canadian eco-architecture

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Submissions to the
Ontario Association of Architects
Committee On The Environment
Call for papers for Envirofest, June 1998
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The Committee would like to thank all the authors involved with environmental and sustainability issues, sharing their experience and insights and helping to raise the awareness of the possibilities and responsibilities of the profession.

Second only to the farmers, architects use the most resources and have the greatest impact on the natural environment.

As individuals and a profession, architects have a profound responsibility and opportunity to minimize the impact of our activities on the natural environment. Indeed, we have an opportunity to correct past mistakes and heal nature.

As William McDonough, the American eco-architect and educator states: “Sustainability may represent only the delicate line between degradation and enhancement”.

The Committee thanks the authors – and Lynn Screawn and Gary Pask, who coordinated with the authors and made this publication possible.

The Committee would also like to thank Concrete Design for their cooperation and help in providing the graphic design and layout of this publication.
Introduction

Gary Pask, O.A.A.
Member, O.A.A. Committee on the Environment

These essays, together with those in the previous three books in this series, show how understanding and applying the principles of ecology can build and nurture sustainable environments in which we can satisfy our needs and aspirations without diminishing the chances of future generations.

They tap into three billion years of ecological wisdom; they show that our values are the central defining characteristic of our creations, that the shift from the arrogance of a human centred system to the integrity of an earth-centred system not only can be made, but must be made. After all, it is what we care about, our values, which determine what we choose to design, how we design, and in the end, what we build.

Sadly, we've managed to put our own backs against the wall. Fortunately, though, ecology takes no prisoners – whether we like it or not, we're all in this together. Our designs have to be, uncompromisingly, one with ecology. Interdependent and co-operative. Flexible and diverse. Partners.

In addition to ecology and sustainability, underpinning the essays in the book, and the other three, is the belief that life is more than a linear, mechanized series of events and humans are more than machines; that we can soar above competition as a way of life, and above striving for unbridled material progress through economic and technological growth.

Together, the authors point to a way of living, designing and building that is defined by our relationships to one another, to future generations, to the web of life and the cosmos.
Energy and Material Conservation: The Straw Argument


Why Straw?
Pioneers are people who push beyond their traditions in positive directions. They move beyond the old way of thinking and doing, because they have to. Either the old way doesn’t work in the grim new circumstances, or they reach past it for new opportunities. For the environmental movement, straw bale construction is one such opportunity.

There have been many pioneers breaking a path to the production of good energy efficient housing. We hope that we and other innovators in the straw bale construction world can extend that path, further developing the concept of sustainable affordable housing. Doing so, we follow in the footsteps of the original straw bale housing pioneers – the Nebraska homesteaders of 100 years ago.

The provision of affordable housing is increasingly limited by the supply of basic resources. Good materials are becoming less plentiful and less accessible, and material extraction is becoming more costly, energy consuming and polluting. Building production as well as material production becomes more capital intensive and costly as we try to produce more from less.

Even wood frame construction, clearly the most successful system based on renewable fibre, is consuming forest resources at a questionably sustainable rate. The forest product innovators have been responding for decades, to assure sustainability and “value-added” profitability, by getting more house from each tree and indeed from what were once “weed” trees. The innovators have in common the production of “reconstituted” wood fibre components, yielding more from less. But this all comes at a price in terms of energy, money and pollution.

More than 100 years ago, needing good homes quickly and lacking access to lumber, Nebraska homesteaders conceived of using an alternative cellulose fibre. This “waste” fibre was abundant and needed no refinement. Handsome examples of “Nebraska Straw Bale” houses are still in use from those first days. The pioneers stacked bales of straw and let them settle. Then they rendered the walls on the outside with mud or stucco and on the inside with this or gypsum plaster, to form loadbearing exterior walls. Their modern followers still do the same.

The Nebraska pioneers showed us that baled cellulose fibre works in wall construction. The fine thermal performance, resistance to sound transmission, excellent loadbearing capacity and fire resistance of plastered straw bale walls have all been demonstrated in lab and field in both Canada and the United States. This performance is achieved without binders, resins, glues, defibrations, treatments, digestions or pollution. Straw bale construction is a proven complement and some might even say alternative to wood frame construction.
But this is true only to a point: Nebraska straw bale wall construction methodology, for all its simplicity and ability to use an inexpensive “waste” product of grain farming, is not yet ready to produce affordable housing “en masse”. Much of the loadbearing straw bale building process, as now enshrined in the building codes of various American states and counties, is slow and marred by wastes of time and materials. We have looked seriously at these redundancies and have developed a method of building with straw bales that eliminates many of these problems.

