficult to attain building code approval (where required) and thus a variety of infill designs are often used.

CHECKLIST

*In agricultural regions where straw is burned or otherwise considered a waste product, consider utilizing straw as an insulation alternative.

REFERENCES

Steen Athena Swentzell, Bill Steen, and David Bainbridge
The Straw Bale House 1994

WEB RESOURCES

Basics of Strawbale Construction
http://www.cedn.org/strawbale/crashc.html

CREST: Strawbale Discussion List Archives
http://www.repp.org/discussion/strawbale/200210

EREN - Strawbale mailing list
http://www.eren.doe.gov/resources/list-Strawbale.html

International Straw Bale Registry Project: Insurance
http://sbregistry.greenbuilder.com/insurance.straw

International Straw Bale Registry Project: Mortgages
http://sbregistry.greenbuilder.com/mortgage.straw

Sourcebook Straw Bale
http://www.greenbuilder.com/sourcebook/strawbale.html

Straw Bale Construction
http://sol.crest.org/efficiency/straw_insulation/index.html

Straw Bale Construction
http://www.chebucto.ns.ca/~kimt/strawbale.html

Straw Bale Home Renewable Energy Powered
http://www.bright.net/~solarcre/so00012.htm

Straw Bale Homes and Straw Bale Construction
http://www.harvesthomes.ca

Strawbale
http://strawbale.archinet.com.au

Strawbale Airdrie Environmental Education Centre
http://www.duxtonwindows.com/Pages/airdrie.html

Strawbale Builders
http://www.well.com/user/demigalt/STRAW/strbld.html

Strawbale Components
http://www2.whidbey.com/lighthook/sbparts.htm

StrawBale Construction
http://web.ionsys.com/~ecorc/Strawbale.html

Strawbale Construction
http://www.21design.com/prodinfo/strawbale

Strawbale Construction
http://www.epsea.org/straw.html

Strawbale FAQ
http://www.dsaarch.com/SB%20FAQ.htm

The Last Straw - The Grassroots Journal of Straw-Bale and Natural Building
http://www.strawhomes.com

Time to Bale
http://www.timetobale.com

U.S. Strawbale Construction: A Short History
http://www.oberlin.edu/news-info/98sep/strawbale_history.html

ENVIRONMENTAL DESIGN ELEMENT

Cob

Earth is probably the world's most common building material. The word cob comes from an Old English root meaning a lump or rounded mass. Cob building uses hands and feet to form lumps of earth mixed with sand and straw, a sensory and aesthetic experience similar to sculpting with clay. Cob is easy to learn and inexpensive to build. Because there are no forms, ramming, cement or rectilinear bricks, cob lends itself to organic shapes, curved walls, arches and niches. Earth homes are cool in summer, warm in winter and suitable to rainy climates.
Cob has been used for millennia even in the harsh climates of coastal Britain. Thousands of comfortable and picturesque cob homes in England have been continuously occupied for many centuries and now command very high market values. With recent rises in the price of lumber and interest in natural and environmentally safe building practices, cob is enjoying a renaissance. This ancient technology doesn't contribute to deforestation, pollution or mining, nor depend on manufactured materials or power tools. Earth is non-toxic and completely recyclable. In this age of environmental degradation, dwindling natural resources, and chemical toxins hidden in our homes, doesn't it make sense to return to nature's most abundant, cheap and healthy building material?

CHECKLIST

Adobe

Adobe is one of man's first building materials. The mass of the adobe walls will absorb heat and radiate it back out into the house at night. In the summer the converse is true. Thus the swing in temperature inside the house is very mild. For thousands of years adobe houses have represented the practical wisdom of people who learned how to use the materials at hand to build homes that fitted the climate and landscape in which they lived. Adobe making runs back to the time of Pharaoh who withheld from the children of Israel the straw for sun-baked bricks. Adobe construction also embodies strands of our southwestern history. When the Spaniards came to New Mexico they found the Indians using adobe, wood, and stone to house themselves. The Indians did not make bricks, but "puddled" the mud allowing each layer to dry before adding more. Adopting these materials the Spanish made moveable sun-baked bricks, formal fireplaces, and wooden doors. "Adobe" is a Spanish word derived from the Arabic "atob," which literally means sun-dried brick. The Spanish brought to the the Southwest the craft of forming the mud into blocks in wooden molds which is still used today.

Today's bricks are 14 inches long, 10 inches wide, and 4 inches high. They are still made with straw to make the dried mud more weather resistant, and also have a small bit of asphalt mixed in to stabilize them. The bricks can be bought at a reasonable price from a manufacturer who uses bulldozers to mix and pour the mud into the forms. After the mud is poured a board is drawn across the top of the forms to take away excess mud and make the surface flat. After the bricks are dried they are taken from the forms and stacked by hand. The average cost of a brick is about 60 cents. Because the weight of an adobe house is so much greater than that of a frame house, the ground must not only be cleared, but should be compressed before the foundation and bricks are laid. If the ground is not compressed there could be movement promoting cracks in the walls at some later time. Next the footing is dug with a back hoe and then hand tampered to compress the dirt once again. In the Albuquerque area the footing is laid about 18 inches below grade (the surface) to avoid the expanding and contracting that takes place when temperatures go below freezing. In the mountains and the colder regions of New Mexico the footing level will be deeper. Both the footing and the stem wall of an adobe home must be larger because of the extra weight of the walls. The footing and stem wall of a frame house are commonly 16" and 6" respectively. The footing and stem wall of an adobe house are commonly 24" and 14" respectively. Of course this increases the cost of adobe construction.

After the foundation is completed, the first layer or "course" of bricks must be laid. This course must be made of special adobe bricks that are made with more asphalt to make them waterproof. It is best is best to lay the adobe bricks in warm weather because the mud used as mortar will freeze. Ditch bank dirt is used for this purpose because it does not have too much clay or too much sand. The right consistency will shake off a shovel. The mud is applied with a shovel and trowel. Each course is laid the whole length of the walls at the same time with bricks overlapping at the corners. Story poles are set at the ends of the walls and support a string used to mark the next course of adobes. Lintels are beams of wood put over the windows and doors. They are often decoratively carved and serve as headers that help support the openings. Construction progresses and adobes are laid one brick at a time with a "more or less" attitude. While, in construction of a frame house, all of the structures and drywall must be measured and cut exactly to fit with precision. People who are sensitive to toxic substances prefer to build with adobe since their is no need to use chipboard filled with formaldehyde.

When the courses of adobes are high enough, bond beams are laid to tie all the walls together and the vigas are laid on top of this with more adobes in between them. The vigas, hewn from trees, make up the ceiling and are often seen sticking out of adobe houses. Traditionally they were not cut off at the walls simply because of the labor involved, but they have since become a notable architectural trait of the adobe house. Over the vigas, latias are laid at 90 degree angles to each other creating a pattern design. Latias are smaller hewn poles made of pine, spruce or aspen. Sometimes today one inch decking boards are used instead of latias because they are more economical. Twelve inches of fiberglass insulation is then installed between 2" x 6" sleepers which are sloped to give a gravel and tar roof drainage.

This is called a pocket roof because the space between the ceiling and the roof provides an area for electrical wiring, recessed lighting, and insulation. A canale, or drain channel, is put in every ten feet or so to help any water drain from the roof.

If two inches of foam insulation is applied to the outside walls at this point it will increase the ability of the adobe walls to maintain an even temperature. This will bring a 14" adobe up to an R-value of 22. A screen is applied after that to help the plaster tack to the walls. Plaster is applied in three coats after the foundation, walls, ceiling and roof are completed. Plastering is said to be an acquired skill. Ninety percent of the cost of the plastering is in the labor.
In present day, the adobe house is for the very rich or the very poor, not because of the expense of the materials or the complexity of construction, but because of the expense or availability of labor. Adobe construction is labor and detail intensive. You must be rich enough to hire out the labor, or poor enough to have the time to do the labor yourself. A custom built adobe house will cost about $100 and up per square foot. An active solar design may add $20,000 to the final cost.

A frame house might go up in two months, while a 3000-3500 square foot adobe might take nine to ten months to construct, Typically, adobe walls range in thickness from 10 to 30 inches with 14 inches being the mean. A frame house will have 4 inch walls and about 5% of the house will be consumes in the walls. The walls of an adobe house will absorb 15-20% of the total space because of their thickness.

CHECKLIST

WEB RESOURCES
Adobe Homes
http://www.epsea.org/adobe.html

Your portal to building Adobe Homes, Rammed Earth, Green building, Adobe Houses, and Passive Solar Homes
http://www.adobebuilder.com

ENVIRONMENTAL DESIGN ELEMENT

Rammed Earth

Rammed/Stabilized Earth
When you take into account energy efficiency, environmental responsibility, price, comfort, longevity, inherent beauty and architectural power, there is simply no better value in today's home buying market.
But before you make the final commitment to build with earth, there are a few important points you need to think about. The advantages, of course, are numerous and we've taken the opportunity of describing them for you below. There are also certain characteristics of the walls that some people think of as limitations (although to others these same features are considered enhancements). It's critical to us that you be fully aware of these characteristics so that if you do build with earth both your experiences during construction and your appreciation of the finished product will be as rewarding as possible.
The Benefits
Thermal Flywheel Effect
The ability of a solid earth wall to store energy for long periods of time results in interior temperatures that change very little from day to night. Mass walls absorb solar energy during winter days and then re-radiate that energy to offset nighttime heat losses within the building. In the summer months, the mass of the walls absorbs excess heat generated during the day, keeping the inside spaces surprisingly cool, then releases that stored heat to the clear night sky. In a properly designed and oriented building, this can mean significant savings in heating and cooling bills. And because the energy that controls the temperature inside the building radiates directly from the mass of the walls, the quality of the

comfort inside is noticeably different than in a space regulated through mechanically altered air. Couple a mass wall with a hydronic radiant slab to achieve the most quiet, uniform, and dust-free heating system available.

Indoor air quality

Earthwalls improve the quality of the indoor environment. Unlike wood-frame buildings, packed full of potentially harmful manufactured materials which can outgas hazardous fumes for months, an earth walled building with a natural finish emits no toxins whatsoever.

Longevity, durability, and low maintenance

Walls built of raw earth in China, Africa, and even the cold wet climates of northern Europe continue to provide shelter after several hundred years of use. With the addition of modern stabilizers, concrete foundations, and steel reinforcing, we can say in total confidence that our earth walls will last for many centuries. And like all other masonry wall systems, whether they are brick, stone, or concrete, exterior maintenance is virtually eliminated.

Fire and insect resistance

Two important reasons for choosing to build with solid earth walls are that they are fireproof and resistant to damage from termites and other insects. Both these factors contribute to greater longevity, of course, but they can also mean an important increase in safety for you and for future occupants

Intangible qualities

One of the most appealing aspects of a house with thick earth walls is the indescribable feeling you get just being inside. There is a certain calmness that simply can't be duplicated with lightweight building materials, no matter what the architecture. Whether it is simply the energy of thermal mass, the healthful air of a natural environment, the quiet that results from the sound absorbing nature of the solid earth, or some other less identifiable quality, there is something special happening inside.

Environmental responsibility

Perhaps the best reason to build with earth is the boost it can give to the health of the planet. Earth is an unprocessed, widely available building material with virtually no side effects associated with its harvesting or use. Since an earth walled building saves construction and energy resources, doesn't pollute, and lasts practically forever it a wise investment in the future of the planet.

The Frequently Asked Questions

Structural integrity

The first question people usually ask about earth walls is, "How do they respond to earthquakes?" The answer is that earthquake safety is our number one concern. In fact, it was the very first engineering task we addressed twenty years ago when the modern renaissance of rammed earth began. Today, there are several different design approaches we employ depending on the design of the building, the method of construction, and the proximity to an earthquake fault. In some cases, individual panels of earth are enclosed within a framework of cast-in-place concrete. In others, the earth walls are fully reinforced with an integral grid of steel reinforcing rods. A third approach is a continuous solid earth wall topped with a bond beam of reinforced concrete. Whatever the engineering design, every wall system is in full compliance with local building codes, including projects built in seismic zone four localities. Each is constructed to the highest standards of workmanship and quality control.

Weathering characteristics

The second most frequently asked question is, "What happens when it rains?" The answer is that if the soil is selected properly and the wall constructed according to specifications, the finished product is as resistant to deterioration as the parent rock from which the soil came, and in some cases even more so. Tests conducted on samples of finished walls demonstrate that stabilized earth can be completely saturated for months at a time without any deterioration whatsoever. Because not all soils are ideal, and because earth loses its insulative properties when it becomes wet, in climates where rainfall can be extreme, walls should be protected against saturation with ample roof overhangs and raised foundations.

What about Radon?

Radon is in fact never confined to any one soil but rather originates deep underground in certain rock formations and passes directly through the mineral soil and the top soil as it escapes to the atmosphere. Radon is of concern when air tight houses are mistakenly constructed on top of these formations.

How much do they cost?

Houses with walls of solid earth will cost slightly more than a comparably designed house with wood-frame walls. As explained above, they are both a better product and a better investment. How much more they cost will depend on your site, the height and complexity of the wall system, the available soil, and the seismic safety factors. Generally the cost increase ranges between 5% and 10%.

The Limitations

The Nature of the Process

Stabilized earth construction, whether it is traditional rammed earth or the new PISÉ process, is still a made-by-hand product. As such, it exhibits all the inconsistencies and variations that characterize any handmade item.

The color and texture of the finished wall will vary from spot to spot. Some areas may be rough and less well-consolidated than others. Shrinkage cracks, honeycombing, and voids are inevitable. Tolerances for line and level are typically more forgiving than for manufactured building materials. In short, a brand new earth wall looks old the minute the formwork comes off.

For the homeowner who desires this old world look, earth walls are a natural. To one who seeks the comfort, security, and energy efficiency of affordable thermal mass, without the patina of antiquity, a wide range of washes and plaster finishes can be applied to the interior wall surfaces.

The truth is, the way the walls look straight off the formwork may not be to your liking, and we recommend that you include the price of a plaster finish in your construction budgeting. If, as the rest of the building takes shape, the natural finish walls enhance the look of the interior in your eyes, then the money reserved for plastering can be invested in some other upgrade to the building finishes.

Efflorescence

In some cases, especially when walls are constructed during wet, cold weather, free lime in the soil mixture can migrate to the wall surfaces, causing a powdery white stain to appear. Efflorescence can be minimized during the curing process by covering the walls with polyethylene if prolonged wet weather is anticipated. Although it is difficult to remove completely, a washing with a mild muriatic solution will greatly reduce the staining.

Exterior waterproofing

Stabilized earth walls, like rock, are slightly porous. In arid regions, the exterior surfaces should require no waterproofing whatsoever. In areas where snow or wind driven rain can be severe, moisture may penetrate all the way to the inside surface of the walls during prolonged storms. In these regions, we recommend sealing the exterior walls, either all of them or only those which are expected to take the brunt of the storm and are not adequately protected by roof overhangs.

Interior wall sealing

Some walls, especially those made with very fine-grained soils, may have a tendency to dust slightly on the inside surfaces. With these soils, and when plaster is not being applied, we recommend applying a coat of clear penetrating sealer such as Ramseal, a product made especially for stabilized earth walls. Even without a dusting condition, a clear sealer can make it easier to keep the natural earth walls clean.

