Submissions to the
Ontario Association of Architects
Committee On The Environment

canadian
eco-architecture

Call for Papers for ENVIROFEST, May 1997
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After two years of canvassing Ontario architects for their environmental initiatives, the Committee on the Environment has expanded our sights. This year the call for papers went across Canada.

Another year has passed and with it advances in environmental architecture. Our objectives for the "call for papers" and the publication have remained the same:

To start with, we continue to measure the level of interest in environmental subjects held by the architectural community.

We want to reach members that have an interest and feel they can make a contribution either by way of example and case study or conceptually in expressing innovative approaches, propositions, or research. We also want to stimulate and involve members, promoting the work and ideas of Ontario architects both within the Association, and also more broadly to others.

Our hopes that the second year would see an increase in the response were satisfied. We received more expressions of interest covering some new subject areas and approaches. Indeed, we received two papers from repeat authors, reflecting ongoing developments to last year's submissions.

The papers in this publication represent a large percentage of the original submissions. Each author has developed and amplified their work with a modest amount of direction from the COTE. We provided encouragement, a few editorial comments, and generally kept the process as open as possible while maintaining the necessary discipline of format and length.

Responsibility for ensuring that the project was a success is given to Gary Pask and Barbara McLean. The tremendous effort involved in coordinating, discussing, and working with each of the authors to produce this work is gratefully acknowledged by the Committee.
The committee also wishes to acknowledge the excellent design and layout of the publication provided again by Reactor Art & Design.

This project has been exciting to continue because of the devotion of the authors to their subjects. The Committee sincerely wishes to thank the authors for their participation and efforts in contributing to this project.

The papers presented in this publication document a high level of interest in environmental design. Added to the previous two publications, the ideas, collectively, contribute to an increasing body of experience in our community.

We are sure that again this year, architects will find this publication a tremendous resource and inspiration encouraging us to consider the many possibilities in our work for greater environmental sensitivity, reduced ecological impacts, and better performance.
Introduction

Gary Pask, OAA, MRAIC
Member,
OAA Committee on the Environment

In a time, locally, when the profession of architecture, not to mention other related and non-related fields, are waking up to the firing of pointed questions by potential clients as to what exactly it is we do and whether or not they really need our services; in a time, globally, when we are drifting closer and closer toward conformism and group mentality — what runs our lives, unfortunately, are deals made by specialist and interest groups.

This book, then, tries in some small way, to take a snapshot of sustainable architecture as it flails about in an increasingly conformist socio-economic environment, and to keep the “concept” alive, kicking, and open-minded.

John Ralston Saul wrote about the decaying effects of conformism in The Unconscious Civilization. And Canadian Eco-Architecture offers him support in that some architects and their related associates both buck the norm — and only if the norm isn’t working, or if it’s getting a little worn at the edges — and search for new ideas outside ideological, specialist, crowd mentalities.

When Luigi Ferrara, formerly the editor of The Ontario Association of Architect’s publication Perspectives, and now Director of the Design Exchange in Toronto, invited me to accompany him to an interview with Dr. David Suzuki when he was invited as a speaker in The Globe and Mail Speakers Series, I was both surprised and exhilarated by Dr. Suzuki’s aggressive enthusiasm.

He exemplified, for me, the free, disinterested, individual and citizen that Saul talks about, who stubbornly challenges ideologies to the point where — and this is my interpretation — he’d prefer never to buy into any specific ideology, but, instead, to improve the “concept” of sustainability through continuous, relentless challenges.

Ontario Eco-Architecture, Ontario Eco-Architecture 2, and Canadian Eco-Architecture 3 are some of our watchdogs: Have we stumbled into the web of group mentality, or have we assertively — even aggressively — accepted the challenge of improving the “concept” of sustainability.

In the first section, Materials and Systems, Steven Sims, from London, Ontario, launches the
book with a status report on certification initiatives that attempt to give us the straight goods on whether or not the wood we specify really did originate in sustainable forests.

Following Steven, Rocco Maragno in Toronto transports us through the urban jungle, proposing we chop traffic congestion, thereby clearing and cleaning space for amenities that add value.

Jilian Balbaa, also in Toronto, shows us, on a corporate scale — specifically, Ontario Hydro — the possibilities of moving toward energy efficiency and sustainability when a large company is supportive and cooperative.

Again from Toronto, Jiri Skopek, continues with a clear explanation of BREEAM (Building Research Establishment Environmental Assessment Method), how it works as a design tool, an assessment tool, and an operational tool — and how it compares to other evaluative methodologies.

Moving out of Ontario, westward, Ben Levinson, from Victoria, British Columbia, leads the Projects section by holding his own residence up high to remind us environmental responsibility can be successful on a small scale, and that, as Barbara McLean said in her Introduction to *Ontario Architecture 2*, what starts locally eventually goes global.

Staying in the west, Mickie Holland gives us the background and details on how he won the Canada Mortgage and Housing IDEAS Challenge with his design for the Columbus House, a housing development for seniors in Sherwood Park, just outside of Edmonton, Alberta.

Dexter Edwards, back in Ottawa, takes us for a ride through his Lanark Earthship, a sustainable dwelling. Comprehensively, Dexter includes extensive research, analysis, and anecdotal and numerical feedback.

Jumping over the Rockies to Vancouver, British Columbia, Joanne Perdue asks what the measure of success is in sustainable design by laying out the design, its goals, and feedback from the C.K. Choi Building, a 30,000 square foot office building at the University of British Columbia. To her credit, Joanne points out “the true measure of success lies beyond the numbers. What is important is if the building has changed our perception of how buildings are designed and built.”

Vince Catalli, also in Ottawa, deconstructs a house diverting 92% of potential waste from landfill! And at the same time making money on the re-sale of the deconstructed materials!

The front end of the Education and Philosophy Section locates us at Ryerson Polytechnic University in Toronto, where co-founders Colleen Brown and Joe Caricari are pumping sustainability with Sustainnovation, an initiative raising awareness, not only with the student body, but also with the community at large.

The finale, Terri Myer-Boake, from the University of Waterloo, makes a welcome return — Terri has contributed to *Ontario Eco-Architecture*, *Ontario Eco-Architecture 2*, and *Canadian Eco-Architecture 3*, all three books published by the Ontario Association of Architects Committee on the Environment — by clearly and concisely explaining an emerging new sustainable vernacular typology, using The Center for Regenerative Studies at Cal-Poly Pomona as an example of independent and self-sufficient sustainable architecture.

Independent and self-sufficient; disinterested and free; assertive — no, aggressive — enthusiasm...
Sustainable Forestry Certification – a Status Report

Steven Sims, MAATO
Architects Tillmann-Ruth-Mocellin
London, Ontario

I have long been fascinated by the unique properties of wood as a construction material. Nothing has the inherent beauties and strengths of lumber. Along with this interest is an awareness of the need to use wood responsibly to ensure that use doesn’t deplete already threatened supply.

With this in mind, we recently attempted to specify framing lumber for a house addition which came from a certified “sustainable” source. After speaking with several forward thinking lumber producers we determined that we could order a transport truckload of dimension spruce to London at a 5% premium on locally available stock. This worked out to five times the quantity we needed. The client considered buying the lot and reselling what we didn’t use, but when we couldn’t be confident we could quickly market the remainder the idea was discarded. Today it seems that specifying wood from a sustainable source is easier said than done.

Of growing concern in the construction industry today is the problem of translating the innovative ideas proposed by experts into practical applications. How do we take possible solutions to an over-arching problem, such as environmentally conscious material specification, and apply it to a project while protecting the owners’ interests in quality, economy and building service?

Such was our concern when we began to question the use of wood as a construction material. Probably no other debate in the sustainable design community is as greatly polarized as the use of wood. Is it possible to use this traditional resource in such a way as to not further deplete our forests and compromise all the other uses they afford us?

Research over the last three years has revealed several sources of new ideas about the use of wood. All are more or less agreed that the answer lies in ensuring practices in silviculture (forest...
management), harvesting, milling and manufacturing follow certain guidelines which will allow the consumer the knowledge that the wood they are using is coming from a sustainable source. That is, that its use will not contribute to the irreparable destruction of the world's remaining forests. Canada is responsible for 10% of these forests and relies heavily on their economic input. So for us, this is a particularly important question. For a comprehensive discussion on what the Canadian wood industry is providing in the way of environmentally sensitive products, we refer you to “Wood Products and Their Environmental Implications” by Peter Berton. (Ontario Eco-Architecture, 1995 edition)

Two possible solutions, the Canadian Standards Association (CSA) initiative on certifying forests for sound management techniques and the Forest Stewardship Council's work in providing “chain of custody” responsibility to sustainable lumber harvesting, will be briefly summarized here. It should be noted that neither one has achieved industry consensus yet, and that these are the first steps in a long process.

CSA Initiative

Ninety percent of Canada's forests are government owned. Lumber companies lease and manage this land for not only lumber production but for recreation, wildlife habitat, hunting and scientific research. In 1992, following the Canada Forest Accord, the Canadian Standards Association (CSA) (long known for their standards of practice which set a common level of performance for numerous construction trades and practices) was asked to provide criteria by which forest managers could “...on a voluntary basis, measure their forest management practices against widely accepted standards and to demonstrate compliance with these standards” (CSA Guidance Document, A Sustainable Forest Management System, 1996). Input from industry, government, academics, environmentalists and the general public has been compiled into a guidance document which will set the benchmark. It is intended that as practices improve the document will push this benchmark higher. The Standards Council of Canada has recognized the CSA initiative as the national standard for Canada.

This document will not result in a “green label” for forest companies to use as a marketing tool. The CSA's technical committee on sustainable forest management is of the opinion that current volumes of lumber, pulp and paper production are such that being able to assure the origin of a single stick of wood and follow it through chain of custody from forest to mill to shop to consumer is physically impossible.

What CSA registration will do is state that the recipient is practicing sound management techniques in silviculture and that the forest is being wisely utilized to protect wildlife, watersheds and recreation access. It will also allow for judicious harvesting of trees, providing income and growth in domestic and export markets. Ellen Pekulis, Project Manager for Environmental Programs Development with the CSA explains that through registration the CSA will “ensure the recipient has set management objectives through a public participation process for the critical elements of the Canadian Council of Forest Ministers criteria for sustainable forest management. CSA registration
cannot be attained unless the Sustainable Forestry Management System (SFM) is actually being implemented in the forest and progress towards achieving SFM objectives is being monitored”.

FOREST STEWARDSHIP COUNCIL

Taking a different approach toward certifying lumber producers is the Forest Stewardship Council (F.S.C.), a not-for-profit organization created in 1992 and based in Oaxaca, Mexico. The F.S.C. board of directors, made up of a member elected panel representing environmental groups, the timber industry and indigenous peoples' organizations from twenty five countries, has created a framework by which various regional certification companies become recognized for providing independent audits of forest managers and successive levels of the lumber industry.

Through this network of certifiers the F.S.C. claim to be able to track lumber from “cradle to grave” thereby answering the chain of custody question. An example of this market driven approach is the Seven Islands Pine Company of north-eastern Maine. This family owned forest of over one million acres has been producing dimension lumber, cedar shakes and flooring for 150 years. They now display in their promotional literature the globe and green cross logo of the Scientific Certification Systems forest conservation program, indicating a sustainable harvest “rating” of 86 (out of a possible 100).

Scientific Certification Systems in turn is one of two regional groups accredited by the F.S.C. in the United States, the other is the Rain Forest Alliance. The F.S.C. notes it is also working with groups in Belgium, Canada, Ireland, Mexico, Sweden and the United Kingdom.

Much of the information surrounding wood as a construction material is generally accepted. For example, smaller dimension lumber, from younger trees, is more readily available because it comes from tree farms and reforested areas, it is also of increasingly poor quality as demand forces contractors to accept less straight and knot free pieces. Also, tree species grown locally are preferable to distant sources. Because the production of dimension lumber is relatively low in cost of embodied energy compared to the mining, smelting and rolling necessary to make a steel stud, the energy costs of shipping lumber by road or rail assumes a larger relative role. And finally, as a renewable resource, lumber supply simply must be harvested more slowly than its replenishment rates (taking into account the fact that, even today, in North America more potential lumber is destroyed each year by fire, insects and disease than is commercially harvested.)

After a point, however, the facts give way to complex, even subjective, debate. “Of all the phases of the life-cycle, (forest resource) extraction is the most subjective. The ecological impacts of forest cutting can differ by several orders of magnitude from best practice to worst practice”(Canadian Wood Council, Wood Design Manual- 1995). Is it possible to selectively remove old growth trees from forests when their size and quality of lumber are of such value?

It is, therefore, important that a system be in place which will allow valid, objective comparison between the use of wood versus other construction materials and between the various sources of
wood and wood products. Groups like the CSA and F.S.C. are beginning to break ground in these new and previously uncharted territories.

Steve Sims is an Architectural Technologist practicing in London, Ontario. Employed with Architects Tillmann-Ruth-Macellin since 1990, an interest in the use of wood as a construction and finishing material has led Steve to research into sustainable design.
Towards Sustainable Energy Development

Jilan Balbaa, OAA, MRAIC
Supervising Architect
Ontario Hydro

Designing With Nature – Ontario Hydro’s Thunder Bay Building

Ontario Hydro has adopted the definition of sustainable development as “development which meets the needs of present generations without compromising the ability of future generations to meet their own needs” (World Commission on the Environment and Development, 1987).


In order to move towards a long term goal of sustainability, our economic activities must be balanced with the capacity of the Earth’s ecosystems to respond to the stresses or changes caused by our activities.

General Design Objectives for (SD) Activities

- Demonstrate the economic viability of sustainable solutions.
- Integrate man-made environment with natural systems. Respect for natural systems, reverence to the ecology of the site.
- Reduce the Footprint of our buildings by reducing overall quantities of energy used, reducing waste.
- Demonstrate the practicality and ease of operating and maintaining a building, with environmentally conscious design solutions.
• Maximize the health and well-being of the users and ensure that the indoor environment is healthy and comfortable.
• Optimize the efficient use of renewable resources.
• Diversify the building Future Energy Options.
• Educate employees and promote the benefits of new environmentally sensitive design solutions.

ECONOMIC AND ENVIRONMENTAL SUSTAINABILITY

Economic development can be achieved through proper management of resources while minimizing environmental impact. In the last decade, the building industry has been governed by principles of monetary gain, greed, and waste. Generally fast turn-over from developers to users yielded short term-gains with very little consideration to the environment, landscape surrounding, health and well-being of occupants, energy efficiency, operating costs, flexibility, and the future potential for recycle and reuse.

Conventional buildings resulting from the lack of long-term planning and from these trends have been imposed on, and are damaging to the environment and social fabric of our lives.

As designers of the built environment, we have a critical role to play. We can design what is truly necessary and shun extravagance. We can heal what is damaged, enhance what is whole. Externalities such as costs of remediation, waste disposal, health care and workers compensation, are subsidies that should be considered when assessing the long term impacts of development.