The Difficulties
The difficulties we examined are outlined as follows:
1. Attempts to improve stability and safety during straw bale construction include the use of hundreds of saplings or steel rebars as vertical dowels pinning bale to bale. They do not work well. Tertiary and repeated bracing is required to keep planes vertical. And after the stucco skins cure, the saplings or rebar pins have nothing structural to do.

2. Before the skins are applied, a settling period of several weeks is required after the roof loads are on. Alternatively a compression method is needed in order to pre-load the bales to a stable uniform height. Several methods have been developed to compress the bales but these involve the use of heavy top plates and more steel rebar or steel cables, both high embodied energy materials. Waiting several weeks for settlement is very detrimental to the building process and leaves the straw exposed to potential rain damage.
3. A poorly compressed straw bale wall can take great amounts of stucco or plaster to form planar surfaces. It may not be stable enough to accept the impact of modern "shotcrete" methods and hand stuccoing is very labour intensive.

4. The final structural properties of the wall rely very largely on the strength and stiffness of the stucco skins as well as the straw's ability to transfer shear forces and stabilize the skins against buckling under load. Straw bale walls are in fact a sort of stressed skin "structural sandwich" composite. Perhaps unaware of these strengths, many users today throw in wood frame wall trusses, large lumber top plates or concrete ring beams, steel framing angles, and heavy wood lintels over openings. They often create a concrete bunker, with cement stucco thickly applied or slip formed over the surface of the straw. These excessive practices virtually erase the benign environmental impact gained by using straw bales in the first place.

5. Cementitious stucco renderings are prone to shrinkage cracking and other tensile breaks. Fissures will permit the ingress of moisture which in turn will promote the rotting of the straw.

6. Good standard details and building practices which will enable straw bale walls to remain dry and rot free for their entire life span in temperate climates are not readily known, researched or developed.

7. Nebraska straw bale construction and its derivatives can produce only the exterior walls. The outside walls constitute just a small fraction of a building. Limitations in straw bale shear properties and skin tensile characteristics make it generally unsuitable for forming the roof-ceiling, to complete the basic building envelope.

**The System**

We looked long and hard at these issues and came up with a building system that answers many of these difficulties by simply exploiting the essential nature of the wall. A straw bale wall is a structural sandwich that wants to have it's sponge-like core compressed and it's skin reinforcing put into tension in order to take care of shear and racking forces. So this is exactly what we set out to do. We enhance the true nature of the wall by precompressing the bales and tensioning the skins. Simply put, we prestress it.

Prestressing a stacked bale wall is done by means of a strong wire mesh on the opposing faces of the wall. We use galvanized 20 gauge 1 inch hexagonal chicken wire mesh; the same mesh most often used to reinforce stucco coatings against cracking. Alternatively plastic meshes can also be used and are currently being studied.

We have created several tools which grasp the mesh on each face simultaneously. These tools pull the wire mesh upward while an equal force pushes downward on the bale wall. Thus we tension the mesh and equally compress the bales vertically. This compression increases the wall's shear resistance. Together with the tensioned wire mesh, we produce a good composite building structure that does not have to rely on the tensile qualities of the final stucco. This prestressing method also results in an excess of mesh atop the compressed wall. This surplus can then be secured to the roof structure, effecting an ideal tie down to the foundation via an anchored sill plate.

Our system has been tested in labs and in recently built one and two storey houses. Vertical load testing on a stuccoed one story test panel (pre-cracked) showed ¼th of an inch deformation, no set and no distress under a vertical load of 4,500 pounds per foot. This was the absolute limit of our test rig and some 3.7 times the design load for a typical 2 story Canadian house. We could not test it to failure. The test panel was vastly stronger than our testing rig.
We call our system the “Prestressed Nebraska” construction system in honour of the original pioneers who built this way.