CHECKLIST

WEB RESOURCES

Amazon.com: buying info: Adobe Pressed Earth and Rammed Earth Industries in New Mexico
http://www.amazon.com/exec/obidos/ASIN/9991556389/qid=996517472/sr=1-5/yourhomeplanet09

Rammed Earth - The Australian Connection
http://www.hahaha.com.au/rammed.earth

ENVIRONMENTAL DESIGN ELEMENT

Gabion Baskets

Seek resource efficient alternatives to concrete and asphalt for land retention.

Gabion baskets are a highly effective, resource efficient, and relatively inexpensive type of retention or check dam structure.

Gabion baskets are rectangular spaces defined by wire-mesh and filled with stone. When stone is readily available, environmental impacts are reduced due to the small embodied energy of the metal mesh (as opposed to concrete) and minimal energy required to transport the gabions and stone to a site. As well, the decommissioning of gabion baskets produces little waste as the gabions are 100% recyclable metals and the stone is local material.<p align=left>

Advantages

- Gabions can be purchased in various sizes to suit the height and width of drop required.
- Economical, especially if field stone is available.
- Less costly (economic, environmental) than rock chutes, especially if rock must be trucked in.
- Easy to transport, assemble and install on-site.
- Channel gradient is reduced, encouraging soil deposition and vegetative growth.
- Gabions are flexible, allowing settlement or frost movement without fracture.
- Little maintenance is required and they can remain as permanent structures.<p align=left>

Disadvantages

- Gabion rock (75–125 mm) can be difficult to obtain at some quarries.
- Baskets are not widely available.
- Basket wire can deteriorate after several years.
- They are limited to intermittent flows and small drainage areas.

Design parameters limit their practical uses to between 0.3 – 1 m vertical drops, intermittent flows up to 1.5 m3/s, and depth and width of spillway of 0.15–0.5 m and 0.6–2.4 m respectively.

CHECKLIST

*Consider utilizing gabion baskets as an alternative to more material and energy intensive (concrete) land retention strategies.

REFERENCES

Stone, R.P. and H.W. Fraser.
<u>Fact Sheet: Gabion Basket Drop Structures Along</u>, Ministry of Agriculture, Government of Ontario. http://www.gov.on.ca/OMAFRA/english/engineer/facts/99-049.htm 1999

WEB RESOURCES

Gabion Baskets,Gabion Walls,Gabion Wire,Gabion Mattresses,Hexagonal Mesh
http://www.kiciman.com

RELATED PRODUCTS

Gabion Baskets
http://www.kiciman.com

ENVIRONMENTAL DESIGN ELEMENT

Water Cycle, Pollution

Fresh water is a finite resource. We cannot easily or cost effectively create more fresh water than what is already within the global water cycle. Like energy efficiency in the 1970's, conserving water in building operations is often easy to implement because of the inefficiency in our current systems.

It is important to understand that fresh water is part of a finite recycling loop on the planet. Fresh water once polluted is extremely difficult to clean due in part to the dispersion of the pollutant throughout the cycle, and the inaccessibility of many fresh water sources.

Below is a digram depicting the cycle of freshwater. The most relevant components for buildings is the surface runoff, infiltration, and groundwater reservoirs.

FIGURE 1: The Water Cycle

Water pollution can take many forms. Pollutants can include chemicals, biological constituents, and/or changes to water characteristics.

Chemicals that can pollute water include both natural and synthetical varieties. Organic chemicals are waste products of organic processes like animal waste decomposition (nitrates, nitrites) that can combine with and become a part of the food chain. Natural occuring constituents like Calcium can produce hard water which has led to a remediation strategy that releases another natural constituent, Sodium to be released in excess quantities into the environment causing saline pollution.

Synthetic chemicals include over 60,000 new chemicals that have been produced since World War 2. Pesticides and herbicides that are sprayed on agriculture run-off into waterways. Heavy metals like Mercury and Cadmium from batteries leach from landfills into groundwater reservoirs. Unused medicines get flushed down the toilet causing an excess of anti-biotics in urban wastewater effluent.

Biological contaminants can develop and flourish based on existing water pollution (for example organic waste effluent) or occur naturally when conditions permit. Numerous bacteria and viral organisms make fresh water their home.

Finally, water characteristics can be altered that impact ecosystems in a variety of ways. Hard water is treated and produces a pollution as a byproduct. Water used in cooling processes is often released into the environment, although clean, with an increased temperature that can affect the downstream ecosystem.

CHECKLIST

*Minimize any barriers or disturbances to the local water cycle.

*Identify sources of water pollution that originate or are instigated by your building or its operation and take action to minimize or eliminate them.

WEB RESOURCES

2,500 Gallons All Wet? - John Robbins
http://www.earthsave.org/newsletters/water.htm

Cleaner Water Through Conservation - Office of Water (EPA USA Government)
http://www.epa.gov/OW/you/intro.html

Earth's Water
http://ga.water.usgs.gov/edu/mearth.html

Family Health News: Water Contamination, Water Purification
http://www.familyhealthnews.com/16.html

Fresh Water and Conservation - Environment Canada
http://www.ec.gc.ca/water/en/manage/effic/e_weff.htm

The World's Water
http://www.worldwater.org

RELATED PRODUCTS
PUR Water Filters
http://www.purwater.com

ENVIRONMENTAL DESIGN ELEMENT

Preservation of Soils and Drainage

Although the net ecological footprint of a project is not readily apparent when looking at a building, the physical footprint is easily discerned and the impacts can be easily quantified. The easiest step to take is simply to minimize any impact on the existing site.

Intact soil and drainage includes entire ecosystems.

CHECKLIST

*Emphasize preservation of mature vegetated soils and lowland areas. Vegetation minimizes erosion, enhances infiltration by slowing water runoff, filters overland runoff into lowland areas, and forms habitat for species. Site construction away from mature vegetation and lowland areas.

*Minimize pavement area. Concentrate and cluster activities, consolidate parking areas, and utilize parking areas for traffic while minimizing width of any pavement.

*Install silt fences to hold sediment on-site during construction. Silt fences should be in place prior to construction beginning and until after construction when soil surfaces are stabilized (vegetated).
*Minimize the landscape irrigation, and the use of synthetic herbicides, pesticides, and fertilisers.

WEB RESOURCES
Center for Watershed Protection
http://www.cwp.org

EPA: Watersheds
http://www.epa.gov/owow/watershed

The Stormwater Manager's Resource Center
http://www.stormwatercenter.net

ENVIRONMENTAL DESIGN ELEMENT

Porous Paving Materials

Besides vegetation and soil removal, blocking infiltration and percolation of precipitation falling on a site is the most significant environmental impact of a building site. The best solution is to avoid disturbing the natural intact system which includes porous surfaces.

Porous Paving Materials:

CHECKLIST

*Consider permeable paving materials. Selecting permeable paving is an important step to minimize surface damage due to runoff, and to facilitate infiltration and replenishment of groundwater reserves.

*Retain permeable vegetated surfaces for occasionally used vehicular zones such as overflow parking and emergency access lanes. For example, permeable pavers laid on sand or block reinforced turf.

*Build pedestrian surfaces, such as walkways and patios, with loose aggregate, wooden decks, or well-spaced paving stones. Avoid using vehicular pavement.

WEB RESOURCES

Environmental Building News - Paving without Asphalt or Concrete
http://www.buildinggreen.com/products/road_oyl.html

Porous Paving
http://stormwater.melbournewater.com.au/content/planning/water_sensitive_urban_design_pp3.asp

RELATED PRODUCTS

Grasspave
http://www.invisiblestructures.com.au/products/grasspave/grasspave2.htm

ENVIRONMENTAL DESIGN ELEMENT

Drainage of Concentrated Runoff

Non-porous surfaces (for example pavement or concrete) common around buildings concentrate runoff which can lead to site erosion and water pollution.

design element

CHECKLIST

*Avoid altering drainage patterns and concentrating runoff that can lead to erosion of topsoil.

*Consider disconnecting pre-existing downspouts and storm sewers from sanitary sewers. Rather allow for runoff to infiltrate into landscape depressions (runoff volumes should be considered in this case) or gravel-filled pits.

*Moderate and treat runoff from roofs and unavoidable impervious pavements and to the degree possible, return it to its natural path in the soil. Direct concentrated flows to spread over vegetated areas. Build broad bottom vegetated swales rather than concrete structural gutters or pipes. Decrease scouring velocity by planting quick rooting riparian plants, bioengineering, and/or natural checkdams. Incorporate vegetation buffers around paved areas (i.e. parking lots).

*Retain or construct infiltration basins.

WEB RESOURCES

Evaluating Slope Drainage
http://www.ecy.wa.gov/programs/sea/pubs/95-107/sldrain01.html

ENVIRONMENTAL DESIGN ELEMENT

Overview

The natural landscape in place prior to building is the "ideal" ecosystem for the location. Through natural selection, the type and distribution of species is optimized. More often than not, landscapers alter this system resulting in increased inputs such as water, fertilizer, weed killer, compost, etc. A better approach is to work with the optimized system.

Most hotel facilities use potable water for landscape irrigation. This expensive as such high quality, treated water is unnecessary for watering plants. A better approach is to first plant drought tolerant native plants and then to either collect rainwater or recycle building greywater for irrigation purposes. High efficiency systems such as micro irrigation, moisture sensors, and weather-based controls may also be installed to effectively irrigate.

CHECKLIST

*Irrigation should be done during early or late hours of the day to avoid excessive evaporation.

*Plant native or well-adapted species. Reduces water used for irrigation. Decreases need for pest management. Enhances biodiversity while protecting local species.

*Preserve native plant population through careful site planning and protection of existing vegetation. Avoid cut-and-fill around the root zone by fencing off vegetation at the drip line.

*Restore the native landscape. Avoid non-native species, which can disrupt local populations and increase maintenance costs.

*Minimise use of high-maintenance lawns. Select drought tolerant or less water intensive varieties. Layout any lawn areas with irrigation in mind (i.e. avoid long rectangular areas, circular layouts are more efficient).

*Minimise use of annual plants. Perennials require less inputs of water, nutrients, and need less maintenance.

*Establish high and low maintenance zones. Locate high maintenance areas in high traffic areas and group similar plantings based on water requirements.

WEB RESOURCES

Water Efficient Landscape Planner (Software)
http://www.epa.gov/grtlakes/seahome/landscp.html

ENVIRONMENTAL DESIGN ELEMENT

XeriscapingTM

An ideal landscape requires no inputs other than the ones naturally provided by the local environment.

Water conservation is becoming a very important consideration when gardening in the Western US. Back in 1981, an environmental planner for the Denver Water Department coined the word "Xeriscape" to embody the principles of water conservation through creative landscaping.

DEFINITIONXeriscaping is derived from the Greek word "xeros", meaning "dry" and combined with "landscape", xeriscape means gardening with less than average water.

Briefly, here are the basic principles of water wise landscaping:

1. Planning and Design.
Whether you're starting from scratch, or renovating an existing landscape, take the time to plan out your design before you start to plant. Create different water use zones and allocate the water where it will most directly contribute to the beauty and comfort of your home.
2. Create Practical Turf Areas.
Limit the size of lawn areas and use native grasses as much as possible. Buffalo Grass is an excellent drought-tolerant alternative to thirsty Kentucky Blue Grass.

3. Use Appropriate Plants.
Use xeric plants for hot, dry south and west facing areas. Use plants that like more moisture along north and east facing slopes and walls. Don't mix plants with high and low watering needs in the same planting area.
4. Improve the Soil.
Add organic matter in the form of compost whenever you plant. This helps the soil hold extra moisture.
5. Use Mulches.
By covering the soil's surface with some type of mulch, you help retain valuable soil moisture. Mulching also helps capture rainwater by allowing hard rains to soak into the soil instead of running off into the street and drainage areas.
6. Irrigate Efficiently.
Don't over-water. Use soaker hoses and drip irrigation to water deeply and encourage deep root growth.
7. Capture Rain and Snow Run Off.
Use rain barrels and cisterns to capture water draining off roofs. Run-off from paved areas can be directed back onto the landscape to water trees, shrubs and flower beds.
8. Maintain Your Landscape and Garden Properly.
Keep irrigation systems running properly. Avoid the lush, thirsty plant growth that results from over-fertilizing.

CHECKLIST

*Planning and Design - Whether you're starting from scratch, or renovating an existing landscape, take the time to plan out your design before you start to plant. Create different water use zones and allocate the water where it will most directly contribute to the beauty and comfort of your home.

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*Irrigate Efficiently - Don't over-water. Use soaker hoses and drip irrigation to water deeply and encourage deep root growth.

*Capture Rain and Snow Run Off - Use rain barrels and cisterns to capture water draining off roofs. Run-off from paved areas can be directed back onto the landscape to water trees, shrubs and flower beds.

*Maintain Your Landscape and Garden Properly - Keep irrigation systems running properly. Avoid the lush, thirsty plant growth that results from over-fertilizing.

WEB RESOURCES
Xericaping step by step
http://www.michaelholigan.com/Departments/TVShow/seg_index.asp?ts_id=5034

ENVIRONMENTAL DESIGN ELEMENT

Irrigation Equipment

Irrigation is a large component of landscape operating costs. Efficient design is paramount to reducing landscape water use.

A water efficient landscape requires a minimal amount of supplemental water from irrigation. When irrigation is used, water should be applied efficiently and effectively to make every drop count. Wasted water costs money and may lead to surface water or groundwater contamination.

CHECKLIST

*Base irrigation design on XeriscapeTM principles. They are: planning and design, use of well-adapted plants, soil and climate analysis, practical, reduced turf areas, use of mulches, appropriate maintenance, and efficient irrigation by grouping plants with similar needs.

*Employ waterharvesting techniques. Avoid directing runoff and wastewater off site. Rather find means to reuse on site (i.e. irrigation, cooling).

*Use greywater in irrigation. Where allowable, reuse greywater for irrigation purposes.

*Install drip irrigation systems. Surficial irrigation is subject to evaporation. Design irrigation to infiltrate soils.

*Increase efficiency of irrigation with controllers and sensors. Automated mechanisms can increase efficiency if installed with conservation in mind.

*Be sure design and layout of the irrigation system is site-specific. Poor design wastes water and pumping energy.

*Maintain irrigation system regularly for efficiency. Schedule regular maintenance.

WEB RESOURCES

Water Efficient Irrigation
http://www.bae.ncsu.edu/programs/extension/publicat/wqwm/ag508_6.html

ENVIRONMENTAL DESIGN ELEMENT

Water Use Reduction

Water use like energy use is easily quantifiable. Unfortunately, the cost applied to the use of water is often far below the true value of a litre. However, similar strategies of conservation apply.

The first step is to reduce overall water usage. This can be achieved by stopping and preventing leaks in piping, installing or converting to water conserving fixtures, insulating hot water pipes, recycling greywater, collecting rainwater, and installing water meters.

Leaks within the building plumbing system may account for 10% or more of total water pumped. Proper, regular maintenance is key to reducing leaks. Low flow fixtures are often cost comparable and can be installed easily (see alternative products below).

