Saman Sami Mohsin
Sustainability in Architecture

O c t 2 0 1 3

TAKING LESS FROM THE EARTH AND GIVING MORE TO PEOPLE
AS A FLEXABLE DESCRIBE FOR THIS NEW KIND OF ARCHITECTURE AS IN ITS PRIMER ON SUSTAINABLE BUILDING BY "ROCKY MOUNTAIN INSTITUTE"

The Lighter Side of Sustainable Architecture

Index

Preface

This essay is about sustainability in architecture and its effect on people's daily live that I believe we as architects should concidered them in our designs. Energy efficiency, water efficiency, building materials, indoor environmental quality....ect, all these items are the points people nowadays care about, so when we put a concept of a subject we should realize that our concept will come true and it will become a building, people using it, so we should thinck in advance about what we will do and what we will use to create an environment the building users and the city satusfying while using and seeing the design.
All these issues I am trying to disscuse in this essay and why our designers do not useing them, does the people not allow the designer or the concept sustainabilty does not become as a regulation to follow or what, focusing on the most important points that I believe its easy and allowed around us.

Introduction

Everyday, people are increasingly realizing the choices they make in their everyday lives, affect the people and the environment around them. However, much is changing. We are seeing a push to create buildings and spaces that do not require external energy to heat, cool or power them. There are efforts to reduce the use of materials that have a high embodied energy and to increase the number of recycled/reused and recyclable/reusable materials.

This document is meant to be a survey of the wide array of options designers and builders have to create spaces that are more sustainable, with a particular focus on residential architecture. When looking at sustainability as it applies to architecture, there are several aspects of a building that are important to consider: atmosphere, longevity, energy, interface and equity.

The atmosphere of a building is the mood and feeling that it engenders. Is there sufficient lighting, how does one move from one room to the next and how is the air quality? A sustainable building will take into account all of these factors because the health of a building's users is intrinsically intertwined with the use of the building. The longevity of a building also plays an important role in its sustainability. Spaces that remain of use to their occupants for a long duration are more sustainable than those that are torn down 35 years after they have been built, the current US average; this compared to 50-60 years for Australia and Britain (Birkeland 46). Designing buildings that will last and be of use for generations should be a major goal of any architect.

Reducing the energy impact of a built space is one of the most important considerations to be taken when constructing spaces. Building energy use comes in two forms: embodied energy and operating energy. Embodied energy, the energy required to create, transport and install the materials that make up a building, surprisingly make up a large portion of a building's energy costs (less if the building lasts longer). Operating energy is the energy a building uses everyday to heat and cool a space, run appliances and power any electronics within.

When creating architecture with a conscious effort towards improving sustainability, one must take into account the way a building interacts with its surroundings. How will people connect with their neighbors, their backyard, the streets? A building that interfaces well with its surroundings is one that is more useful and likely to be appreciated for longer. Also of importance is how the building affects the immediate environment, i.e. what plants and animals are being displaced, how much of the local topography will be changed, will weather systems be significantly impacted by the new building (such as from storm water or wind)? Finally, an aspect of sustainability that is often overlooked is that of equity.

Too often money is the solution to unsustainable situations. However if technology and design are too expensive for the average person, they can never be sustainable because they won't be widely adopted (although if expensive technology is embraced, it is likely to become more affordable). Of course one can argue that the true costs are often hidden (environmental, human rights violations, etc.), but this argument does little to encourage adoption. Solutions like home made bidets (which reduce toilet paper usage) and slow sand filtration are low cost alternatives to expensive Japanese toilets with built in bidets and UV light filtration systems respectively. If sustainable architecture is ever to make a significant impact, it must be affordable to the masses.

Principles of Sustainable Design

The three developed levels of the conceptual framework (Principles, Strategies, and Methods) correspond to the three objectives of architectural environmental education: creating environmental awareness, explaining the building ecosystem, and teaching how to design sustainable buildings. The overall conceptual diagram for sustainable design is shown in Figure 1.

The principles of sustainability in architecture. *Economy of Resources* is concerned with the reduction, reuse, and recycling of the natural resources that are input to a building.

Life Cycle Design provides a methodology for analyzing the building process and its impact on the environment. *Humane Design* focuses on the interactions between humans and the natural world. These principles can provide a broad awareness of the environmental impact, both local and global, of architectural consumption.

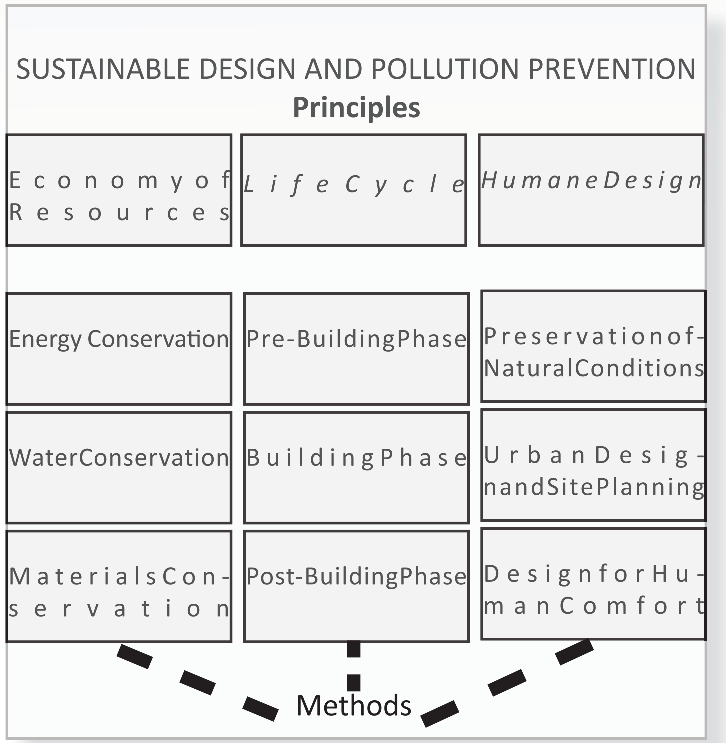

Figure 1: Conceptual framework for Sustainable Design and Pollution Prevention in Architecture.