The Solutions
Our answers to the difficulties listed earlier are as follows:
1. We rarely use doweling, unless necessary by poor bale quality and then only on the top 3 rows of bales. We use temporary light wood form work framed into the sill plate, and make use of the door and window boxes as part of the bracing system. They also get used as supports for construction tent work. We do not use steel rebar doweling of any kind, no rebar “stapling” of corners or “imbalers” coming up from the concrete foundation. They do not keep the bales from sliding around, only working beside rather than on top of the bale wall does this job. Any doweling used is minimal and done with fast growing coppiced species or bamboo.

2. We compress the bale walls with a material that is already required to be used for its longevity – the wire mesh, thus eliminating a redundancy of materials and creating a fully stable wall very early on in the building process.

With our prestressing tools we can control the amount force that is exerted on the wall for different loading conditions, compressing the straw bale walls under loads which are beyond what they will ever receive.

3. Prestressing the wall creates a very strong structure able to resist the impact of modern shotcrete plastering systems and forms tight planar surfaces for the stucco to adhere to.

4. We use streamlined top plates, window and door lintels, and base wall sill plates. Lumber is kept to a minimum since it is the stucco skins and not the straw and lumber which in the long run take the most of the loads. Wide contact area is necessary between the wire mesh reinforced stucco and the wood transfer members. The tensioned reinforcing mesh of the stucco skins gives a straight planar surface for the stucco to adhere to. A minimal amount of stucco (¼ of an inch) can then be applied for wall strength and weather protection of the bales. The more planar the surface the less stucco is needed to even out the lumps and bumps inherent in many straw bale walls.

Prestressing the wall also eliminates the potential problem of the eventual stress relaxation of the straw under long term load by making sure that the reinforced skins are strong enough to do take all the loads.
5. By prestressing the wall, we pretension the skin reinforcing to the extent that the final skin material will not be subjected to tension even under substantial live loads. This reduces the possibility of cracking and the potential for water damage.

6. Working with Canada Mortgage and Housing Corporation, Agriculture Canada and many others we are researching the parameters of moisture degradation in straw bale walls. We are also working to provide good standard details regarding dampproof courses, moisture egress from the stucco, and protection against wind driven rains.

7. Laboratory structural testing of “Prestressed Nebraska” wall panels showed that they are strong enough to create floors and roofs as well as walls.

The test panels were prestressed with a force of 600 to 700 pounds per linear foot using the wire mesh and then rendered with 3/4 of an inch cement stucco on both sides.

We decided to horizontally load this panel to test it to wind failure. We applied no simultaneous vertical load to the test wall (a worst case scenario) and received great results. We were able to go up to a wind loading of 135 pounds per square foot before we could achieve any cracking in the stucco surface. We continued to load up to 153 pounds per square foot, over 7 times hurricane design load, before creep became apparent. The prestressed sandwich behaved much like a floor structure, not just a vastly over strong wall.

These tests have encouraged us to explore conceptual work on the possibilities of prestressed arched roof ceiling forms to encompass much more of the building envelope.

The full testing report is available from the Canadian Housing Information Centre, operated by CMHC head office in Ottawa, under the title “Developing and proof-testing the Prestressed Nebraska method for improved production of baled fibre housing.”

**How the System Works**

The prestressing can be implemented pneumatically, hydraulically or mechanically. We have created a preferred tool that consists of a long pneumatic tube along with fingered prestresser plates which can prestress and fine level whole walls or sections of houses in minutes.

After the bales have been stacked to the desired height, a wood top plate made of 2 x 3’s and 1/2 inch waferboard or plywood is put in place. If the top plate is underneath the roof (as opposed to the 2nd floor) place a 6 millimetre polyethylene sheet underneath the top plate as a precaution against roof leaks and water damage. Full height door and window “buck’s” are made of 2 x 6’s or 2 x 8’s with a wide boxed lintel that carries the loads from both the interior and exterior stucco skins into the foundation.

An 8 inch diameter pneumatic prestresser tube is laid on the wood top plate. A prefabricated wood prestresser plate (in small sections) with steel “fingers” for grabbing the wire mesh is then placed on top of the long tube to complete the sandwich. Rolls of chicken wire mesh are then stapled to the sill plate and raised up to the prestresser plates and hooked on to its fingers.