A lot of water is wasted when people turn on the hot water and wait for it to arrive at the tap. If possible hot water production should be located nearest the points of usage. Increasing pipe insulation or installing recirculating units can save not only water but energy as well! Finally, installing water meters allows for data collection and the ability to set water reduction goals with a means to measure conservation success.

CHECKLIST

*Reduce overall water usage. Reducing water consumption decreases municipal infrastructure (if connected), reduces wastewater, reduces energy to produce hot water.

*Perform a water budget analysis to project the amount and configuration of daily wastewater flows. Without a budget, it is difficult to identify potential savings and quantify conservation successes.

*Specify, install, and retrofit low flow water fixtures.

*Select low flush 6 litre or less toilets, or install composting toilets.

*Select low or no flush urinals.

*Install aerators on all taps.

*Install or replace showerheads with low flow nozzles.

WEB RESOURCES
Water Wiser
http://www.waterwiser.org

RELATED PRODUCTS
Faucet Aerators
http://www.amconservationgroup.com/aerators.htm

Shower Aerators
http://www.amconservationgroup.com/shower.htm

Ultra-Low-Flush Toilets
http://www.watersavelogic.com

ENVIRONMENTAL DESIGN ELEMENT

Collecting Precipitation

Prior to urban water infrastructure, many people collected their own water. They understood how much water was available and how to avoid running out. Today most of us have no idea how much water we use or how much our bio-region can supply. There are some people who still collect, store and clean rainwater that falls on their roofs and they offer us some of the best lessons in sustainable building design and lifestyles.

Rainwater in many urban locations is simply directed to the sewers. This removes it from the natural process of permeating into the soil and replenishing groundwater. It is surprising in areas of aridity how only a few rainstorms a year can accumulate a significant amount of water collected over a typical roof catchment. Many of the tools are already in place as roofs are generally built to shed rain into downspouts offering a relatively easy method of collection.

CALCULATE COLLECTING POTENTIAL

Roof Area Parallel to Ground (m2) X
[Annual Precipitation (mm) / 1000 (mm/m)]

equals Average Water Collection Potential (m3/yr)

EXAMPLE: Calgary, Alberta

Roof Area Parallel to Ground = 30 m2
Average Annual Precipitation = 399 mm

AVERAGE ANNUAL COLLECTION POTENTIAL = 11.97 m3
or 11970 litres/yr (1000 litres/m3)
or 32.8 litres/day

CHECKLIST

*Collect and use “harvested” water. Rainwater, downspout runoff, cooling tower runoff can all be gravity fed to storage tanks if proper considerations are taken at the design stage. Rainwater has historically been used for a whole range of uses including potable water when proper filtering, etc. is used.

*Consider quality of rainwater. Design water runoff paths to avoid synthetic chemical surfaces (i.e. untreated asphalt shingle roofs). Specify metal or clay roofs.

*Design an appropriate harvesting and storage system. Utilize gravity wherever possible to harvest and distribute collected rainwater. Install screens or filters to remove larger particles that can clog the storage tanks and distribution piping.

WEB RESOURCES
Rainwater Harvesting and Purification System
http://www.rdrop.com/users/krishna/rainwatr.htm

Sourcebook Harvested Rainwater
http://www.greenbuilder.com/sourcebook/Rainwater.html

ENVIRONMENTAL DESIGN ELEMENT

Innovative Wastewater Treatment

A large proportion of wastewater from a typical building can be easily filtered and reused. Unfortunately, conventional plumbing prohibits this by assuming all wastewater is destinied for the treatment plant and thus is collected together.

CHECKLIST

*Reduce the generation of wastewater and potable water demand while increasing recharge of local aquifer. Check with local authorities about regulations and requirements for greywater use.

WEB RESOURCES
Living Technologies
http://www.livingtechnologies.com

Waterless sole US No-Flush Urinals manufacturer
http://www.waterless.com

RELATED PRODUCTS
Baking Soda to Clean Sinks
http://www.armandhammer.com/HowItWorks/body.htm

Dish Washing Detergent
http://www.ecover.com

Laundry Soap
http://www.ecover.com

ENVIRONMENTAL DESIGN ELEMENT

Greywater

In a building, water is typically used once and then directed to the sewer. Unfortunately, a large proportion of this water can be easily cleaned using filters and reused ("sewage is not necessarily sewage"). Instead, we have come to use expensive, treated water to flush toilets and water lawns.

Greywater or graywater (USA) refers to wastewater that can be easily reused for certain water uses within the building. It includes all the wastewater of a building besides toilet wastewater (blackwater) or other wastewater that may include biological or chemical contaminants that cannot be filtered.

Greywater contains far less nitrogen than blackwater. Nitrogen (in the form of nitrites and nitrates) is the number one problem when dealing with building wastewater. One difference between greywater and blackwater is the amount of oxygen required to decompose (nitrification) the biological contaminants. This is measured as the Biological Oxygen Demand over 5 days (BOD5). Greywater is 90% decomposed in the first 5 days whereas blackwater is only 40% decomposed.

Greywater contains less pathogens and any biological contaminants decompose quickly. The nitrogen present in greywater is also a great fertilizer and thus its application on lawns can be very beneficial as the nutrients are taken up by soil organisms and plants.

CHECKLIST

*Separate and use greywater generated from indoor uses such as laundries, showers, and sinks. Investigate during the design stage the expected quantities of greywater production for the building to see whether it is cost effective.

*Check with local health-code department to learn about regulations governing the use of greywater. Follow local regulations and requirements (i.e. setbacks from potable water sources, greywater quality standards).

*Install dual plumbing lines in building interiors. If greywater usage is cost effective for the building, then dual plumbing lines should be designed for and installed during construction to avoid added costs of retrofits. Avoid any exchange of potable water with greywater.

*Utilize greywater for non-potable purposes. Recycle greywater within building using dual plumbing lines when available.

REFERENCES

Olson E. et al.
<u>Residential Wastewater</u>. The Swedish Nation Institute for Building Research. 1968

WEB RESOURCES

A Compendium of Greywater Mistakes and Misinformation on the Web
http://oasisdesign.net/books/misinfo.htm

Graywater and Rainwater use
http://ag.arizona.edu/AZWATER/arroyo/071rain.html

Greywater (and Blackwater) Explained

http://www.greywater.com

Greywater Central
http://www.greywater.net

Greywater-Sustainable Building Sourcebook
http://www.greenbuilder.com/sourcebook/Greywater.html

ENVIRONMENTAL DESIGN ELEMENT

Blackwater

Human fecal waste is typically treated with precious water resources. Water being the simplest medium to transport human waste in the urban wastewater system. However, much of this system could be elimnated by treating toilet wastewater on-site and in fact at the point of deposit.

Blackwater refers to wastewater that has higher organic waste content that cannot easily be reused.

CHECKLIST

*When possible, treat blackwater from toilet flushing with on-site systems. Possible systems include: biological systems (i.e. constructed wetlands), aquaculture systems (wastewater becomes source for plants and aquatic animals in contained system), sand filters and aerobic tank treatment (sand filters are very cost effective), innovations in septic tanks (i.e. low-pressure dosing), and composting toilets.

*Check with local health-code department to learn about regulations governing blackwater systems.

WEB RESOURCES
Greywater (and Blackwater) Explained
http://www.greywater.com

ENVIRONMENTAL DESIGN ELEMENT

Composting Toilets

Conventional toilets (up to 20 litres per flush) attached to an urban wastewater infrastructure are inefficient means to deal with the problem of human fecal waste. Instead, composting toilets offer the opportunity to treat waste on-site without using fresh water, minimizing the amount of plumbing required (both in the building and the urban infrastructure), and providing a free source of organic fertilizer.

HOW DO COMPOSTING TOILETS WORK?

Composting toilets are the most efficient waste systems as they use little or no water in operation. And the end product is fertiliser.

CHECKLIST

*Consider employing composting toilets as a means to reduce water use and pollution.

WEB RESOURCES
Sun-Mar Composting Toilets
http://www.sun-mar.com

World of Composting Toilets - Online Journal
http://www.compostingtoilet.org

RELATED PRODUCTS
Composting Toilets
http://www.sun-mar.com

Ultra-Low-Flush Toilets
http://www.watersavelogic.com

ENVIRONMENTAL DESIGN ELEMENT

Water Reclamation

Many buildings currently treat fresh water resources as the only source of water. Thus, we water lawns and flush toilets with chlorinated potable water. Numerous efficiency gains are possible if instead we reclaimed and reused water for non-potable purposes.

Reclaimed water may include greywater or any water that has been used once in the building. This water can be used in a variety of situations to reduce overall water consumption.

CHECKLIST

*Use reclaimed water (water that comes from wastewater treatment plant) for purposes such as toilet flushing if dual distribution lines are in place. Other uses include fire protection, outdoor water features, street cleaning, wetlands recharge, cooling water, and boiler-feeder water.

*Check local regulations on use of reclaimed water.

*Apply reclaimed effluent to land. Works best with quantities of at least 10 million gallons a day or more. Can be applied to golf courses, orchards, etc. See above – Check local regulations.

*Establish site-specific monitoring procedures. Monitor for any buildup of nitrogen, phosphorus, potassium, calcium, iron, and sodium.

WEB RESOURCES
Graywater and Rainwater use
http://ag.arizona.edu/AZWATER/arroyo/071rain.html

ENVIRONMENTAL DESIGN ELEMENT

Water Conditioners

Conditioning of "hard water" consumes resources (salt, electricity, water) and produces water pollution. Unfortunately, taking no action on hard water can increase environmental impacts (for example inefficient hot water heater coils). A number of jurisdictions are considering banning salt-water softeners and thus an understanding of the alternatives is important.

In many parts of the world, available fresh water sources are “hard” or contain high concentrations of ions such as calcium. Hard water flowing through appliances tend to build up on metal objects, eventually leading to clogged pipes and reduced efficiency of hot water heat exchangers.

Calcium scale formation on the inside of pipes and water heaters, on sinks, tubs, shower doors and other water contact surfaces is a multi-million dollar problem for individuals and businesses. A thin, 30 mm (1/8th inch) layer of scale is such an effective insulator that it reduces the efficiency of your water heater by 20%. This translates directly to increased energy cost to attain the desired water temperature. Scale also increases the cost of equipment maintenance and shortens equipment life. When these costs are added together, the price of calcium scale is staggering.

THICKNESS OF SCALE IN MM (INCHES)	LOSS OF HEAT TRANSFER EFFICIENCY %
16 (1/16)	15
32 (1/8)	20
64 (1/4)	39
127 (1/2)	70
191 (3/4)	

The conventional solution to hard water has been to add salt via a water-conditioning device. This costs the building operator in regular salt instalments, electricity to run the conditioner unit, and water used in the process of adding salt. As well, the wastewater effluent is salt enriched which becomes a pollutant to fresh water.

The alternative to salt water conditioning is maintenance free magnetic water conditioners. Magnetic water softener technology, when specified in the design stage, provide decades of maintenance free operation. Retrofitting a magnetic water softener can also improve water circulation and reduce pumping pressure required by removing scaling within pipes and water appliances.

Magnetic water conditioners ... are operating extensively throughout the world today with tremendous economic effect. Marked reduction in scale formation ... has been verified in practice and confirmed in laboratories.
Excerpt from: U.S. Dept. of Energy Study 1986.& Re-quoted in Popular Mechanics June, 1992

The basic technology has been used in heavy industry for years for control of scale, algae and corrosion. What's new is the use of high-technology ceramics in the magnets ... the magnetic field [changes] the water ... This is a physical change brought about directly, whereas, traditionally, changes have been caused by chemicals.
Pool & Spa News - October, 1987.

Large amounts of Calcium Carbonate were being discharged ... Normal water flow was completely restored ... Cost savings is being reflected...

The Coast Guard Engineer's Digest, Winter 1980.

...a recent discovery indicates that a magnetic field ... is effective in preventing the formation of scales ...
Advanced Research Projects Agency of the Dept. of Defense monitored by the Air Force Office of Scientific Research Contract No. F44620-72-0053 - January 1973.

Unfortunately, the magnetic technology industry hasn\'t effectively communicated the benefits of the technology. It is difficult for the consumer to find reliable, independent information on technologies and products. Ironically, numerous industrial processes utilize magnetic technology to prevent build up in pipes including the petroleum and transportation industries.

The most recognized studies of non-chemical water softening alternatives are the following:

- Non-Chemical Technologies for Scale and Hardness Control, Federal Technology Alert, 1998.

Non-Chemical Technologies for Scale and Hardness Control
Produced for the U.S. Department of Energy by Battelle Columbus Operations January 1998

Abstract
The magnetic technology has been cited in the literature and investigated since the turn of the 19th century, when lodestones and naturally occurring magnetic mineral formations were used to decrease the formation of scale in cooking and laundry applications. Today, advances in magnetic and electrostatic scale control technologies have led to their becoming reliable energy savers in certain applications.

For example, magnetic or electrostatic scale control technologies can be used as a replacement for most water-softening equipment. Specifically, chemical softening (lime or lime-soda softening), ion exchange, and reverse osmosis, when used for the control of hardness, could potentially be replaced by non-chemical water conditioning technology. This would include applications both to cooling water treatment and boiler water treatment in once-through and recirculating systems.

The primary energy savings from this technology result from decrease in energy consumption in heating or cooling applications. This savings is associated with the prevention or removal of scale build-up on a heat exchange surface, where even a thin film can increase energy consumption by nearly 10%. Secondary energy savings can be attributed to reducing the pump load, or system pressure, required to move the water through a scale-free, unrestricted piping system.

This Federal Technology Alert provides information and procedures that a Federal energy manager needs to evaluate the cost-effectiveness of this technology. The process of magnetic or eletrostatic scale control and its energy savings and other benefits are explained. Guidelines are provided for appropriate application and installation. In addition, a hypothetical case study is presented to give the reader a sense of the actual costs and energy savings. A listing of current manufacturers and technology users is provided along with references for further reading.

- 30-day trial conducted by the Department of Chemical Engineering University of Bath University on Super IMP water softeners and other competitive hard water treatment products.

SEE ADDITIONAL RESOURCES

- Water - a Polar Molecule

CHECKLIST

*When water conditioning is required, investigate and employ non-salt alternatives where possible.

WEB RESOURCES

Brita International
http://www.brita.com

RELATED PRODUCTS

Water Filters
http://www.brita.com

ENVIRONMENTAL DESIGN ELEMENT

Pool and Spa

Chemicals (for example chlorine) used to disinfect water in pools and spas can have negative impacts when released into the environment.

Many conventional pools and spas use chlorine or bromine to disinfect the water in order for guests to enjoy a safe water environment. However, the by-products of chlorine chemistry in the water coupled with the excess chlorine can have damaging effects when released into the environment. Alternatives exist now to reduce chlorine use or eliminate chlorine altogether.

There is now a viable alternative to using chlorine or bromine as a swimming pool sanitizer. Copper/silver ionization is a proven technology used to sanitize water in many different applications. It is used for drinking water, cooling towers, fountains, fish ponds, zoo water features, industrial waste water, industrial process water and of course for swimming pools. Its most notable use is by NASA as the treatment method of choice to purify drinking water aboard their spacecraft.