Each of these principles embody a unique set of strategies. Studying these strategies leads to more thorough understanding of architecture's interaction with the greater environment. This allows them to further disaggregate and analyze specific methods architects can apply to reduce the environmental impact of the buildings they design.

When examining a building, consider two streams of resource flow (see Figure 2). Upstream, resources flow into the building as input to the building ecoystem. Downstream, resources flow out of the building as output from the building ecosystem. In a long run, any resources entered into a building ecosystem will eventually come out from it. This is the law of resource flow conservation. For a given resource, its forms before entry to a building and after exit will be different. This transformation from input to output is caused by the many mechanical processes or human interventions rendered to the resources during their use in buildings. The input elements for the building ecosystem are diverse, with various forms, volumes, and environmental implications.

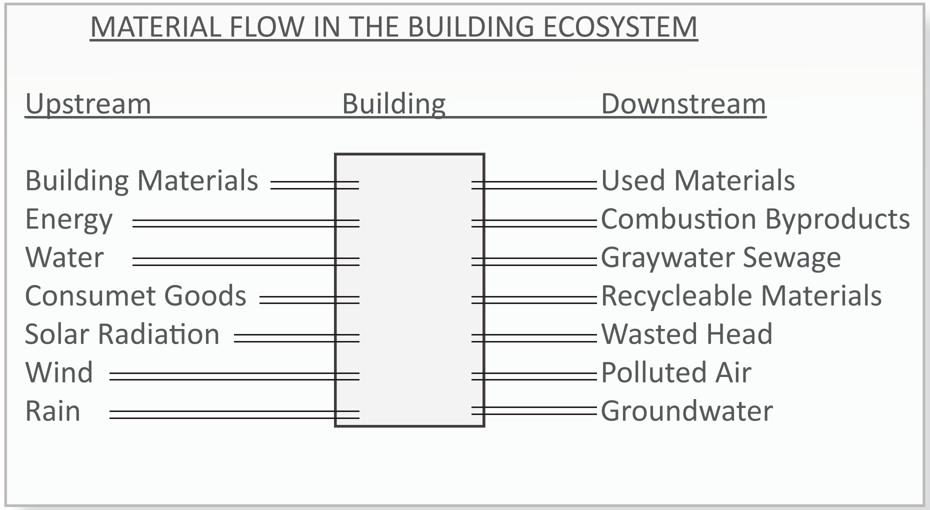

Figure 2: The input and output streams of resource flow.

Principle 1: Economy of Resources:

By economizing resources, the architect reduces the use of nonrenewable resources in the construction and operation of buildings. There is a continuous flow of resources, natural and manufactured, in and out of a building. This flow begins with the production of building materials and continues throughout the building's life span to create an environment for sustaining human well-being and activities. After a building's useful life, it should turn into compoents for other buildings.

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Each focuses on a particular resource necessary for building construction and operation.

Energy Conservation;

After construction, a building requires a constant flow of energy input during its operation. The environmental impacts of energy consumption by buildings occur primarily away from the building site, through mining or harvesting energy sources and generating power. The energy consumed by a building in the process of heating, cooling, lighting, and equipment operation cannot be recovered. The type, location, and magnitude of environmental impacts of energy consumptions in buildings differ depending on the type of energy delivered. Coal-fired electric power plants emit polluting gases such as SO2 , CO2 , CO, and NOx into the atmosphere. Nuclear power plants produce radioactive wastes, for which there is currently no permanent management solution. Hydropower plants each require a dam and a reservoir which can hold a large body of water; construction of dams results in discontinuance of river ecosystems and the loss of habitats for animals and plants.

Water Conservation;

A building requires a large quantity of water for the purposes of drinking, cooking, washing and cleaning, flushing toilets, irrigating plants, etc.. All of this water requires treatments and delivery, which consume energy. The water that exits the building as sewage must also be treated.

Material Conservation;

A range of building materials are brought onto building sites. The influx of building materials occurs primarily during the construction stage. The waste generated by the construction and installation process is significant. After construction, a low-level flow of materials continues in for maintenance, replacement, and renovation activities. Consumer goods flow into the building to support human activities. All of these materials are eventually output, either to

Principle 2: Life Cycle Design

The conventional model of the building life cycle is a linear process consisting of four major phases: design; construction; operation and maintenance; and demolition (see Figure 3). The problem with this model is that it is too narrowly defined: it does not address environmental issues (related to the procurement and manufacturing of building materials) or waste management (reuse and recycling of architectural resources).

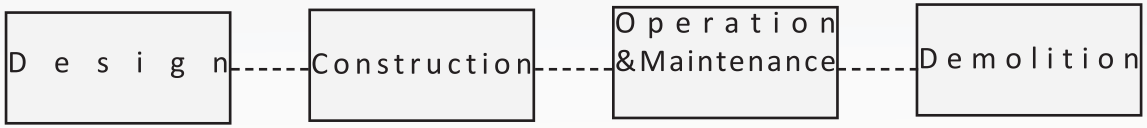


Figure 3: Conventional model of the building life cycle.