Air is blown into the prestresser tube by compressor or hand pump and it is fully inflated in minutes, compressing the bale walls to a maximum of about 5 inches or to the desired wall height. The wall is compressed while the wire mesh is tightly stretched. The mesh is stapled into place where the desired height has been achieved. As with most straw bale walls a perfectly level top plate is still a rare achievement and some final shimming may be necessary before floor joists or roof trusses can go on.
The wire mesh is now fully tensioned and the wall compressed. The wire mesh is permanently fixed to the wood top plate via ¾ inch galvanized staples at 3 inches on centre before the prestresser tube is deflated. After the tube is deflated, the prestresser plates and the tube are removed and taken away for use on the next section of wall. We use both 50 foot and 20 foot lengths of tube for our wall fabrications. The excess wire mesh that is left at the top plate can be cut, wrapped around and stapled to the roof trusses for a superior tie-down connection to the foundation.

The prestresser tube is easily controlled and can load walls to specific limits or compress them to specific heights. The tube is designed to work with low air pressures so that hand pumps can be used in remote locations. The tube is rated to a maximum of 30 pounds per square inch. If we inflate the 8 inch tube with air at a pressure of 15 pounds per square inch and use a 4 inch surface contact width (against the prestresser plates) while creating a 6 inch rise in tube height: we can exert a force of approximately 720 pounds per linear foot of wall. (15 pounds per square inch \times 4 \text{ inches} = 60 \text{ pounds per linear inch} \text{ and } 60 \text{ pounds per linear } \times 12 \text{ inches per foot } = 720 \text{ pounds per linear foot}) Greater loading can be achieved with larger diameter tubes, by doubling up the tube, by re-tightening the wire mesh over the fingers or by increasing the air pressure used.

The super strong wall is now ready to receive floor joists, a second story wall, roof trusses, hand stuccoing or the heavy impact of shotcrete finishing without any significant deflection.

**Positive Impact**

The Prestressed Nebraska system is a truly innovative green technology. It entails no defibration, refinement, resins, or heat. In fact it creates no waste and no pollutants. It uses the whole straw or other waste fibres, mechanically compacted and friction bound, as a complete insulating core of a structural sandwich wall.

It minimizes the amount of construction and finishing materials needed, maximizes the cheap and highly insulative straw, improves insulation quality by compressing out air leak gaps, simplifies the whole construction process and helps keep costs low.

The prestressing system is versatile and can transform almost any baled fibre into a stronger, more stable structure capable of withstanding bending loads. It can transform straw or fibre bales into structural roofs as well as walls.

We have created a truly benign housing construction system suitable for contract builders and developers as well as the individual owner-builder. We can create quality, well insulated, and attractive housing with low cost, renewable, non-toxic, energy efficient, and “waste-stream” type materials and simple production labour techniques.

In short, our prestressing innovation and the advantages it creates depend upon exploiting the structural sandwich composite in a simple but novel way. This new method can extend the influence and viability of straw bale construction as a modern and environmentally benign technology. We are indeed building the straw argument.

Linda Chapman is the principal of Linda Chapman Architect, a sole proprietor practice based in Ottawa, Ontario. She received her Bachelor of Architecture from the University of Toronto in 1983. Upon graduation she apprenticed with several large architectural firms in Toronto and then began private practice in 1991. Her practice has focused on commercial and residential projects with a special emphasis on environmentally friendly materials and sustainable building technologies.

With the assistance of Canada Mortgage and Housing Corporation, Ms Chapman has been involved in field and laboratory testing of straw bale wall construction. Two reports on this research, including structural analysis and migration, have been published and are available from CMHC.

Ms Chapman is one of the leading architectural experts in Canada on straw bale construction and has complete straw bale projects in Ontario, Quebec and Nova Scotia. She lectures regularly on the subject and has been involved in many hands-on workshops and wall raisings.

With Engineer partner Bob Platts, she has formed Fibrehouse Limited, a research and design/build corporation which specializes in various techniques of creating loadbearing straw-bale walls. They continue to research straw and other organic waste fibres for use in construction. They have recently assisted with the development of Internatural Corporation’s “Bioblock” construction blocks made from shredded wood wastes.
A Regionally Adapted System for Assessing Building Performance

Nils K. Larsson, Natural Resources Canada, Ottawa, Canada
Raymond J. Cole, School of Architecture, University of British Columbia, Canada

The testing and labeling of buildings is in its infancy and there is no consensus yet on the range of performance characteristics that should be covered, nor how much rigour needs to be applied in the application of such a system.