Copper is a well known algaecide and bactericide and silver is also well known for its ability to kill bacteria and viruses. Pool ionization eliminates the constant need for chlorine, though ionized pools still need a regular shock routine, this can be accomplished with a non-chlorine shock, if you want to totally eliminate chlorine from your pool. In the long run this reduces overall chemical costs, not to mention the pleasure of no chlorine smells and associated bleaching. You and your guests will really notice the difference, especially for an indoor pool.

CHECKLIST

*Minimize the chlorine used in operating the pool.
*Consider alternatives to chlorination for pool disinfection.

REFERENCES

Peter Crawford
<u>Green Resources for the Green Hotel</u> http://www.vtgreenhotels.org/articles/ionpool.htm 2000

WEB RESOURCES

Chlorine Alternatives for Pools
http://www.vtgreenhotels.org/articles/ionpool.htm

RELATED PRODUCTS

Caribbean Clear Swimming Pool Ionization Sanitizer Systems
http://www.caribbeanclear.com

Hercules Power Ion Swimming Pool Ionization Sanitizer Systems
http://www.poolproducts.com/cleanpure.html

Natural Mineral Purifiers
http://www.nature2.com

Swimming Pool Ionization Sanitizer Systems
http://www.carefreeclearwater.com

Swimming Pool Ionization Sanitizer Systems
http://www.sunshinepool.com

Swimming Pool Ionization Sanitizer Systems
http://www.liquitech.net

Swimming Pool Ionization Sanitizer Systems
http://www.denatec.com

Swimming Pool Ionization Sanitizer Systems
http://www.wailani.com

ENVIRONMENTAL DESIGN ELEMENT

Efficiency, Pollution, Role of Fossil Fuels

CHECKLIST

*Energy conservation is the most important and the easiest means to reduce the environmental impact of a building.

WEB RESOURCES
ACEEE - American Council for an Energy Efficient Economy
http://www.aceee.org

ENVIRONMENTAL DESIGN ELEMENT

Energy Conservation

Identify and implement all available energy conservation strategies. Conservation is less expensive than any energy retrofits. Reduce energy usage by targeting the largest component of energy use first. Space conditioning (heating or cooling) is often the largest component of energy usage in a hotel and should be addressed by preventing heat transfer within the building. Improving windows, decreasing infiltration, insulating exterior partitions and ductwork, and retrofitting lighting fixtures are effective strategies. This can be identified at the design stage or during operation with the aid of electricity meters. Shifting electricity usage to off peak times may also reduce costs.
Make it a priority to save energy wherever possible. Conservation measures involve little investment and are the most cost-effective means of reducing operating costs.

CHECKLIST

*Make it a priority to save energy wherever possible. Conservation measures involve little investment and are the most cost-effective means of reducing operating costs.

WEB RESOURCES
Alliance to Save Energy
http://www.ase.org

Alliance to Save Energy -- Energy Efficiency for Educators
http://www.ase.org/educators

ENEWS - Energy Electronic Library
http://www.unicamp.br/nipe/enews

ENVIRONMENTAL DESIGN ELEMENT

Energy Systems

Every effort should be made to reduce energy use.

CHECKLIST

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Electrical Power Systems

Specify energy efficient office equipment. Select office equipment with automatic shut off systems.
Specify energy efficient appliances. Select energy efficient models in all appliance categories. Replace older appliances with newer energy efficient models. Select CFC-free refrigerators. Dispose of old refrigerators properly.
Consider higher system voltages. Higher voltages installed at the design stage will provide a lifetime's worth of energy savings.
Improve power factor. Select proper motor sizes and corrective equipment to minimize losses from poor distribution and motor losses.
Use K-rated transformers. They handle harmonics introduced to the system from appliances such as personal computers more efficiently.
Size conductors correctly. Proper selection of conductors reduces voltage drops and the resulting losses of power.

CHECKLIST

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WEB RESOURCES
BOSCH WFK24 Washer
http://www.boschappliances.com/appliances/washers_dryers/washers_dryers.html

Damianco Washer
http://www.damianco.com/wasmac.html

Energy Star Appliance Rating Program
http://www.energystar.gov

Equator Clothes Processor 3600CEE - Washer/Dryer Combo Appliance
http://www.equatorappl.com

Splendide Washer/Dryer Combination
http://www.splendide.com

Washer Dryer Combination - Quietline - All-In-One Washer Dryer
http://www.quietline.com

Washing Machines by Staber Industries

http://www.staber.com

Whirlpool
http://www.whirlpool.com

ENVIRONMENTAL DESIGN ELEMENT

Electrical Power Systems - Renovation Issues

Optimise energy use of current equipment. Optimize existing appliances and systems. Specify that any new appliances are efficient models.
Retrofit computers with shut off devices.

CHECKLIST

*Optimise energy use of current equipment. Optimize existing appliances and systems. Specify that any new appliances are efficient models.

*Retrofit computers with shut off devices.

ENVIRONMENTAL DESIGN ELEMENT

Plumbing Systems - Hot Water Heating

Consider hot-water heating options. Specify efficient equipment including heat pumps, heat recovery systems, tankless water heaters, and combination space heating-water systems.
Reduce hot-water system standby losses. Apply insulation to hot water distribution lines and storage tanks. Install tank insulation, anti-convection valves, and heat traps. Select the smallest heater and most efficient heat recovery systems for the task.
Evaluate system configuration. Compare the costs of localized versus central hot water heating systems.
Reduce hot water service temperatures. Determine the minimum temperature required to cut energy use and losses.
Install hot water system controls. Consider a time-of-day control system that lowers operating temperatures during off peak times.
Consider solar hot water heating. Either as supplemental heat or as a full system, solar hot water systems can be extremely effective and efficient in warm and hot climates.

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RELATED PRODUCTS

On-Demand Tankless Hot Water Heaters
http://www.e-tankless.com

Solar Hot Water Heaters
http://www.sierrasolar.com

ENVIRONMENTAL DESIGN ELEMENT

Plumbing Systems - Water Pumping

Use low flow plumbing fixtures. Saves both water and energy used for pumping and heating hot water.
Use water booster pumps. Consider systems with a pressurized tank to reduce pump cycling and increased efficiency.
Prepare an efficient plumbing system layout. Design simple, short piping layouts. Stack water services in multi-storey buildings. Employ gravity rather than mechanical systems for effluent flows. Calculate minimum pressures required for distribution and booster pumps.

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ENVIRONMENTAL DESIGN ELEMENT

Outdoor Lighting and Electrical Systems

Light the minimum area for the minimum time. Avoid lighting areas that do not require it. Identify lighting needs and direct light through shades or other means to only light required area. Utilize timers, motion sensors to avoid constant excessive lighting and energy use.
Clearly identify the actual purpose of lighting to determine minimum acceptable levels.
Use energy-efficient lamps and ballasts. Only specify energy efficient fixtures and lamps with the exception in the case of indoor environmental quality.
Use low-voltage lighting. They decrease energy use and cost of 120 Volt installation.
Use renewable energy sources for lighting and other outdoor power. Utilize PV systems when lighting is more than 150 metres from the grid.

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*Use renewable energy sources for lighting and other outdoor power. Utilize PV systems when lighting is more than 150 metres from the grid.

ENVIRONMENTAL DESIGN ELEMENT

Heat Recovery Systems

Install greywater heat-recovery equipment in residential projects, commercial or institutional buildings with multiple showers, and industrial applications with large, continuous flows of hot water, such as clothes washers. Manufactured products are available and well proven.

Greywater heat-recovery equipment can save up to 60% of water-heating energy where hot water drain flow occurs at the same time as hot water supply flow - such as multiple showers or industrial process water systems. Systems serving fixtures on upper floors, where 60 in. of vertical drain pipe is replaced by proprietary greywater heat-recovery devices, need no pump and little or no maintenance. For below-grade applications, systems with demand-operated pumps are available; these need occasional service, and are best installed in a mechanical room for regular maintenance access.

Where there is less simultaneous hot water drain and supply flow (i.e., predominantly baths, sinks, laundries, etc.), greywater heat-recovery systems with heat storage add heat to the water supply to the hot water tank. These require more space, and regular inspection and cleaning.

CHECKLIST

*Attempt to recover heat from all wastewater.

RELATED PRODUCTS

Drainwater Heat Recovery Systems

http://www.endlessshower.com

ENVIRONMENTAL DESIGN ELEMENT

Renewable Energy Systems

Renewable energy is a reliable, nearly pollution free source that can be obtained with minimal impact to the environment.

Diversify energy sources by changing to a portfolio that includes renewable energy sources such as photovoltaics (PV), mini-hydro, wind, biofuels, fuel cells, geothermal, and less polluting fossil fuels such as propane.

Geothermal (Heat Pumps)

Power generation is feasible only in certain areas, and environmental concerns limit its application. However, more local building size heat pumps are used for heating and cooling and are extremely efficient. Often energy efficiencies in the range of 300 percent can be achieved due mainly to the free source of heat - the Earth.<p align=left>

What it costs: 4 to 6 cents ($US) per kWh

CHECKLIST

*Attempt to buy or generate energy only from renewable sources.

WEB RESOURCES
National Renewable Energy Laboratory (NREL)
http://www.nrel.gov

ENVIRONMENTAL DESIGN ELEMENT

Solar Electric Photovoltaics

Heat and light from the sun is one of the most reliable events in our daily lives. Civilization has relied on the \"power\" of the sun for millenia. One method to reduce our reliance on non-renewable energy sources is to convert sunlight into electricity with solar panels.

Solar photovoltaic panels were originally developed for spacecraft. Arrays of photovoltaic cells arranged into panels (or windows, roofing tiles, wall panels) convert solar light rays into electricity. Thin-film technology and economies of scale are reducing the relatively high cost of manufacturing solar arrays.

Typically, commercial photovoltaic panels convert 10-25% (efficiency) of the light that reaches the panel. Electricity generated by photovoltaic panels is direct current (DC)electricity although panels are available with inverters built into the system that provice alternating current (AC).

Photovoltaic systems can be optimized by orienting the panels to an optimum angle perpendicular to the sun. This optimum angle can be determined by knowing your latitude.

Optimum Panel Angle Calculation:
(Note this is for northern hemisphere, reverse sign for southern hemisphere)<p alight=left>

Summer Solstice (June 21) Angle
(Latitude - 23 degrees) = Angle from horizontal<p align=left>

Winter Solstice (December 21) Angle
(Latitude + 23 degrees) = Angle from horizontal<p align=left>

For example:
In Rockhampton, Australia the optimum December 21st panel angle would be perfectly parallel to the ground (latitude = -23 degrees + 23 degrees = 0) or 0 degrees.

Further efficiency is possible by mounting the panels on a tracking system. In this way, the panel is in the optimum perpendicular position for the majority of daylight hours. Of course, a clear view path is necessary for the optimum energy gains to be achieved.

What it costs: 12 to 40 cents ($US) per kWh

CHECKLIST

*In sunny locations, employ solar photovoltaic panels to generate electricity.

*Consider using tracking devices to optimize the efficiency of the panels.

*Consider conventional and remote electrical uses for PV power. Devices that require constant direct current or have diurnal power needs are well suited for a PV source of power.

*Consider utility-integrated PVs where utility demand charges are very high and there is extensive sunshine during the facility's peak electric loads.

*Consider PV-driven battery systems where air-quality restrictions limit the use of gas generators for emergency backup.

WEB RESOURCES

BP Solar
http://www.bpsolar.com

Canadian Solar Industries Association - CanSIA
http://www.cansia.ca

Independent Power Producers of Ontario
http://www.newenergy.org

International Solar Energy Society
http://www.ises.org

MrSolar Your Solar Energy Source.
http://www.mrsolar.com

PV Facts
http://www.becosolar.com/general.htm

PVPortal
http://www.pvportal.com

Siemens Solar
http://www.siemenssolar.com

Solar
http://start.at/solar

Solar Energy Society
http://www.solarenergysociety.ca

ENVIRONMENTAL DESIGN ELEMENT

Building Integrated Photovoltaics

The main requirement for solar photovoltaics is collector area and angle to the sun. Considering the amount of wall and roof area available on every building, it is no surprise that photovoltaics are being employed on building surfaces to both generate electricity and provide other services such as weather protection.

Rack-mount PV systems or mount them directly on roof and wall surfaces. Optimize the panel's tilt to take full advantage of solar energy. Incorporate panels into building envelope or roof design.

Watch for the commercial availability in the near future of partially transparent PV panels for use as window-shading devices.

Consider the use of large PV arrays to generate electricity while shading parking lots or other outdoor areas.

On a smaller scale, PVs can be used to economically power nighttime walkway and landscape lighting. This system saves the cost of installing an underground electrical system.

CHECKLIST

*Examine the potential for using building integrated photovoltaic panels as exterior walls, windows, skylights, and roof shingles.

ENVIRONMENTAL DESIGN ELEMENT

Wind Energy

Wind is a by-product of solar heating of the planet's surface. Fortunately, windy weather is common when storms limit solar exposure, making for a perfect complimentary energy source to solar power.

Wind energy is the fastest growing energy source on the planet. Technological advances have made wind power competitive with fossil-fuel generation – if you have the right site for your turbine farm. Wind generates about 1 percent of America’s electricity, 15 percent of Denmark’s.

In Denmark, a country that has embraced wind energy through manufacturing and installation, the growth rate of the domestic industry is so dramatic that the entire country would be employed by 2020 if the growth continued.

The unit cost of wind energy is already comparable to other energy sources even though it receives only minimal subsidization as compared with other non-renewable energy sources.

Wind currents turn turbines that generate electricity. The downside with wind energy is that it requires some space to erect a wind turbine. Fortunately, many can still take advantage of wind energy either through the use of smaller turbines (for example 400 Watt) roof mounting units or through utility companies that provide green power. <p align=left>

By using renewable energy you prevent the release of:
CO2 = 2.2 tonnes/yr
*based on a 1000 Watt Generator<p align=left>

What it costs: 3 to 9 cents per kWh

CHECKLIST

*In windy locations and especially where the average wind speed is 14 km/h or above 10 mph, employ wind turbines to generate electricity.

WEB RESOURCES
American Wind Energy Association
http://www.awea.org

British Wind Energy Association: Calculations for wind energy
http://www.bwea.com/edu/calcs.html

Canadian Wind Energy Association
http://www.canwea.ca

European Wind Energy Association

http://www.ewea.org

ENVIRONMENTAL DESIGN ELEMENT

Small or Micro Hydro

Although hydroelectricity is considered a more environmental choice than other non-renewable sources of energy, large hydroelectric dams cause significant damage to their ecosystems. However, small micro hydro turbines can be used as a "run of the river" application that significantly reduces environmental impacts.

Water power has been harnessed since the earliest civilizations for agricultural processing and latterly for the production of electricity. If you live in an old mill or have an upland stream flowing through your property, you probably have a site suitable to generate all or a significant proportion of your domestic power requirements.

The main power requirements are in the winter months, so there should be little or no conflict with other river demands. Adequate provisions may have to be made for migratory fish, and if new works are to be constructed, care must be taken with regard to the effect on land drainage upstream of your intake. If there is insufficient power to provide your needs electrically, then there is the additional possibility of using water power to drive a water source heat pump which will increase the power output by three times in the form of heat.

