Chapter 3:

THE EMERGENCE OF A NEW SUSTAINABLE VERNACULAR TYPOLOGY:

INTRODUCTION:

The climate sensitive nature of Sustainable Design, as well as its awareness of regional environmental and material concerns, demands a fresh look at the issue of the vernacular as it pertains to the practice of Passive based Sustainable Building. The current practice of Sustainable Design encompasses a range of green strategies that include, but are not limited to, passive climatic design, active solar and wind technologies, and a new vocabulary of low embodied energy/renewable/recycled materials. Comprehensive Sustainable design strategies must not only respond to passive climatic design principles related to the site, but must make full use of the available site ecology in order to create a development that approaches an "independent" sustainable state. The nature of this use of the site extends the notion of a Sustainable Vernacular Typology to include differentiation based upon both the potentials and problems presented by a specific bioclimatic region.

Modern passive design technology has learned to build upon the climate responsive methodology that is found in traditional vernacular typology and regional directions in architectural form. Active strategies have been incorporated into Sustainable developments as a means to reduce dependence on non-renewable energy sources. The climate and regional issues which form the focus of the traditional vernacular type, coupled with a new vocabulary of low embodied energy/renewable/recycled materials, can begin to generate a New Sustainable Vernacular Typology which recognizes environmentally based regional climates and concerns. The use of Solar and climate sensitive design strategies in buildings has become the essential starting point for Sustainable Architecture as pursued by Architects. Climate responsive strategies can be typified which support Passive Climatic Design and Active Solar and Wind Design. Passive and Active Design do not in and of themselves constitute Sustainability, but they can be seen as vital supporters of Sustainable Design.

Where Passive and Active Solar and Wind strategies may be seen to support Sustainable Development, in actuality, the basis of their respective pedagogies can be seen as *oppositional.* It will be the thrust of this paper to understand the contrasting precepts of Passive and Active Design, as well as their complementary and integrated roles in the synthesis of a New Sustainable Vernacular Typology. The issue of the impact of "green materials" on the generation of a typology as well as the implications of ecological site strategies will also be addressed.

Two Sustainable Education Developments will be examined as critical examples of the emerging Sustainable Vernacular; the YMCA Environmental Learning Center in Paradise Lake, Ontario, and, The Center for Regenerative Studies at California Polytechnic Institute in Pomona, California. These cases have been chosen for their specific representation of cold versus hot climate solutions.

ECOLOGICAL SITE STRATEGIES ENLARGE THE DOMAIN OF TYPOLOGY:

Much of the architectural character of Sustainable Design is derived from the relationship of the building to its site, and the nature of the development of the site, as it is by the function, form and materiality of the building itself. The site requirements for a Sustainable Development are significant -- both from the perspective of size as well as services. It is largely the site area and type required for the creation of a fully self-sustaining development that exacerbates the problem of designing Sustainable Architecture in an urban setting. This tends to suppress fully sustainable "high urban" development and support the emergence of a Sustainable Vernacular Typology that is more strongly sub-urban and semi-rural. Although many more examples of Sustainable developments may be found in less populated areas, there are significant examples of urban types emerging.[12] This discussion focuses on the emergence of the site intensive sustainable building type.

Comprehensive Sustainable design strategies extend their response to passive climatic design principles to include the full use of the available site ecology. The nature of this use of the site extends the definition of a Sustainable Vernacular "Architectural" Typology to include the manner in which the site can service the function of the building. This type of typological classification differentiates solutions as they address both the potentials and problems postured by a specific bioclimatic region. This departs from the notion of "building typology" as historically presented by Nickolas Pevsner, which primarily classifies building types according to function and form.[3] This appropriation and incorporation of the site ecology is necessary to facilitate the creation of a development that approaches an "independent" sustainable state. This independence may refer to the generation of power, the treatment of waste waters, the growth of food and the space required for effective composting.

The sustainable practices of typical bioclimatic regions can be further differentiated because of the influence of local codes and accepted building practices. Code variations significantly in the acceptability of the re-use of "graywater", the treatment and subsequent use of "blackwater" and the use of biological wastewater systems and aquaculture ponds to treat wastewater for ultimate reuse on site. The State of California, for example, permits the use of "graywater" for irrigation.[4] Other states with similar hot-arid water shortage problems do not permit graywater reuse. Subsequently, hot-arid California Sustainable developments will often incorporate aquaculture ponds or other water treatment systems on site, and use both the water and the creation of a cool microclimate in the design of the building. Other hot-arid regions where graywater reuse is not permitted will be less likely to incorporate such elements and be unable to create a cooler microclimate using more expensive water. In these conditions, alternate solutions must be sought to satisfactorily resolve irrigation and water related site issues. Rainwater collection systems and cisterns are both appropriate and permissible in most urban and rural situations. There are many existing vernacular roof types designed to collect water in a clean and cool manner. The island of Bermuda, with no fresh water source available, makes extensive use of smooth white finished stepped masonry roofs which direct all available rainwater to site cisterns. These are employed on all buildings, regardless of location or size.

Many of the site strategies that facilitate the development of Sustainable Architecture are labor intensive in their conception, construction and ongoing maintenance. Wastewater systems and aquaculture ponds require the feeding and breeding of the fish, routine harvesting of water hyacinth, and irrigation and harvesting of plant life. The site aspects of the Sustainable Vernacular also extend the notion of the "building type" to include the requirement of an "active" and "process related" type which requires a high level of occupant participation and system maintenance.

DIFFERENTIATING THE BASIS OF ACTIVE AND PASSIVE DESIGN

On an broad level, Active and Passive Systems can be differentiated through an examination of their advocates, their supporters, sources of research funding, their users, and their usual scale of implementation.