However, it is clear that there is increasing interest in some sort of robust and validated system that can provide comprehensive performance assessments of buildings. Further, there is a need for a model that can encompass the wide variety of physical conditions, building traditions and environmental priorities that occur in different countries and in regions within countries. This paper describes the features of a model that has been designed through an international collaborative process to meet these objectives.

The Green Building Challenge Project in Brief
Before getting into details and issues, it will be useful to have a short overview of the project, called Green Building Challenge ’98 (GBC ’98). It should be noted that GBC ’98 consists of two related elements: a two-year process of developing and testing a performance assessment model, called Green Building Assessment Tool (GBA Tool), and an international conference to mark the end of this process. The overall goal of GBC ’98 is to test and demonstrate an improved method for measuring building performance, and then to inform the international community of scientists, designers and builders about the results. The project was initiated by Canada, but is being carried out in partnership with representatives from thirteen other countries.

Specific objectives of GBC ’98 include:
• To develop a second-generation method for assessing building performance, with an emphasis on energy and environmental performance;
• To develop the method through an international and collaborative process;
• To test the system on buildings in each participating country; and
• To report on the results of the process in an international conference.

International projects are always expensive. Why, then, has this ambitious project to develop an environmental performance assessment system been launched, especially when several systems already exist?

There are several reasons, but the one most relevant to this paper is the nature and limitations of the existing first generation environmental performance assessment systems. We will provide a quick overview of only three of these in this paper.
**Existing Performance Assessment Systems**

**BREEM**
The first and most widely known is the Building Research Establishment Environmental Assessment System (BREEM) (1), which is jointly operated by the Building Research Establishment (BRE) and a private firm, ECD Ltd. The BREEM system has now been adopted in a number of countries and is reportedly used to assess some 15% to 20% of new office buildings in England.

**BEPAC**
Another first-generation system is the Building Environmental Performance Assessment Criteria (BEPAC) system (2), developed at the School of Architecture, University of British Columbia. The developers had the advantage of having BREEM as a prior model, and the result is that BEPAC is more detailed and comprehensive than the first BREEM variants, although BEPAC is limited to office buildings.

**LEED**
The U.S. Green Building Council (USGBC) funded by NIST, has launched a system designed specifically for use as a green labelling system for rating the performance of commercial office buildings. The system (3), known as Leadership in Energy and Environmental Design (LEED), is very simple in its structure in that all criteria are placed at the same level of importance. However, the criteria in the system are linked to a series of existing performance standards established by other credible bodies, which is an asset. Also, an elaborate management system has been established to implement it and several major industrial suppliers are strong backers, which give the system a significant chance for widespread adoption in the U.S.A.

**DESIGN LIMITATIONS OF EXISTING SYSTEMS**
Although the BREEM, BEPAC and LEED systems are all ground-breaking initiatives, there are some factors which are likely to limit their widespread application, including their difficulty in handling different levels of detail in assessments, and the difficulties resulting from attempts to use them as design guideline instruments. For the purpose of this paper, however, the most relevant problem is the difficulty encountered in adapting these systems for use in different regions and countries.

For example, although we can compensate for climatic differences in analyzing the energy performance of office building in Zurich with one in Toronto, it would be misleading to directly compare the normalized results, since large differences in energy costs underlie a large number of decisions made by the owners and designers with respect to systems used and levels of performance sought.
Regional differences are not confined to energy costs and climate. The European building tradition places greater emphasis on daylighting and access to operable windows, which make the deep floor plates typical of North American practice unacceptable there. Can we therefore meaningfully compare the inherently more energy-efficient shapes of North American office buildings with their European counterparts?

Even cultural differences come into play. Office workers in Japan and Europe are more willing to accept short-term deviations from a thermal comfort envelope than are their North American counterparts, and this can have major implications for the designed capacity of heating or cooling systems.

In summary, our view is that regional differences are of such significance that meaningful performance assessments must take them into account from the outset. This results in the use of locally-valid benchmarks of performance, so that an assessment is more a reflection of improvement within the region rather than the production of a set of results that can be compared across countries or continents. The trade-off is that some information relevant to international performance benchmarks may be lost, but at least one can be sure of the validity of the regionally-based results.

In the GBC '98 assessment framework, an attempt is being made to develop a system that addresses these requirements.