Hydroelectric Business Unit has incorporated the principles of sustainable development into their new Service Center in Thunder Bay, Ontario. A building that is designed in harmony with the natural environment, responds to the changing climate and ecology of the area, uses energy efficiently, makes use of the natural elements such as sun, land, wind, water, and has low operating and maintenance costs. The incremental costs of these “green designs” buildings will be offset by annual energy savings.
BACKGROUND

The Hydroelectric business needed a new centralized Service Center to house both office and industrial work. The recommendation was to amalgamate both its operation and office staff in one main location, in order to increase the performance of work activities and improve on productivity.

Several alternatives to building a new facility were considered. Feasibility studies on each alternative were carried out incorporating a range of criteria. In all cases, a significant expenditure was required in order to adapt existing facilities to serve the new use. Thus a decision was made to build a new facility on Ontario Hydro property in Thunder Bay.

STRATEGY/DESIGN CONCEPT

To achieve a sustainably optimal design is to start out at the conceptual stage of the project with a multi-disciplinary, integrated project team. Communication and dialogue with all stakeholders involved in the project was a fundamental part of the design and construction process.

The goal of the project team was to reach consensus among the owner, end user, and operator prior to making any decisions that would affect the project, and to emphasize that every part of the project functions interdependently as a part of the larger whole.

Filtering through the layers of information to obtain maximum design value, ideas were tested with the client evaluating their feasibility in terms of cost, social and environmental impact, technology, regulations, approval, and available time constraints.

Trade-off between these criteria were then made to develop a building design which was innovative, environmentally friendly and energy efficient.

SITE

The site selected offered good potential to interact and harmonize with the topography of the natural landscape and the ecology and climate of the area.

The final location for the building was originally part of a wetland. A big portion of the original wetland was paved-over and functioned as an industrial yard. The design plan was to restore and replenish the wetland area featuring a built environment connection. An adjoining wood lot added to the overall appeal of the site, creating opportunities for wildlife enhancement and naturalization.

The environment became the new ordering principle in the design of the building. The built form was a function of it. In more traditional building a "steady state" is assumed, whereby variations in time of seasons, heat, light, are not addressed into the building design and function, instead in the Thunder Bay building the dynamic concept used, continually responds to changes in the internal and external environment. This concept made the structure "alive".
Highlights of the Environmental Design

Key areas considered by the design team included the use of landscape design, passive solar, active solar, daylighting, and renewable technologies, use of green building materials, ventilation and temperature control.

The building is a one story, 13,000 square foot facility abutting a wetland site.

Two work areas were clearly defined; an office area and a workshop. The best orientation for each function on the site was determined depending on the nature of the work and kind of atmosphere desired in each case.

The office area was designed recognizing that comfort and indoor air quality induces productivity, people would spend most of their day indoors, hence requiring an indoor environment which was comfortable, inviting, and connected to nature. In order to maximize the total sun exposure, the office area was oriented towards the south.

The shop area, where work such as carpentry and welding takes place, has a more "used as needed" basis, daylighting was identified as a high priority since intricate and detailed work would be done on the shop floor.

Landscape Design

The site was formed and planted to take advantage of the adjacent wood lot and natural wetland. Summer breeze from the south and west blow across the wetland and cool the air around the building creating a micro-climate; trees will protect the building from prevailing northwest winter winds promoting a true "marriage with nature".

A low retaining wall with a raised planting bed wraps around the building foundation in an effort to reduce heat loss in winter. This allows snow to accumulate and insulate the base flashing of the exterior walls. The wall and plantings further integrate the building with the adjacent landscape setting. Deciduous shade (solar friendly) trees were planted to offset the urban heat island effect of hard surfaces from the parking lot therefore reducing the cooling loads and energy. They would also offer wind protection. During winter the
leaves would fall to allow the heat transfer into the building, providing a natural heating effect and reducing energy.

Native trees, and flowering shrubs were used to extend the woodlot edge and create opportunities for wildlife enhancement. The original design incorporated a storm water detention pond to recharge the on-site wetland and create a cooling effect. The client decided to delete the pond for economical reasons.

Rain run off is recycled and channeled for use in the woodlot. Vegetation planted around the building, links the adjacent woodlot and wetland ecosystem, providing movement and colonization opportunities for species. A storm water detention filter strip was incorporated in the drainage pattern of the site.

PASSIVE SOLAR HIGHLIGHTS

The orientation of the building was critical to maximize the sun’s benefits. The sun must then be controlled for maximum indoor comfort.

Awnings were installed externally at each window location to control the incoming sunlight.

A computer simulation was performed to determine the angle of the sun throughout the year. The results were used to calculate and to determine the projection of the awnings from the face of the external wall for maximum shade.

The office area building envelope included a masonry cavity wall to act as a thermal mass and regulate the interior temperatures. During sunny periods, this mass absorbs heat and radiates into the interior spaces. It also minimizes heat loss and heat gains.

The landscape was carefully planned to produce a micro-climate effect around the building as well as creating a pleasant outdoor-indoor connection, which was aesthetically pleasing for the employees working in the building.
**Daylighting**

For maximum daylighting in the office area, light shelf were installed internally at each window location. The light bounces-off reflective surfaces on the lightshelf and the ceiling, creating a very pleasant and comfortable indoor environment on a sunny day. Employees near windows can dim or brighten lights depending on the type of day, a flexibility which also saves on energy costs. A variety of light levels were installed to improve the internal work environment and avoid glare from the south and west facing windows.

Solar tubes captured light throughout the day to brighten dark windowless areas.

Free natural light coming out of a 10" tube, illuminates 100 square feet, providing the equivalent 200 watt of energy.

The windows are high performance, triple glazed, argon filled units with fiberglass frames. The glass is separated with silicone edge spacers and coated with spectrally selective low "E" coatings. The rating on the window is approximately .8 RSI. Fibre glass has a low conductance, greater strength than aluminum, the same coefficient of expansion as glass and is produced with much lower amounts of energy than aluminum. Clear Low E coating permits the sun to reach the interior work spaces.

**Active Solar Features**

The design incorporated several renewable energy technologies (RETs).

The most cost-effective RETs application for the Thunder Bay climate was active solar technology use for the heating of ventilation air in the workshops. A south facing solarwall (a dark colored perforated metal siding system) captures the solar energy falling on it and raises the temperature of the required ventilation by 15 to 20 degrees celsius depending on solar intensity.

The building was also equipped with a prototype solar vacuum tube lexan system which allows the infra-red rays of the sun to heat up copper plates to provide the hot water for the building.

**Energy Efficiency**

The building was designed to exceed the requirements of Ashrae 90.1 standards. Annual energy savings achieved 140,000 kWh compared to a conventional type building.

The heating ventilation and air condition system is a water loop heat pump system capable of using alternative energy. The Heating System was built to permit dual energy in the future with the flexibility to use gas, electricity or biomas (the lowest energy cost in the market).

The office is heated and air conditioned in zones with individual heat pumps. There are 7 zones in the building featuring a separate mechanical ventilation system with automatic balanced
Urban Mobility

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Principal
Maragna Architect Incorporated

Abstract

Winters in Boston can be deadly cold. One evening, during the academic year 1975/76, while walking to the Widener Library the following thoughts occurred to me:
"...if only I could get into one of the cars solidly stacked along both sides of Cambridge Avenue..."
"...a machine's primary function is to work constantly rather than sit idle..."
"...where is mass transit when one needs it..."
"...if only the vehicles were publicly held..."

With a sniffling nose I continued along the frozen way thinking that mobility ought to be a public utility.

Wanting to explore these thoughts further, I found the opportunity in one of the courses I was taking while attending the Graduate School of Design at Harvard University. The outcome was documented in a report which recommended a new attitude towards mobility for humans. In producing such a document I found myself between opposing desires to, on one hand, inspire action and give visible direction, and on the other hand produce a plan which is enforceable and implementable. The intention was to do both, while discovering and understanding the catalytic possibilities inherent in an academic project. The report presented not a finite solution but rather an offering of a stimulus for action.

For two decades the report has sat dormant, awaiting a more propitious time for its dissemination: the advent of contemporary globalization; the dawning of knowledge-based era which allows one to live anywhere; advanced development of the electric automobile; the stark limitations of mass transit; an undiminished global love affair with the automobile; cultural cross-fertilization of ideas; economic interdependence; integrated product development...

It is my intention to convey the following thoughts to certain political ideologies and to the automotive industry. Should these concerned groups be positively influenced, then the thoughts generated on that cold night in Boston would have accomplished more than its original academic mis-
sion. A working instrument should not be shelved, as it attempts to explore the link between inquiry and socio-political responsibilities.

**INTRODUCTION**

The urban environment, a complex artifact, is created by the interactions of a variety of factors, whose results are further complicated by the dynamic character inherent in the same interactions. This urban complexity expresses itself through conflicts among the dynamic forces that choose to remain conservative and/or directionless and inactive, and those which elect to manifest their latent energy and thus create a state of continuous flux.

A major element in this complex dynamism, which under varied circumstances appears and disappears only to reappear again is the street. Humanity, during various historical periods, has repeatedly employed this urban element in structuring the basic framework of its settlements. With the advent of the automobile and the unavoidable expansion of the urban fabric, the street's importance has been greatly reduced. The amount of urban space allotted to this structuring element has been indeed vast, yet the returns have been less than minimal.

Today the long indefinite asphalt and concrete ribbons with super-imposed bridges, traffic circles, by-passes, etc., is the predominant urban form. This machine-like infrastructure achieved and continually maintained at exorbitant costs has its own moments of idleness; as has the inanimate machines that use it. The street, therefore needs to be re-considered as an 'urban fact', and recovered in its entirety for a proper defined purpose. This is a significant parameter in the evaluation of urban phenomena, since it addresses the appropriation and use of space in the city.

This objective may be achieved by recognizing the ambiguity and complexity of urban space as qualified factors, analysing them and directing the findings towards an action plan; or through intervention, in the attempt to break the acquired equilibria and increasing the self-conscience of the users on the possibilities of carrying out a strategy of re-qualification of the urban environment through the recovery of the collective space in the city.

In the final analysis a change of this magnitude will have huge ramifications for the well being of our environment and ourselves.

**INTEGRATED PRODUCT DEVELOPMENT**

The further we stray from our hearth and venture into the realm of discovery, the more we realize the necessity to improve on past achievements. Yet, day after day, each one of us abdicates from behaving as an individual in order to become reconciled with an imposed consciousness, which demands of us, with a varying degree of freedom, that we may become part of a great majority. This transformation is a consequence of the attitude of conveniently delegating to somebody else the power of
deciding how we shall behave. Thus, belonging to that community that may be defined as mass controlled.

Our century has sought equality by planning everything. We are happy in our conformism, yet we no longer blindly accept the traditions of the past. We want to believe in a better future, yet we fear the unexpected which might harm our general peace of mind. The resolution to these paradoxes requires the capacity of invention.

The city is mankind's artifact which allows humanity to partake in the totality of its social, political, economical and spiritual orders. For all of this to take place and more the city has developed urban characteristics that are reflected in the collection of infrastructures, buildings and urban spaces of considerable complexities. These spaces are no longer self-contained entities, they are linked in various ways to other spaces: by cables, telephones, water mains, drains, roads and so on. Partly as a result of this, our urban problems continue to mount behind an unstable wall of gadgets and technological improvisations.

Of all the linkages, that of surface connection is the most visible and perhaps the most important. Between habitats a variety of movements occur involving goods, commodities, messages and people. A key item worthy of considerable attention is human mobility. Indeed, mobility has become a necessary feature of our age.

Mass transit was once seen as the solution to urban congestion. Based on past evidence it is not a phenomenon unique to the contemporary city. It existed in Rome during the reign of Julius Caesar, it prevailed in London before the Industrial Revolution, it dominated the streets of Moscow after the liberation of the masses, it chokes the traditional city cores of developing nations.

At times, it seems that the problem of congestion is a condition of our minds as witnessed in the transportation sections of our libraries, rather than a condition in our streets. The accumulated data, in its vastness and redundancy, has spawned its own complications, and it has yet to progress to the stage where it can resolve the complications introduced. We know a countless time more than Aristotle knew, yet his vision of nature and of man as part of it, would be by its very ignorance more comprehensive. Why is it that with all this knowledge man repeatedly fails to comprehend the nature of his habitat?

Today urban congestion continues to exist in spite of mass transit. This form of transit has become a leviathan on the backs of the tax payers and a bureaucratic monument kept alive for the purpose of patronage.

During the growth and development of North America, certain urban attitudes emerged because of specific needs, beliefs and ideologies. With the passing of time the environment has gone through incredible transformations, yet many of those attitudes are still with us. Some have become archaic and do not necessarily reflect our contemporary way of life.

In general Western civilization, as we know it, is a part in history beginning with Plato dividing humankind in mind and body: "Gymnastic for the body, and music for the mind". This split created philosophy. From philosophy came science and hence technology. There was no necessity that this development take place. It happened nevertheless, and we are today working out the consequences.
A key product of technology is the automobile. It offers freedom of mobility. "For better or worse, in sickness and in health...", the pattern of urban life has been shaped by the automobile. With this machine, man can enjoy reasonably good access to almost all of the resources in the metropolitan and regional areas. But for people without an automobile, such freedom of access is inconvenient, if not impossible.

Are there fewer cars on the streets of Milan or Toronto as a result of extensive subway systems? Have the subways of Western cities prevented street congestion? Just the opposite, they have encouraged downtown development and thereby encouraged congestion. While mass transit is often a necessary condition for the accomplishment of planned urban goals, rarely it is both necessary and sufficient.

The main task of those that are occupied with urban problems, in general or in particular, should be that of creating within limits of public action, the conditions so as to allow the inhabitants of the city to take part in the realization and transformation of the urban space, equipped with tools that will enhance the changes of society.

The time is now ripe for transportation to shed its archaic purpose and take on a new meaning. This is mainly a social and political goal. Our hope is to recognize these changes as they occur and prepare a reception worthy of humankind's dreams. Less than a century ago the most hotly debated question among German planners was about the best way to move human excrement out of the city: by cartage or by pipe. Today of course, the hotly-debated question is how to best move millions of people: by automobile or by some form of mass transit system, resulting in a constant battle between the private and public interest. Perhaps the time is ripe to shed the concept of monumentality and reconsider that of smallness.

The reality is that the diffused pattern created by the automobile is difficult to serve by modes other than the door-to-door service of the automobile. Another reality to keep in mind is the concern shown by small minorities who refute the idea that our age, defined as a consumer/technological/efficient civilization can continue to solve humankind's problems. Still, immediate concern for ecology, energy conservation and economic interdependence are creating new attitudes and at the same time destroying many dated ones.

By considering these factors, it is proposed that mobility becomes a public utility. A public or private agency or a combination of both become the sole owner of a new type of computerized mobile, which is mass produced by the existing automotive companies. This agency, in turn, will make the mobiles available to the urban inhabitants in the same manner that water, electricity, sewage, and waste systems are provided, regardless of the class status of the consumers.