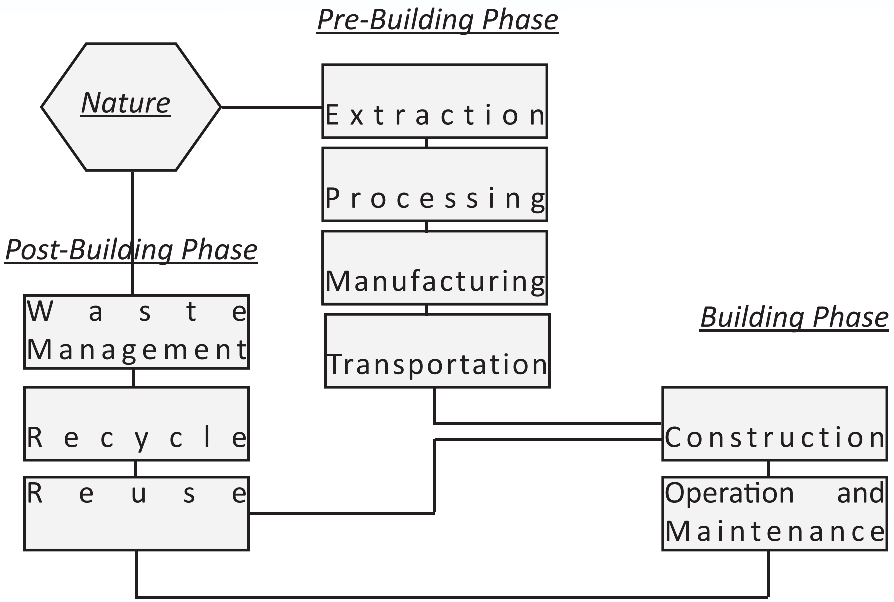


Figure 4: The sustainable building life cycle.

The second principle of sustainable architecture is life cycle design (LCD). This "cradle-to-grave" approach recognizes environmental consequences of the entire life cycle of architectural resources, from procurement to return to nature. LCD is based on the notion that a material transmigrates from one form of useful life to another, with no end to its usefulness.

For the purpose of conceptual clarity, the life cycle of a building can be categorized into three phases: pre-building, building, and post-building, as shown in Figure 4. These phases are connected, and the boundaries between them are not obvious. The phases can be developed into LCD strategies that focus on minimizing the environmental impact of a building. Analyzing the building processes in each of these three phases provides a better understanding of how a building's design, construction, operation, and disposal affect the larger ecosystem.

Pre-Building Phase

This phase includes site selection, building design, and building material processes, up to but not including installation. Under the sustainable-design strategy, we examine the environmental consequences of the structure's design, orientation, impact on the landscape, and materials used.

The procurement of building materials impacts the environment: harvesting trees could result in deforestation; mining mineral resources (iron for steel; bauxite for aluminum; sand, gravel, and limestone for concrete) disturbs the natural environment;
even the transport of these materials can be a highly
polluting activity, depending on their weight and distance from the site. The manufacturing of building products also requires energy and creates environmental pollution: for example, a high level of energy is required to manufacture steel or aluminum products.

Building Phase

This phase refers to the stage of a building's life cycle when a
building is physically being constructed and operated. In the
sustainable-design strategy, we examine the construction and
operation processes for ways to reduce the environmental
impact of resource consumption; we also consider long-term
health effects of the building environment on its occupants.

Post-Building Phase

This phase begins when the useful life of a building has ended.

In this stage, building materials become resources for other
buildings or waste to be returned to nature. The sustainabledesign
strategy focuses on reducing construction waste (which
currently comprises 60% of the solid waste in landfills1) by
recycling and reusing buildings and building materials.

Site and Building Interactions;

The LCD concept calls for consideration of the environmental consequences of buildings in all three phases of the life cycle. Each phase of building life cycle is associated with two groups of ecological elements: site and building (see Figure 5). The principal domain of architectural design is in the building phase, but sustainable building can be achieved by finding ways to minimize environmental impacts during all three phases of building life cycle.

Pre-Building	SITE: Elements of site ecology that exist within or in the vicinity of a building site, including sun- such as light, wind, precipitation, water table, soil, flora, fauna, etc. ... ... before construction. ...	BUILDING: Natural or manufactured resources, building materials, water, or energy ... before they arrive at the site.
Building	... from the time construction begins through the duration of the building's useful life.	... from the time they arrive at the site for installation or operation though the duration of the building's useful life.
Post-Building	... after the building's useful life.	... after the building's useful life.

Figure 5: Ecological elements of Site and Building associated with the building life-cycle phases.

Principle 3: Human Design:

Humane design is the third, and perhaps the most important, principle of sustainable design. While economy of resources and life cycle design deal with efficiency and conservation, humane design is concerned with the livability of all constituents of the global ecosystem, including plants and wildlife.
This principle arises from the humanitarian and altruistic goal of respecting the life and dignity of fellow living organisms.
Further examination reveals that this principle is deeply rooted in the need to preserve the chain elements of the ecosystems that allow human survival.
In modern society, more than 70% of a person's lifespan is spent indoors. An essential role of architecture is to provide built environments that sustain occupants' safety, health, physiological comfort, psychological well-being, and productivity.
Because environmental quality is intangible, its importance has often been overlooked in the quest for energy and environmental conservation, which sometimes seemed to mean "shivering in the dark." Compounding the problem, many building designers have been preoccupied with style and form-making, not seriously considering environmental quality in and around their built environments .
Remember the performance factor of design. When a product saves energy, does it perform as well as what it is replacing?
And how does it affect the performance of building occupants?