Active systems are researched and promoted on a broad scale by government bodies, established research institutions, industry and large corporations. Wind power and photo-voltaics, as manufactured systems, are able to be adopted on a wide community or urban scale as a means to supplement and eventually replace our dependency on traditional grid source (non renewable) electric generation. These industries are focused on marketing to third world countries. The economics of active systems become more viable to regions who have no foreseeable access to the electrical grid, and who could be supplied with electricity -- and all of the modern conveniences and life saving devices it supports -- through photovoltaic and wind installations. Electricity, as an addition to vernacular climate responsive architecture, will be able to substantially improve the rustic, not so romantic, standard of living in third world counties.

In contrast, the advocates of Passive systems are architects and architectural educators, in particular teachers of Environmental Control Systems and Building Technology. Passive applications, although employing broad principles, by their design specific nature, are typically adopted at a much smaller "building" scale, with an emphasis on "whole building energy management". Passive design involves the conceptual design, end configuration and material selection criteria for the base building. This scale of application seems to make Passive Architectural Design more easily comprehended, taught and applied by Architects and architectural educators. Funding sources for research and development for passive design strategy development are typically smaller and more limited. Government supported research initiatives associated with Passive Design show a greater interest in the development of accurate analytical tools. Current focus is on the development of energy analysis computer programs that are able to accurately predict the effectiveness of passive design applications in reducing energy consumption. [5]

Active and Passive system can be differentiated on the basis of their pedagogy. Whereas active systems focus on implementing the adoption of alternate energy "systems" (related to industry initiatives and product marketing), passive systems focus on the adoption of "principles" of design to reduce energy requirements. The principles of Passive Climatic Design often include the use of "systems", but in a manner to supplement building level design decisions based on orientation, climate and wind. Sustainable Passive strategies can be viewed as...

- a holistic approach to design to reduce the use of electricity and general energy consumption
- the use of natural systems versus high tech dependency
- an emulation of the purity and successes of vernacular construction for heating and cooling
- an architecture which in its response to climate involves the total design of a building and its site
- passive climatic design strategy, as an aspect of sustainable building design in the reduction of non renewable energy use
- requiring active user participation to ensure effectiveness and consistency
- a return to the rustic...simplified lifestyle...back to earth...a romantic view...

Yes, a romantic view. The audience at the American Solar Energy Society's Annual Conference in July 1995, 'Solar 95', was captivated by John Reynolds' (University of Oregon) study of temperature patterns in vernacular Spanish courtyards in Cordoba. [6] The images of the lush foliage and cool comfort of the courtyard, contrasted the harsh heat of the urban surround. No energy dependent systems were employed to achieve comfort -- but rather, natural cooling principles, foliage and water. Ken Haggard's (Pomona Solar Group) exposition at the conference of straw bale construction, and a presentation of David Sellers' Vermont Tree House both suggested a return to the use of natural, renewable materials, and a lower technology lifestyle. Passive Design Case Studies also suggested a reduction in expected comfort levels, in comparison with accepted comfort criteria in mechanically heated and cooled buildings. The Reynolds study documented courtyard temperatures in the mid 80's, as compared with adjacent street temperatures in the mid to high 90's. [7] The Passive Cooling was achieved through high mass and evaporative cooling (potentially fountains and watering of plants). The courtyard felt adequately comfortable in comparison to the adjacent urban environment, in spite of recording temperatures at least 10^{o}F higher than would be expected in a mechanically cooled building, and measured conditions at the high end of the accepted "Comfort Zone" as first described by Victor Olgyay in "Design With Climate" in 1963. [8]

Passive design case studies presented at 'Solar 95 and 96' stressed effecting a reduction in all aspects of energy consumption -- lighting, heating, cooling and embodied material energy -- through climate sensitive building design. Sustainable developments, such as the "Harmony" Resort[9], which employed passive principles were illustrated which required occupants (yes, even resort vacationers...) to reassess their consumption of natural resources. It was necessary that occupants change their lifestyle and effect thoughtful interaction with the building and its systems -- limit water use, turn off fans, lights and air conditioning systems when not in use -- and lower their expectations of convenience and comfort.

Active strategies, in contrast with "natural" passive systems, are technology dependent solutions. The use of active systems can effectively alleviate the pressure on non-renewable energy sources -- independent of architectural form and without radically altering occupant lifestyle or level of comfort. Active strategies can be viewed as...

- systems oriented; incrementally adaptable to community requirements
- the generation of electricity via photo-voltaics and wind to reduce dependence on grid based power

- climate dependent installations based on the availability of solar radiation and wind
- applications currently limited as a product of initial capital costs
- long term benefits as a result of low operating and maintenance costs
- active solar and wind strategies as an aspect of sustainable building design
- a pragmatic solution that can operate effectively independent of active user participation.

Photovoltaic and wind systems can operate effectively with little interference on the part of the average occupant. Where such systems are properly designed, and with adequate storage capability, occupants need not be aware of the source of power, or radically alter their energy consumption pattern or lifestyle. Where effective Passive Design strategies normally require cognitive integration at the early planning and siting phases of a project, Active Systems can be considered later in a project and are capable of supplanting existing electricity sources for established developments and communities.

The contrasting pedagogy of Active and Passive Design strategies can be summarized as follows. These contrasts can in some applications make it more appropriate to select one approach over another, *or, use the differences in a complementary manner in response to specific climate conditions* -- to synthesize a new approach towards creating Sustainable Architecture.