Having lived in a town with only a few public fountains supplying water, for me it was a miracle when I entered my home in the new world to find water running out of a faucet. The infrastructure of services that feed our homes are out there under the street, and the street itself is for everyone's use. In a complex urban area, mobility is a necessity; therefore, it should be a public utility, which can grow incrementally at a modest cost.

With these mobiles on the street the individual then has the freedom of movement at his/her
disposal at all times. The community regains a large part of the excess space which is now required for moving and parking the private automobile and this recaptured space may begin to generate new forms and a new image of our habitat.

The development of cross-fertilization between the Old and New World is fast impacting the most populous region on this planet. As more and more experts attempt to follow in the footsteps of Marco Polo, instant architecture and engineered planning is becoming the norm. Will these new settlements result in the epilogue of city planning of the 20th century or will it be the prologue to a new urbanism for the third millennium? To achieve the latter we must at times be polemical with our ideas.

At a time when our civilization is seriously concerned with the restoration of ecological balance, conservation of resources and respect for cultural diversity, we cannot allow ourselves the luxury of continuing to build according to past ideals. Behind the apparent freedoms of globalization lurks a potential damage: that of turning the city from a collection of urban fragments into a mere staging ground for artificial consumption.

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INTRODUCTION

In the early 1960’s, when architectural historian Rayner Banham described the integration of environmental systems in his seminal book “An Architecture of Well Tempered Environment”, he anticipated the day when most adults in North America would spend 90% of their time indoors. The euphoria of the design community for high tech engineering led to an over-reliance on mechanical systems, with less attention given to health and environmental issues. By the 1970s, however, the focus on buildings’ environmental impact was sharpened by the energy crisis and growth of the environmental movement. Carbon dioxide emissions from the consumption of fossil fuels contributing to the global greenhouse effect; tall buildings producing dangerous winds in the neighborhood; and sick building syndrome are now but a few current examples from a long list of global, local and indoor environmental effects of buildings. Evidently there is a call for continuous improvement in the design and management to optimize building performance and minimize environmental impact. BREEAM (Building Environmental Performance Assessment) promotes the improvement or “greening” of buildings by providing a holistic and comprehensive benchmarking system for environmental issues.

Fortunately, there is a growing realisation that green buildings are healthy not only for the environment but also for the bottom line. This awareness is providing a marketing edge for the more progressive players in commercial real estate, who are using building performance assessment to provide visible recognition of buildings which have addressed and minimized environmental impacts.
What is BREEAM?

BREEAM (Building Research Establishment Environmental Assessment Method) is a methodology to assess a building's environmental quality and performance in terms of energy efficiency, environmental impact, health and comfort, operation and management. BREEAM initially started as a way to improve the environmental performance of buildings at the design stage. Subsequent versions of BREEAM for existing buildings extended the scope to include buildings' operation and management.

The method was developed by BRE (Building Research Establishment), the principal organization in the United Kingdom carrying out research into building and construction, and ECD Energy and Environment. Since its introduction in UK in 1990, over 40% of new buildings including offices, superstores, industrial units and homes are now assessed using BREEAM, and the major British real estate publication, Property Week uses BREEAM ratings as a common reference.

The Canadian version of BREEAM for existing offices was developed by CSA in cooperation with BRE and ECD Energy and Environment Canada. It is published by the Canadian Standards Association as CSA Plus #1132 publication, which is a part of their BQM (Building Quality Management) Program.

Today BREEAM is the international industry standard for the evaluation of building environmental performance. It provides the real estate industry with a tool for benchmarking environmental performance and sets practical targets for environmental improvement. BREEAM covers issues ranging from global atmospheric pollution, the local environment of the building and the comfort and health of occupants. These include:

- carbon dioxide emissions and building energy efficiency.
- healthy building features
- indoor air quality
- minimizing ozone depletion and acid rain
- recycling and reuse of materials
- ecology of the site
- water conservation
- noise
- microbial contamination
- hazardous materials
- lighting.

BREEAM INTERNATIONAL and BREEAM CANADA

Today, BREEAM INTERNATIONAL oversees the use of BREEAM in many parts of the world. Based on the maxim "Think globally, act locally", versions have been adapted to suit regional conditions. As
more and more countries in Europe are using the method, a standardized BREEAM is being developed by the European Commission Directorate. In Hong Kong, a Pacific version of BREEAM was developed by the Real Estate Developers Association of Hong Kong and the Hong Kong Polytechnic University.2

In Australia, BREEAM OZ is being specifically developed in time for the evaluation of buildings for the next Olympic Games. In Canada, leading property management companies such as Enterprise Property Group, Oxford Development Group, and Nexacor Realty Management Inc. have been awarded BREEAM certificates. BREEAM Certificates have also been presented to CANMET and Ian Cook Construction for “Green on the Grand”, the first building to be produced in Canada under the C2000 scheme.

Many regional variations of BREEAM relate to environmental and cultural conditions. The Canadian system recognizes a larger reliance on mechanical ventilation and air-conditioning and the criteria and credits have been adjusted in keeping with North American standards. Issues which have raised some contention were credits for openable windows, emphasis on cycling to work and bicycle racks, and including Legionnaires’ disease as one of the issues. However the design of Canada’s C2000 Green on the Grand, which was assessed using BREEAM Canada has demonstrated, that Canada’s most energy efficient building can incorporate openable windows while maintaining a high degree of indoor comfort. Similarly, it is a Canadian study3 which indicates that encouraging cycling is the most economically beneficial means of supporting work-site fitness, which helps improve health, reducing heart problems by 40%. As for Legionnaires’ disease, the Quebec 1996 incident has put property managers on guard with respect to protection against future occurrences.

How it Works

The assessment is in two parts. The first part relates to the building’s fabric and services, and the second, to the operation and management of the building. This distinction is important because it is possible to have an older building which inherently may not be very energy efficient, but which is being extremely well managed.

A BREEAM assessment compares the building’s environmental performance against defined
standards, which relate to design, maintenance, operation and management of the building. These BREEAM CANADA criteria are based on generally accepted standards and "best practices" and were peer reviewed by CSA.

The methodology for existing buildings uses a comprehensive checklist approach, based on a questionnaire as well as a walk-through of the building and meeting with the building's management. The assessment is reported in two stages. The preliminary report indicates how the building performed, crediting good practice, red flagging concerns, and providing practical and realistic measures to improve the rating. Any improvements are included in the final rating. The certificates, one for the building fabric and one for the building's operation, accompany the final report and provide credible third party endorsement of the building.

Benefits

BREEAM is a marketing, benchmarking and design tool. The BREEAM Certificate recognizes "green" buildings that have addressed and minimized environmental impacts. It provides meaningful differentiation of buildings in the marketplace. This can have a positive effect on the leasing and resale value of the buildings and helps keep tenants.

BREEAM for new buildings provides advice with regard to environmental performance targets at the design stage. BREEAM is also a Management Tool for building improvement. By benchmarking the building against best practice criteria, it is easy to put together an action plan to improve the performance and health of a building. Investors can compare the ratings of various buildings and their management, based on a credible third party assessment. This is a powerful tool for property and asset managers and for real estate portfolio planning.

As a design tool, the methodology sets out target requirements. These are related to design measures minimizing environmental impact, material selection, and performance specifications.

A building which meet the targets is awarded a BREEAM certificate.

A BREEAM assessment provides benefits for owners and managers in four major areas, namely,

- Operational Savings
- Legal and Insurance Costs
- Health and Productivity Gains
- Corporate Image and Marketing

Savings up to 50% in fuel costs can be achieved by better insulation, higher efficiency boilers and air cooling equipment, lower wattage lamps, high efficiency electronic ballasts, improved lighting controls, variable speed fans and motors and rebalancing supply air and distribution, etc.

Legal and insurance claims which can be astronomical, especially when it comes to health and safety related issues, can be reduced with regard to asbestos, hazardous materials, lead, radon,
microbial contamination and toxins in the ambient air. Health and productivity can also be significantly affected by building related issues. High frequency lighting cuts headaches and eyestrain, and the avoidance of Sick Building Factors can improve absenteeism and productivity figures. Several productivity studies in the US and Canada indicate that improvements as high as 15% can be achieved from a better indoor air quality and overall indoor environment for building occupants. Corporations which are “green” not only promote environmental responsibility within their organizations but also demand it from others, in their normal course of business. Being “green” also promotes good will, personal wellness, and a positive atmosphere in which to work.

BREEAM is also a means to support “continual improvement” which is part of many Total Quality Management systems, including the international ISO 14000 Standard for Environmental management, now being introduced to the real estate industry.

A recent study by Touche Deloitte credited BREEAM particularly with its contribution to the improvement of environment, design advice, PR/marketing, health and well being improvements and financial benefits to the building.

BREEAM is not the only building environmental performance assessment tool. There have been several other efforts to establish a systematic approach for evaluating total building environmental performance such as BEPAC, and “Building for Environmental and Economic Sustainability”

(BEES) being developed by Barbara Lippiatt at NIST. The main issue in any discussion of building environmental performance assessment is how to prioritize the specific environmental performance criteria. “Weighting” the criteria can lead to considerable complexity and subsequent difficulty of practical application. Because of its straightforward approach, BREEAM has emerged as currently the most practical and acceptable method by the industry for building environmental performance evaluation.
Conclusion

An objective assessment of environmental issues is a useful starting point, from which to make design and building improvements. BREEAM is the result of co-operation by the public and commercial sectors as well as the research community to produce a tool which can be used voluntarily by many players in the construction industry. Designers can demonstrate environmental achievements of their work to the client. Developers can credibly communicate the high environmental performance of a building and improve sales. Landlords or occupants can cost-effectively audit their property portfolio and identify where to make environmental improvements and set verifiable targets. Managers can reassure staff that they have a healthy workplace which can contribute to increasing productivity.

BREEAM provides the measure of a building’s effect upon the environment so that it can be objectively judged on its own merits. BREEAM is therefore, a powerful marketing and auditing tool which creates impetus for improvements for a better global, local and indoor environment.

Jiri Skopek is a Toronto Architect and Planner and the managing director of ECD Energy and Environment Ltd., an environmental consulting firm and the operating agent of BREEAM Canada. He has developed the Canadian version of Building Research Establishment Environmental Assessment Method BREEAM (BREEAM Canada), which is now published by the Canadian Standards Association as their CSA Plus 1132 publication and forms a part of their BQM (Building Quality Management) Program.

Throughout his career, Jiri Skopek has been involved in the environmental field. With John Doggart, the founder of BREEAM, he initiated the Solar Research and Development Group of the Milton Keynes Development Corporation, in England, and designed and built the first active solar house in the U.K. In Toronto, Jiri was a senior designer with Bregman and Hamann Architects where he masterplanned the BCE complex. Subsequently he was invited to Paris, France to manage the office of well known Architect-Engineer Santiago Calatrava, the designer of the BCE galleria. On his return from Paris, Jiri started his own architecture firm and received several awards in planning and architecture competitions including the City of the Future, Milwaukee, and the CMHC/CANMET multi-residential “IDEAS” competition (in association with Doug Pollard).
REFERENCES

1. BREEAM Canada, An Environmental Performance Assessment for Existing Office Buildings, CSA- Plus 1132, 1996

2. HK-BEAM 2/96 (Existing Offices) 1996


6. BEPAC (Building Environmental Performance Assessment Criteria); Version 1, Office Buildings, British Columbia, Vancouver: University of British Columbia School of Architecture, 1993.

Experimental Energy House Revisited

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I grew up in Medicine Hat, Alberta during the 1940's and 1950's at a time when low cost natural gas was so inexpensive that insulation in the walls of buildings was rare.

In the 1960's I attended University of Manitoba School of Architecture, where the word "environment" was not understood and the word "cybernetics" was starting to infiltrate the vocabulary at the university campus. What we did concentrate on was organic design - "Form Follows Function" where aesthetics were the "quality of life" factor.

I started my practice in the 1970's when Victoria was going through a boom growth period. There was little concern for energy cost and increase in building insulation methodology. It was during this era that my interest in solar energy research peaked.

In the early 1980's I had a chance to apply my architectural knowledge to energy research. I designed and built a house for my family. The questions outweighed the answers so my wife and I tried to base our design on future energy savings, while at the same time solving the problem of living in Victoria, BC during the three dark grey winter months, and enjoying the other nine months of outdoor/indoor west coast living. What evolved was a comfortable, airy, bright, and interesting family home that has so far given us 16 years of the quality of life we sought.

THE ORIGINAL PROJECT

In 1980 our old house, originally built in 1938, was totally renovated to create an energy efficient, economical, aesthetically pleasing living environment in which to enjoy the amenities of location and the aspects of family living. The architectural design for this renovation was literally formed by the functional requirements of all of the impacting pressures normal in a family renovating their home,
but in this case there were other demands:
1. High quality of life demanded by the residents; everyone wanted an ocean view from their bedroom. Each family member wanted a view of the ocean from almost every room in the house including family room, bathrooms, kitchen, music room, office, living room, dining room, breakfast room, bedrooms and balconies.

However, the dollar governed, as it usually does. This meant that each decision had to be calculated to payback in energy savings. Therefore the design proceeded, shaped with a reason for each decision. The views of the ocean were south facing which allowed

an energy saving advantage by placing large clear glass windows on the south side of the house and small windows at the north. The walls were painted off-white to give high reflection.

2. The house is on the ocean and beach wood is cheap, demanding use of a wood fireplace.
3. A demand for a bright, open house that would require very little artificial lighting during the daylight hours to display the art collection.
4. A demand for a comfortable house where the family would not have to worry about dressing warmly or turning up the heat while in the house.

Therefore, the introduction of a stone wall heat storage chimney in the centre of the house with two fireplaces that were heat conservers using outside combustion air replaced the old heat guzzling fireplace formerly located on the outside wall.

The old house cooled rapidly and demanded that the furnace start and stop often, thus wearing out the motor and starting mechanism. Therefore, in order to reduce the time of cooling, a rock bed was installed under the family room. This contained four tons of river boulders spaced to allow air from the rest of the house to circulate around each boulder, giving heat in day and taking heat from the rocks at night.

The old oil furnace was retained even though we were assured by specialists and repairmen that it wouldn't last more than two years (16 years later it's still going strong after two new fan motors and two new burner motors). When we moved the furnace we added an air filtration system and a humidifier (my daughter had a dry skin allergy problem). We later removed the humidifier because it was ineffective.
THE TRANSFORMATION OVERTIME

When we renovated the toilets we used large capacity tanks for flushing action. As Victoria grew and put demands on its water source, water usage has now become a concern and we have recently started to change to energy saving toilets and faucets with water restrictors and have installed an underground irrigation sprinkler system in the garden.

Our lifestyle has changed since our children left home and we spend more time in our kitchen and breakfast area in the evening. We have now added radiant electric floor heating which we can turn on and off as we use this room. This allows us to keep other parts of the house cooler and affords us a comfort zone that starts at our feet (feet are the first part of the body to get cold).