The power available from a stream is determined by the head and flow of water on the particular site. This power is harnessed by constructing a dam or diverting the flow in such a way that all the fall occurs in one place. Where it is not practical to construct a channel, the water may be piped and the head of water is exploited as a high velocity jet driving an ‘Impulse Turbine’. The power available is a function of the fall (head) and flow so building a large waterwheel on a low fall will only increase the cost and reduce the shaft speed but not increase the power.

HEAD
Metres (Feet)
FLOW Litres/Min (Gallons/Min)

40 (10)
80 (20)
150 (40)
300 (75)
400 (100)

3 (10)

20
50
90
120

6 (20)
15
40
100

180
230

15(50)
45
110
230
450
600

30 (100)
80
200
500
940
1100

60(200)
150
400
900
1600

Water wheels are limited to sites with a head of less than 10 meters. They are aesthetically pleasing and have good performance under low water conditions. Unfortunately, due to their size, they are both costly to build and install, largely because of the gearing required to increase the shaft speed, typically from 10 to 1500 rpm. The use of low speed generators does not help since it is the low speed end of the drive which is the expensive part.

Water turbines, on the other hand, are able to make use of a very wide range of head, from less than a metre to many hundreds of metres. To cover the full range of sites, it is necessary to make use of several different types of turbine. It is not that you cannot use one type of turbine for all sites but that each design has it economic and hydraulic area.<p align=left>

What it costs: 5 to 12 cents ($US) per kWh

CHECKLIST

*Where available, employ micro hydro turbines to generate electricity from local streams and rivers.

WEB RESOURCES
International Network on Small Hydro Power
http://www.inshp.org

Micro Hydro Discussion Group
http://groups.yahoo.com/group/microhydro

Micro Hydro Power
http://www.microhydropower.com

Micro Hydro Web Portal
http://microhydropower.net

RELATED PRODUCTS
Micro Hydro Turbines
http://www.spsenergy.com/products/micro_hydro.htm

ENVIRONMENTAL DESIGN ELEMENT

Fuel Cells

A fuel cell is a battery that is not a closed system, but rather requires fuel (hydrogen and oxygen) to operate. The by-products of a pure hydrogen-oxygen fuel cell are nothing but electricity, heat and water. Which is excellent for buildings that often require electricity and heat.

A fuel cell operates like a battery. Unlike a battery, a fuel cell does not run down or require recharging. It will produce energy in the form of electricity and heat as long as fuel is supplied.

A fuel cell consists of two electrodes sandwiched around an electrolyte. Oxygen passes over one electrode and hydrogen over the other, generating electricity, water and heat.

FIGURE 1: A Fuel Cell

Excerpt from http://www.fuelcells.org/whatis.htm

Hydrogen fuel is fed into the "anode" of the fuel cell. Oxygen (or air) enters the fuel cell through the cathode. Encouraged by a catalyst, the hydrogen atom splits into a proton and an electron, which take different paths to the cathode. The proton passes through the electrolyte. The electrons create a separate current that can be utilized before they return to the cathode, to be reunited with the hydrogen and oxygen in a molecule of water.

A fuel cell system which includes a "fuel reformer" can utilize the hydrogen from any hydrocarbon fuel - from natural gas to methanol, and even gasoline. Since the fuel cell relies on chemistry and not combustion, emissions from this type of a system would still be much smaller than emissions from the cleanest fuel combustion processes.<p align=left>

What it costs: 8 to 15 cents ($US) per kWh

CHECKLIST

*Identify the potential for converting existing non-renewable energy sources to on-site fuel cells.
*Consider a fuel cell power plant as an alternative system to provide heat and electricity.

WEB RESOURCES
Ballard Power Systems Inc.
http://www.ballard.com

Fuel Cell Today - Opening Doors to Fuel Cell Comercialisation
http://www.fuelcelltoday.com

History of Fuel Cells

http://fuelcells.si.edu

Hydrogen Fuel Cells
http://www.eren.doe.gov/RE/hydrogen_fuel_cells.html

Online Fuel Cell Information Center
http://www.fuelcells.org

ENVIRONMENTAL DESIGN ELEMENT

Biomass

Biodiesel, a product that can be made from used cooking oils, is a less expensive and more environmentally friendly fuel for diesel powered vehicles.

Bioenergy technologies help protect the environment by making use of renewable plant material such as sawdust, tree trimmings, rice straw, alfalfa and switchgrass; poultry litter and other animal wastes; industrial waste; and the paper component of municipal solid waste. They are used today in a wide variety of processes, including the production of clean transportation fuels, electricity and chemicals.

By displacing more polluting forms of energy generation, bioenergy resources help the developed world reduce its dependence on oil and cut emissions of harmful greenhouse gases. Bioenergy technologies are also creating jobs and fueling economic growth across the world. <P align=left>

What it costs: 8 to 15 cents ($US) per kWh

CHECKLIST

*Where available, attempt to supplement non-renewable sources of energy with energy from biomass.
*Consider using bio-fuels in your vehicles including converting diesel vehicles to biodiesel.

WEB RESOURCES
American Biomass Association
http://www.biomass.org

American Coalition for Ethanol
http://www.ethanol.org

Biodiesel resources on the Web: Journey to Forever
http://journeytoforever.org/biodiesel_link.html

Veggie Van, Biodiesel, and Vegetable Oil Fuel
http://www.veggievan.com

ENVIRONMENTAL DESIGN ELEMENT

Green Power

Steps can be taken to choose environmentally friendly power without having to purchase and install any equipment. In many cases, it is as simple as contacting your utility company.

The term "green power" generally refers to electricity supplied in whole or in part from renewable energy sources, such as wind and solar power, geothermal, hydropower, and various forms of biomass. Increasingly, electricity customers are being given electricity supply options, either as retail power markets open to competition or when their regulated utilities develop green pricing programs. More than one-third of retail customers in the United States now have an option of purchasing a green power product directly from their electricity supplier. In addition, consumers can support renewable energy development through the purchase of green energy certificates.

Why Buy Green Power?

By choosing to purchase a green power product, you can support increased development of renewable energy sources, which can reduce the burning of fossil fuels, such as coal, oil, and natural gas.

CHECKLIST

*Diversify purchased power portfolio by substituting renewable energy sources available now in many jurisdictions. Wind and bio-generated power is the most common.

*Add Green power to the building's energy portfolio.

*Promote renewable energy alternatives in your community.

WEB RESOURCES

Green Power Network
http://www.eren.doe.gov/greenpower

Green-e Renewable Electricity Certification Program
http://www.green-e.org

ENVIRONMENTAL DESIGN ELEMENT

CFCs/HCFCs/Halons

CFCs and their impact on the ozone layer is one of the most undisputed examples of environmental damage caused by humans and the synthetic chemical industry. It is imperative that CFCs be avoided.

Do not select appliances or mechanical equipment that uses chlorofluorocarbons (CFCs) as refrigerants or cooling chemicals. Avoid composite materials and components that contain products that use or release CFCs in their manufacturing. Specify fire suppression equipment that does contain CFCs or Halons. Dispose of old equipment properly using professionals to reclaim the refrigerants.

CHECKLIST

*Eliminate all ozone-depleting substances in the hotel design and operation.
*Remove any existing ozone-depleting substances with approved methods or contractors that capture and dispose of substances properly.

WEB RESOURCES

Ozone Layer
http://www.epa.gov/docs/ozone

Stratospheric Ozone Depletion
http://www.nas.nasa.gov/About/Education/Ozone

ENVIRONMENTAL DESIGN ELEMENT

Elimination of CFCs/HCFCs/Halons

CFCs have given way to HCFCs (less harmful) and are now giving way to alternatives that do not contain and CFCs or HCFCs. Alternatives exist and should be employed.

In retrofit projects with existing air-conditioning and refrigerating equipment, conduct a life-cycle cost analysis to assess replacement with equipment using chlorine-free refrigerants. The analysis should consider rising CFC/HCFC costs, maintenance and energy operating costs. It is often cheaper to replace older chillers with new HFC 134a equipment, both on a life-cycle and a first-cost basis. CFC air conditioners and heat pumps more than eight years old (midway through typical service lives) are often cost-effectively replaced by new equipment using HCFC or non-chlorinated refrigerants.

For new equipment, the choice of air conditioners and heat pumps using non-chlorinated refrigerants is currently limited. Non-HCFC equipment is preferable, if it meets capacity, efficiency and other criteria, since HCFC equipment is likely to be replaced or retrofitted in future as R-22 (the principal HCFC refrigerant) production ends.

CHECKLIST

*Specify alternatives to HCFCs.

*Specify fire-extinguishing products without Halons.

WEB RESOURCES

C$$L Sense - Integrated Chiller Retrofits
http://ateam.lbl.gov/coolsense/cfc.html

Reduce or Eliminate Use of CFCs & HCFCs in Cooling Equipment
http://greenbuildings.santa-monica.org/hvac/hvaccfchcfc.html

ENVIRONMENTAL DESIGN ELEMENT

Indoor Environmental Quality

Many of us now spend more than 90 percent of our lives indoors. Unfortunately, the indoor environment that we have created is remarkably different from the outdoor natural environment in which we evolved. It is important for designers and operators a like to understand the potential problems and solutions to poor indoor environments.

What is Indoor Environmental Quality (IEQ)?
The public is probably more familiar with the terms "Indoor Air Quality" and "Sick Building Syndrome." "Indoor Air Quality," as the name implies, simply refers to the quality of the air in an office environment. "Sick Building Syndrome" is a term many people use to convey a wide range of symptoms they believe can be attributed to the building itself. Workers typically implicate the workplace environment because their symptoms are alleviated when they leave the office.
NIOSH prefers to use the term "Indoor Environmental Quality" (or IEQ) to describe the problems occurring in office buildings and schools throughout the nation. The Institute, through its Health Hazard Evaluation (HHE) Program, evaluates potential health hazards in workplaces in response to requests from employers, employees, employee representatives, state and local government agencies, and Federal agencies. NIOSH investigators have found that concerns about air quality may be caused by a number of factors, encompassing much more than air contamination. Other factors such as comfort, noise, lighting, ergonomic stressors (poorly designed work stations and tasks) and jobrelated psychosocial stressors can individually and in combination contribute to complaints. Hence, IEQ more accurately describes the scope of the problem.

What are the typical symptoms associated with IEQ?

The symptoms reported to NIOSH have been diverse and usually not suggestive of any particular medical diagnosis. A typical spectrum of symptoms includes headaches, unusual fatigue, varying degrees of itching or burning eyes, skin irritation, nasal congestion, dry or irritated throats, and nausea.

How big is the IEQ problem?

During the last decade, there has been a significant increase in public concern about IEQ. NIOSH scientists have completed approximately 1300 evaluations related to the indoor office environment since the late 1970's, and the number of these requests as a percentage of the total has risen dramatically.

In 1980, requests to evaluate office environments made up only 8% of the total requests for NIOSH investigations. In 1990, the Institute received 150 IEQ requests, which accounted for 38% of the total. Since 1990, IEQ requests have made up 52% all requests.

Why are IEQ problems increasing?

During the 1970's, ventilation requirements were changed to conserve fossil fuels, and virtually air-tight buildings emerged. At the same time, a revolution occurred in office work throughout the country. Computers and other new work technologies forced a change in office procedures and productivity, and ergonomic and organizational stress problems may have increased. Coupled with the conservation measures and changing technology was a dramatic increase in the number of workers in white collarjobs. Greater awareness of the potential for IEQ problems may also be contributing to a rise in reporting of suspected problems. All of these factors may have contributed to the increase.

Media coverage of IEQ has profoundly influenced the number of IEQ requests the Institute receives. Following a network television report on the subject in October 1992, NIOSH received over 6,000 phone calls and nearly 800 requests for investigations.

CHECKLIST

*Learn, understand, and assess the indoor environmental quality of your building. Set goals to improve the indoor environment and measure success through employee and client indicators.

WEB RESOURCES

Building Standards - Indoor Air Quality (IAQ)
http://www.energy.wsu.edu/buildings/IAQ.htm

Health House -- Raising the Standard for Home Environments
http://www.healthhouse.org/iaq/default.htm

Healthy Home
http://www.healthyhome.com

Indoor Air Consultants
http://www.indoorairconsultants.com

MCS, Multiple Chemical Sensitivity, Safe Housing
http://www.thenaturalplace.com

The Healthy House Institute
http://www.hhinst.com

The Multiple Chemical Sensitivities Primer
http://www.geocities.com/HotSprings/Spa/4415/index.html

Vinyl Chloride Information - Occupational Disease Information
http://www.baggettmccall.com/vinylchloride.htm

Overview - Indoor Air Quality, Sick Building Syndrome, Multiple Chemical S

Many people now live and work indoors. In the winter in colder climates, people can spend over 90 percent of their time in the indoor environment. Considering that we spend a significant portion of our lives in bed, the bedroom should have the cleanest indoor air of any interior space.

Employ an integrated approach. Involve building owners, entire design team, operators, maintenance staff, and tenants in the process.
Practice "prudent avoidance". Avoid materials and components that may contribute to the problem. Choose increased ventilation. Steer clear before problems appear.
Evaluate the costs and benefits of all strategies. Compare life cycle costs versus the potential health consequences of occupants, decrease in guest satisfaction/worker production, and other economic and health consequences.

CHECKLIST

*Become educated on the issues of poor indoor environmental quality.
*Assess the indoor environmental quality of existing buildings by surveying environments, employees, and clients.
*Develop a plan to improve environmental quality of interior spaces.

WEB RESOURCES
Air Purification Express
http://www.galaxymall.com/household/airpurifiers

Air Quality -- Indoor Air Quality Index
http://www.lungusa.org/air/air_indoor_index.html

Air Quality Data
http://www.cleanet.lk/colomboair

Air Testing Environmental Consultants-The Mold and Moisture Remediation Specialists
http://www.air-testing.com

Airmisc.com - air purifiers, water purifiers. Air purification units. Alpine Industries, Ecoquest International, Windtree
http://www.airmisc.com

American Hydrogen Association
http://www.clean-air.org

American Indoor Air Quality Council
http://www.iaqcouncil.org

California Indoor Air Quality Program
http://www.cal-iaq.org

Formed Concrete and IAQ (Radon from concrete)
http://www.radonserv.com/_discussion/00000003.htm

Health House - Indoor Air Quality
http://www.healthhouse.org/iaq/default.htm

Healthy Indoor Air for America's Homes
http://www.montana.edu/wwwcxair

Indoor Air 2002
http://www.indoorair2002.org

Indoor Air Quality
http://www.hc-sc.gc.ca/ehp/ehd/bch/air_quality/indoor_air.htm

Indoor Air Quality
http://www.iaq.es/html/index.htm

Indoor Air Quality
http://www.teriin.org/indoor/indoor.htm

Indoor Air Quality (IAQ)
http://www.epa.gov/iaq

Indoor Air Quality (IAQ) - IAQ Hotlines and Resources
http://www.epa.gov/iaq/iaqinfo.html

Indoor Air Quality Association
http://www.iaqa.com

Indoor Air Quality: Molds and Dust, CDFS-191-96
http://www.ag.ohio-state.edu/~ohioline/cd-fact/0191.html

Indoor and Outdoor Air Quality and Allergies
http://www.pp.okstate.edu/ehs/LINKS/Iaq.htm

ENVIRONMENTAL DESIGN ELEMENT

Source Control

Indoor air quality problems can originate within the building envelope (materials, components, furniture, and HVAC system) and/or outside sources. Many of these sources can be controlled, reduced, or eliminated. Choices made at the design stage are most cost effective.