COMPARATIVE ANALYSIS OF DESIGN PEDAGOGY AND IMPLICATIONS OF ACTIVE VERSUS PASSIVE CLIMATIC DESIGN

Active Climatic Design	Passive Climatic Design
* an incremental systems approach	* a comprehensive design approach
* can be added later in a project	* requires incorporation in planning stage
* few architectural implications	* major architectural implications
* no lifestyle change required:	* lifestyle change:
* little occupant participation	* significant occupant participation
* small increase in occupant awareness of climate and seasons	* greatly increases occupant awareness of climate and seasons
* makes electricity	* avoids/reduces use of electricity
* applicable from small to large scale projects	* mostly small scale
* high technology	* low or natural technology
* no interest in vernacular	* *looks to vernacular for solutions and ideas*

REBUILDING THE VERNACULAR TO ACHIEVE SUSTAINABLE DESIGN

The basis of a significant portion of the contrast in Passive and Active Design lies in the pedagogical derivation of Passive Strategies from Vernacular Prototypes and Practices. Sustainable Design, in building upon Passive/Vernacular research looks to emulate and expand upon the successful natural cooling and heating strategies of countries whose architecture and design was not compromised during this century by the Modern Movement and the invention of mechanical heating, ventilating and cooling.

Prior to the advent of mechanical heating and cooling, differentiated architectural form developed which responded to local climatic factors. The International Movement in Modern Architecture has been blamed for significant losses in vernacular forms, regional initiatives and climate sensitive design in both North America and Europe.[10] A reliance on non renewable energy intensive HVAC systems resulted in buildings which ignored the implications and potential of climate due to the availability of mechanical and electrical systems and inexpensive energy. Such building design practices persist despite increased energy costs and environmental awareness. This type of design approach built a lifestyle expectation of guaranteed all-season comfort, with minimal intervention by the occupant. The invention of computerized thermostats increased the *passive role of the occupant*. This "lifestyle", based on convenience and total comfort, has perhaps become one of the greatest barriers to the widespread adoption of both Passive and Sustainable Design principles -- contrasting the romantic and rustic attitude emulating from vernacular architecture -- and has necessitated a rebuilding of vernacular traditions.

Climate based vernacular/passive building types have been well documented over the past decades and follow four basic classifications: Cold, Temperate, Hot-Arid and Warm-Humid.[11,12] Bio-climatic regionalism and vernacular practices also form the starting point for conceptual design decisions in Sustainable Developments. Vernacular concerns and regionalism are extended in Sustainable design to include issues of the availability of materials, local technology, population concerns, culture, and environments at risk. Photovoltaic and wind systems must account for the amount and reliability of solar radiation and wind -- also based on the bio-climatic condition. Active and Passive Design, as a subset of concerns within Sustainable Design, require a synthesized, complementary approach in their appropriate responses to the specific climate and environment.

THE MATERIAL NATURE OF SUSTAINABLE ARCHITECTURE

An examination of Sustainable Architecture reveals the generation of a distinct palette of "green materials". Sustainable materials are selected which must respond to the following requirements:

- natural materials which are renewable; i.e. wood, straw
- recycled materials; i.e. plastic wood, recycled content carpet and rubber flooring, concrete aggregate
- low embodied energy materials
- regional or local materials; those that do not require excessive transportation
- low VOC materials and finishes for interiors; to promote a healthy interior

That Passive Design plays a key role in achieving Sustainability presents a dilemma in the area of "green" material selection. Materials must also be used in Sustainable Architecture that are selected for their durability, high thermal mass attributes or specialized "scientific" performance, which are not inherently "green", but which are irreplaceable. These materials are typically high embodied energy materials which use non renewable resources. Although some regions incorporate recycled aggregate in the mix for concrete, typically this is not the practice. Significant amounts of concrete are used in constructions to achieve required thermal storage levels. There is a narrow availability of high quality reclaimed materials and finished products for use on buildings. The use of these products poses difficulty for the practitioner as the consistency and quality varies within the project and between projects. The majority of the glazing systems specified for Sustainable projects use double or triple glazing, low-e coatings, argon fill and highly durable and thermally resistant frames. At present these systems are not widely available and are often shipped great distances to the site.

Just as the familiar cross sectional development of the Passively designed building and the presence of solar collectors and PV arrays begin to define the Sustainable Vernacular Type, so does the material palette. The Sustainable Vernacular type makes regular use of wood siding, often from a reclaimed source and exposed concrete slab floors. Wood is also the material of choice for trellises and also exposed structure, where permitted by code. The large south facing windows are typically double or triple glazed, as varies with climate, combining large central fixed panels with top and bottom awning type windows to promote ventilation.

The materials that are notably NOT used in Sustainable buildings provide a means of recognition. Except where required by code, structural steel and concrete frames are absent from the vocabulary. Also missing are exotic woods, excessive amounts of material used for decorative effects, asphalt and petroleum products, large expanses of carpets, and materials which offgas. Sustainable buildings, in their finishing and detailing appear to alter the expression "Less is More" to mean "More is Wasteful".

Regardless of the bioclimatic region, location, or function, Sustainable Buildings generate a specific atmosphere that is connected to the repetitive use of the narrow material palette, passive and active design strategies and systems, and ecological use of the site.