For instance, early fluorescent lighting systems were more efficient than their incandescent counterparts; however, some fluorescents were known to buzz. The bulb might save $30 in annual energy costs, but if the noise irritated the employee working nearby, the employee's resulting drop in productivity could cost the employer a lot more, thereby wiping out any financial benefits gained from lighting energy conservation.

A general rule of thumb in such comparisons is that the annual energy bill of a typical office building amounts to around five hours of employee labor cost; therefore, any building energy conservation strategy that annually reduces productivity by more than five hours per employee defeats its purpose. This is not to say that energy conservation can't be financially beneficial, just that it should be kept in holistic perspective, taking other pertinent factors into account.

Introduction to Sustainable Design December 1998 Sustainable Design • 15 The following three strategies for humane design focus on enhancing the co-existence between buildings and the greater environment, and between buildings and their occupants,

Preservation of Natural Conditions: An architect should minimize the impact of a building on its local ecosystem (e.g., existing topography, plants, wild-life).

Urban Design and Site Planning: Neighborhoods, cities, and entire geographic regions can benefit from cooperative planning to reduce energy and water demands. The result can be a more pleasant urban environment, free of pollution and welcoming to nature.

Human Comfort: As discussed previously, sustainable design need not preclude human comfort. Design should enhance the work and home environments. This can improve productivity, reduce stress, and positively affect health and well-being.

Methods for Achiving Sustainable Design

The three principles of sustainable design

- -Economy of resources.
- -Life cycle design.
- -Humane design.

provide a broad awareness of the environment issues associated with architecture.
The strategies within each principle focus on more specific topics.
These strategies are intended to foster an understanding of how a building interacts with the internal, local, and global environments.
This section discusses methods for applying sustainable design to architecture.

Economy of Resource:

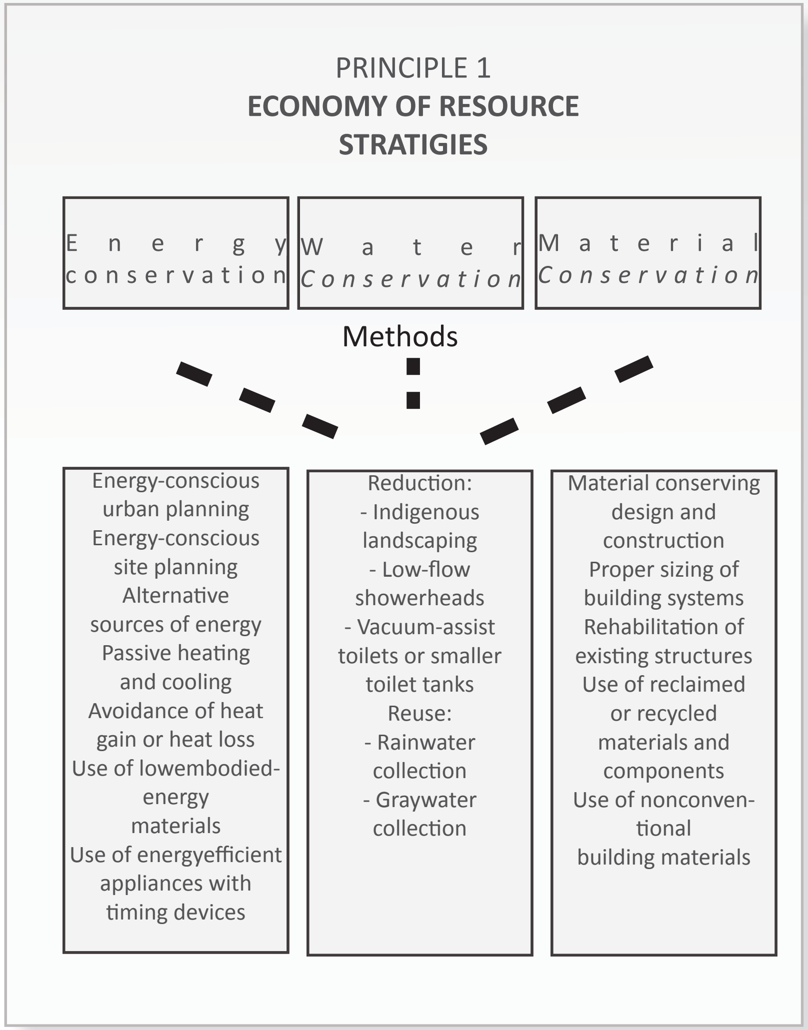
Achieving principle number one of sustainability in architecture through conservying energy, water and materials, These methods can be classified as two types.

1) Input-reduction methods reduce the flow of nonrenewable resources input to buildings. A building's resource demands are directly related its efficiency in utilizing resources.

2) Output-management methods reduce environmental pollution by requiring a low level of waste and proper waste management.

Energy Conservation:

Energy conservation is an input-reduction method. The main goal is to reduce consumption of fossil fuels. Buildings consume energy not only in their operation, for heating, lighting and cooling, but also in their construction. The materials used in architecture must be harvested, processed, and transported to the building site. Construction itself often requires large amounts of energy for processes ranging from moving earth to welding.



Water Conservation:

Methods for water conservation may reduce input, output, or both. This is because, conventionally, the water that is supplied to a building and the water that leaves the building as sewage is all treated by municipal water treatment plants. Therefore,a reduction in use also produces a reduction in waste.
Reuse Water Onsite,
Water consumed in buildings can be classified as two types:
graywater and sewage. Graywater is produced by activities such as handwashing. While it is not of drinking-water quality, it does not need to be treated as nearly as intensively as sewage. In fact, it can be recycled within a building, perhaps to irrigate ornamental plants or flush toilets. Well-planned plumbing systems facilitate such reuse.
In most parts of the world, rainwater falling on buildings has not been considered a useful resource. Buildings are typically designed to keep the rain from the occupants, and the idea of utilizing rain water falling on building surfaces has not been widely explored. Building envelopes, particularly roofs, can become rainwater collecting devices, in combination with cisterns to hold collected water. This water can be used for irrigation or toilet-flushing.