Set source control priorities that are feasible within the project budget, project schedule, and available technology. Identify likely candidates of indoor pollutant problems and deal with those first.

Establish the building owner(s)'s and occupants' criteria and guidelines for improved IAQ. Educate them with respect indoor air quality issues.

Request Material Safety Data Sheet (MSDS) for priority materials from product manufacturers. Note that an MSDS does not necessarily identify all potential indoor air quality problems.

Perform the following steps to evaluate the materials, products, and furniture in terms of their VOC contribution to the indoor air: Set total volatile organic compound (TVOC) limits for the project. Use an IAQ specialist to set limits if information is unavailable. Request emissions test data from product manufacturers.

Evaluate the emissions test data.

Based on the above information, determine if the priority material item is: Acceptable and not hazardous or whether the product installation requires modifications by manufacturer, specific installation requirements (temporary ventilation), or is unacceptable based on the limits specified for the project.

Take steps to control the MVOC contribution to the indoor air from materials. Specify materials that are resistant microbial growth. Encapsulate materials that may support microbial growth (i.e. insulation). Specify that any materials susceptible to microbial growth that become wet during construction be removed. Clean HVAC systems prior to

occupancy. Install the vapour barrier properly (i.e. cold climates – on interior side of wall, hot-humid climates – on exterior side of wall).
Consider a building flush out. This is an opportunity to test (at maximum output) and commission HVAC systems while removing interior pollutants that may have concentrated while ventilation systems were inoperable. Often a test of the heating system enhances the release of emitting pollutants.
In remodelling projects, test for and remove know hazardous materials such as asbestos, lead, polychlorinated biphenyls (PCBs), and fungal contamination. Utilize specially licensed contractors, employ negative pressures, isolate areas while removal is in progress, and flush out area once complete.

CHECKLIST

*Minimize the use or avoid selecting interior matierals and products that out-gas potentially harmful substances.

ENVIRONMENTAL DESIGN ELEMENT

Moisture Control

design element content

CHECKLIST

*Minimize any moisture building up in the interior environment.

ENVIRONMENTAL DESIGN ELEMENT

Ventilation

Review the building occupants' use needs, programmatic requirements, and the energy conservation code requirements to determine whether fixed or operable windows will be provided. Select operable windows where possible and adjust HVAC system controls accordingly.
Evaluate the HVAC system and develop the design criteria in accordance with applicable codes and ASHRAE standards. Provide adequate ventilation for building population. Eliminate sources or potential microbial growth areas. Design HVAC system for ease of maintenance and cleaning.
Design HVAC outdoor-air-intakes with indoor air quality concerns in mind. Locate intakes away from sources of pollutants (car parks, traffic routes, loading bays, plumbing vents, and air-outtakes). Protect air-intakes from biological contamination (i.e. birds).
Consider other HVAC design issues related to IAQ. Install high efficiency filtration. Design HVAC system for ease of maintenance for operators. Consider energy efficient economizers that allow the operator to decrease outdoor air intake to levels of minimum ventilation. Consider heat recovery between intake and outtake systems. Consider separate, individual exhaust systems for rooms with specific pollutant problems. Consider positive building pressurization to flush interior air outside (and in hot-humid climates to minimize humidity indoors).

CHECKLIST

*Design for constant ventilation above building code requirements.

ENVIRONMENTAL DESIGN ELEMENT

Occupancy Activity Control

CHECKLIST

*Implement a building commissioning program similar to the three step commissioning process. Specify maximum room occupancies and design HVAC systems to meet occupancy limits.

*Consider the use of carbon dioxide and VOC sensors in the occupied spaces. Detectors can be linked to HVAC system signifying when increased outdoor air is required.

*Implement a non-smoking rule from the commencement of construction through the life of the building.

ENVIRONMENTAL DESIGN ELEMENT

Building Maintenance

Indoor air quality problems once initiated grow to large problems rapidly without proper, regular maintenance.

CHECKLIST

*Select easy to maintain building materials and systems. For example, specify hard floors as opposed to carpets at main entrances.

*Implement an integrated pest management program using only pre-authorised and non-hazardous chemicals that do not violate the integrity of building IAQ. Avoid using synthetic chemicals. Give preference to organic, biological products and methods.

*Select low emitting, environmentally friendly cleaning agents for use in regular maintenance.

*Prepare project specifications with appropriate warranties and, where appropriate with extended maintenance contracts. See specs

*Institute a tenant policy for IAQ practices, including a no-smoking rule. Educate occupants on IAQ issues and incident reporting policies.

*Adopt specific procedures for building operators to notify tenants when hazardous chemicals are used.

*Prepare an IAQ plan to be administered by the building IAQ manager. The plan should include the following: system design and layout plans, commissioning plan and report, maintenance plan and schedule, performance criteria, IAQ documentation.

*Prepare a maintenance plan with a schedule and budget for the HVAC systems, building materials, and furniture. The maintenance plan should include the following: HVAC systems, carpets, chairs, office systems, and other finish materials.

*Develop and provide the building operators with complete operations and maintenance manuals and a plan for appropriate system operation training.

*After the tenants have occupied a new or remodelled building, implement post occupancy building commissioning and flush out the building as necessary to fine tune the building systems under normal operating conditions.

*Develop a plan to provide post-occupancy building commissioning on a regular basis every few years.

ENVIRONMENTAL DESIGN ELEMENT

Minimum IAQ Performance

CHECKLIST

*Design the building to meet at least a minimum indoor air quality standard.

ENVIRONMENTAL DESIGN ELEMENT

Environmental Tobacco Smoke

Design the interior space to control any tobacco smoke as it is mandatory now in many jurisdictions to control tobacco smoke and associated contaminants to prevent non-smokers from being subjected to any exposure.

CHECKLIST

*Reduce or eliminate smoking within the building.

WEB RESOURCES

Smoking and Indoor Air Quality - Health Canada

http://www.hc-sc.gc.ca/hppb/tobaccoreduction/factsheets/indoors.htm

ENVIRONMENTAL DESIGN ELEMENT

CO2 Monitoring

CHECKLIST

*Install CO2 meters and monitor on a regular basis.

ENVIRONMENTAL DESIGN ELEMENT

Increase Ventilation Effectiveness

CHECKLIST

*Design new buildings with adequate ventilation. Retrofit existing buildings to meet latest ventilation and air exchange standards.

ENVIRONMENTAL DESIGN ELEMENT

Low Emitting Materials

CHECKLIST

*Select and specify materials and components that have little or no off-gassing potential. Avoid glues that are water-soluble. Avoid products that contain formaldehyde.

ENVIRONMENTAL DESIGN ELEMENT

Indoor Chemical and Pollutant Source Control

CHECKLIST

*Control all sources of indoor pollutants by removing them from the interior space, containing them to avoid off gassing and indicate safety requirements.

RELATED PRODUCTS

Pest Control Treatment

http://www.recyclestore.com

ENVIRONMENTAL DESIGN ELEMENT

Controllability of Systems

CHECKLIST

*Allow occupants to control thermal, lighting, and HVAC systems for their specific space.

ENVIRONMENTAL DESIGN ELEMENT

Thermal Comfort

CHECKLIST

*Provide interior spaces with adequate thermal ranges.

ENVIRONMENTAL DESIGN ELEMENT

Daylighting and Views

CHECKLIST

*Maximize daylighting in the design and retrofit. Provide not only natural lighting but sufficient viewpoints for building occupants.

ENVIRONMENTAL DESIGN ELEMENT

Natural vs Artificial

CHECKLIST

*Maximize daylighting of interior spaces.

*Select light fixtures that have the highest CRI in their class.

WEB RESOURCES

Fluorescent Lighting
http://www.holisticmed.com/toxic/fluorescent.html

OTT-LITE Technology - Environmental Lighting Concepts
http://www.ott-lite.com

Role of Light in Health
http://www.maxpages.com/durotest/Role_Of_Light_In_Health

RELATED PRODUCTS

OTT Lites
http://www.ottbiolight.com

ENVIRONMENTAL DESIGN ELEMENT

Planning

CHECKLIST

*Identify local zoning codes regarding noise and determine requirements for the project's adherence to such codes.

*Determine the impacts of proposed building systems on surrounding areas and ambient conditions. Consider transportation routes, exterior mechanical systems (i.e. cooling towers, vents), and other systems for their impacts on adjacent properties.

*Consider how the noise level from external sources around the building will affect occupants. Consider noise impacts from other properties (i.e. including air traffic) on the proposed building's occupants. Identify zones that may require mediation.

ENVIRONMENTAL DESIGN ELEMENT

Design

CHECKLIST

*Locate noise sensitive areas away from noise producing elements. Careful design can minimize mediation measures required later.

*Evaluate slab construction between floors. Determine whether slab thicknesses are sufficient for sound absorption (especially around mechanical equipment rooms).

*Consider the acoustic benefits of drywall construction. Consider resilient nailing strips for extra sound absorption.

*Select appropriate partitions to achieve the required speech privacy rating between spaces and separation from HVAC equipment areas.

*Use constructed or natural screens to reduce the impact of noise from external sources.

ENVIRONMENTAL DESIGN ELEMENT

Finishes

CHECKLIST

*Consider acoustical properties when selecting surface finishes.

*Confirm that acoustic material selections meet the project's environmental criteria.

*Select appropriate ceiling tiles based on ceiling sound transmission class rating.

*Avoid using acoustic materials that may adversely affect indoor air quality.

ENVIRONMENTAL DESIGN ELEMENT

Electro Magnetic Fields

Electric fields are produced by the motion of charged particles (i.e. electrical current). When these charged particles are passed through a wire coil then a magnetic field is produced (i.e. electromagnet). Electric fields can be mitigated with dense material (i.e. lead). Magnetic fields can only be mitigated with distance from source (intensity decreases ? 1/d2). Place equipment that produces electromagnetic fields away from positions that occupants occupy for extended periods of time. Strength decreases exponentially with distance.

CHECKLIST

*Identify potential sources of electromagnetic fields and locate areas where occupants spend the most time as far away from sources as possible.

ENVIRONMENTAL DESIGN ELEMENT

Design Guidelines

The contractor should be instructed on the environmental goals of the project. Guidelines should be drawn up and discussed about specific considerations.

The design team can establish and enforce environmental guidelines for construction by doing the following: incorporating guidelines into construction drawings and specifications, and monitoring the contractor.

In some cases, contractors may need education about environmentally preferable practices in order to take advantage of them.

The owner, design team, and contractor should develop collectively a staging plan for the project. Balance contractor's desire to build efficiently with the owner's desire for long-term protection of site resources.

Develop specific site protection requirements that the contractor to submit plans for meeting them. Use specific language in the contract and construction documents. Include requirements for site utilization. Designate specific vegetation for protection. Specify requirements for site access. Specify requirements for site clearing and grading. Review stormwater management plan.

CHECKLIST

*Develop guidelines for the efficient construction of the building or project.

ENVIRONMENTAL DESIGN ELEMENT

Site

design element content

CHECKLIST

*Develop a plan to minimize damage to the site during construction.

ENVIRONMENTAL DESIGN ELEMENT

Materials

Reduce construction waste during the design stage. Design for common component dimensions. Specify high quality products to minimise rejections. Put in place a plan for on-site sorting of waste. Divert construction waste from the landfill by reusing materials, recycling, and donating waste to non-profit organisations or other organizations that can put the products to use.

Recycle waste products. Consider that 50% of construction waste stream is cardboard and wood and can easily be recycled. Metals can also be recycled.

Provide bins or areas for sorting and recycling. Specify and label bins for each recycled waste stream (i.e. wood, cardboard, steel, plastic).

Contain hazardous and/or toxic materials in one area. Dispose of these materials properly. Avoid ground water contamination over construction period.

CHECKLIST

*Develop a plan to maximize material efficiency during construction.

WEB RESOURCES

Gypsum Board C&D Waste

http://www.human.cornell.edu/dea/extension/docs/sum96/wasteman.htm

ENVIRONMENTAL DESIGN ELEMENT

Energy

design element content

CHECKLIST

*Develop a plan to maximize energy efficiency during construction.

ENVIRONMENTAL DESIGN ELEMENT

IAQ Management

Develop an indoor air quality management plan before construction begins to minimise or eliminate any excessive indoor pollution problems.

CHECKLIST

*Develop an indoor air quality management plan before construction begins to minimise or eliminate any excessive indoor pollution problems.

ENVIRONMENTAL DESIGN ELEMENT

Administrative Practices

CHECKLIST

*Develop an IAQ construction management plan.

*Identify potential health hazards and take necessary safety precautions, comply with all right to know requirements, and obtain MSDS information as necessary.

*Isolate construction sites from occupied areas.

*Schedule noxious work during off-hours.

*Tailor IAQ management to the varying requirements of the construction phasing plans.

*Sequence construction steps to minimise contaminant sinks.

*Test and inspect for potential contaminants.

ENVIRONMENTAL DESIGN ELEMENT

HVAC System Practices

CHECKLIST

*Flush out newly constructed interior spaces prior to occupancy.

*Flush out occupied areas during off-hours.

*Depressurize the construction work area.

*Pressurize the occupied areas.

*Increase outside air.

*Protect ventilation systems and components.

ENVIRONMENTAL DESIGN ELEMENT

Source Control Practices

CHECKLIST

*Use low emission products.

*Install a temporary local exhaust to ventilate the construction area.

*Install localized cleaning and filtration equipment.

*Institute sound housekeeping procedures. Good cleaning, storage, and waste handling procedures can reduce concentrations.

ENVIRONMENTAL DESIGN ELEMENT

Resource Efficiency

CHECKLIST

*Include language in construction documents that promotes energy and water conservation. Indicate to contractor their responsibilities for utility costs, and energy and water permit fees to encourage conservation and efficiency.

*To conserve resources, the contractor should: monitor energy and water usage, install temporary lighting so other lighting can be turned off during construction, install motion sensors, use energy efficient lamps and fixtures, install low flow fixtures, use the building's HVAC system to maintain ventilation.

*Use products and materials with recycled content, as appropriate and consistent with construction plans and specifications, good IAQ practices, and health recommendations.

*Purchase materials in a manner that minimizes waste and unnecessary costs.

*Require an on-site recycling system for waste materials.

*Require the recycling and reuse of materials salvaged from demolition.

*Track the actual wastes produced from construction, measuring waste generation levels against project guidelines for materials' recycling and reuse.

ENVIRONMENTAL DESIGN ELEMENT

Continuous Commissioning

Once the construction is complete. Commissioning must be done to fine-tune all systems and ensure that all systems are acting in unison to achieve optimal efficiency. Any changes can be made at this time and the operator can be educated re the design performance.