REALIZING A NEW SUSTAINABLE VERNACULAR

Sustainable Architecture and Developments are in the process of creating new forms of climate sensitive vernacular for the 21st century. These bio-regional designs illustrate an acceptance of the complementary roles of Passive and Active Solar and Wind Design as well as the use of Sustainable Materials. Recent projects of particular interest are environmental education facilities which allow the practice of Sustainable Living to be more broadly experienced by students, educators and other interested parties. Two such projects are the YMCA Environmental Learning Center in Paradise Lake, Ontario, Canada and the Center for Regenerative Studies at Cal Poly, Pomona. Although the YMCA Center works to create a Sustainable Vernacular for a cold climate, and the CRS derives its design from hot climate criteria, both use *appropriate vernacular* *and bio-climatic based* Passive and Active Strategies to support their Sustainable goals, both make use of Sustainable materials and methods in the site and building design, *and both require their occupants to reassess their lifestyle and relationship to the building functions.*

The YMCA Environmental Learning Center:[13]

That Passive and Sustainable Design necessitate a reassessment of lifestyle and the adoption of a more active role in building occupancy and maintenance is broadly perceived as a central issue in the design of Sustainable Architecture. Architect Charles Simon writes of the YMCA Environmental Learning Center, a camp whose intention it is to "operate an integrated environment (of natural features, buildings, technologies and programs) which will greatly encourage and inspire transformation of the lifestyles of all who visit and help them 'live more lightly on the earth.'"

> "A more romantic notion of sustainability leads to fairly significant lifestyle implications and the acceptance that indoor comfort levels will vary with the external conditions in summer and winter and that they will be affected significantly by the users' active participation in drawing the shades, opening and closing windows and doors, firing the heater, conserving hot water, etc. *Passive buildings require active users."*[14]

The Environmental Learning Center was conceived of as a demonstration of sustainable design. Its intention is " to create a Centre where the whole site - building and surroundings - explores environmental values," with the goal to gently encourage and inspire transformation in the life styles of all who visit and help them 'live more lightly on the earth.' The Environmental Learning Center is presently comprised of two buildings: the Earth Residence (Figs.1, 2) and the Day Center (Figs. 3,4).

The Site

The Environmental Learning Centre is situated on the western shore of Paradise Lake on a seventy-seven acre lot full of grassy meadow, forest, wetland ponds and a pine tree plantation of which twenty acres of the is designated as an Environmentally Sensitive Policy Area.. The complex is owned and operated by the Kitchener-Waterloo YMCA and primarily serves as a campground geared towards children. Paradise Lake is a kettle lake, a rare geological formation created from the melting of a glacier. Fish habitat and nesting is located in the marsh and along the lowland of the shore. With the protection of forest, many deer, birds and small animals are able to co-habitate here successfully amongst human activity. With this in mind, when consideration was first given to providing new services at the campground, the decision was made to constructing a space that was as self-sustaining as possible, retaining a level of comfort while responding to both the site and the human occupation.

The siting and use of the site takes full advantage of the cold climate of the region, natural site features, sun, wind and water systems. The buildings use the natural fall of the landscape to achieve insulation through earth berming. Availability of water for plant irrigation is not a concern. Maintaining the purity of the adjacent lake and preventing contamination from wastewater generated by the project provided a focus for the design of the building systems. These responses included the use of composting toilets and the inclusion of a natural water filtration system.

The Day Center (Solarium):

The Day Center was completed in the Fall of 1995. The Day facility is a point of central arrival to the site. Located just south of the marsh, the Solarium encompasses several environmental control systems in its design: solar power, natural water purification, passive cooling and ventilation. The building consists of two main spaces - the greenhouse and the Great Hall - as well as tributary areas. The design uses local reclaimed materials, is based upon passive solar principles and includes supplemental active systems to complete the cold climate energy requirements. As illustrated in Figure 3, images taken while the building was under construction, high levels of insulation are employed to reduce heat loss, which are typical of cold climate modern vernacular design.

The greenhouse is designed to provide passive solar heating in the winter. The south wall is comprised of a series of triple glazed windows with two coats of low E and Argon and an insulating factor of 8.4 RSI giving the building a net gain of energy efficiency. These windows have a filtering effect making it cooler inside than outside during the summer. The building efficiency primarily focuses in the ability of this wall to be a solar collector. From these windows, two solar panels are attached to the interior of the glass at the top. These panels contain glycol which is used as a thermal conductor to provide the electricity to the entire building. Evidently, it does tend to become quite warm in the greenhouse, however measures have been taken to ensure an effective interior environment. On the mezzanine, fans collect the hot air and push it down large metal tubes that distribute it to vents into the plenum in the floor of the rooms thereby heating the concrete floor and creating a thermal mass which can be used to maintain comfort during the night.

At the top of the north wall of the greenhouse, vents have been placed which operate electronically. If the temperature goes above a setpoint determined by the staff at the ELC, they open, allowing the hot air to escape until normal room temperature has been achieved. These vents are also located at the bottom of the glass wall. This building has been designed to create a stack effect; if there is no wind outside on a particular day, opening one window will produce enough of a breeze inside the building to make it a more comfortable temperature than the outside temperature.

A cistern filled with rainwater, used primarily for nighttime cooling, is located at the south end of the greenhouse. Every night, water is pumped to the top of the south wall and released down the front of the greenhouse, creating a natural form of air conditioning for the interior of the building.

The greenhouse will eventually house a “living machine” to cleanse waste-water. This system would be comprised of a series of interior tanks containing goldfish, plants and other microlife that eat waste as a source of food, naturally cleaning the water making it suitable to drink. The system will terminate in a miniature wetland and a small pond. The end product water will be “virtually” potable and will be re-cycled to the toilets or returned to the water table. When construction began on the Solarium, the original intention was to install this biological waste treatment system to treat all the water used in the building. When the original estimate of $30,000.00 given to the client was changed to $50,000.00, there were insufficient funds remaining to complete this element of the project - especially in light that there are only four toilets in the building. Until it is incorporated, low flow toilets have been hooked up to a septic system.

The materials used in the construction of the Solarium were chosen to maximize the use of products with recycled content. Sixty percent of the building is constructed of reused timber that was specifically salvaged from the demolition of a nearby industrial building. The resilient rubber flooring tile is comprised of 100% post consumer tires. The aggregate used in the concrete is comprised of old sidewalks. A sod roof will be created on the north side of the building to increase the thermal resistance value of the roof and minimize the visual impact of the building on the site.