Reduce Consumption

Water supply systems and fixtures can be selected to reduce consumption and waste. Low-flow faucets and small toilet tanks are now required by code in many areas of the country. Vacuum-assisted and biocomposting toilets further reduce water consumption. Biocomposting toilets, available on both residential and commercial scales, treat sewage on site, eliminating the need for energy-intensive municipal treatment.
Indigenous landscaping — using plants native to the local ecosystem — will also reduce water consumption. These plants will have adapted to the local rainfall levels, eliminating the need for additional watering. Where watering is needed, the sprinkler heads should be carefully placed and adjusted to avoid watering the sidewalk and street.

Material Conservation:

The production and consumption of building materials has diverse implications on the local and global environments. Extraction, processing, manufacturing, and transporting building materials all cause ecological damage to some extent. There are input and output reduction methods for materials conservation. As with water, some of these methods overlap.

Adapt Existing Buildings to New Uses,

One of the most straightforward and effective methods for material conservation is to make use of the resources that already exist in the form of buildings. Most buildings outlive the purpose for which they were designed. Many, if not all, of these buildings can be converted to new uses at a lower cost than brand-new construction.

Incorporate Reclaimed or Recycled Materials,

Buildings that have to be demolished should become the resources for new buildings. Many building materials, such as wood, steel, and glass, are easily recycled into new materials.

Some, like brick or windows, can be used whole in the new structure. Furnishing, particularly office partition systems, are also easily moved from one location to another.

Use Materials That Can Be Recycled,

During the process of designing the building and selecting the building materials, look for ways to use materials that can themselves be recycled. This preserves the energy embodied in their manufacture.

Size Buildings and Systems Properly,

A building that is oversized for its designed purpose, or has oversized systems, will excessively consume materials. When a building is too large or small for the number of people it must contain, its heating, cooling, and ventilation systems, typically sized by square footage, will be inadequate or inefficient. This method relates directly to the programming and design phases of the architectural process. The client's present and future space needs must be carefully studied to ensure that the resulting building and systems are sized correctly.

Architects are encouraged to design around standardized building material sizes as much as possible. In the U. S., this standard is based on a 4'x8' sheet of plywood. Excess trimming of materials to fit non-modular spaces generates more waste.

Reuse Non-Conventional Products as Building Materials,

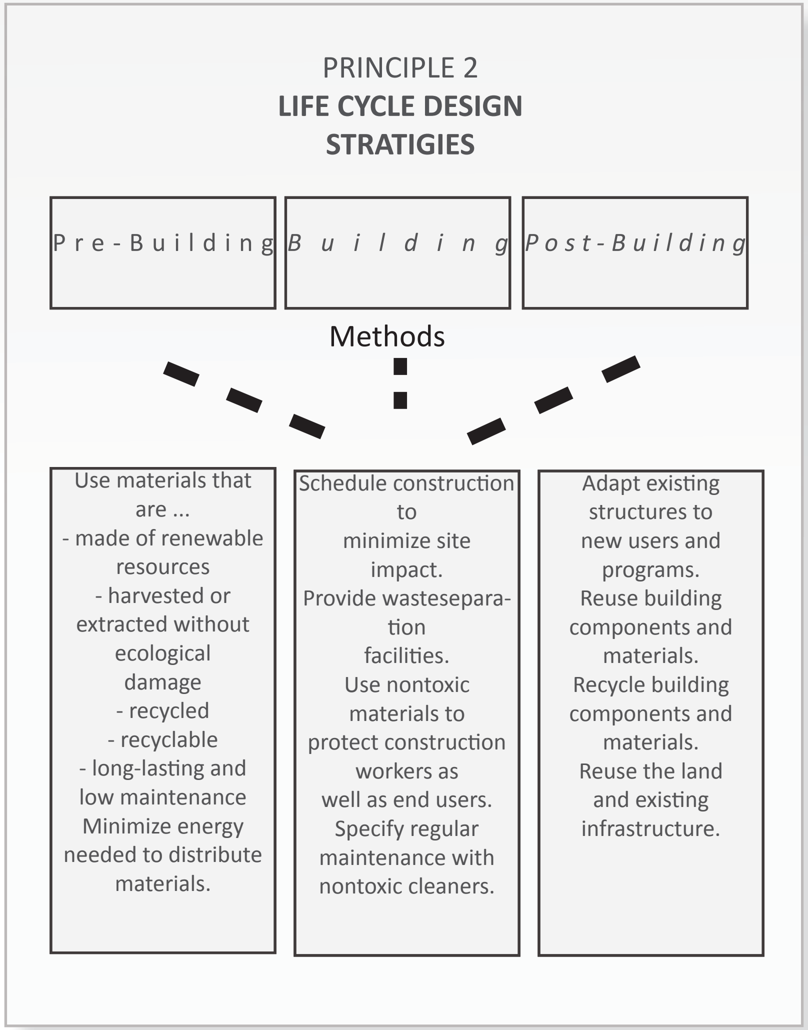
Building materials from unconventional sources, such as recycled tires, pop bottles, and agricultural waste, are readily available. These products reduce the need for new landfills and have a lower embodied energy that the conventional materials they are designed to replace.