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**The GBC '98 Development Process and Framework Structure**

The process being followed in the development of GBC '98 can best be described as an international partnership. Canada took the lead, but the other thirteen participating countries are making substantial staff and financial contributions, and have a decisive influence on the development of the system through their participation in the International Framework Committee (IFC), the committee that contains representation from all participating National teams.

The design of the framework began in the summer of 1996 and underwent several iterations in its design, based on extensive feedback from the IFC. At the time of writing the framework and software, called GBTool, has been completed and national teams are in the process of testing the system in their own countries.

The GBTool is designed to be modifiable by national teams, based on their interpretation of applicability to local conditions. It includes the following elements:

- Parameters descend in generality from Performance Categories to Criteria and, at the most detailed level, Sub-Criteria;
• a scoring system has been established that ranges from -2 to +5, with the 0 (zero) level being the reference level;
• the performance level required to achieve a certain score is based on the 0 (zero) level being the locally relevant reference or industry norm level; a -2 is significantly inferior and a +5 is set so that is extremely difficult to reach;
• each parameter contains written statements related to each relevant score so that assessors can relate the actual performance to the nearest relevant statement, and National Teams can modify these statements within limits;
• weighting is possible at both the sub-criterion and criterion level, again modifiable by National Teams;
• criteria and sub-criteria can be declared critical at the option of National Teams, and failure to meet a critical level can disqualify the subject building;
• versions of the system are being prepared for each of three major building categories, including office buildings, multi-unit residential buildings and schools. These were selected by the IFC as representing some of the most generic building types extant, thereby maximizing the value of international comparisons; and
• the GBA Tool is being implemented in the form of two distinct software modules: a Green Building Input (GBI) module, and a Green Building Assessment (GBA) module. These modules are being developed within a user-friendly database program. Conceptually, the system is relatively simple, although both modules include some calculation fields. The software system is also intended to facilitate the work of National Teams in specifying the characteristics of hypothetical reference buildings to serve as benchmarks, and in modifying scoring statements and weighting values.

The completed framework covers issues that are given in-depth assessments down to the level of sub-criteria. These include four Resource Consumption categories, four Environmental Loadings categories and five categories relating to Quality of the Indoor Environment. Other sections deal with Longevity, Process and Contextual Factors, which are assessed only at an upper (Criterion) level. The current organization reflects the view of the IFC that in a process with limited time and resources, there is a need to focus the detailed assessments on factors that are most germane to the goals of the process, e.g. resource consumption, environmental loadings and health/comfort issues.

**Future Applications**

The presentation of the results of this ambitious process at the GBC '98 conference in October 1998, should be not be viewed as an end-point. We may be closer to achieving consensus on what factors collectively constitute excellence in environmental performance, but it is likely that much further work will be necessary to position the system as an implementable system in the industry. Given this, it is likely that the process will continue and that a GBC 2000 conference will take place in another country.
In addition, work will begin this fall to extend the system so that it can serve as a related guideline system for building designers and developers. The GBTool could be pressed into service for this purpose, but to make it a fully effective guideline system many specific recommendations will have to be prepared that relate to each assessment parameter.

Given that there is need and potential demand for an assessment system, how could such a system be launched? Existing systems such as BREEAM, BEPAC and LEED were developed to serve the specific requirements of the context in which they are used and have invariably been tempered by the necessity to meet the compromise of stake-holders and the practicalities of implementation. Each of these methods will continue to evolve and mature. The GBC '98 assessment framework will offer new assessment methodologies for them to consider and, if they so desire, to use.

However, if a consensus emerges that the system provides a substantial improvement over current systems, there may be a desire to implement GBC '98 or GBC 2000 as a complete stand-alone system for commercial building performance assessment. If this occurs, there are a number of desirable organizational features that should be considered:

- the body that develops and continues to improve the system should establish links with one or more recognized standards bodies;
- agencies that implement the system should be quite separate from the development agency;
- the development agency should be in a position to certify that implementing agencies are “100% pure GBTool” in terms of their system structure, procedures and staff training requirements; and
- the high cost of developing hypothetical reference buildings to serve as benchmarks will have to be reduced; possibly by developing a library of off-the-shelf stock reference buildings or benchmarks based on archetypes of common building types and forms.