When one calculates savings, one also calculates payback on personal time spent on repairs – this changes and affects installations. We installed one of the first homemade active solar collectors on a residential property in Victoria. This solar collector received southern sun and transferred solar gain to a pipe running to the rock bed heating the boulders. This solar heating system, although simple, had to be maintained yearly. This was no trouble for the first few years, but soon became costly and a chore to maintain, so we have (temporarily?) covered this solar collector, waiting for a time when payback will again allow it to be active. Others with more sophisticated higher quality solar collectors swear to their effectiveness. Our passive solar windows continue to afford us great heat savings.

The original light fixtures in our house used incandescent bulbs. The fixtures were inexpensive and bulbs lasted about a year. We have now replaced more than half of those fixtures with halogen light fixtures and halogen light bulbs. This gives a better spread of light at lower wattage thus saving energy. It also puts less load on the electrical circuits allowing lower amperages to zones that require increased light levels. Also the use of rheostats save energy by allowing one to adjust the amount of energy use and light to suit the task. One of the greatest heat loss areas to houses in Victoria is air infiltration during high winds. Our house is located on the ocean and receives more
than its fair share of these winds. We therefore made an extensive effort to stop air infiltration. This
was achieved by caulking all joints, caulking vapour barrier to windows, putting bags around the out-
let boxes, eliminating the many small holes in the walls, and upgrading the weatherstripping. Our
next task will be replacing the window weatherstripping, which has deteriorated over 15 years. When
I designed the Energy House in Victoria, it was found that the greatest heat loss and energy conserva-
tion payback was to caulk all holes where air infiltration occurred.

The paddle fan at the upper floor allows air to circulate. Thus the air from the upper floor
which gets warm on sunny days is transferred to lower floor.

On the hot summer days when we want to have the southwest view but the heat gain from
passive solar systems (windows) is too great, we have a portable air conditioner to temper the upper
floor bedroom. This occurs about 15 days per year.

It is unfortunate that property tax law does not give sufficient incentive to those who wish to
spend more on their house for energy payback in the future. We are taxed on our improvements. Also,
mortgage companies do not calibrate their high ratio mortgages to allow borrowers to spend more
today on their house in an effort to save more in the future. This would give borrowers the chance to
pay off mortgages faster using the savings from energy paybacks.

When energy savings are considered, the general public often ignores the logical items that
are solved by architects every day when they work with building codes, aesthetics, and functional
solutions. Even the choice of a property location can affect energy costs as residents are forced away
from the pedestrian community to the vehicular high energy demands of suburbia. The cost of two
cars to transport to work, school, recreation, and shopping each day is costly. Our house is located on
a cul-de-sac near a bus stop a few blocks from a shopping centre and a five minute drive from work
and downtown Victoria.

There is now availability of recycling such items as compost, paper, cardboard, newspaper,
glass, tin and plastic. However, when it comes to construction, recycling the old wood framing and
siding did not have a substantial payback because of the heavy labour costs needed to pull nails,
store, strip paint and reuse. The aesthetic reward and world energy cost savings, in my opinion, are
worth the effort.

**Conclusion**

In this paper we have presented an incentive for investing in energy savings now in order to reap the
benefits in future. In renovating energy restrictions can lead to unique design solutions. There is no
need to lose sight of ones quality of life when creating an energy efficient house.

It is our hope that our house with all of its energy conservation ideas can demonstrate that the
architect can design a highly functional, energy efficient design that can give beautiful and comfortable
living as well as long term return on investment. The best part about many of these energy
conservation investments is that with inflation, they give a higher return on investment while allowing one to live a better life.

My challenge to architects is to design new or renovated houses stepping into the future and encouraging world energy conservation methods such as those introduced by this house.

Cheaper is not necessarily better. It is the duty of each of us to make a larger initial investment, because energy conservation contributes to our quality of life, and reduces life cycles costs. It is up to each of us to make our community, our province, our country and the world a better place for our children and their children.

*Benjamin Bryce Levinson is principal of the firm Benjamin Bryce Levinson, Architect & Planners. He has been practicing architecture in Victoria, British Columbia for over 25 years specializing in environmentally friendly design and construction. He was a charter member of Solar Energy Society of BC and has designed many energy efficient buildings and renovations. He has received heritage awards for restorations and was the architect for the Victoria Energy House which developed the “Hot Can” project, one of the forerunners to the national R-2000 program.*
Columbus House: IDEAS Challenge Winner

Mickie Holland, F.R.A.I.C., M.A.A.A.
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The name of the place is Columbus House and it’s intended to provide affordable and adaptable housing for seniors in Sherwood Park, just outside Edmonton, Alberta.

The 175-unit high-rise calls for two separate buildings: a 91-unit condominium complex and an 84-unit rental property. The residential project is to be built by the Sherwood Columbus Club (Knights of Columbus) on a two-acre site in the heart of Sherwood Park, within walking distance of shops, medical offices and a golf course. It’s bound to be a welcome addition to the seniors’ housing market, which is expected to double within the next 15 years.

Columbus House has yet to take shape. The design by Holland & Associates – Architects and Planners with Rob Nespliak of Reid Crowther and their consultant team was one of five regional finalists in the IDEAS Challenge, a national design/construction challenge held in 1994 to demonstrate the application of improved design and construction practices for high-rise residential buildings. Canada Mortgage and Housing Corporation (CMHC) and Natural Resources Canada/CANMET co-sponsored the Challenge with additional financial support from Hydro Quèbec, the Ontario Natural Gas Association and the Ontario New Home Warranty Program. CMHC later asked Holland & Associates to submit the Columbus House design to this publication.

To win the Prairie regional division of the Challenge, the design had to meet stringent standards regarding durability (50 years or more), reduced energy consumption, superior indoor air quality and mechanical ventilation, environmental sustainability and increased accessibility and adaptability. All these requirements had to be met on a minimum eight-story high-rise apartment building. Much of the durability factor for Columbus House is addressed by the choice of basic building materials. Reinforced concrete, precast concrete, bricks and concrete blocks are essentially durable in nature when assembled in a proper manner.
But the proposed building envelope also incorporates the latest innovations in building envelope technology, including pressure-equalized rainscreen, continuous air barrier and moisture protection principles. All these measures aim to lengthen the building's life to 50 years or more, getting away from the North American practice of building for the short-term, as opposed to Europe, where buildings last hundreds of years.

Computer simulations and the design team’s experience indicated that thermally fused, reinforced, modified, dual purpose bituminous air barrier and water proofing membrane interior building components should handle the problem of rain penetration through an exterior wall or window. The structural air barrier will be reinforced/modified bituminous membrane which is thermally fused on the concrete block. The choice of air barrier follows the move in the early eighties away from vapor barrier. Between 1981 and 1983 the firm, Holland & Cummings Architects, in conjunction with Alberta Public Work Services, designed the St. Albert Provincial Building. Deemed energy efficient (for the time) and air tight, subsequent studies found the air barrier tightness of the building envelope was one of the main factors in the energy efficiency of the building.

Moisture protection features for Columbus House include carefully detailed and installed flashings, precast caps and sills and a protected membrane roof system.

Regarding energy efficiency, the design goes well above what was required. The Challenge rules stipulated energy consumption must be reduced to no more than 55 per cent of the benchmark standards from ASHRAE (American Society of Heating, Refrigeration & Air Conditioning Engineers). The building will be able to reduce by 38 per cent the energy consumed by a normal well-designed apartment built to ASHRAE 90.1 standards.

Energy-saving measures for Columbus House include:

- using computer simulation to determine the best thermal insulation levels for exterior walls, windows and roofs
- taking into account the mass storage capability of the exterior masonry wall assembly to help level off or reduce peak energy demands on the heating and cooling systems
- selecting high performing glazed windows and doors to cut down on energy loss through the exterior walls
With the help of a high-tech window with a greater R factor than most of those available. The building has an R factor up to nearly 8, (compared to the more common R2 or R3) which saves 300 per cent of the energy that would normally be lost through the windows. The high-performing window reflects heat inside in the winter and reflects excessive heat to the exterior in summer.

- using ground source energy to cut down on fossil fuel and electrical consumption for heating and cooling
  This step involves taking groundwater, which has a temperature of 50°F — to two fan coils in the suites and effectively using that groundwater to minimize heating and cooling required by direct mechanical means. That 50°F water in summertime would avoid use of any compressors to cool the room, obtaining the effects of air conditioning without its inherent expense and polluting vapors.
  In winter the groundwater could be tempered with a heat pump, which uses relatively little electricity.

- incorporation of leading-edge technology to maximize the energy performance of the building
  These technologies will include a central, computer-controlled direct digital energy management and control system, with the energy system monitored by the building manager using a central computer. As well, each suite will have a room temperature sensor, a heat pump direct digital control panel and a microprocessor power monitoring system, all connected to the local control panel.
  High energy efficient motors, compact fluorescent lighting systems, photoelectric lighting controls and Energuide labeled appliances are other energy-saving measures designed into Columbus House.

Reducing energy consumption has a direct effect on carbon dioxide emissions, bringing them down as well. Doing one thing can have a positive effect on another, eg. Canada's current push to reduce carbon dioxide emissions.

Indoor air quality, ventilation and occupant comfort were important matters in the Challenge. Achieving energy efficiency goals resulted in a very tight building envelope on the project.

In order to achieve a healthy environment for residents, the design team resolved to reduce the level of contaminants built into the building, remove contaminates at the source of production and dilute the air within the building with fresh outside air. To this end, manufactured products with low or minimal VOC (volatile organic compounds) emissions as proposed in the 1994 R-2000 Emission Criteria and described in Healthy Material, a CMHC publication from the spring of 1994, are to be selected. These materials include wool, cotton or latex-free backings with no underpad or adhesives, or limiting carpet to 50 per cent of the total floor area. Air filtration with a minimum 50 per cent average dust spot efficiency, water based or Ecologo paints and varnishes, water-dispersed or low-toxic flooring adhesives, solid wood or sealed particleboard cabinets and Ecologo wood floor coverings are other suggested materials.
Oil and gas vapors from the underground parking and the heating equipment will be exhausted directly to the exterior of the buildings. Moulds, dusts and pollens – all potential health hazards — should not be a problem due to the building envelope systems, which will prevent moisture penetration that encourages the growth of mould or mildew. Air filtration systems will control dust and pollen from entering the building from outside.

The central ventilation system will consist of an air handling unit at roof level and will be used in conjunction with compartmental fan units on each floor to distribute air in the suites. Variable frequency drives on fans will be used to save energy and operating costs. Supply air temperature will be reset based on room demands, with air to be provided into each enclosed room of the suite and exhausted from room grilles and hoods in bathrooms and kitchens.

Indirect lighting from color improved fluorescent sources will be used to cut down on direct and reflected glare while maintaining required energy consumption requirements. Soundproofing and room control of heating and ventilation systems operating temperatures will also add to occupant comfort and control.

Other measures intended to enhance indoor air quality include:

- limited use of natural wood, with low emission woods like birch and maple preferred to decrease VOC from wood resins.
- the wood used will be sealed and finished with a water-base lacquer finish.
- no installation of gas stoves or gas fireplaces in the complex, thus eliminating these potential sources of pollutants and/or irritants

Environmental and resource conservation was an important consideration in designing Columbus House. Domestic water pressure controls, domestic hot water piping heat tracing, low-flow water closets, showerheads and faucet aerators will be incorporated into the plumbing system design to decrease water use and waste water treatment. HCFC-based refrigeration and fire protection equipment will be avoided wherever possible.

The design team tried to use locally-made products, such as brick, concrete block and cement, as much as possible, rather than calling for products that must be trucked in.

During construction, a waste reduction of 50 per cent (compared to conventional building practices) will be aimed for. Crushing bits of brick and concrete block on site and using the crushed material for drainage fill, sidewalks, and light topping for roofs is one plan. During construction we would take bins and sort the material and find recycling places that would take pieces of drywall and metal. We would grind up all waste wood products and treat them, for use in landscaped areas to keep the weeds down. The idea is that very, very little would go to the garbage dump.

Regarding accessibility and adaptability, the key thing was to allow people to age in place. This means all floors will be accessed by elevators, with visual and tactile signs, and lowered controls for those in wheelchairs. Handrails will be found along all corridors, with notches in the handrails to
let people with visual impairment know when a door opening is near. Enhanced lighting, non-slip flooring, elimination of sharp edges on counters and numerous other details have been considered to ensure safety of the residents. Provisions will be made to accommodate the possible future needs of residents. Adjustable counter tops, adjustable shelving, blocking for future grab bars and wheelchair width doors are just a few of the adaptability considerations to be incorporated into the design.

Working drawings have been prepared for the project and interested parties are being sought with a view to further development. Moving the project from paper to actual construction may be a challenge in these tight economic times, which in no way reduces the importance of the IDEAS Challenge.

The Challenge results in plans that might bring about a better environment for people to live in and help overcome shortfalls in housing.

Much of the technology used in our buildings today is antiquated. This is a way to push the technology forward. What we need to do is to get a few examples built so that people will copy and grow upon them.

A.M. Holland Architect Ltd. is a medium sized architectural design firm in Edmonton, Alberta and over the years the principals have been involved in the architectural design of a very wide range of buildings, hotels, office buildings, institutional buildings, educational facilities, shopping centres, industrial projects, airports, restoration/renovation work, etc. Furthermore, the firm has designed over 30,000 multiple housing units (apartments, row housing and highrise complexes) across Canada from St. John New Brunswick to Nanaimo, B.C.
The Lanark Earthship


Principal
Dextor A. Edwards Architect

A Sustainable Dwelling for Hilary Houstoun and Raymond Lefebvre

Preface

The environmental challenges and pressures facing Canada and the world are increasing with the modern changes in industry. Our degree of change exceeds our ability to collectively understand, predict or control it. Until recently, only a few people were concerned enough to design to protect the environment. In our profession, we have the ability to make a direct impact on the built environment. Seize any opportunity that comes along!

Introduction

In July of 1996 Hilary and Raymond (my clients) approached me with a simple request: Provide us with a comprehensive plan to help us build our own sustainable dwelling. Why a sustainable dwelling? If you met them you would say why not! Their very lifestyle exemplified what we all strive to attain in our daily life. (Inner peace with a relaxed approach to everyday activities and a very conscious awareness of their place in the environment). They then said “We would like to build this dwelling using re-cycled tires” I automatically had visions of the Hagersville tire fire over a decade ago and a potential off-gassing nightmare. I then began to ask many questions and acquired research material which provided me with answers that allayed my fears totally. I understood that personal need to make a contribution to our environment. I have personally pursued sources of renewable energy since being introduced to alternate approaches to building in 1980.
1. Design Program

The physical program of the dwelling consisted of the following: 2 Bedrooms, 1 Living/Dining Area, 1 Kitchen, 1 Bathroom and 1 Large Indoor Garden. All of the rooms listed are standard to any dwelling except “the Garden”. This would be a garden that would process sanitary drainage, produce plants that would be abundant enough to enhance indoor air quality for the occupants. The mental program of the dwelling was to minimize any adverse impact on the environment and reinforce the client’s belief in ecologically sound endeavors.