Consumer Goods,

All consumer goods eventually lose their original usefulness. The "useful life" quantifies the time of conversion from the useful stage to the loss of original usefulness stage. For instance, a daily newspaper is useful only for one day, a phone book is useful for one year, and a dictionary might be useful for 10 years. The shorter the useful life of consumer goods, the greater the volume of useless goods will result. Consequently, more architectural considerations will be required for the recycling of short-life consumer goods. The conventional term for consumer goods that have lost their original usefulness is waste. But waste is or can be a resource for another use. Therefore, in lieu of waste, it is better to use the term "recyclable materials." One way buildings can encourage recycling is to incorporate facilities such as on-site sorting bins.

Life Cycle Design:

As mentioned in principle (2)/ (life cycle design, which involve three stratigies:
-Pre-building phase.
-Building phase.
-post building phase.
These stratigies mainlly improve the sustainibility of archtecture, through,
These methods focus mainly on reducing input. Consuming fewer materials lessens the environmental impact of the associated manufacturing processes. This then reduces the eventual output of the building ecosystem.



Pre-Building Phase:

During the Pre-Building Phase, the design of a building and materials selected for it are examined for their environmental impact. The selection of materials is particularly important at this stage: the impact of materials processing can be global and have long-term consequences.

Use Materials Made From Renewable Resources:

Renewable resources are those that can be grown or harvested at a rate that exceeds the rate of human consumption. Using these materials is, by definition, sustainable. Materials made from nonrenewable materials (petroleum, metals, etc.) are, ultimately, not sustainable, even if current supplies are adequate. Using renewable materials wherever possible reduces the need for nonrenewable materials.

Use Materials Harvested or Extracted Without Causing Ecological Damage:

Of the renewable materials available, not all can be obtained without significant environmental effects. Therefore, the architect must be aware of how various raw materials are harvested and understand the local and global ramifications.

Use Recycled Materials:

Using recycle materials reduces waste and saves scarce landfill space. Recycled materials also preserve the embodied energy of their original form, which would otherwise be wasted. This also reduces the consumption of materials made from virgin natural resources. Many building materials, particularly steel, are easily recycled, eliminating the need for more mining and milling operations.

Use Materials with Long Life and Low Maintenance:

Durable materials last longer and require less maintenance with harsh cleansers. This reduces the consumption of raw materials needed to make replacements and the amount of landfill space taken by discarded products. It also means occupants receive less exposure to irritating chemicals used in the installation and maintenance of materials.

Building Phase:

The methods associated with the Building Phase strategy are concerned with the environmental impact of actual construction and operation processes.

Minimize Site Impact:

Careful planning can minimize invasion of heavy equipment and the accompanying ecosystem damage to the site.
Excavations should not alter the flow of groundwater through the site.
Finished structures should respect site topology and existing drainage.
Trees and vegetation should only be removed when absolutely necessary for access.
For sensitive sites, materials that can be hand-carried to the site reduce the need for excessive road-building and heavy trucks.

Employ Nontoxic Materials:

The use of nontoxic materials is vital to the health of the building's occupants, who typically spend more than threequarters of their time indoors. Adhesives used to make many common building materials can outgas — release volatile organic compounds into the air — for years after the original construction. Maintenance with nontoxic cleansers is also important, as the cleaners are often airborne and stay within a building's ventilation system for an extended period of time.

Post-Building Phase:

During this phase, the architect examines the environmental consequences of structures that have outlived their usefulness.

At this point, there are three possibilities in a building's future:

reuse, recycling of components, and disposal.
Reuse and recycling allow a building to become a resource for new buildings or consumer goods; disposal requires incineration or landfill dumping, contributing to an already overburdened waste stream.

Reuse the Building:

The embodied energy of a building is considerable. It includes not only the sum of energy embodied in the materials, but also the energy that went into the building's construction. If the building can be adapted to new uses, this energy will be conserved. Where complete reuse of a building is not possible, individual components can be selected for reuse — windows, doors, bricks, and interior fixtures are all excellent candidates.

Recycle Materials:

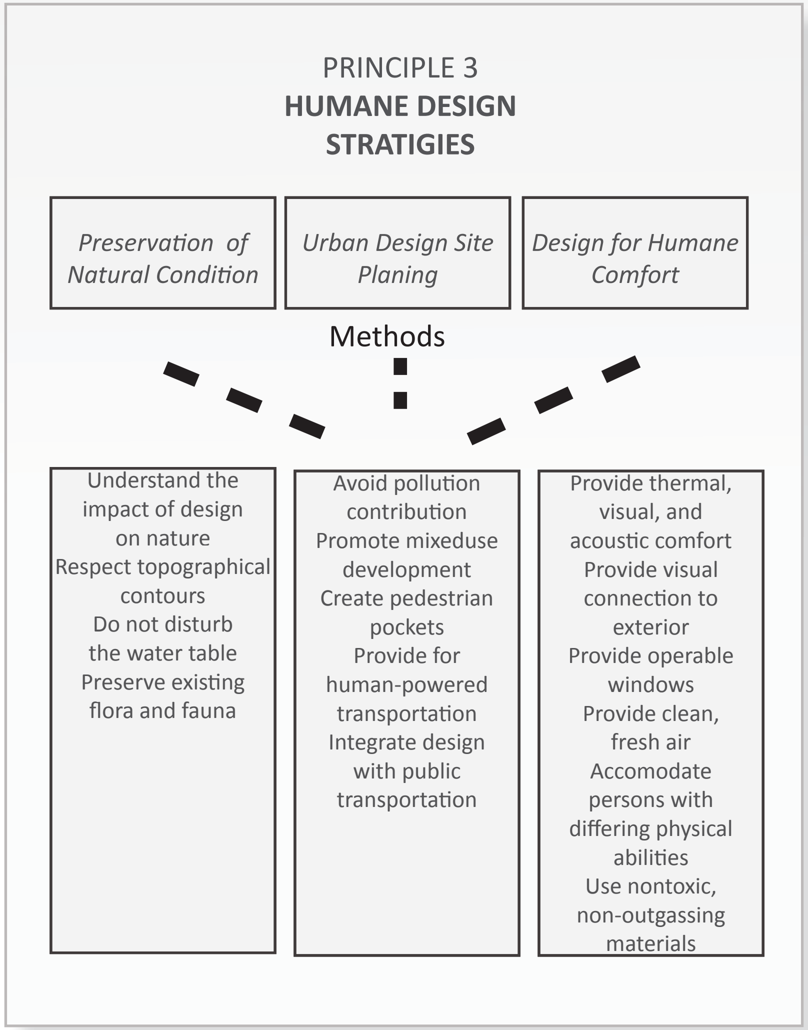
Recycling materials from a building can often be difficult due to the difficulty in separating different substances from one another. Some materials, like glass and aluminum, must be scavenged from the building by hand. Steel can easily be separated from rubble by magnets. Concrete can be crushed and used as aggregate in new pours.