Since the Solarium is not off the grid, a high efficiency wood-burning boiler has been installed as a back up system if not enough sun is produced to maintain the independent functioning of the heating and hot water systems of the building. Current by-laws require that this facility be connected to the "grid". The client is hopeful that the legislation will be amended to permit the camp to return power generated on site to the grid to equalize the system -- becoming energy neutral.

The Earth Residence (Burrows):

To the north end of the marsh lies the Burrows. Unlike the Solarium, the Burrows is 100% off the grid. The basic design strategy for the Earth Residence employs a cold climate vernacular based "cottage" design that takes advantage of Passive heating and cooling principles to reduce energy requirements, complemented by minimal active systems. The active systems were part of the initial design premise, however some supplemental systems have been added to respond to the full operation of the facility. These systems supplement varying energy shortfalls when they occur. The north wall is entirely buried and the walls and ceilings are well insulated for the cold Canadian climate. Large glazed areas to the common area and clerestory windows to the sleeping areas are oriented southwards to take advantage of solar radiation.

The central feature to the interior of the common space is an unusually large, custom designed, contra flow central masonry wood-burning heater. More than a fireplace, it has been designed specifically to heat the entire building through radiant heat working on the same principles as the sun. The fireplace will provide additional heat in the winter months. Occupants must fire the heater once each twelve hours to ensure radiant nighttime heating. Summer cooling is via cross-ventilation, stack effect and movable trellises to shade the south facing windows. Each individual bedroom in the building contains high windows to the south which are use to provide solar gain during the winter and high level ventilation for the sleeping quarters during the summer.

This building is used to house up to forty campers who come to the ELC to engage in activities that will enable them to understand the environment and how to occupy it more efficiently. The temperature in the building is monitored very closely to maintain a temperature of twenty degrees Celsius at all times. Therefore, even something as subtle as a consistent temperature requires individuals to rethink their position on energy consumption.

Solar panels provide domestic hot water, with additional heat borrowed from the masonry fireplace. The building is not connected to the hydro grid, and electricity generation occurs through the use of PV panels, battery storage, human pedal power and a wind machine. There is a grid of solar panels outside the north end of the building that contain glycol and operate on the same principles as the Solarium solar panels. Since the Burrows is a highly used building - a camping lodge - it was necessary to install a greater number of panels to compensate for this regular use: Photovoltaic cells are located above the windows on the south wall that provide most of the electricity for the building and a wind machine which can produce approximately 300W of energy consistently in one day was incorporated into the design. It takes less energy to power this whole building in a day than it takes to boil a kettle (1000 WATTS).

The materials are local, with a large proportion reclaimed. The building is comprised of 95% reused timber with the only new wood element being the two inch ply tongue and grove flooring in the basement to stop shifting and cracking.

Composting toilets

The Earth Residence makes use of composting toilets to reduce the impact of the residents on the site. Invented in Sweden in 1939 by the ecologist and artist Rikard Lindstrom, this toilet is flushless, uses no chemicals and does not produce any sewage. Minimal maintenance is required as long as there is a conscious effort to clean the toilets daily by adding a mixture similar to peat moss, which helps to digest the waste. These composting units contain worms that digest human waste. With four toilet and two composting units, it is only necessary to remove one fifteen liter bucket of residue, primarily worm castings, after over 800,000 uses every five years.

A bio-filter is located in the basement to deal with the gray water in the building. It eats all organic material out of the gray water. In order to make this water potable, it would be necessary to treat it with ultraviolet to remove any bacteria not consumed by the bio-filter. However, Ontario laws require it to be released into the ground.

Further Considerations

Due to the recent completion and experimental nature of the installed systems, there has been little documentation on the ELC published to date. However, both the architect and director of the Centre confirm that technically, the buildings are performing as projected. The Center’s energy efficient technologies can be described and evaluated in conventional quantifiable terms. However, such an approach might allow one to miss a range of criteria that are integral to the project. The relationships between the systems are as critical as the systems themselves. It seems that technology has been handled with sufficient expertise to allow a more focused examination of the Center’s other implications.

Circumstances unique to the ELC also deserve some elaboration. The client’s priorities are particular in calling for a facility that could operate an integrated environment (of natural features, buildings, technologies, and programs) serving to teach environmental principles and imbue environmental values. Rarely do architects have to conform to a mandate where the client’s first objective is not cost savings.

Also, as a camping facility and a demonstration of sustainable design, the project is in a category lying partially outside the demands for typical institutional and residential buildings. This allows a greater freedom from more formulaic solutions to problems and a looser attitude toward building aesthetics. The ELC's Solarium demonstrates this quite vividly as the special technologies are left entirely exposed. This move demonstrates the 'green approach' in its use of materials while betraying what many sustainable designs compromise, mainly aesthetics. This inherent contradiction is more adequately resolved in the Burrows where the technical mechanisms remain largely hidden. This issue of 'green architecture' being a means to an end rather than an end in itself serves to question the position that sustainable design will take in the architectural realm.

Presently, the Environmental Learning Centre offers multiple approaches to sustainable design that engages renewed standards and expectations of the built environment; a valuable tool to greater awareness and consciousness of our world.

Up to date sustainable education materials are available for visitors to the Day Centre, and the large south-facing greenhouse will be used to demonstrate a variety of natural processes. The Architect and client hope that the building will be able to offer a new possibility for Sustainable Vernacular Architecture. At the YMCA Environmental Learning Center it can be seen that the facility accomplishes Sustainable Design through the thorough integration of both Passive Design and Active Systems. Passive Design strategies for a cold climate are used to reduce the amount of energy required to be provided by Active Systems. The Center creates a solution whose pedagogy, function, appearance and associated lifestyle support the notion of a new cold climate Sustainable Vernacular.