2. Design Objectives

This dwelling will not be connected to the hydro grid, therefore the needs for electricity will be met in an efficient and responsible manner using solar energy. Solar energy is essentially perpetual, inexhaustible and is the basis of all sustainable life on this planet. Ancient civilizations depended directly on the sun for their food, warmth and light. In Canada, we have promotions of across-the-board energy efficiency targeting reductions in industrial and consumer consumption but the effort has to begin at home.

3. Solar Energy Analysis

My clients feel they have a contribution to make, therefore their 1,500 square foot home would generate its own electricity through the proper orientation of the right components making it an autonomous system. The means of power generation would be photovoltaics. Photovoltaic cells are an efficient means to convert direct sunlight into electricity. It was finally developed efficiently in the 1950's by Bell Telephone scientists in the United States. These 100 millimetre wide silicon disks are placed in large amounts on flat surfaces which are oriented toward the direction and angle of maximum solar exposure for the particular location. Photovoltaic (PV) systems can be simple or complex depending on the application. In my client’s case the requirement would be, PV modules, batteries, power conditioning equipment and standard equipment such as panels, and monitoring equipment.

The size of this autonomous system is determined by establishing a list of appliances to be utilized in the dwelling, an estimate of the available sunlight for the area based on Environment Canada records, a selection of the type of PV module, and the desired amount of back-up storage capacity based on the chance of any malfunction with the PV modules. See Appendix A for an illustration of the power needs of the dwelling.
4. Site / Building Ecosystem

Ventilation

There are many issues to be explored in the ecosystem. The following is a typical question from the local building official: “What method of air exchange is used for fresh air intake”? In a standard dwelling, the furnace or heat recovery ventilator has a fresh air intake component that is processed by mechanical means. In a solar dwelling, mechanical ventilation means one more appliance that will tax the PV system. My clients wanted to reduce or eliminate anything they deemed unnecessary despite the need for code compliance:

Answer: “The method of air exchange to be used will be natural ventilation as per section 9.32.2.1 of the Ontario Building Code. The “Earthship” is essentially one large space with a combination of rooms except for the bathroom, the pump room and the battery room. There is a provision for three operable roof windows totalling 16 square feet each spread equally at each pod (16 sq. ft. x 3 = 48 sq. ft.). This satisfies all rooms within the dwelling which only need 3 sq. ft. total excluding the bathroom. The bathroom and battery room will be provided with a side wall vent as shown in the detail documents. This will be a permanent shicane through layers of batt insulation at the shafts shown in these rooms. The orientation of the dwelling encourages cross ventilation through the summer months when the east and west entry doors are opened. The provision of plants in the solarium area will also eliminate carbon dioxide and replenish oxygen as part of the natural plant growth process.

Waste

The primary issue encountered in this dwelling and any other dwelling not connected to a city infrastructure and treatment plant is sanitary waste: The dwelling’s waste water is always assumed to be contaminated, because it sometimes is. The organic matter in sanitary waste is in various stages of decay and produces by-products which are dangerous to health if it is not disposed of properly. There are two categories of sanitary lines: soil lines which carry water from the toilets and waste lines which carry all other waste from inside the dwelling. Vents are used to relieve the pressure build-up and vent hazardous gases and odours. The soil stack is a large pipe into which all of the soil and waste lines from all fixtures empty and it is open to the outside air at the top of the roof. The vent stack is a smaller pipe which is the air intake line for all the fixtures which is also separately open to the outside air at the top of the roof. In the soil stack, the section above the highest fixture is called the stack vent. This whole network is designed in this dwelling the standard way. Our deviation from the normal dwelling begins with the drainage lines from the fixtures. An average toilet uses from three to five gallons of water per flush. This water is called black water and is non-renewable through our gravity filtration process. My clients decided to use compost toilets which reduce human waste to a dry, odourless earth-like substance that will be used for fertilizer.
A further step was taken to minimize the wasteful use of clean water, and it was decided to separate the bathtub water, sink water, and washing machine water to recycle it and reduce the cost per gallon. This is called grey water technology. Although certain detergents must be avoided, this concept is ecologically beneficial since it reduces waste. The grey water will be gravity drained through a plastic weeping tile at a quarter inch to the foot slope below a large indoor planter bed. This planter bed is also a containment tank/filter that allows the water to slowly percolate through earth, layers of sand and crushed gravel. The water leaves all sedimentary deposits behind and is pumped up ready to be used for gardening or an exterior hose bib. However!

The municipality insisted on the provision of a leaching pit outside of the dwelling for all waste water except the sinks which were allowed to feed the indoor planter beds. The leach pit is simply a holding well dug into the ground with a sieve-like wall so that the liquid leaks out over a bed of gravel which filters the liquid waste before it seeps into the soil. All attempts are relatively successful at managing the dwelling's waste with little water wastage within the confines of the property.

5. Efficient Site Orientation

The site is a 20 acre tract with large stands of trees on the perimeter creating a safe haven at the central clearing. The short ends of this rectangle are adjacent to a river and a gravel roadway at the municipal frontage. The dwelling is a rectangle with a long side directly facing south allowing maximum passive radiation and an appropriate surface to place a photovoltaic array that would need to generate 4,378 peak watts of power in the winter months. This autonomous PV system array not only needs to be oriented within 15 degrees of due south but also tilted vertically relative to the geographical latitude of the location. In this case the PV array is tilted at 55 degrees off horizontal for maximum year-round performance. The autonomous PV arrays need to be tilted at a steep angle, typically 10-15 degrees greater than the location's latitude.

The dwelling is sited at the northern edge of the 20 acre clearing which definitely ensures that there will not be any shadows cast from nearby vegetation. There are a couple of complexities: One is the complexity of ignoring the compass directions which give magnetic references. True references have to be used. Another complexity is the mounting of large arrays that do not sit flat on the roof surface. This is subject to unusual wind loads which will affect the structure of the dwelling. The arrays need to be designed typically to withstand winds of 175 kilometres per hour. All this information can be easily obtained from Geological Survey of Canada.
6. LIFE CYCLE COSTING ANALYSIS

The life cycle cost of a system is the total amount of money which must be budgeted at the start of the first year of operation to cover the initial cost and all the operating costs over the useful life of the system. The estimated cost of this system is $22,000 with a life expectancy of approximately 20 years which includes the PV modules, the power inverter for DC to AC current, the storage batteries, a controller, a load distribution centre, a lightning arrester, a back-up propane gas water heater and generator. This is a large amount up front but if you consider the average home heating costs of $1,200 per year for most home mortgage amortization at 25 yrs; the saving in the long run is $5,000 plus the cost of inflation, operation and maintenance costs over the same period of time. A PV system has little or no moving parts which minimizes system wear and tear. The operation of the system will be the flick of a switch and manageable to the average homeowner. It makes practical and economic sense.

7. CONSTRUCTION MATERIALS RESEARCH

The primary building blocks for the dwelling will be discarded tires and tin cans.

This is the primary description of an “Earthship”.

What is an Earthship? This is what we call a home that is self-sufficient and is built utilizing recycled tires, aluminum cans and earth for construction materials. The materials are indigenous to the planet, and they are as plentiful as trees. These materials, except the earth, do not contribute to our ecosystem. Earthships are designed with materials that we discard, and achieves self sufficiency by getting power from the sun, water from rain and recycling its grey water and sewage.

See the following diagrams for a visual description of the planned layout.

The main walls of the three main spaces described as pods are built with the tires filled with rammed earth. They are stacked flat like large building blocks in a staggered fashion. These walls serve as load bearing support for the entire structure. The non-bearing walls are built using tin cans and cement and can be naturally finished with adobe mud, plaster or stucco.
The Earthship is a heating and cooling unit using the principles of thermal mass to maintain a constant temperature. In the winter, the earthen/tire walls act as a mass wall with high heat retention from the passive radiation gain at the south-facing full-height glazing. A wood stove is used to provide additional heat if and when required. The Earthship concept was started 25 years ago and realized in 1990 by “Solar Survival” who coined the phrase and started a demonstration community of Earthships called Reach (Rural Earthship Alternative Community Habitat) outside of Taos, Nevada, U.S.A. Although the popularity of Earthships is rising in the United States, I am only aware of nine such projects in Canada. This makes the approvals process difficult for potential homeowners, due to its novel concept to public officials. The first Earthship builders in any municipality have to take on the role of pioneer, educating building inspectors, planners and zoning boards; it took persistence and a lot of time from Hilary, Raymond and myself, with the help of engineering reports, literature and videos from “Solar Survival”.
8. Building Envelope Analysis

My study of the building envelope and earthship construction has indicated they are well suited for extreme weather conditions based on excellent orientation, minimized wind chill on the north face of the dwelling due to berming, and maximized southern glazed fenestration. The obvious concerns are dealing with heaving at the south base wall because most earthships sit above the frost-line and the continuity of effective damproofing at the rear of the pods below the berm.

The frost heave can cause havoc with the glazing panels which will result in leaks therefore there is provision for perimeter footings at the front half of the earthship below the frostline. The worst enemy of a retaining wall condition – which exists at the back of the dwelling – is improper drainage, which results in increased pressures, therefore there is added provision of a two tiered drainage line that sits in crushed gravel and granular fill.

Due to my client’s reluctance in providing anything more than a wood stove and a backup gas heater for warmth, the dwelling’s envelope is super-insulated. The roof is designed to a resistance value of 57, the pod walls are designed to a resistance value of 33 and all other exterior walls are designed to a resistance value of 45. These features in combination with the “mass wall” concepts described in the building materials research will evoke comfort.

9. Environmental, Geotechnical and Hazards Reports

What about these tires? Are they toxic timebombs? Is there any off-gassing? Are they still flammable? In my research so far, I haven’t been made aware of any instance of illness or even awareness of any off-gassing of tires in 25 years of research and development.

Chris Kaiser of Solar Survival Architecture writes, “Off-Gassing is looming out there as a hypothetical issue coming from those who have never experienced the concept of an Earthship in person. In view of the above, and the serious issues surrounding current tire disposal globally, we think and accept the fact that those who are trying to make an issue out of this are irresponsible themselves. Furthermore, the Earthship building concept can be implemented with other forms of thermal mass besides tires rammed with earth. However, the reason we use tires is because they are the most economical and environmentally appropriate way to achieve both thermal mass and structure in an actively thermal dynamic building. Anyone who has spent 25 years trying to make human existence on this planet less painful to the planet and the humans themselves is not going to risk exposing people to a hazardous situation. We simply do not see disproving off-gassing any further than the extensive study done by the University of Wisconsin-Madison and our own experience as an appropriate place to spend time and money given the serious housing and energy issues that our current method of living is now presenting. Tires are being recommended to absorb off-gassing produced by waste water from communities, industries, and agricultural activities.

Here are some highlights from the report: ‘If tires are reused as a construction material, the
unique properties of tires can once again be exploited in a beneficial manner (Ahmed 1993). The benefits of using scrap tires are particularly enhanced if they can be used to replace virgin construction materials made from non-renewable resources. Additionally, scrap tires are shown to have significant absorption capacity for organic liquids and vapors (Park, Kim, and Edil 1993). Recent research indicated that shredded tires do not show any likelihood of being a hazardous waste material or of having adverse effects on groundwater quality (Edil and Bosscher 1992).

'There may be some concern about leachate quality since scrap tires are considered a waste material. Laboratory and field evidence available does not show any likelihood of scrap tires being a hazardous waste or having potential for significant adverse effect on water quality (Edil and Bosscher 1992).'

In order to obtain an early evaluation of potential environmental problems, duplicate EP toxicity and AFS leaching tests were performed on tire chip samples by the State Laboratory of Hygiene (Edil, Bosscher, and Eldin, 1990). The duplicate results showed excellent correlation for all substances."

**CONCLUSION**

The objective of my clients remains the same: Inner peace with a relaxed approach to everyday activities and a very conscious awareness of their place in the environment. This process has allowed me an opportunity – I think I've seized it!

**ACKNOWLEDGEMENTS:**

Hilary Houstoun, Raymond Lefebvre, Brigitte Larose, DeMeo Graphics, Solar Survival Architecture.
## APPENDIX A

The chart format shown below illustrates how the power needs for this dwelling were determined.

<table>
<thead>
<tr>
<th>APPLIANCE LOAD</th>
<th>AC or DC</th>
<th>RATED WATTAGE (Actual or typical values)</th>
<th>HRS. USED PER DAY</th>
<th>WH/DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washing machine</td>
<td>x</td>
<td>791</td>
<td>.2</td>
<td>158.2</td>
</tr>
<tr>
<td>Hair blower</td>
<td>x</td>
<td>1400</td>
<td>.1</td>
<td>140</td>
</tr>
<tr>
<td>Toaster</td>
<td>x</td>
<td>650</td>
<td>.1</td>
<td>65</td>
</tr>
<tr>
<td>Sewing machine</td>
<td>x</td>
<td>75</td>
<td>.1</td>
<td>7.5</td>
</tr>
<tr>
<td>VCR</td>
<td>x</td>
<td>23</td>
<td>1.5</td>
<td>34.5</td>
</tr>
<tr>
<td>TV</td>
<td>x</td>
<td>125</td>
<td>2</td>
<td>25</td>
</tr>
<tr>
<td>Turntable</td>
<td>x</td>
<td>4</td>
<td>.1</td>
<td>0.4</td>
</tr>
<tr>
<td>Receiver</td>
<td>x</td>
<td>195</td>
<td>1</td>
<td>195</td>
</tr>
<tr>
<td>Tape deck</td>
<td>x</td>
<td>20</td>
<td>.5</td>
<td>10</td>
</tr>
<tr>
<td>Portable stereo</td>
<td>x</td>
<td>55</td>
<td>4</td>
<td>220</td>
</tr>
<tr>
<td>Refrigerator</td>
<td>x</td>
<td>336</td>
<td>4</td>
<td>1344</td>
</tr>
<tr>
<td>Food processor</td>
<td>x</td>
<td>300</td>
<td>2</td>
<td>60</td>
</tr>
<tr>
<td>Drill</td>
<td>x</td>
<td>360</td>
<td>.01</td>
<td>3.6</td>
</tr>
<tr>
<td>Grinder/buffer</td>
<td>x</td>
<td>600</td>
<td>.01</td>
<td>6</td>
</tr>
<tr>
<td>Juicer</td>
<td>x</td>
<td>200</td>
<td>.1</td>
<td>20</td>
</tr>
<tr>
<td>Coffee grinder</td>
<td>x</td>
<td>100</td>
<td>.1</td>
<td>10</td>
</tr>
<tr>
<td>Vacuum cleaner</td>
<td>x</td>
<td>1020</td>
<td>.2</td>
<td>204</td>
</tr>
<tr>
<td>Lamps (5)</td>
<td>x</td>
<td>100</td>
<td>3</td>
<td>300</td>
</tr>
<tr>
<td>Bedroom lights (2)</td>
<td>x</td>
<td>44</td>
<td>2</td>
<td>88</td>
</tr>
<tr>
<td>Kitchen lights (2)</td>
<td>x</td>
<td>60</td>
<td>2</td>
<td>120</td>
</tr>
<tr>
<td>Outside lights (2) w/sensors</td>
<td>x</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toilet fan</td>
<td>x</td>
<td>2</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Kitchen fan</td>
<td>x</td>
<td>6</td>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td>Ceiling fans</td>
<td>x</td>
<td>18</td>
<td>4</td>
<td>72</td>
</tr>
<tr>
<td>Bathroom lights</td>
<td>x</td>
<td>54</td>
<td>1</td>
<td>54</td>
</tr>
<tr>
<td>Elect. Rm. lights (1)</td>
<td>x</td>
<td>20</td>
<td>.5</td>
<td>10</td>
</tr>
<tr>
<td>Pump Rm. lights (1)</td>
<td>x</td>
<td>20</td>
<td>.5</td>
<td>10</td>
</tr>
<tr>
<td>Entrances/Foyer lights (2)</td>
<td>x</td>
<td>60</td>
<td>4</td>
<td>240</td>
</tr>
<tr>
<td>Water pump</td>
<td>x (12v)</td>
<td>90</td>
<td>2</td>
<td>180</td>
</tr>
<tr>
<td>Circulating fan motor</td>
<td>x</td>
<td>250</td>
<td>4</td>
<td>1000</td>
</tr>
<tr>
<td>Hot water heater (propane)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage/Walk—in closets</td>
<td>x</td>
<td>20</td>
<td>7 (x4)</td>
<td>560</td>
</tr>
<tr>
<td>Power module equip.</td>
<td>x</td>
<td>1000 (est)</td>
<td>50</td>
<td>500</td>
</tr>
</tbody>
</table>