Reuse Existing Buildings and Infrastructure:

It has become common for new suburbs to move farther and farther from the core city as people search for "space" and "nature." Of course, the development of new suburbs from virgin woods or fertile agricultural fields destroys the very qualities these suburbanites are seeking. Moreover, in addition to the materials for new houses, new development requires massive investments in material for roads, sewers, and the businesses that inevitability follow. Meanwhile, vacant land and abandoned structures in the city, with its existing infrastructure, go unused, materials wasted.

Humane Design:

As mentioned in principle (3)/ (human design, which involve three stratigies:
-Preservation of Natural Conditions.
-Urban Design and Site Planning.
-Design for Human Comfort.
These stratigies mainlly improve the sustainibility of archtecture,
These methods focus primarily on improving the quality of life for humans and other species.



Preservation of Natural Conditions:

Respect Topographical Contours:

The existing contours of a site should be respected. Radical terraforming is not only expensive but devastating to the site's microclimate. Alteration of contours will affect how water drains and how wind moves through a site.

Do Not Disturb the Water Table:

Select sites and building designs that do not require excavation below the local water table. Placing a large obstruction (the building) into the water table will disturb natural hydraulic process. If the water table is exposed during construction, it will also become more susceptible to contamination from polluted surface runoff.

Preserve Existing Flora and Fauna:

Local wildlife and vegetation should be recognized as part of the building site. When treated as resources to be conserved rather than as obstacle to be overcome, native plants and animals will make the finished building a more enjoyable space for human habitation.

Urban Design and Site Planning:

Integrate Design with Public Transportation:

Sustainable architecture on an urban scale must be designed to promote public transportation. Thousands of individual vehicles moving in and out of area with the daily commute create smog, congest traffic, and require parking spaces.

Promote Mixed Use Development

Sustainable development encourages the mixing of residential, commercial, office and retail space. People then have the option of living near where they work and shop. This provides a greater sense of community than conventional suburbs. The potential for 24-hour activity also makes an area safer.

Design for Human Comfort:

Provide Thermal, Visual, and Acoustic Comfort:

People do not perform well in spaces that are too hot or too cold. Proper lighting, appropriate to each task, is essential. Background noise from equipment or people can be distracting and damage occupants' hearing. Acoustic and visual privacy also need to be considered.

Provide Visual Connection to Exterior:

The light in the sky changes throughout the day, as the sun and clouds move across the sky. Humans all have an internal clock that is synchronized to the cycle of day and night. From a psychological and physiological standpoint, windows and skylights are essential means of keeping the body clock working properly,

Provide Operable Windows:

Operable windows are necessary so that building occupants can have some degree of control over the temperature and ventilation in their workspace.

Provide Fresh Clean Air:

Fresh air through clean air ducts is vital to the well-being of building occupants. The benefits of fresh air go beyond the need for oxygen. Continuous recirculation of interior air exposes people to concentrated levels of bacteria and chemicals within the building.

Use Nontoxic, Non-Outgassing Materials:

Long-term exposure to chemicals commonly used in building materials and cleaners can have a detrimental effect on health.

Accommodate Persons with Differing Physical Abilities:

One aspect of sustainable design is its longevity. Buildings that are durable and adaptable are more sustainable than those that are not. This adaptability includes welcoming people of different ages and physical conditions. The more people that can use a building, the longer the building's useful life.

Material:

Key Building Materials and Sources


Limestone quarry


Limestone for cladding


Crushed limestone


Crushed limestone


Limestone quarry


Limestone for cladding

Limestone:

Limestone is perhaps the most prevalent building material obtained through mining. It is used as a cladding material and plays an important role in the production of a wide range of building products. Concrete and plaster are obvious examples of products that rely on limestone; less obvious is the use of limestone in steel and glass production.
An abundant natural resource, limestone is found throughout the world. In the U.S., the states of Pennsylvania, Illinois, Florida, and Ohio are the largest producers.5 The mining of this sedimentary rock generally takes place in open-pit quarries. Pit-mining requires the use of heavy equipment to move the topsoil, vegetation, and overlaying rock (collectively referred to as “overburden”). Large blocks of stone are removed from the rock bed by controlled drilling and explosions. These blocks may be cut into smaller units for use as structural masonry or veneer material. Most limestone is crushed at the quarry, then converted to lime, by burning, at another location. The burning of limestone creates sulfide emissions, a major contributor to acid rain. Limestone (primarily calcium carbonate) is converted to quicklime (calcium oxide) through prolonged exposure to high heat. This removes water and carbon from the stone and releases carbon dioxide into the atmosphere. The quicklime is then crushed and screened. Before it can be used in plaster or cement, it must be mixed with water and then dried. The hydrated lime then becomes an ingredient in concrete, plaster, and mortar.