Conclusions

The development of the core GBTool is now complete, but it will only be possible to evaluate success or failure after national teams have gone through the process of adapting it to their own conditions and have tested it on several projects each. Considering the effort, resources and collective expertise of the sponsoring countries that is going into its development, however, it is likely to at least make a substantial contribution to the state-of-the-art.
Acknowledgments

The technical coordinator for the GBC '98 process is Nils Larsson. Natural Resources Canada, principal technical consultant is Dr. Raymond Cole of the School of Architecture, University of British Columbia, and the software has been developed primarily by Woytek Kujawski of Iniplo Consulting Ltd. The following individuals lead their respective national teams and have also greatly contributed to the development of the GBC '98 framework:

Iilari Aho, Finland
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Chiel Boornstra, Netherlands
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Jorn Dinesen, Denmark
Philippe Duchene-Marullaz, France
Sverre Fesstad, Norway
Susanne Geisler, Austria
Mauritz Glaumann, Sweden
Werner Hässig, Switzerland
Nobuyuki Kimita, BCS team, Japan
Gail Lindsey, USA
Günter Löhnhart, Germany
Aleksander Panek, Poland
Michiyo Suzuki, IBEC team, Japan

References


Nils Larsson is an architect with experience in both the residential and commercial building sectors. Mr. Larsson is Program Manager for CANMET’s C-2000 Program for Advanced Commercial Buildings, which has resulted in the design and construction of several state-of-the-art commercial buildings across Canada. He is also the main organizer of Green Building Challenge '96, an international project to develop new methods of assessing the environmental performance of buildings. He is a founding member of the Green Building Information Council, is coordinator of the DB W-100 international committee on Environmental Assessment of Buildings and is founder and editor of the Advanced Building Newsletter.

Ray Cole teaches at the School of Architecture, University of British Columbia. He is a prolific researcher, writer, and consultant on sustainability.
Environmental Wood Specification

The number of projects requiring environmentally appropriate specification, and the level of performance expected is increasing steadily. Environmental knowledge is rapidly becoming an essential element of good practice and a competitive advantage.

Specifying environmentally appropriate wood and related products is not as easy as it might seem, and is just the first step of the process. The recent proliferation of claims and standards have not made it any easier to specify appropriately.

Furthermore not all wood products will have associated standards which practitioners can use to judge their environmentally appropriateness. Approved species are not necessarily application or site appropriate and every species and project have their own unique environmental and performance characteristics. Wood is not an end product, it is part of a system such as a floating floor with many components which must work together.

As a professional involved in the planning, design and construction of environmentally appropriate projects it is helpful to know what certification systems are in place, their strengths and weaknesses, and what shade of green they are. This paper will not go into depth on this particular subject area but simply update the previous Eco-Architecture paper on wood certification (Steven Sims, Canadian Eco-Architecture, 1996).

Finally, once you have specified the product, ensuring it conforms to the claims made by supplier and certification bodies is not as straightforward as it seems. There are simple questions and guidelines that can help make the process easier, quicker and less daunting, both for you and your client.

This session then, will cover environmentally appropriate products, labels and certification systems, and a set of simplified guiding principles to help you apply them effectively in the field.

Since the early 1990’s we have seen the proliferation of various certification initiatives. At the time, certification was seen as a promising initiative for sustainable forestry. Today, certification is quick becoming an enduring reality in the forest products industry. Most significant with respect to the Canadian forest industry are the certification systems of the Forest Stewardship Council (FSC) and the Canadian Standards Organization (CSA).

The CSA has adapted the International Standards Organization (ISO) environmental management standards to the Canadian forest industry. Its approach is largely consistent with the ISO’s 14000 series of standards dealing with environmental management systems.
Notably different in its approach, The FSC approach focuses on on-the-ground forestry practices. Founded in 1993, the FSC is an internationally recognized organization established by interests from the scientific community, environmental organizations, foresters, timber traders, certification organizations and indigenous groups.

The table below sets out the major differences between the systems. While there is extensive debate within the industry and from observers, and much written on the strengths and weaknesses of both systems, we have chosen to package the debate specifically for the purposes of those involved in the specification of wood products. For more detailed information we have included at the end of this paper, a list of additional reading and organizations involved in certification.