### WINTER

| AC: 3,718.2 Wh/day |

Adjust AC loads for inverter losses:

\[
\text{AC load} = 3718 \quad \text{Wh/day} = 4374 \quad \text{Wh/day} \\
\text{Eff (dc ac)} = 0.85 \\
\text{Total Daily Load: DC loads + adjusted loads} = 6,550 \quad \text{Wh/day}
\]

### APPROXIMATE HOURS OF PEAK SUNLIGHT

Sunlight: 22 hrs./day
REQUIRED PV ARRAY SIZE (peak watts (Wp))

Array Size (Wp) = Total daily load (Wh/day)

= Peak sunlight hours x Eff (bat) x Eff (reg)

6,550  Wh/day

= 2.2 hrs/day x 0.8 x 0.85

= 4,378  Wp  (December — Winter)

REQUIRED BATTERY CAPACITY (Ampere — hours)

Battery Charge Regulator Efficiency: (Eff (reg)): 85%
Battery Efficiency: (Eff (bat)): 80%
Nominal Voltage of Battery: (V (bat)): 12 V  Vdc
Maximum Depth of Discharge of Battery: DoD: 75%
Number of Days of Battery Storage Needed:

Battery Capacity (Ah) = Total daily load (Wh/day) x days of storage

= Battery voltage (V (bat)) x Eff (bat) x DoD

4,378  Wh/day  x 1 day

= 12 V  x 0.8  x .75

= 608  Amp. Hours  (December — Winter)

SUMMER

Adjust AC loads for inverter losses:

DC: 2,176  Wh/day

AC load 3718  Wh/day = 4374  Wh/day
Eff (dc ac) = 0.85

Total Daily Load: DC loads + adjusted loads = 6,550  Wh/day

APPROXIMATE HOURS OF PEAK SUNLIGHT

Sunlight: 4.4  hrs./day
REQUIRED PV ARRAY SIZE (peak watts (Wp))

Array Size (Wp) = Total daily load (Wh/day)

= Peak sunlight hours x Eff (bat) x Eff (reg)

= 6,550 Wh/day

= 4.4 hrs/day x 0.8 x 0.85

= 2,189 Wp (September — Summer)

REQUIRED BATTERY CAPACITY (Ampere — hours)

Battery Charge Regulator Efficiency: (Eff (reg)): 85%
Battery Efficiency: (Eff (bat)): 80%
Nominal Voltage of Battery: (V (bat)): 12 V Vdc
Maximum Depth of Discharge of Battery: DoD: 75%
Number of Days of Battery Storage Needed: 1 day

Battery Capacity (Ah) = Total daily load (Wh/day) x days of storage

= Battery voltage (V (bat)) x Eff (bat) x DoD

= 2,189 Wh/day x 1 day

= 12 V x 0.8 x 0.75

= 304 Amp. Hours (December — Winter)
Sustainable Design: What is the Measure of Success?

Joanne Perdue, B.Arch., MAIBC
Project Architect
Matsuzaki Wright Architects

The C.K. Choi Building is a 30,000 square foot office building located on the Campus of the University of British Columbia. The building has been occupied for one year, and attracting a lot of attention. At the beginning of the design process for this project representatives of the building users, UBC Campus Planning and Development, UBC Plant Operations, the project architects and their consultants worked together for two days to collectively establish project goals. It was agreed that the project was “to set new standards in sustainable design, construction and operations”. A number of specific goals were established which reflected the groups opinion of what a sustainable project might be. The architects and their consultants then set out on a two and half year journey into the design and the construction process. It is now time to ask if the Choi Building successfully fulfilled its mandate: To set new standards in sustainable design, construction and operations?

To answer this question it is necessary to define what sustainable design is and then consider how to evaluate if it has been successfully achieved. One definition of sustainability is: to be sustainable something must be given to balance that which has been taken or degraded. A garden demonstrates this in that it cannot be sustained if nothing is given to maintain and replenish it. If we apply this to buildings, sustainability might be measured by environmental compensation given for resource consumption and atmospheric degradation resulting from construction and operations. A more common definition of sustainable design is: “Improving the quality of life today without diminishing it for the next generation”. As stewards of today’s resources we must utilize them thoughtfully to ensure that future generations inherit a good infrastructure and have resources to sustain them. The project goals established for the Choi Building reflect the team’s
consensus on responsible stewardship. The goals and the solutions employed in the Choi Building are organized into four categories.

I. Reduce Waste By Products and Water Consumption

Each day in the Greater Regional District of Vancouver we generate 229 million gallons of waste water and over 7,500 tons of solid waste. We also consume 237 million gallons of water, the cost of building, maintaining and operating the infrastructure for water delivery, sewage collection and treatment is enormous. As tax dollars are spread thinner and urban centers continue to expand, centralized waste treatment may no longer be economically and environmentally viable. Complete or partial processing of waste at the source would reduce infrastructure loads and might help to increase awareness of the waste we are producing.

Goal: Eliminate the sewer connection.
The use of composting toilets and on-site greywater recycling eliminated the need for a municipal sewer connection. The three story building has three toilets and one urinal per floor all of which are connected to five composting bins in the basement. This is a significant precedent for addressing the question of how to avoid continued expansion of infrastructure for transporting and processing of sewage waste.

The aerobic composting system reduces human digestive by-products by 90%. The end products of the compost process are a humus-like soil product and a liquid compost tea which are both rich in nutrients and suitable as fertilizer. The first cycle of dry compost will remain in the composting bins for approximately five years after which the annual compost production will be approximately one cubic foot per bin. In this installation the compost tea flows by gravity to a concrete sump where it is diluted by greywater collected from the building sinks. This mixture is pumped to an outside subsurface greywater recycling trench which extends 120 feet along the east side of the building.

The greywater trench is lined with a recycled PVC membrane and filled with gravel. The roots of the plants growing in the trench contain bacteria which neutralize greywater bacteria leaving clean water for site irrigation. Testing of the operational system was performed with results that significantly surpassed Vancouver Department of Health requirements. The results at the end of the greywater trench are less than 10 part fecal coliform per 100 mil. As the maximum allowable count for swimming water is up to 200 parts per 100 mil, this is very clean.

Goal: Reduce water consumption to 50% of normal consumption.
As composting toilets do not require water for flushing, they provide a substantial reduction in water use. Depending on building occupancy, the savings could be as much as 1000 gallons per day. The use of recycled grey water along with collected rainwater from roof areas eliminates the use of city water for site irrigation. City water is only used for washing and drinking water. Faucets have water saving devices for further savings.
Goal: Reduce construction waste.
Site sorting and recycling of construction waste was employed during construction. Recycling bins were set-up for a variety of materials. The size and type varied depending on the phase of construction. Each month the contractor submitted forms indicating the amount of waste removed from site along with weigh bills from the companies that received waste materials. From an initial review of the weigh bills, it is estimated that more than 50% of the construction waste was diverted from landfills.

II. Reduce Embodied Energy in Construction

A powerful way of looking at buildings is to think in terms of the footprint that our projects leave on the planet. Architects often think of the footprint as the outline of a building as it sits on the site. The impact of this footprint should consist not only of the impact of the building and the by-products of building operations, but also past and future impacts: upstream in extraction, processing and transportation of resources into building products; downstream in what we do with buildings when they no longer serve our “needs”.

Goal: Incorporate 50% reused and 50% recyclable materials.
Approximately 65% of the Choi Building's structural system is reused heavy timbers from a demolished building previously located across the street. The original thin slab concrete structural design was abandoned when the architects convinced the University to allow the salvage of the long span trusses and beams from the neighbouring armouries building. Modifications were made to the design to accommodate the varying lengths of available beams. A grader was employed during the design phase to ascertain the strength of the members for design purposes. The structural engineers worked with a grader and the contractor to assess each member which was numbered and given a location in the building. This process enabled the use of almost 100% of the salvaged timbers.

The exterior cladding of the Choi is primarily red brick salvaged from Vancouver City Streets. The bricks were prepurchased to ensure availability for the project. Testing was necessary to determine if the bricks were appropriate vis a vis porosity, strength etc.

All of the wood doors and 90% of the hollow metal doors in the Choi Building are reused from a downtown office building. The solid core doors came with hinges and a given direction of the swing. The design process was more like a renovation accommodating existing products instead of specifying new products to fit the design. Other reused materials include interior aluminum guardrails, electrical conduit, toilet partitions, washroom sinks, paper towel and built-in garbage receptacles and the drinking fountain.
When reused materials were not available the next strategy was the incorporation of building components with recycled content:

<table>
<thead>
<tr>
<th>Material</th>
<th>Recycled Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Steel</td>
<td>90% recycled content</td>
</tr>
<tr>
<td>Cellulose Insulation</td>
<td>100% recycled content</td>
</tr>
<tr>
<td>Gypsum Wall Board</td>
<td>20% recycled gypsum, 100% recycled paper</td>
</tr>
<tr>
<td>Ceramic Tile</td>
<td>75% recycled content</td>
</tr>
<tr>
<td>Carpet Underlay</td>
<td>100% recycled content</td>
</tr>
</tbody>
</table>

Reusing and recycling to reduce embodied energy would not be complete without eliminating unnecessary finishes. For example, dropped ceilings are not used to hide services. Floors are polished concrete in areas where acoustic considerations permit. Additional measures such as reducing the cement content of the concrete by increasing fly ash and silica fume content further reduce embodied energy.

While the exact quantities of reused and recycled materials has yet to be calculated, it appears that the goal of 50% recycled content and 50% recyclable content has been achieved and perhaps exceeded. When compared to typical construction the savings in embodied energy and green house gas emissions are substantial. The use of reused materials helps to lighten the footprint of previous projects by allowing their waste resources to be incorporated into this project.

III. Reduce Operational Energy Use

Over the life of a building the greatest impact on energy consumption comes from the day to day operations to light, heat and cool. Studies show that the greatest impact on energy consumption comes from the building architecture. Features such as thoughtful orientation, and building forms that optimize site conditions such as breezes for cooling, daylight without heat gain, sunlight for power and heating, determine the size of mechanical and electrical systems. The early design decisions made by architects are the most significant contributor to either increasing or reducing operational energy consumption.
Goal: Reduce operating energy by 60% of ASHRAE 90.1; reduce the lighting power density factor to 0.5 watts per square foot.2

To attain these goals the project team approached the problem from the perspective that “less is more” and “keep it simple”. The building design is organized around a series of atria that provide daylighting to reduce reliance on electric lighting. The atria also generate a stack effect that facilitates natural ventilation.

A traditional ducted air change system was avoided by the use of ventilation strips in window frames to admit fresh air and relief air louvres in the atria. Small fans are also located high in the atria to assist with the stack effect when natural ventilation is inadequate. The fans allow for night flushing of the building to cool concrete which becomes a thermal sink for moderating temperature change during the day. In addition, operable windows are provided throughout the building. The design is a “low tech” approach. Continuous air change eliminates peaks and valleys in indoor air quality.

To maximize energy savings from daylighting, photo cells automatically dim lights when adequate natural light is available. Occupancy sensors turn off unnecessary lights when a room is vacant. Further savings are achieved by providing lower ambient lighting levels for general illumination with task lighting at work stations where higher light levels are required.

Addition features expected to lower operational energy consumption are preheating domestic water from waste heat in a nearby steam manhole, and the thermal efficiency of the building envelope. The insulation value of walls and roofs was kept high and attention was paid to reduce thermal bridging of materials. The modified PVC window system was selected for its low conductivity and high insulating quality. Windows are double glazing with a low emissivity coating (Low-E). The sloped south facing roof forms were designed with photo-voltaic panels in mind, however, they were not within the project budget. Hopefully their future installation will enable further reductions in energy use.
The elimination of a traditional mechanical system and the modified lighting strategy substantially reduced the electrical load enabling both primary and emergency power to be obtained from excess capacity in a nearby building. In addition to cost savings on mechanical equipment, the project realized savings from the elimination of a new unit substation for power service.

Computer simulation of the Choi operations project that it will exceed the ASHRAE 90.1 standard by 50%. The lighting power density factor is calculated at 0.7 watts per square foot, however, it is hoped that given the abundant amount of natural daylight, the building may operate at 0.5 watts per square foot.

IV. Promote Longevity

For any project to be considered sustainable it must achieve longevity. The benefits of designing an energy efficient building with low embodied energy are limited if a building becomes obsolete after 30 or 50 years. Our expectations for the life of a building shift considerably if we think in terms of buildings such as Hagia Sofia, built over 1500 years ago, and still in use as a place of veneration. For buildings to achieve longevity floor plans must be flexible to accommodate changing uses over time, and services must be accessible for upgrades as technology changes. The building envelope must be durable. Buildings must also be maintained. Most importantly though, buildings must be healthy inspirational places that people want to live and work in.

Goal: Create liveable working spaces.

Occupants of the Choi Building enjoy an abundance of natural daylight, and 100% fresh air at all times. In their offices they have the choice to open windows, and manually control the heating and lighting. Interior materials were selected to minimize undesirable emissions: carpets were laid without adhesives; paints lacquers and sealants are non-solvent, low emission products; interior millwork is made from formaldehyde-free fibreboard. Photocopy areas are also equipped with direct venting.

Goal: Design for longevity.

Floor plans were designed to accommodate a variety of uses allowing for future retrofit. Interior walls can be relocated without structural modifications. The design of the power distribution and telecommunications systems have anticipated relocation and modification by being easy to access. Raceways have additional capacity for future expansion. Exterior cladding materials and interior finishes are durable and low maintenance.