Figures:

YMCA Environmental Learning Center

Fig. 1 The Earth Residence, south facade, with trellis sun shades/with PV collectors atop

Fig. 2 The Earth Residence, masonry heater which supplements solar heat during the winter months

Fig. 3 The Day Center, south elevation

Fig. 4 The Day Center, interior under construction showing triple glazed greenhouse, high insulation levels (6” fiberglass batt inside + 2” rigid polystyrene outside), mass thermal storage in concrete floor

The Center for Regenerative Studies:

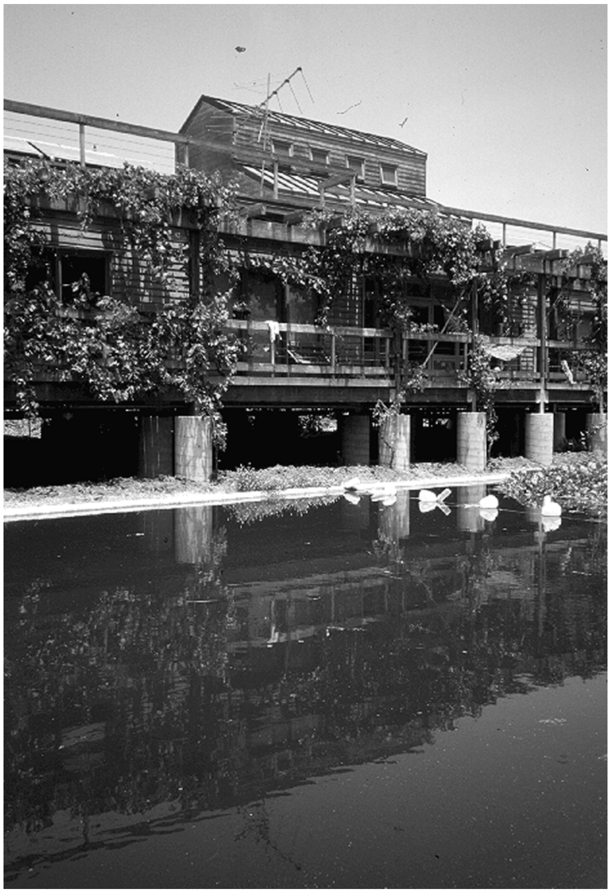

Fig. 5 Front elevation of the waterfront pavilion which overlooks one of the lower aquaculture ponds. Note that the pavilion is elevated on piloti.

Fig. 6 Detail of the south facing trellis outside the classroom area.

Fig. 7 South facing trellis outside the dining area. Note the lush vegetation (2 years growth)

The Center for Regenerative Studies:

The Center for Regenerative Studies at Cal Poly Pomona, a physically larger facility with University education connections, extends the concepts and strategies of Sustainable Living illustrated in the YMCA Environmental Learning Center. The CRS integrates students' daily experience of living with education, sustainability, social organization and technology. The students must become active participants in all aspects of the program in order to ensure its success. Students and faculty members are able to experience a wide range of practices and technologies associated with waste, water, energy, food and shelter - to effectively contain these cycles on the site.

> "The process of living in a more sustainable way requires using the feedback from the systems to make choices that often require changes in behavior."[15]

The Site:

The Center for Regenerative Studies is located on a 16-acre plot in the arid hills of Pomona, California, sandwiched between the California Polytechnic University and a large regional landfill site. The aridity of the landscape of this part of California makes a central issue of the use and reuse of water, for human consumption, bathing and irrigation. The Center responds to this water crisis by focusing on the use of the local climate to passively heat and cool the buildings, as well as by creating a water cleansing system to provide abundant water for irrigation. The production of high quality compost materials, combined with the nutrient level in the processed irrigation water is able to enhance food production on the site, create a cool green microclimate, and visually, if not actually, produce an oasis in a desert.

The complex is comprised of a series of south facing buildings which house a central common space and eating area, combination residences and meeting/office spaces exterior and interior connecting walkways and gathering spaces. The primary building design uses passive climatic principles which fits the buildings into the existing land forms of the site in a manner to take advantage of natural heating and cooling conditions. The buildings are nested into the arid hills and terrace downward to face a series of manmade aquaculture ponds, and vegetable and herb gardens. The majority of the landscaping is "edible", and becomes a vital part of the sustainable life cycle of the occupants.

The Aquaculture Ponds:

Great care has been taken in the creation of a series of ponds that are designed to cleanse the graywater water of the site. The ponds are approximately one meter deep and are stocked with talapea, who thrive on the algae present in the ponds. The talapea are bred in large external containers on the site, and will be grown to a size suitable for marketing and on site consumption. Other smaller fish are stocked whose role it is to eliminate the potential mosquito population that can result. A third of the pond is planted with water hyacinths, which filter the remaining unwanted chemicals from the water. The water hyacinths require weekly harvesting to prevent their growth from overtaking the ponds. The plants are pulled, allowed to air dry (to reduce their transportation weight) and added to the compost mixture. The growth of the two year old plantings on the site are a prime indicator of the success of the rich compost and pond produced irrigation water.

The Residences:

The vernacular style of the buildings is remarkably similar to the Earth Residence in Paradise Lake. The exterior is clad in wood siding. The shell is framed and insulated (although to California standards) and finished with low VOC painted gypsum board on the interior. The floor is exposed concrete to create thermal mass. The south facing windows have low and high level awning components, and are shielded on the exterior with wood trellises with metal rods to support vines -- almost identical in detail to those at the YMCA Camp (with the exception of solar related geometry). The buildings are heated via direct solar gain and are all cross ventilated to promote cooling. The occupants direct air movement by using operable low and high level awning windows, with transfer grilles, and ceiling fans. The primary energy sources for the development are passive solar with an active complement, biomass and wind. The use of electricity is monitored by the occupants as part of an ongoing study to understand and cognitively manipulate energy use patterns in order to reduce overall energy consumption.