CHECKLIST

*Select the building systems to be covered in the commissioning process. Consider integrated systems.
*Develop a strategy to implement the building commissioning process.

*Prepare the design documentation and design criteria for the HVAC system, including the following information: HVAC system building-commissioning design documentation form, HVAC design criteria, and HVAC system description.

*Use the HVAC system design documents to: verify with building owner and/or occupants the intended activities and equipment.

*Have the design team and building operators review the documents to confirm that the building is properly designed for its intended uses. Make sure building use does not overextend equipment and systems.

*Prepare design documentation and design criteria for the other building systems to be commissioned according to the format used for the HVAC system.

*Prepare specifications to describe the commissioning process. The commissioning process should be described in Division 1 sections of the Specifications Institute documents (CSI).

*Specify facility startup amount in the commissioning section of Division 1 specifications. This monetary amount should be used for specific commissioning tasks.

*Ensure that the commissioning process is addressed in contract documents and construction meetings.

*Form a commissioning team and designate a commissioning authority.

ENVIRONMENTAL DESIGN ELEMENT

Construction Phase

Problems identified during the construction phase can more easily be modified than problems found once the building is complete.

CHECKLIST

*Involve the design team in monitoring the constructive commissioning process.

*Conduct pre-commissioning workshops and commissioning progress meetings.

*Observe the construction is in accordance with the contract documents. Architect(s) should monitor commissioning process, meetings, and workshops to ensure proper commissioning of the project.

*Perform systems and equipment startup.

*Demonstrate operations and conduct training.

*Recommend acceptance of the work and payment of the facility startup amount.

*Prepare the commissioning report which includes: building description, size, location, and use; team members and responsibilities; final project design documents; written or schematic description of each system; summary of system performances relative to design intent; completed pre-function checklists; completed functional checklists; approval, non-compliance, and tracking forms; manuals for each system.

ENVIRONMENTAL DESIGN ELEMENT

Post Occupancy Phase

CHECKLIST

*Schedule regular maintenance inspections to identify problem areas and repair any equipment or components that are under performing. Further commissioning scheduled perhaps yearly will ensure efficient building operation.

*Conduct fine-tuning of building systems and equipment after one year of occupancy.

*Recommission buildings throughout their life on a regular schedule, possibly every one to two years.

ENVIRONMENTAL DESIGN ELEMENT

Energy Systems

design element content

CHECKLIST

*Commission energy systems to ensure maximum efficiency and effectiveness with other systems.

WEB RESOURCES

Commissioning for Energy Efficiency

http://www.eren.doe.gov/buildings/comm_energyeff.html

ENVIRONMENTAL DESIGN ELEMENT

HVAC Systems

Commissioning the HVAC equipment is one of the most important steps to achieve optimum performance of building systems.

CHECKLIST

*Use the commissioning process to ensure that HVAC operations meet expectations.

ENVIRONMENTAL DESIGN ELEMENT

Lighting Systems

design element content

CHECKLIST

*Commission lighting system to achieve maximum efficiency and effectiveness with other systems.

ENVIRONMENTAL DESIGN ELEMENT

Overview

Other incentives to move in an environmental direction are the potential benefits awarded to operations that are environmentally friendly. Increasingly, companies and customers worldwide are choosing operations that meet certain environmental criteria. Thus a market is developing that serves as a reward to establishments that meet the criteria.

CHECKLIST

*Seek environmental certification as a marketing, management, and overall economic tool.

WEB RESOURCES

BEES - Building for Environmental and Economic Sustainability Assessment Tool
http://www.bfrl.nist.gov/oae/software/bees.html

BEPAC - Building Environmental Performance Assessment Criteria (UK Canada)
http://www.bepac.dmu.ac.uk

Green Leaf Eco-Rating Program
http://terrachoice.ca/hotelwebsite/indexcanada.htm

NRCan, CBIP,
http://cbip.nrcan.gc.ca

The Green Hotel Association
http://www.greenhotels.com

ENVIRONMENTAL DESIGN ELEMENT

LEED 2.1

An environmental building rating system developed by the U.S. Green Building Council was designed for rating new and existing commercial, institutional, and high-rise residential buildings. The self-assessing system applies a set of criteria of which points are awarded for meeting each criterion providing a standard for what constitutes a “green building”. An auditor is required to receive certification that is good for the year audit was performed. Applications accepted internationally.

CHECKLIST

*Attempt to meet and exceed the Platinum level (52+ points) for LEED certification.

REFERENCES

U.S. Green Building Council
LEED 2.0 Green Building Rating Scheme 2002

WEB RESOURCES

LEED: Leadership in Energy & Environmental Design
http://www.usgbc.org/LEED/LEED_main.asp

U.S. Green Building Council
http://www.usgbc.org

ENVIRONMENTAL DESIGN ELEMENT

LEED Certified Professional

design element content

CHECKLIST

*Seek specialized expertise to solve difficult problems and support local practioners whenever possible.

WEB RESOURCES

U.S. Green Building Council
http://www.usgbc.org

ENVIRONMENTAL DESIGN ELEMENT

Green Globe 21

Green Globe 21 a world-wide certification programme dedicated to helping the Travel & Tourism industry around the world develop in sustainable ways - ways that improve the environment, well being and the way of life for local people and for visitors.

CHECKLIST

*Put in place an environmental management system that generates continual environmental improvement in line with the Green Globe 21 certification system.

WEB RESOURCES

Green Globe 21 - Sustainable 21st Century Tourism http://www.greenglobe.org

Green Globe 21 - Sustainable 21st Century Tourism
http://www.greenglobe21.com

ENVIRONMENTAL DESIGN ELEMENT

BREEAM

The Building Research Establishment Environmental Assessment Method (BREEAM) is an assessment method that was developed in the UK and made available in 1993. It allows the owners, users and designers of buildings to review and improve environmental performance throughout the life of a building. A variety of versions of BREEAM include new offices, existing offices, industrial, supermarkets, new housing, and other building topics. It is a voluntary evaluation system that is widely accepted in the UK and respected for setting a benchmark for environmental performance.

CHECKLIST

*Attempt to exceed the criteria set out in the BREEAM standard.

WEB RESOURCES
BREEAM UK
http://www.breeam.com

ENVIRONMENTAL DESIGN ELEMENT

GB Tool

design element content

CHECKLIST

*Download and utilize the Green Building Tool software to assist in environmental design and optimizing operation.

WEB RESOURCES
Green Building Information Council
http://www.greenbuilding.ca

ENVIRONMENTAL DESIGN ELEMENT

ISO 14000

The International Organisation for Standardisation (ISO) is a non-governmental organisation with more than 120 countries participating with the objective of standardising environmental management practices, audits, performance evaluation, labelling, and life-cycle assessment practices around the world. The ISO 14000 standard is becoming an economic instrument in the world market for countries and businesses to require a minimum environmental standard. To date over 15,000 businesses worldwide have voluntarily registered. Trained professionals carry out audits. Costs for this evaluation range depending on the size of the business.

CHECKLIST

*Put in place an environmental management system in line with the ISO 14000 standard.

WEB RESOURCES

ISO 14000 Questions and Answers
http://www.awm.net/wwwboard/wwwboard.shtml

ISO14000.org
http://www.iso14000.org

ENVIRONMENTAL DESIGN ELEMENT

Green Leaf Eco-Rating Program

The HAC Green Leaf™ Eco-Rating Program is a graduated rating system designed to identify hotels across Canada committed to improving their bottom line fiscal and environmental performance.
The program was established by TerraChoice Environmental Services, to recognize environmental achievements through a reward of 1 to 5 Green Leafs; 1 for a minimum of committing to a set of environmental principles and 2 through 5 for results in applying those principles. Members are located across Canada.

At present, only two establishments have achieved the top 5 leaf rating. Both of them are situated in the Rocky Mountains of Alberta.

The Fairmont Chateau Lake Louise
111 Lake Louise Drive
Lake Louise, Alberta
Canada
T0L 1E0
Telephone: (403) 522-3511
Fax: (403) 522-3834
Email: chateaulakelouise@fairmont.com

Aurum Lodge
Alan & Madeleine Ernst, Owners
P.O. Box 2277
Rocky Mountain House, AB
T4T 1B7
Tel: (403) 721-2117
Fax: (403) 721-2118
Email: info@aurumlodge.com

CHECKLIST

*Attempt to exceed all criteria to receive the full 5 Green Leaf Eco-rating.

WEB RESOURCES

Hotel Associaton of Canada - Green Leaf Eco-rating
http://www.terrachoice.ca/hotelwebsite/indexcanada.htm

ENVIRONMENTAL DESIGN ELEMENT

ECOTEL

The ECOTEL® Collection is an exclusive group of international inns, hotels, and resorts that define the concept of environmental responsibility in the hospitality industry. All certified hotels must pass a detailed inspection and satisfy stringent criteria designed by environmental experts.

CHECKLIST

*Attempt to exceed all five goals set out in the ECOTEL environmental standard.

WEB RESOURCES

HVS Eco Services
http://www.hvsecoservices.com

ENVIRONMENTAL DESIGN ELEMENT

Environmental Impacts Operation vs Construction

Although environmental building design is critically important to reduce environmental impacts of an operation, on average the operation of the building over its lifetime (i.e. 50 years) contributes 5 times the impacts of the initial construction. Thus, a life-cycle analysis is required to fully understand the environmental impacts of a building.

"Viewed over a 30-year period, initial building costs account for approximately just two percent of the total, while operations and maintenance costs equal six percent, and personnel costs equal 92 percent" (1996) (see Figure 1 below).

FIGURE 1: Environmental impacts of buildings over a life-cycle (30 years).

CHECKLIST

*Focus initial efficiency and waste reduction efforts in the operation of the hotel.

REFERENCES

Public Technology Inc., US Green Building Council.
<u>Sustainable Building Technical Manual</u> 1996

WEB RESOURCES

Good Practice Checklist : 100 Actions for a Green Office
http://www.cheshire.gov.uk/eco/100ways.htm

ENVIRONMENTAL DESIGN ELEMENT

Benchmarking

It is impossible to measure environmental success without knowledge and data on current and past practices. Benchmarking allows for more accurate decision-making and illustrates the benefits of adopting environmental practices.

CHECKLIST

*Measurement of processes and operations is critical in order to improve.By defining the existing operational efficiency, goals can be set to improve the management of systems.

ENVIRONMENTAL DESIGN ELEMENT

Continual Improvement

The design and operation of a hotel facility can never eliminate environmental impacts. Thus, the adoption of environmental values requires a continual search for improvements on existing practices. Fortunately, this process also contributes to improved economic performance as well.

CHECKLIST

*Establish a management practice of continual improvement. This includes a regular measurement of operation efficiency and comparison to past benchmarking and goals set. When goals are met, new goals should be specified to improve existing systems and operations. Full records need to be kept of progress on each goal.

WEB RESOURCES

Green Office
http://www.ec.gc.ca/office

Self Assessment Guide for Sustainable Commerce
http://www.sustainable-busforum.org/graphics/susguide.pdf

Solicitations by Sustainablebusiness.com
http://www.sustainablebusiness.com/B_Connections/index.cfm

SustainableBusiness - Business, Environment, Clean & Green Technologies
http://www.sustainablebusiness.com

UBC Campus Sustainability Office
http://www.sustain.ubc.ca

What is a Green Office?
http://www.coopamerica.org/business/sgo_whatis.htm

ENVIRONMENTAL DESIGN ELEMENT

Storage and Collection of Recyclables

Achieving environmental efficiency in an organization requires the complete adoption of environmental practices throughout the organization and by all employees. Facilitating the recycling of waste is the simplest means to leverage employees to take action.

Design the interior layout to facilitate collection and recycling practices by building occupants. Include areas for waste collection, separation, and storage to occur within the building.

CHECKLIST

*Design for ease of recycling for occupants and maintenance staff.

ENVIRONMENTAL DESIGN ELEMENT

Composting Organic Waste

Any organic product can be composted to return 100% of the material back into the biosphere. On-site composting is an economic and environmentally beneficial means of dealing with solid organic waste.

Composting is the transformation of organic material (plant matter) through decomposition into a soil-like material called compost. Invertebrates (insects and earthworms), and microorganisms (bacteria and fungi) help in transforming the material into compost. Composting is a natural form of recycling, which continually occurs in nature.

An ancient practice, composting is mentioned in the Bible several times and can be traced to Marcus Cato, a farmer and scientist who lived in Rome 2,000 years ago. Cato viewed compost as the fundamental soil enhancer, essential for maintaining fertile and productive agricultural land. He stated that all food and animal wastes should be composted before being added to the soil. By the 19th century in America, most farmers and agricultural writers knew about composting.

Today there are several different reasons why composting remains an invaluable practice. Yard and food wastes make up approximately 30% of the waste stream in the United States. Composting most of these waste streams would reduce the amount of Municipal Solid Waste (MSW) requiring disposal by almost one fourth, while at the same time provide a nutrient-rich soil amendment. Compost added to gardens improves soil structure, texture, aeration, and water retention. When mixed with compost, clay soils are lightened, and sandy soils retain water better. Mixing compost with soil also contributes to erosion control, soil fertility, proper pH balance, and healthy root development in plants.

The standard means of disposal for most yard and food waste include landfilling and incineration. These practices are not as environmentally or economically sound as composting. Yard waste which is landfilled breaks down very slowly due to the lack of oxygen. As it decomposes, it produces methane gas and acidic leachate, which are both environmental problems.

Landfilling organic wastes also takes up landfill space needed for other wastes. Incinerating moist organic waste is inefficient and results in poor combustion, which disrupts the energy generation of the facility and increases the pollutants that need to be removed by the pollution-control devices. Composting these wastes is a more effective and usually less expensive means of managing organic wastes. It can be done successfully on either a large or small scale, but the technique and equipment used differ.

Decomposition occurs naturally anywhere plants grow. When a plant dies, its remains are attacked by microorganisms and invertebrates in the soil, and it is decomposed to humus. This is how nutrients are recycled in an ecosystem. This natural decomposition can be encouraged by creating ideal conditions. The microorganisms and invertebrates fundamental to the composting process require oxygen and water to successfully decompose the material. The end products of the process are soil-enriching compost, carbon dioxide, water, and heat.

Composting is a dynamic process which will occur quickly or slowly, depending on the process used and the skill with which it is executed. A neglected pile of organic waste will inevitably decompose, but slowly. This has been referred to as "passive composting," because little maintenance is performed. Fast or "active" composting can be completed in two to six weeks. This method requires three key activities; 1) "aeration," by turning the compost pile, 2) moisture, and 3) the proper carbon to nitrogen (C:N) ratio. Attention to these elements will raise the temperature to around 130=-140=, and ensure rapid decomposition.

The success with which the organic substances are composted depends on the organic material and the decomposer organisms involved. Some organic materials are broken down more easily than others. Different decomposers thrive on different materials as well as at different temperature ranges. Some microbes require oxygen, and others do not; those that require oxygen are preferable for composting.

A more diverse microbial community makes for a more efficient composting process. If the environment in the compost pile becomes inhospitable to a particular type of decomposer, it will die, become dormant, or move to a different part of the compost pile. The transforming conditions of the compost pile create a continually evolving ecosystem inside the pile.