There is a high request rate on Campus for office space in the Choi Building and the building users are indicating how much they enjoy working in the building. Hopefully this is an early indicator that the building may achieve a long life span.

Much research is proposed to evaluate if the Choi Building "set new standards for sustainable design, construction and operations". The embodied energy savings and reduction in green
house gas emissions will be tallied as will the reduction in construction waste. Operational studies will be done and researchers will review the numbers to quantify success or failure in the building performance. These numbers will be valuable in the context of understanding the accuracy of both our methods of predicting the performance of buildings, and our assumptions about how to achieve a more sustainable building.

When considering if the Choi Building was successful at “Improving the quality of life today without diminishing it for the next generation”, the true measure of success lies beyond the numbers. What is important is if the building has changed our perceptions of how buildings are designed and built. What has changed in the eyes of the University, and others who commission buildings? Will the building across the street from the Choi have composting toilets or be connected to the sewer system? Will University and college facilities across the province ask that all future buildings exceed ASHRAE 90.1 by 60%? Will more architects design with reused materials? Will the ethic of “code minimum equals developer maximum” be overcome? To be successful the Choi Building must be a model for change impacting politicians, building owners, developers, regulatory authorities, architects and other design professionals.

For this project neither the University nor the design team replenished the garden by assisting in reforestation or clean-up of a waterway to compensate for the footprint that the Choi building is making. Perhaps though, the compensation to future generations lies in the planting of a seed that will germinate into change in the expectations of those who commission buildings and those who design them.

Joanne Perdue was the project architect for Matsuzaki Wright Architects during the design and construction of the C.K. Choi Building. A graduate of the University of Oregon (1986), Joanne is the current chairperson of the AIBC Energy and Environment Committee.

1. 1996 Statistics from the Greater Regional District of Vancouver. Solid waste figures include municipal, commercial and DLC waste.

2. An ASHRAE prototype office building is approximately 1.2 to 1.7 watts per square foot and an office building not done to ASHRAE standards would be higher.
Design Team for the C.K. Choi Building:

Architect: Matsuzaki Wright Architects
Structural Engineer: Read Jones Christoffersen
Mechanical Engineer: Keen Engineering
Electrical Engineer: Robert Freundlich and Associates
Landscape Architect: Cornelia Hahn Oberlander
Deconstruction:  
Construction in Reverse  

Vince Catalli, B.Arch., MRAIC  
President  
by dEsigN consultants

“We should do something when people say it is crazy. Crazy is praise for us. If people say something is good, it means that someone else is already doing it.” HIJIME MITAeAI, CANON PRESIDENT.

BACKGROUND

As federal and provincial governments set goals for a 50% reduction in waste disposal by the year 2000, landfill sites strain to meet the current demand. Meanwhile, the construction, renovation and demolition industries continue to produce between 20% and 33% of the waste stream in Canada. Ottawa-Carleton’s construction and demolition (C&D) industry generates 24% of the total waste stream, or 160,000 tonnes of waste annually.

As the imperative to change disposal practices becomes more urgent, innovative thinking and new demolition and construction practices are essential for environmental sustainability. Industry must be willing to look at alternatives to standard practices, as it is up to those who manage construction and demolition projects to take responsibility for the reuse and recycling of waste, in order to compete for government contracts and remain competitive in the marketplace.

In cooperation with Canada Mortgage and Housing Corporation (CMHC), Tamarack Developments Corporation, BFI Waste Systems, Goode-X Equipment Ltd., Eco-Mat Inc., and the Regional Municipality of Ottawa Carleton (RMOC), by dEsigN consultants has coordinated a deconstruction project at 1659 Kilborn Avenue, Ottawa, Ontario. The intent of deconstruction is to reuse and recycle as close to 100% as possible of the building materials resulting from demolition. Through planning and a commitment to careful dismantling, the wastes typically generated during demolition can be diverted from landfills and generate revenue.
Deconstruction is not a new concept. Prior to this project, four trial deconstruction projects with a team of 8 qualified volunteers having building/construction knowledge, were conducted with the Ottawa Re-store and by dEsignt consultants. In these cases the deconstruction occurred over a period of two to three days with 10% to 15% of materials salvaged. Materials recovered from these projects included lumber, windows, cupboards, electrical fixtures, hardwood flooring and many other building products. Moderate successes on these projects have led to the belief that a more efficient deconstruction process can be applied to most demolitions.

The 1659 Kibborn Avenue project has shown that deconstruction can provide an environmental benefit and has a positive economic potential to divert C&D waste. The long term goal of this and future deconstruction projects is to create an approved standard of deconstruction processes aimed at guiding contractors within the demolition industry towards more environmentally sustainable and economically viable work practices.

This deconstruction project dismantled three buildings which dated back to the early 19th Century.

1. 4 story house 6,627 sq.ft. (including basements)
2. 2 story barn 2,769 sq.ft.
3. 1 story garage 290 sq.ft. (detached)
   Total cumulative floor area 9,686 sq.ft.

**Project Methodology**

The management of the project consisted of four phases: planning, supervision of work, analysis of results and a deconstruction workshop. The following is an overview of the process.

**Planning**

Developed a set of working drawings (eg. plans, cross sections, etc...) and Materials Assembly List (an accurate description of the materials used for a given assembly such as a wall, floor, roof, etc...) for reference during creation of the Waste Audit; created an initial Waste Audit; conceived a Project Schedule; tendered project with above support documents; reviewed tender submissions and awarded a contract; obtained demolition approval (eg. permit, signing off for capping of services, etc...); and generated public interest through media exposure.


**SUPERVISION OF WORK**

Supervised work on site; monitored and tracked quantities of wasted, reused and recycled materials throughout project; and revised the initial Waste Audit and Materials Assembly List throughout project to accurately reflect nature of home's construction.

Analysis of results; analyzed forecasted targets against project results to identify where improvements can be made on future projects; met with all parties involved in the project to gain input on how the process might have been improved; and assembled a case study report for distribution.

**DESTRUCTION WORKSHOP**

Distributed case study; and, educated C&D industry about deconstruction and current waste management infrastructure.

**WASTE AUDIT**

The initial Waste Audit was based on estimates compiled before deconstruction began. Through site surveys, plans were developed to facilitate the estimate of quantities, in which certain assumptions were made about walls, floors and other assemblies. The Waste Audit was divided into 10 material categories: concrete, metals, wood, thermal & moisture protection, doors & windows, equipment, finishes, furnishings, mechanical, and electrical. Each material is quantified by unit count, lineal dimension (lineal feet), area (square feet), volume (cubic feet), or weight (pound). Within the 10 material categories quantities of waste, reuse and recycle was also tracked. The Waste Audit provided material volume estimates in order to anticipate sorting requirements for reuse, recycling or landfill. As well, it provided contractors (prior to tender submission) an idea of what they might encounter during deconstruction.

Throughout the project the Waste Audit was continually refined to account for certain non-typical material assemblies found during deconstruction. For example, once the ground floor was removed we could accurately measure the thickness of the foundations and the several layers of concrete and stone work.
Table 1: Waste Audit Overview

<table>
<thead>
<tr>
<th>Material Category</th>
<th>Weight (% of total)</th>
<th>Volume (% of total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete</td>
<td>77</td>
<td>34.9</td>
</tr>
<tr>
<td>Wood</td>
<td>11</td>
<td>26.3</td>
</tr>
<tr>
<td>Finishes/Furnishings</td>
<td>4</td>
<td>5.48</td>
</tr>
<tr>
<td>Roof Membrane</td>
<td>2.8</td>
<td>0.7</td>
</tr>
<tr>
<td>Metals</td>
<td>2</td>
<td>0.2</td>
</tr>
<tr>
<td>Insulation</td>
<td>1.43</td>
<td>28.8</td>
</tr>
<tr>
<td>Doors &amp; Windows</td>
<td>0.83</td>
<td>1</td>
</tr>
<tr>
<td>Other Materials</td>
<td>0.94</td>
<td>2.62</td>
</tr>
</tbody>
</table>

To account for the differences in material densities, final waste compositions are represented by both volume and weight. For example, concrete made up 77% of total waste tonnage but only 34.9% of the waste volume. Conversely, wood’s weight was only 11%, but 26.3% of the total volume.

Although it is clear that concrete made up the majority of the project’s waste, it should be understood that the home’s unique construction may lead to the possible misinterpretation of material proportions. Similarly, solid framing in several exterior walls resulted in much higher volumes of wood waste than were originally anticipated.

Deconstruction Methodology

The process is essentially the reverse of construction. With careful attention paid to connections, the buildings were dismantled in a manner which minimized damage to materials, thus maximizing their re-sale and reuse potential.

Deconstruction begins on the roof and proceeds downward towards the foundation. After the windows, doors, finishes and furnishings are salvaged, the roof is removed. Interior partitions are dismantled, followed by exterior walls and the floor system. Depending on the size of the house, the procedure is repeated on subsequent storeys.

The entire project employed six workers who had a general knowledge of construction but limited skills, and almost no deconstruction experience. As the work progressed it became apparent that the constant presence of a competent supervisor was necessary to coordinate disassembly in an efficient and safe manner.
Cost/Benefit Analysis

Overview

Instead of incurring traditional demolition costs, the contractor directed project resources towards alternative work methods. By factoring in revenue from the sale of materials and a reduced amount of hauling and tipping fees, the project budget took on a unique dynamic. The revenue generated from material sales off-set the higher labour costs incurred as result of meticulous dismantling.

Deconstruction

The total cost presented below is not representative of a typical situation. The test house had suffered considerable damage due to vandals and the fire department, who used the house and barn as a test site. Also, there was a learning curve that the demolition contractor had to overcome, due to a lack of experience. Lastly, considerable time and money went into documenting the work which is included in the figures below. For this project, the deconstruction process cost approximately $44,000. However it generated $10,000 in revenue from the sale of reusable materials and resulted in the transport of only 8 bins (30 cubic yards each) to landfill.

Table 2: Comparative Cost Breakdown

<table>
<thead>
<tr>
<th>Deconstruction — Breakdown</th>
<th>Amount</th>
<th>Traditional Demolition — Breakdown</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour</td>
<td>$27,300.00</td>
<td>Labour</td>
<td>$3,050.00</td>
</tr>
<tr>
<td>Licenses &amp; Permits</td>
<td>$400.00</td>
<td>Licenses &amp; Permits</td>
<td>$400.00</td>
</tr>
<tr>
<td>Administration</td>
<td>$5,700.00</td>
<td>Administration</td>
<td>$3700.00</td>
</tr>
<tr>
<td>&amp; Overhead</td>
<td>$1,600.00</td>
<td>&amp; Overhead</td>
<td></td>
</tr>
<tr>
<td>Materials &amp; Supplies</td>
<td>$1,200.00</td>
<td>Materials &amp; Supplies</td>
<td>$800.00</td>
</tr>
<tr>
<td>Equipment</td>
<td>$7,800.00</td>
<td>Equipment</td>
<td>$7,600.00</td>
</tr>
<tr>
<td>Disposal</td>
<td>$10,000.00</td>
<td>Disposal</td>
<td>$12,000.00</td>
</tr>
<tr>
<td>Total Expenses</td>
<td>$34,000.00</td>
<td>Total Expenses</td>
<td>$27,550.00</td>
</tr>
<tr>
<td>Revenues</td>
<td>$10,000.00</td>
<td>Revenues</td>
<td>$550.00</td>
</tr>
<tr>
<td>Net Cost*</td>
<td>$34,000.00</td>
<td>Net Cost</td>
<td>$27,000.00</td>
</tr>
</tbody>
</table>

* The deconstruction cost above includes $5,000.00 of added documentation costs which is not typical. The net cost without documentation costs would be $29,000.00.
The high administration costs are a result of the project's unconventional character. The large work crew coupled with the longer project duration increased the amount of accounting and payroll requirements normally encountered during a demolition project.

This project benefitted the local economy in that six people, with common hand tools, received four weeks of employment. A traditional demolition of this magnitude would employ two ground workers and four equipment operators for four days, and produce an estimated 33 bins (averaging 30 cubic yards each) of wasted materials, at a cost of roughly $27,000.

Revenues Due to Material Sale

Due to the wood's potential for reuse and high market value, it made up the largest portion of material sales. With care taken to avoid damage during the salvage phase, doors, windows, and finishes also proved to be popular re-usable items. It is interesting to note that concrete, which made up the highest portion of the project's waste, generated the least amount of revenue. This revenue came from the sale of patio stones, and a road building contractor's purchase of crushed concrete for aggregate and backfill material.

Table 3: Revenues Breakdown

<table>
<thead>
<tr>
<th>Material Category</th>
<th>% Weight</th>
<th>Revenue</th>
<th>% Revenue</th>
<th>Reuse</th>
<th>Recycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood</td>
<td>11</td>
<td>$5,020.00</td>
<td>50.2</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Doors &amp; Windows</td>
<td>0.83</td>
<td>$1,810.00</td>
<td>18.1</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Finishes</td>
<td>1.5</td>
<td>$800.00</td>
<td>8.0</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Furnishings</td>
<td>2.5</td>
<td>$640.00</td>
<td>6.4</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Metals</td>
<td>2</td>
<td>$520.00</td>
<td>5.2</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Mechanical</td>
<td>0.2</td>
<td>$340.00</td>
<td>3.4</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Insulation</td>
<td>1.43</td>
<td>$320.00</td>
<td>3.2</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Electrical</td>
<td>0.23</td>
<td>$310.00</td>
<td>3.1</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Concrete</td>
<td>77</td>
<td>$240.00</td>
<td>2.4</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Roof Membrane</td>
<td>2.8</td>
<td>$0.00</td>
<td>0.0</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Final Results

Through planning and a tendering process which stressed the importance of responsible waste management, an informed and willing work force were able to divert 91% of the material away from landfill. Of the 91% waste diverted, 60.5% was reused and 30.5% was recycled.
The success of this project, also indicates the vast economic potentials that reuse and recycling can provide. An examination of the final figures indicates the presence of two relationships:

1. Revenue from Material Sales Versus Waste Compositions

Most significant, perhaps, is the fact that concrete made up the largest portion of waste but had the smallest re-sale value. Whereas, doors, windows, and finishes made up small waste percentages and generated relatively large revenues. Further studies and analysis may eventually lead to a standardized framework in which contractors are able to make informed decisions about where to concentrate deconstruction efforts in the event of time or budget restraints.

2. Total Project Revenue Sources Versus Percentages of Reuse and Recycle

Reused materials accounted for 95.5% of the total revenue and 60.5% of the material generated. Recycled materials yielded 4.5% of the project's income and generated 30.5% of the material. It should be noted that the specific return on investment will vary depending on material processing methods.

Project Review

With few projects of this nature to refer to as precedence, it became obvious that the project would be a learning experience for all involved parties. Because of the traditional attitudes prevalent in the demolition industry, it was necessary to stress to the chosen Contractor the importance of reuse and recycling. It was made clear from the beginning that considerable effort would be necessary to maximize the project's potential. Without the Contractor's willingness to learn new systems this project would more than likely have failed.