Steel:

Steel requires the mining of iron ore, coal, limestone, magnesium, and other trace elements. To produce steel, iron must first be refined from raw ore. The iron ore, together with limestone and coke (heat-distilled coal) are loaded into a blast furnace. Hot air and flames are used to melt the materials into pig iron, with the impurities (slag) floating to the top of the molten metal. Steel is produced by controlling the amount of carbon in iron through further smelting. Limestone and magnesium are added to remove oxygen and make the steel stronger. A maximum carbon content of 2% is desired.
Other metals are also commonly added at this stage, to produce various steel alloys. These metals include magnesium, chromium, and nickel, which are relatively rare and difficult to extract from the earth's crust. The molten steel is either molded directly into usable shapes or milled.

Aluminium:

Aluminum, derived from bauxite ore, requires a large amount of raw material to produce a small amount of final product. Up to six pounds of ore may be required to yield one pound of aluminum. Bauxite is generally strip-mined in tropical rainforests, a process that requires removing vegetation and topsoil from large areas of land. When mining is completed, the soil is replaced. The land may then be allowed to return to rainforest, but is more likely to be used as farmland.
Aluminum manufacturing is a large consumer of electricity, which in turn comes from burning fossil fuels. The refined bauxite is mixed with caustic soda and heated in a kiln, to create aluminum oxide. This white powder, in turn, must undergo an electrolytic reaction, where direct electrical current is used to separate out the oxides and smelt the material into aluminum. The material must be heated to almost 3000°F for this process to occur. The processing of bauxite into aluminum results in large quantities of waste (called “mud”) that contain traces of heavy metals and other hazardous substances. A byproduct of the smelting process (called “potliner”) contains fluoride and chlorine and must be disposed of as hazardous waste. Approximately 0.02 pounds of potliner are produced for every pound of aluminum.
Because aluminum has such a high embodied energy content (103,500 Btus at point of use), it is best applied where its light weight, corrosion resistance, and low maintenance can be used an advantage. Recycling aluminum requires only about 20% of the energy of refining bauxite into usable metal. Although the recycling of aluminum beverage containers is common, only about 15% of the aluminum used in construction is ever recovered.6

Bricks and Tile:

Clay and adobe soil must also be mined. They are usually found in shallow surface deposits, and manufacturing is often done nearby, reducing extraction and transportation costs. With the exception of adobe, bricks and tiles must be fired to be useful building materials. The firing process exposes the formed clay to high, prolonged heat, producing a hard, waterproof, permanent brick or tile. The firing process can take hours or even days and requires a large amount of energy. Glazed bricks and tiles are fired twice: first to make the shape permanent and then to melt and adhere the glazed finish, which usually contains glass. The end product has much embodied energy but is also very long-lasting. Even without firing, properly maintained adobe bricks can last 350 years or more.

Petrochemicals:

The building industry is highly dependent on materials derived from petroleum and natural gas. These are used in a wide range of products including plastics, adhesives for plywood and particleboard, laminated countertops, insulation, carpeting, and paints. Drilling for oil and gas is both hazardous and expensive. Heavy machinery is required, and contamination of the groundwater and soil is common.

Wood:

Wood is the harvested material most commonly used in buildings and building products. Dimensional lumber is used in framing the majority of residential buildings and many commercial structures. Wood products such as plywood, particleboard, and paper are used extensively throughout the construction industry. Until recent years, the most common method of harvesting wood was clear-cutting, a process wherein all vegetation within a given area is removed for processing. Now, where clear-cutting takes place, lumber companies are required to replant the area.
Some lumber is now being produced on tree farms (“plantations”). However, replanting alone does not replace the natural biological diversity that existed before harvesting. Monoculture (same-species) plantings are particularly vulnerable to disease and insects. More companies now practice “selective cutting”: choosing only those trees large enough or valuable enough to remove and leaving the surrounding vegetation intact.
Sustainable forestry practices include a professionally administered forestry management plan in which timber growth equals or exceeds harvesting rates in both quantity and quality. In addition, rivers and streams are protected from degradation, damage to the forest during harvesting is minimized, and biodiversity and fair compensation to local populations is emphasized.

Conclusion:

In sustainable architecture we seek to minimize the negative environmental impact of buildings by efficiency and moderation in the use of materials, energy, and development space.

The idea of sustainability, is to ensure that our actions and decisions today do not inhibit the opportunities of future generations.

- We have to think about humane design through realizing a stratigical methodology of preservation on nutural conditions, urban design and site planing and finally design for humane comfort.

- We need to realize the life cycle design from pre-building phace, building phace to post building phace.

- We need to use economy resources through realizing a stratigical methodology of energy conservation, water conservation and material conservation.

- Local authorities should give more attention to the environmental factors and encourage developers, architects and designers to realize the sustainability principles from economy of resource which it could be achieved by using natural resources of energy (electricity, heating, cooling...ect), and natural resources of water by minimizing the consumption of water duiring post building phase and re-using waste, natural water, and using local materials from pre-building phace up to building phace esspecialy we in our region have a wide range of building material for construction and finishing materials, design and check to approach sustainability from urban design and site planing to preservation of natural conditions while puting the design concept for humane comfort.

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