The north side of the north bank of residences is bermed into the hill to provide insulation for the cool winter months and earth cooling for the hot summers. The southern residence buildings that overlook the aquaculture ponds are exposed on all sides, as well as raised on pilotti. It is anticipated that floor grilles will be installed to encourage additional cool venting from the microclimate created on the south side of these buildings by the ponds.

The Center for Regenerative Studies creates a Sustainable Vernacular suited to the climate of California by integrating hot climate Passive Cooling and Heating Strategies to reduce the required energy contribution of the Active Systems on the site. The pattern of student use, and their study and involvement in the functions and processes, highlights the significance of lifestyle change and user participation in the development of a new hot climate Sustainable Vernacular that makes use of the complementary aspects of both Passive and Active Climatic design strategies.

The plumbing systems for the residences use solar collectors to provide domestic hot water. This provides more than adequate amounts of hot water as a result of high normal insolation levels in Pomona. The institutional nature of the facility preferred the use of low flush toilets over the more environmentally efficient composting toilets used at the YMCA Camp.

<u>Occupant Involvement in the Sustainable Building:</u>

In educating students about Sustainability, the Center for Regenerative Studies accentuates the vital importance about intelligent user interaction with the systems and strategies that comprise the development. One of the perceived drawbacks of Sustainable Developments is the demand on time required by active participation in the building and its functions. Students at the Center in addition to full time University study, are heavily involved with food preparation, the sorting of waste and composting, maintenance of the planting beds, aquaculture ponds, and the control harvesting of the water hyacinths. The CRS study results have indicated, however, that the actual time spent by the students in labor related to the regenerative systems was actually less than the amount of time expected [16]. Discussions with students at the Center reveal a level of interest and satisfaction with their experiences. The Center at present accommodates only 20 students -- and is constantly full to capacity. Plans are underway to increase the size of the facility to eventually accommodate 80 students and faculty. The positive results generated by the CRS thus far should serve to increase the viability of this type of development for a wider market.

The level of involvement of the occupants at the CRS differs greatly from those at the YMCA Camp as a function of the length of stay of the residents. Typical residents at the CRS participate in the facility for at least one academic year. These students are able to understand the role of the active resident not only on a diurnal basis, but through seasonal changes. This effects a very real understanding of the functionality of the Sustainable Vernacular Type within real time and broad application. The occupants of the YMCA Camp are generally much younger in age, and the typical length of stay may be from several days to several weeks. It would be unlikely for campers to be exposed to the contrast required in participation from summer to winter. Visitors to the Day Center may not even be exposed to the full diurnal functioning of the building. Where the short stay may not be ideal or present a fully realistic picture of the Sustainable Vernacular Type, it does permit a wider range of interested parties to experience Sustainable Living. The CRS also operates on a short stay basis to accommodate visiting faculty and small meetings or conferences.

<u>THE EMERGING "CHARACTER" OF THE SUSTAINABLE VERNACULAR TYPE:</u>

In spite of climatic differences, functional variation and contrasting scales, the character of the YMCA Camp and the Center for Regenerative Studies are remarkably similar and would seem to support the broad development of a new Sustainable Vernacular building type. The specific nature of the character of the "type" is consistent in its response to what may be concluded are the 5 characteristics which define the new Sustainable Vernacular type:

- ecologically sensitive development of the site according to bioclimatic considerations
- the use of "green" materials, including renewable, recycled, recyclable; the further use of local or indigenous materials
- the use of Passive Design principles to attain energy efficiency in heating and cooling the building
- the use of Active Solar and Wind systems to complete the energy requirements of the facility
- a high level of occupant involvement in caring for the building and ensuring the efficient functioning of its passive and site systems

Although it may be concluded that Sustainable building must respond to these five basic characteristics, variation within the type will result from differentiation in the nature of the architectural manifestation of the response due to bio-climatic demands, regional differences/preferences, client/program and local building authorities.

Whereas the character of the camp-like setting at the YMCA resulted in a "rustic" sustainable vernacular building, with warm comfortable interiors, the character of the Center for Regenerative Studies created an "institutional" type exhibiting coldness in its interior spaces. Although both facilities responded to the Sustainable criteria on all levels, there was variation in the specific nature of the response. This difference in character within the Sustainable type was due largely to material and systems choices that were a function of the client, the specific nature of the use and local building codes.

The nature of the ecological development of the site exhibited typical response variation from cold to hot-arid climate. This was manifested in the preservation of the natural habitat at Paradise Lake and the creation of new water habitat in Pomona.

Both facilities made significant use of like "green" materials in the structure and cladding of the buildings. The non institutional use of the YMCA allowed for a broader use of recycled and *reclaimed* materials for the structure, the cladding *and the interior*, that resulted in a more "rustic" atmosphere for the camp. University building requirements for the Center for Regenerative Studies required the use of materials with a high level of durability and that would meet fire code requirements. The interior finishes were limited to painted gypsum board and exposed concrete. The majority of the materials used at the CRS were new products that were largely renewable or containing recycled content. The nature of regionally available materials would support the notion of a variation within the Sustainable Vernacular type due to specific variation in location, climate and indigenous renewables.