The proposals submitted by contractors during the tender process were to outline their project approach and include: estimated percentages of waste, schedule, type of tools to be used, and anticipated labour forces. However, the tenders which were received revealed that there is a lack of knowledge in the industry to create proposals and perform this type of work.

Other industry barriers and difficulties which currently face deconstruction include: lack of experience within the C&D industry, market limitations, Contractors' inexperience with the marketing and retail of reusable materials, longer project durations (compared to demolition), site restrictions, and issues of liability.
Conclusions

The successful realization of this deconstruction project has made it clear that sound waste management practices can provide an end-product for which benefits outweigh costs. By committing to the project’s objectives, the Contractor not only reduced the amounts of waste which normally would have been sent to landfill, but managed to offset operating costs by generating revenue from the sale of reusable materials.

For deconstruction to achieve legitimate status within the industry, contractors must realize that the regulations which now surround the C&D industry are not an inevitable hindrance to operations. Rather, efficient waste management and the conservation of building materials can create economical reuse and recycling markets, increase employment, reduce environmental impact, and reduce demolition costs.

Recommendations

To further acknowledge deconstruction as a viable alternative to demolition, the C&D industry must continue to undertake projects which prove the value of this type of work. For change to occur within the industry there must also be public/client demand for processes which are less harmful to the environment. To alter current attitudes, agencies such as the RMOC, the Ministry of Environment and Energy (MOEE) and CMHC must continue to promote (on a regional, provincial and national level respectively) the existence of alternatives. Similarly, those involved in the demolition industry must recognize the trends which demand more environmentally responsible work practices. The market for reusable and recycled materials will begin to grow and sustain itself, once those within the industry make efforts to exploit it.

Vince Catalli is president of by dEsign consultants, a firm which specializes in environmental, energy and waste issues related to the design, construction and building management industries. He has also managed numerous 3Rs compliance projects which demonstrated best practises in construction and demolition waste management. Four recent accomplishments in this field are Hangars 10, 12 and 13 at Uplands Air Force Base Ottawa — a demolition project of 36,500 m2 for National Defence; Ramsayville School in Gloucester — a new
5,000 m² facility for the Carleton Board of Education; Parliament of Canada, Centre Block (basement improvements) — a 1000 m² retrofit for Public Works Government Services Canada (PWGSC); and Revenue Canada, Winnipeg, Manitoba — a 4,000 m² retrofit for PWGSC.

Mr. Catalli is currently researching and developing “Green” Construction Specifications in cooperation with the National Master Specification (NMS), PWGSC. The project will review twenty fundamental sections of NMS, all of which will integrate environmentally responsible approaches. Additionally, the company has recently developed and tested a Non-Hazardous Materials Waste Management specification section for PWGSC. This new specification section is currently being piloted on two PWGSC projects in Ottawa and Winnipeg.
Sustainnovation

Colleen Brown and Joe Caricari
co-founders of Sustainnovation

Our Premise

Sustainnovation is an environmental committee formed and organized by a handful of senior students at Ryerson Polytechnic University. It is the result of a student initiative, designed to address a growing concern by Ryerson’s student body. We concluded that there existed a lack of awareness surrounding issues of sustainability in architecture, not only in our curriculum, but throughout the community in general.

Our Scope

The objective behind Sustainnovation is to raise awareness about, as well as to promote, the implementation of sustainable architecture throughout the community. But it is important to note that our long term intentions do not end there; we believe that a more holistic approach to researching sustainability must be exercised and this includes the opinion that sustainability is ultimately a way of life.

We realize that in order to change any of the accepted attitudes, methodologies and practices which may potentially pose a threat to the survival of future generations on an ecological scale requires traveling down a long, hard road filled with many obstacles that need to be overcome. For this reason, we believe it helpful to us to adopt a very open-minded attitude ourselves in dealing with the ideals of sustainability. Although many of the suggestions behind sustainable design are quite innovative, there are basic concepts, or fundamentals, that we find are essential to our approach in dealing with this important issue.
Our History

This year at Ryerson, a series of lectures was set up to include guest speakers, the majority of whom were architects that showed prominent development in their work with respect to environmental considerations. It was called the Green Architecture Lecture Series and was successful in attracting attention among the architecture students at Ryerson, as well as throughout the community. Lectures of particular interest were delivered by Neil Munro, Richard Williams and William Lishman.

Before the Winter of 1997, there existed no academic course in our curriculum that partially or exclusively handled issues of sustainability. The first signs of interest in this domain was brought about in the fall semester through a collaborative effort between a few students and a faculty member. Many students felt that the topics were of such significance that perhaps they should be included as mandatory aspects of our education here, at Ryerson. Through the guidance and encouragement of certain people knowledgeable in environmental architecture and sustainability in general, we were motivated to organize a committee to meet the needs of students who wished to expand their knowledge in sustainable design.

Our Procedure

The most obvious method of maintaining student interest in sustainability was to continue to have lectures delivered by prominent members of the community who were directly involved in this fast growing field. We thought that organizing the lectures in such a manner that they could be scheduled into an accredited course might not only promote attendance but convey the seriousness of the committee to the students in our pursuits. In addition, the course being elective in nature, we figured that a competition with a monetary award could serve as the focus of the course, thereby attracting even more students. The course was successfully administered in time for the Winter 1997 academic semester.

The formation of a web site to be displayed on the Internet is currently in progress. The course itself is underway and in addition to benefiting from interesting and enlightening guest and resident lecturers, students enrolled in the Sustaininnovation course have enjoyed visits to several sites throughout southern Ontario that have incorporated many of these ideas. Information and resources, most of which is provided by the lecturers, is collected and made available for reference to the students and all members of the community in our Resource Center, located in the Architecture Building.

The design competition consists primarily of the hypothetical renovation of the Architecture Building in which the program currently takes place, as well as its surrounding site. Participants have formed groups of 3 to 5 members ranging from each of the four distinct disciplines offered at Ryerson. The Department of Architecture at Ryerson offers four-year degrees with two common foundation years followed by two years in one of four options, Architecture, Building Science, Project
Management or Landscape Architecture. Independent studies in the final years allow students to follow academic interests of their own choosing, while faculty supervision also on a voluntary basis provides academic credit for the work. Students are expected to apply innovative and sustainable design solutions to meet the changing requirements of students who utilize the building as it exists today. By encouraging interdisciplinary cooperation, we hoped to instill an appreciation of the unique aspects of our program, however only building science and design students are participating in the competition. Simultaneously, with the aid of Charles Middleton, the course's faculty advisor, students will learn about the importance and the sensibility of implementing sustainable ideas into their designs now and in the future. They may also gain the satisfaction of feeling as though they are able to participate and contribute to this escalating matter in our field as well as many others.

The competition includes a number of criteria in which each group will be evaluated. Each group is required to include a working definition of sustainability and demonstrate innovative thought. The solution must indicate practical value for other buildings and provide some form of economic assessment. Another criteria is the inclusion of a ‘living wall’. This portion is included because our department has received a small grant to actually make it happen.

Guest Lecturers to Date: Alex Waters
Ted Kesik
Charles Simon
Bob Sawatski
Martin Leifheber
Jilin Balbaa
Richard Williams
Per Drewes
Doug Pollard

Site Visits:
Body Shop Headquarters
Canada Life building ("Living Wall")
Kortwright Centre
CMHC Healthy House
Y.M.C.A.
Boyne River Education Centre

**Our Views on Sustainability**

In creating a balance between the environment and architecture, it is important to first explain what sustainability means to us. In simple terms it can be defined as providing a high quality of human comfort without compromising the potential of the environment to provide for future generations.

To make our environment more sustainable we must identify a symbiosis. The influential factors of
human design relate mutually with and rely upon the natural world, with expansive and various implications at every scale. As Architects, our design considerations must be expanded to include the recognition of future effects on our environment. Activities that are sustainable come mainly from human characteristics like creativeness, appreciation, communication, movement, and spiritual and intellectual growth.

If we use materials in continuous cycles we can eliminate the concept of waste. Evaluation and optimization of the life-cycle of products and processes is essential. This can easily be done in the practice of Architecture. A progression to sustainability involves a shift from linear to cyclical processes and technologies. The only procedures we can rely on infinitely are cyclical; all linear procedures must come to an end eventually. In following this practice, we will approach the state of natural systems, in which there is no waste. Unless you’re talking about a system in which there is an unlimited amount of resources available, such as with wind and sun power, producing, consuming, and discarding goods in a straight-line method is obviously not sustainable. Our system is closed—what goes “out” eventually must come back “in.”

In practicing sustainability we must study the essential form-generating processes in architecture, integrating a broader search for a scientific theory of the development of form in the natural world. This proposes that the originating force for architectural form is the model of nature. Architecture is considered as a form, susceptible, like the natural world, to principles of genetic coding, duplication and selection. The aim of future architecture is to acquire in the built environment the symbiotic manner and metabolic balance that are typically found in the natural environment.

**Our Future**

As with any committee, we were created out of a need to achieve certain realizations. Ours is simply to promote the execution of environmentally conscious ideas that stem from a sustainable way of life. Sustainability is not just some fashionable trend, nor is it limited to the architectural profession. On the contrary, it affects the well being of everyone and is applicable in almost activity we as members of the human race on this planet, undertake in our daily lives. Its continuing employment is dependent upon increased awareness beginning at the community level (i.e., the generation of sponsored events) and stretching to a more global scale. We hope to see our organization continue and grow, we have already volunteered to set up our program again next year at Ryerson and we would be willing to do so for other schools that are interested. We have already received a lot of support from organizations such as the Ontario Association of Architects. Through collaboration with similar organizations, we hope to help initiate other sustainable design-related organizations. We don’t want to stop here, we would like to address the entire industry and we are open to ideas or suggestions from anyone.

*Colleen and Joe are 4th year Architecture Students at Ryerson Polytechnic University.*
The Emergence of a New Sustainable Vernacular Typology

Terri Meyer Boake, B.E.S., B.Arch., M.Arch.
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The current practice of Sustainable Design encompasses a range of green strategies which include, but are not limited to, passive climactic design, active solar and wind technologies, and a new vocabulary of low embodied energy, renewable and recycled materials. Comprehensive Sustainable design strategies must not only respond to passive climactic 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. This requirement includes differentiation according to a specific bioclimatic region. 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.

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. This, coupled with a new vocabulary of low embodied energy, renewable, and recycled materials, can begin to generate a New Sustainable Vernacular Typology which recognizes environmentally based regional climates and concerns.

Rebuilding The Vernacular

Sustainable Design, in building upon Passive based Vernacular typology and research looks to emu-
late and expand upon successful natural cooling and heating strategies. 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 (from “Design With Climate” by Victor Olgyay, 1963). Bio-climactic regionalism and vernacular practices should also govern conceptual design decisions in Sustainable Developments. Sustainable design extends these issues to include the availability of materials, local technology, population concerns, culture, and environments at risk.

**Ecological Site Strategies**

Much of the viability as well as architectural character of Sustainable Design is derived from the relationship of the building to its site, and the nature of specific site development. Site service requirements are intensive. Area is required to support the collection of solar radiation, make use of wind, and cleanse wastewater. The site size and type required for the creation of a fully self sustaining development exacerbates the problem of designing Sustainable Architecture. This tends to suppress fully sustainable “high urban” development and support the emergence of a Sustainable Vernacular Typology which is more strongly sub-urban and semi-rural.

The sustainable practices of typical bioclimatic regions can be differentiated by local codes and accepted building practices. Codes vary significantly in the acceptability of the re-use of “graywater”, the treatment and subsequent use of “blackwater” and the viability of biological wastewater systems and aquaculture ponds to treat waste water for ultimate reuse on site. Numerous regions only permit the use of “graywater” for irrigation. Rainwater collection systems and cisterns are suitable 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.

Many of the site strategies which 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 Material Nature Of Sustainable Architecture**

Sustainable Architecture uses 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, 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 and 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 which 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 material palette used creates a recognizable type. The Sustainable building 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 familiar cross section of the Passive building type and the presence of solar collectors and PV arrays are also a source of recognition, as is the use of plant material to alter the microclimate.

The materials that are notably NOT used in Sustainable buildings also 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”.

Realizing a New Sustainable Vernacular

The Center for Regenerative Studies, Cal Poly Pomona

Sustainable buildings, in their current experimental state and with the requirement of occupant involvement are well suited as educational facilities. Environmental education facilities have recently been constructed which allow the practice of Sustainable Living to be more broadly experienced by students, educators and other interested parties. The Center for Regenerative Studies at Cal Poly, Pomona, designed by the firm Dougherty and Dougherty in 1993, is one such development. The CRS derives its design from hot climate criteria, using appropriate vernacular and bio-climactic design based Passive and Active Strategies to support Sustainable goals, employs Sustainable materials and methods in the site and building design, and requires the occupants to reassess their lifestyle and relationship to the building functions.
The Center for Regenerative Studies at Cal Poly Pomona exemplifies the concepts and strategies of the Sustainable Typology. 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 and the effective containment of these cycles on the site.

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, meeting/office spaces, exterior and interior connecting walkways and gathering spaces. The primary building design uses passive climactic 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 man made 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

The site employs a series of ponds to cleanse the graywater of the site. The ponds are approximately one meter deep and are stocked with tilapia, who thrive on the algae present in the ponds. The tilapia 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. 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 is a prime indicator of the success of the rich compost and irrigation water produced by the pond.

THE RESIDENCES

The vernacular style of the buildings is remarkably similar to the YMCA Environmental Camp, in Paradise Lake, Ontario designed by Charles Simon. (Another Sustainable Vernacular type devoted to education, published in Ontario Eco-Architecture 1). 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 incorporating 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 which overlook the aquaculture ponds are exposed on all sides, as well as raised on pilottis. 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 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 required the use of low flush toilets rather than the more environmentally efficient composting toilets used at the YMCA Camp.
OCCUPANT INVOLVEMENT

In educating students about Sustainability, the CRS accentuates the vital importance of 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. Typical residents at the CRS participate in the facility for at least one academic year. 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. 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 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 which makes use of the complementary aspects of both Passive and Active Climactic design strategies.

FIVE POINTS TOWARD A SUSTAINABLE VERNACULAR TYPE

It is clear that the ultimate goal of Sustainable architecture is independence and self sufficiency. The new Sustainable Vernacular type may be characterized by architectural design which includes all of the following: 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 a fully Sustainable building must respond to all of 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-climactic demands, regional differences, regional preferences, client and program requirements, and local building authorities.

The full development and understanding of a Sustainable Vernacular Type will not be possible without a deep reexamination of vernacular climactic 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. 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.

*Terri Meyer Boake has been a full time Assistant Professor at the University of Waterloo School of Architecture since 1986, responsible for core curriculum development and teaching in the Technology Theme Area, including Building Construction, Theory, Design and Passive/Sustainable Applications and Principles.*
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