CHECKLIST

*All food waste should be composted or directed to agencies that reuse the food waste.

WEB RESOURCES

City Farmer - City of Vancouver Composting
http://www.cityfarmer.org/paulcomp66.html#Vanccompost

Enviro Care Composting, Recycling and Conservation Products
http://www.envirocare.net

Soil, Compost and Mulch Forum
http://forums.gardenweb.com/forums/soil

The Compost Resource Page
http://www.oldgrowth.org/compost

Worm Composting
http://www.cityfarmer.org/wormcomp61.html

Worm Forum
http://www.wormdigest.org/forum/index.cgi

Worm Suppliers
http://www.cityfarmer.org/wormsupl79.html#wormsupplies

Yard Waste Management
http://www.cahe.nmsu.edu/pubs/_h/h-122.html

RELATED PRODUCTS

Vermicomposter Bin
http://www.cleanairgardening.com/worcomverbin.html

ENVIRONMENTAL DESIGN ELEMENT

Renovations and Retrofits

Renovation projects can address a variety of environmental inefficiencies related to building operation. Consider entire systems and integration of systems when seeking increased efficiencies.

Serious consideration of life-cycle costs and benefits is needed before any renovation or retrofitting of systems or appliances is done. Renovations can have benefits as long as the end goals are attainable. For example, if the target is to achieve 100% passive solar heating of a building, than it may not be cost effective to increase insulation of exterior partitions of a poorly insulated wall. In some cases, it may be more cost-effective to start with a highly energy efficient building design. On the other hand, retrofits of systems and appliances typically provide instant economic and environmental benefits.

CHECKLIST

*Consider existing strategies to deal with passive solar gains. Reduce HVAC operating costs by upgrading fenestration, insulation, and mechanical equipment.
*Consider replacing all chlorofluorocarbon refrigerants. Take advantage of retrofits to eliminate refrigerants that contain CFCs and replace them with environmentally benign alternatives.
*Replace outdated systems or components.
*Address and correct past problems with ventilation and indoor air quality.
*Re-size components to current requirements.
*Improve occupant comfort. Commission any retrofits to ensure efficient and proper operation of HVAC systems.
*Upgrade systems, equipment, and layout to meet existing codes.
*Install new building-control systems.

WEB RESOURCES

Bendix and THOR washing machines dishwashers dryers Australia Australian
http://www.bendixaust.com.au/duomatiic.htm

Bosch Appliances
http://www.boschappliances.com

Energy Star - Air Conditioner Ratings
http://www.energystar.gov/products/roomac

Energy Star - Clothes Washer Ratings
http://www.energystar.gov/products/clotheswashers

Energy Star - Dishwasher Ratings
http://www.energystar.gov/products/dishwashers

Energy Star - Fax Machine Ratings
http://yosemite1.epa.gov/estar/consumers.nsf/content/faxmachines.htm

Energy Star - Photocopier Ratings
http://yosemite1.epa.gov/estar/consumers.nsf/content/copier.htm

Energy Star - Refrigerator Ratings
http://www.energystar.gov/products/refrigerators

Energy Star - TV, VCR Ratings
http://yosemite1.epa.gov/estar/consumers.nsf/content/tvs_and_vcrs.htm

Malber WD1000 Compact Combo Washer/Dryer - 24 Inch Space Saver
http://www.malberusa.com/wd1000.html

Maytag
http://www.maytag.com

Rebates and Assistance

In order for new renewable sources of energy to compete economically in the marketplace with conventional fuel sources, the subsidies must be equalized (or eliminated altogether!). Currently, the fossil fuel industry is heavily subsidized and thus it only seems appropriate that rebates and other tax incentives are applied to encourage the purchase of green power.

CHECKLIST

*Obtain input from utilities early in the design process. In many jurisdictions, rebates or incentives are available for conservation measures.
*Seek out utility resources and design assistance early in the project development.
*Institute rebate documentation and verification measures with utility.
*Assess the impact of deregulation. Estimate costs and exposure to energy cost increases. Evaluate building systems for present and future efficiency gains.

WEB RESOURCES
Green Power Network
http://www.eren.doe.gov/greenpower

ENVIRONMENTAL DESIGN ELEMENT

Organic Produce and Local Food

Conventional, large-scale, food production optimizes the economic benefits to the producer but reduces the species variety, nutritional content of the produce. As well, significant environmental and social costs including synthetic chemicals introduced into the environment, synthetic fertilizers that produce water pollution, and large transportation distances that result in seed stock choices that are optimized for transport and shelf life as opposed to nutritrition and taste.

The use of conventionally produced food products may have significant environmental impacts associated with them. Large scale industrial agriculture often requires excess inputs (synthetic fertilizers, herbicides and pesticides, fossil fuels for machinery, annual cropping and tilling that exposes the soil to erosion).

CHECKLIST

*Seek local or regional food products and use food that is harvested in the local season.

WEB RESOURCES
National Organic Program
http://www.ams.usda.gov/nop

Organic Consumers Association
http://www.purefood.org

Organic Food Production
http://www.nal.usda.gov/afsic/ofp

Organicfoods.Co.UK
http://www.organicfood.co.uk

ENVIRONMENTAL DESIGN ELEMENT

Maintaining Building Efficiency

An efficient building requires maintenance to maintain optimum performance. A green building likely has many systems working in unison and thus it is important for any building maintenance staff to understand all the building systems.

Although a building may be designed efficiently, the systems and equipment must be maintained and continually monitored to retain the high level of efficiency. Aside from the obvious tasks like changing filters or balancing HVAC systems, maintenance on every piece of building equipment can influence the energy performance of a building. An overheating fan motor will not only raise operating costs of the fan, but may also lower the efficiency of the entire HVAC system. A leaking chiller pump will draw extra power and will also hurt the chiller efficiency. And certain thermostatic controls, particularly pneumatic controls, need to be regularly calibrated to keep them operating properly.

Maintenace procedures may include the following:

1. Performance monitoring — Equipment should be continuously or at least periodically monitored in order to recognize problems that need attention.

2. Defect and failure detection — Equipment errors or malfunctions can be detected through service alarms or predicted based on previous performance histories.

3. System protection — Backups, standbys or other resources can be used to minimize the effects of equipment failures, allowing the failed component to be isolated and repaired without interrupting system performance.

4. Fault localization — Use of test systems, both internal and external, to determine whether information about faults is complete or sufficient for other actions to take place.

CHECKLIST

*Ensure programs and procedures are in place to maintain optimum efficiency in all areas of the hotel building and operation.

WEB RESOURCES

Building Operating Management Magazine
http://www.facilitiesnet.com

Saving Energy Through Operation and Maintenance
http://www.eren.doe.gov/buildings/comm_saving.html

ENVIRONMENTAL DESIGN ELEMENT

Educating Employees

An environmentally-friendly hotel cannot be achieved by the work of a single person (but don't let that stop you!). It requires the involvement and work of the majority of the employees, management, owners, and guests. Education is a key component to achieving this goal.

An efficient successful environmental organization is one where all the employees including managers, employees, and contractors are aware of the goals and practices of the organization. To achieve maximum success it is important to have an educational program in place that allows for participation throughout the organization.

Consider the following educational strategies:<p align=left>

1. Develop an environmental management system that includes managers and employees from throughout the organization.<p align=left>

2. Involve each department of the hotel by empowering employees and managers to benchmark, set targets, and compete for environmental efficiency and performance between each other.<p align=left>

3. Organize an environmental seminar by inviting local and international speakers, consultants, or employees of local environmental institutions and companies. Don't shy away from the competition, but rather embrace their successes and seek to go beyond their achievements.<p align=left>

4. Offer volunteer opportunties for your employees to take time off to volunteer for environmental causes.<p align=left>

5. Join local environmental organizations.

CHECKLIST

*Continual improvement and performance requires continual education of employees, managers, and clients.

WEB RESOURCES
10 Keys of Engaging and Educating Employees
http://www.greenbiz.com/toolbox/howto_third.cfm?LinkAdvID=4201

ENVIRONMENTAL DESIGN ELEMENT

Becoming a Leader in the Community

In the hospitality industry, visibility in the marketplace is paramount. Environmental leadership is just one more avenue that a hotel can use to gain positive exposure.

The arrival of a new trend or paradigm offers opportunities for those early adopters and those who seek to leverage it to their advantage. Environmental building design and operation is no different. An environmental operation that educates the surrounding community can achieve greater environmental success through cooperation and increased market share.

Some ideas for community outreach and cooperation:

1. Use coconut husks from restaurant as planters to grow indigenous plants to be given free to the community.
[Kandalama Hotel, Sri Lanka]

2. Develop a CD that illustrates and educates viewers on the environmental design and performance of the hotel.
[Orchid Hotel, India]

3. Host an environmental conference.
[Kandalama Hotel, Orchid Hotel]

4. Develop an eco-library within the hotel.
[Kandalama Hotel]

5. Organize a clean up the beach event that includes employees and managers of your hotel.
[Confifi Eden Hotel, Sri Lanka]

6. Refusing to sell endangered local flora and fauna and educating consumers and clients.
[Le Touessrok Hotel, Mauritius]

7. Management of the local marine park and free excursions for local school children.
[Chumbe Island Coral Park, Zanzibar]

8. Purchase as much product locally as possible, support small local businesses.
[Yelverton Brook Luxury Eco Retreat, Australia]

CHECKLIST

*Provide leadership not only in hospitality but environmental stewardship as well.

WEB RESOURCES
The Orchid Hotel
http://www.orchidhotel.com

ENVIRONMENTAL DESIGN ELEMENT

Building Decommissioning

Demolishing a building is necessary in some cases, where the cost to retrofit outweighs the cost (environmental and economic) to start a new. However, many new green buildings have utilized existing buildings as a shell or material source for the new efficient building.

Prior to any building decommissioning, the following steps should be taken.
1. Initial Investigation
 - Environmental assessment
 - Regulatory review
 - Equipment inventory
 - Building inspection

The first phase of any decommissioning project defines the current conditions, regulatory requirements, areas of concern, and alternatives for future action. The initial investigation provides the information to base future technical and financial project decisions.

An environmental assessment needs to be performed to identify and determine the nature and extent of any hazardous building materials or environmental contaminants in the building. Use existing information to direct the environmental investigation efforts rather than starting out with a widespread sampling program. The environmental sampling activities then can be directed toward the potential sources of concern.

Available information sources should be reviewed as the first step of the environmental assessment. Potential sources of existing information that may be helpful to direct subsequent phases of the environmental assessment include current site conditions based on observations, operational reports, information regarding past maintenance practices, interviews with senior facility staff,
previous environmental investigation and management reports, and regulatory Agency inspections, reports and files.

If known or suspected hazardous building materials or environmental constituents of concern are believed to be present based on the results of the information collection efforts, sampling should be performed to define the full nature and extent of these materials. Considerations for the differences between indoor and outdoor areas need to be made during planning for the environmental sampling activities.

A regulatory review is another component of the initial investigation phase of work that should be performed concurrent with the environmental investigation activities. The regulatory review should identify applicable regulations relating to the constituents of concern, required analytical methods and minimum detection levels for sampling, and target cleanup levels for any required remediation.

An equipment inventory is another component of the initial assessment as it is important to determine the equipment and materials present inside a building before it can be decommissioned. The level of detail for an equipment inventory can vary greatly, from a simplistic assessment describing that there is a building of a certain size filled with a particular type of equipment, to a
detailed listing of every piece and size of item in place.

A building inspection is another component of the initial assessment that also can provide valuable information for deciding on alternatives for future use. Inspection of the facility design, materials of construction, and current condition can provide useful information to help direct other portions of the environmental assessment. The structural integrity of the building is an important factor to consider in evaluating whether the buildings should be reused or demolished.

2. Evaluation of Alternatives

- Financial issues
- Environmental goals
- Engineering considerations
- Anticipated future use

The results of the initial investigation is used to develop alternative response actions with their associated estimated costs. This assessment leads to the selection of the desired approach and formulation of the plan for its implementation in the following phase. The general alternatives for decommissioning a building are:
Mothball – take no further action and leave the facility in place, as is. Hazardous building materials and environmental contaminants, if any, would be left in place to be dealt with at a later time, possibly during a future demolition project.
Remediate and Mothball – remediate the immediate environmental concerns and leave the rest of the building as is.
Remediate and Dismantle Equipment – remediate all the environmental concerns and dismantle all the equipment inside the building leaving the shell of the building.
Demolish – complete demolition of the building to what is often referred to as a “greenfield” condition. This includes removal of the building and all associated infrastructure to a depth of 1 metre below grade. Environmental remediation may also be required. The option exists to send contaminated building debris to the appropriate landfill in lieu of cleanup or decontamination of those building materials. Depending on the level of existing contamination and the extent of remediation, this approach may result in a “brownfield” rather than a greenfield condition.

3. Facility Decommissioning

- Environmental remediation
- Equipment dismantling
- Building demolition

The decommissioning phase of the project can begin when all of the assessment and planning activities are completed. Facility decommissioning may include environmental remediation, equipment dismantling, or building demolition based on the results of the initial investigation and the selected response action.

4. Adaptive Reuse

Once the building has been decommissioned, the search for recycling and reuses can begin. If the building was completely demolished, the remaining property may be suited for new construction or rehabilitated green space. If the shell of the original building remains, it is now ready for modifications to prepare it for its new intended use. The choice of the new function is highly dependent upon the combination of factors investigated above including the location, architectural design, local demographics, public and/or private interest, and available funding.

CHECKLIST

*Consider every component including the entire building shell and interior for adaptive reuse or recycling opportunities.

WEB RESOURCES

Facility Decommissioning and Adaptive Reuse
http://www.westonsolutions.com/Publications/ScaddenNDIA01.pdf

King County Reuseable Building Materials Exchange
http://dnr.metrokc.gov/swd/rbme

ENVIRONMENTAL DESIGN ELEMENT

Building Reuse and Recycling

Ideally, everything in a building can either be reused, recycled, or returned to nature as compost. In any decommissioning of a building, materials need to be accounted for and separated to maximize the reuse/recycling potential.

Reuse and recycling is important to get the most out of our resources and to maintain a sustainable relationship between economics and stewardship for our environment. Besides deriving the maximum amount of value from a resource, recycling also reduces or prevents emissions to air and water, saves energy and natural resources and reduces greenhouse gas emissions from landfills.

Consider at minimum recycling the following materials:

- Metals (Steel, Aluminum 100%)
- Wood (Large dimension lumber particularly valuable)
- Plastics
- Asphalt and Concrete
- Ceiling Tiles
- Carpet
- Gypsum Board
- Plumbing Fixtures
- Mechanical Equipment

CHECKLIST

*Every opportunity should be made to salvage and reclaim building materials and components and make them available or send them to recycling operations.

WEB RESOURCES

Construction and Demolition Debris - Waste Reduction
http://www.epa.gov/epaoswer/non-hw/debris/waste.htm

Green Building Materials RecycleWorks
http://www.recycleworks.org/greenbuilding/gbdatabase.html

Recycler's World
http://www.recycle.net

Recyclops
http://www.recyclops.com

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