Although commercially produced Sustainable Building is usually Spartan in terms of decoration and detail, institutional requirements can increase this feeling of "coldness" by mandating the use of highly durable doors and hardware, selecting durable finishes, color selection, the use of institutional "type" furniture, and by limiting the personalization of space. Creating a feeling of warmth in a space with a bare concrete floor presents designers with difficulty. To leave the material fully usable as a thermal mass requires that it not be covered. Traditional vernacular types have often used lightly woven throw rugs to soften the space for human comfort and to provide visual interest. Whereas the CRS has chosen to fully expose the concrete floors, the YMCA Camp has partially carpeted the Residence building, and provided alternate thermal mass in the large masonry heater. Human comfort may necessitate compromise.

Each facility employs similar building cross sections and external shading devices -- capable of providing passive solar heating and promoting ventilating for cooling. The comprehensive use of passive systems is complemented in both facilities by a strategic use of active systems. These are implemented to compensate for any energy shortfall as a result of passive design, and to comply with local code requirements.

Occupant involvement in the successful functioning of the Sustainable type is implemented on differing levels at the YMCA Camp and the CRS. Although occupant involvement is essential, the architectural development of the passive building and site systems has been altered to account for the abilities of the users, their age and length of stay. The high occupant participation in the running of the CRS allows for the incorporation of a higher level of Sustainable activities into the building program.

The full development and understanding of a Sustainable Vernacular Type will not be possible without a deep reexamination of vernacular climatic building strategies, appropriate use of green materials, a comprehensive and strategic adoption of *both active and passive systems,* and a program of education for occupants and users of Sustainable buildings. Passive and active strategies need to be seen as complementary and interdependent -- a positive product of their apparent diametric opposition. The implementation of active systems, if coupled with an education towards the adoption of vernacular based passive strategies, will be able to better reduce the overall consumption of energy. A comprehensive approach to Sustainable Design, with active user participation, will enable renewable energy sources to more easily meet demand levels. A key new aspect of building "typology" demonstrated in the Sustainable Vernacular Building type is the need for active, educated occupants to ensure the success of the function of the building. In this way, Passive and Active Design Strategies can act to support the creation of a redefined Vernacular, based on an inclusive bioclimatic approach to Sustainable Architectural Design.

It is important that educators understand the full potential of Sustainable Design through experiencing the active participation of the Sustainable lifestyle. The importance of this type of Sustainable Living experience is becoming more widely recognized. The Society of Building Science Educators is held its 1996 Education Retreat at the Center for Regenerative Studies at Cal Poly, Pomona as a way to more fully engage ECS educators in the activities associated with a Sustainable "lifestyle". Such involvement not only asked of educators that they "practice what they preach", but allowed professors to understand the implications and potential engendered by complete Sustainable Living -- Passive + Active + Participation -- and take an Active role in teaching the creation of a new Sustainable Vernacular.

Notes:

[1] Ferrara, Luigi. *Conserve, Condense, Collapse: Interface Zoning and Live/Work.* Ontario Eco-Architecture. Submissions to the Ontario Association of Architects Committee on the Environment. Call for Papers for Envirofest, May 1995. p. 62-67.

[2] Liefhebber, Martin. *The Codicile House*. A competition solution presently under construction in Toronto, Ontario. The purpose of which is to create sustainable urban infill in city lanes.

[3] Pevsner, Nickolas.

[4] Barnett, Dianna Lopez. *A Primer on Sustainable Building*. Rocky Mountain Institute, 1995. p. 80-82.

[5] *Energy-10 Design Tool Software: Low Rise Building Design*. Presented for beta testing at Solar 95. Funded by U.S. DOE-Office of Building Technology, National Renewable Energy Laboratory, Lawrence Berkeley National Laboratory and Passive Solar Industries Council.

Ener-Win. Version 95.02. Field Evaluation and Computer Simulation Software. Larry O. Degelman. Texas A&M University. Demonstrated for testing at SBSE Vital Signs Training Session. August 95.

[6] *Spanish Courtyards: High Mass Cooling in Hot Weather*. 20th National Passive Solar Conference. Conference Proceedings. Minneapolis, Minnesota. July 15-20, 1995. p.52

[7] A hobo is a portable data logger which is able to collect air temperature, relative humidity or daylight, at specific selected time intervals. The information can then be downloaded into a computer for analysis.

[8] Olgyay, Victor. *Design With Climate: A Bioclimatic Approach to Architectural Regionalism*. New York: Van Nostrand Reinhold, 1963, 1992. p.17-23.

[9] *"Lessons from "Harmony",* a Sustainable Resort in America's Paradise. Nelson Uzzell, Builder. Presented at SOLAR 95.

[10] Moore, Fuller. *Environmental Control Systems.* New York: McGraw-Hill, Inc., 1993. p.4

[11] Olgyay, Victor. *Design With Climate: A Bioclimatic Approach to Architectural Regionalism*. New York: Van Nostrand Reinhold, 1963, 1992.

[12] Moore, Fuller. *Environmental Control Systems*. New York: McGraw-Hill, Inc., 1993. p.41-54.

[13] Part of the research material gathered for this project was carried out for an architectural research project by: Victoria Lucas, Szenzeni Steingruber and Matthew Galloway.

[14] Simon, Charles. *The Environmental Learning Center - A Demonstration of Sustainable Design.* Ontario Eco-Architecture. Submissions to the Ontario Association of Architects Committee on the Environment. Call for Papers for Envirofest, May 1995. p. 56-61.

[15] Stine, Sharon R. *Learning Towards a Sustainable Future*. Solar Today. July/August 1995. p.30-33.

[16] Stine, Sharon R. and W. B. Stine. *Waste, Water, Energy, Food and Shelter: Studying Sustainability as a Part of Daily Living.* 20th National Passive Solar Conference. Proceedings. July 1995. p.110-114.