<table>
<thead>
<tr>
<th>Standards Organization</th>
<th>CSA</th>
<th>FSC</th>
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<tbody>
<tr>
<td>Goal</td>
<td>Continuous Improvement</td>
<td>Excellent forestry performance</td>
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<tr>
<td>Focus</td>
<td>Management Systems</td>
<td>Management systems and on-the-ground practices</td>
</tr>
<tr>
<td>Organizational Sponsor(s)</td>
<td>Private companies</td>
<td>NGO's, private companies, foundations</td>
</tr>
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<td>Product Label</td>
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<td>Yes</td>
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<td>Third-party certifiers</td>
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<tr>
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</tr>
<tr>
<td>Key</td>
<td>CSA: Canadian Standards Organization</td>
<td>FSC: Forest Stewardship Council</td>
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adapted from Vol. 8(1) of "Understory" the Journal of the Certified Forest Products Council

For the most part, available literature focuses on the debates between proponents of either major model and the strengths and weakness of the principles and processes behind each. A previous Eco-Architecture paper on wood certification (Steven Sims, Canadian Eco-Architecture, 1996) provided an overview of the CSA and FSC systems.

A few key factors summarized in the above table bear particular relevance for professionals involved in environmentally appropriate projects.
While we are not intending to promote a particular certification process, experience leads us to believe that a few factors inherent in the two main certification systems, make FSC certification more attractive to architects, planners and designers.

1. Management systems vs. On-the-ground practices — While the CSA process assesses the adequacy of the candidates forest management planning process, FSC certification measures both management systems and actual-on-the-ground practices. As such, the CSA standards are not directly related to any qualitative characteristics of an actual product and cannot be used in product labeling.

2. Product labeling — Unlike the CSA process, FSC certification is meant to serve as a product labeling system. A key element of FSC certification is the provision of a “chain of custody” process, designed to ensure a system is in place to track certified wood from the forest, through each stage of distribution to the point of sale. Chain-of-Custody certified companies are required to adhere to a minimum set of procedures which ensure that certified wood is kept separate from non-certified wood during production and distribution streams. CSA does not require the tracking of products from certified forest lands and is not an eco-labeling system.

Similar are voluntary codes of conduct such as the American Forest and Paper Associations “Sustainable Forestry Initiative”. As essentially, a self-declaration to a set of principles, such programs do not qualify as third-party certification and are only meant to declare a company’s commitment to a set of standards. It is important to note that while such “certification” (the CSA process as well) is intended to communicate “good corporate practices” it should not be confused as actual declarations for product.

If a forest products company claims they are CSA/ISO certified (or European Eco-Management Auditing System, EMAS, the European equivalent) you cannot be sure that the actual product you purchase was harvested in a sustainable manner. Since no chain of custody process exists, there is no link between products sold by a CSA registered company and their management systems.

3. Auditor accreditation — Because the CSA does not accredit certifiers their self, monitoring the advertising claims of forest companies (a task which falls to certifiers) is made more difficult. The FSC system of certification is based on the monitoring and accreditation of certifiers. The FSC requires accredited certifiers to obtain a contractual agreement with certified companies controlling the ways in which the FSC and FSC accredited certifiers trademark and certificate are used in all forms of advertising and promotion. Companies are monitored and those misrepresenting their situation or product are more apt to be disciplined. A documented case does exist where the FSC removed a companies certification the accredited certifier publicly sanctioned and made to undertake corrective measures in its certification procedures.

Perhaps the most difficult task for specifiers of certified wood is in making the distinction between advertised claims and actual environmental merit. While marketing claims (whether in the form of advertising or certification certificates) may enable forest products companies to claim the moral high ground, and prove persuasive in the marketplace, the actual product may be highly questionable in terms of its impact on forest ecology and forest-based economies (communities).

Obtaining even a basic knowledge of certification systems is a start, however once a decision is made to use certified wood, difficulties may still arise. Anecdotal evidence exists to suggest misrepresentation of “certified” product can occur and that a degree of diligence (though not onerous) is required on the part of architects and designers.
The following set of general principles will serve as a useful tool to simplify the process of incorporating certified wood products into projects. Experience suggests that with even a cursory knowledge of certification and due diligence (as in any business practice), the use of certified wood can quickly and easily become customary practice for any project.

**Guiding Principles**

1. Pay attention to the type of certification in use – make note of the above descriptions and ensure that the client is aware of what they are getting when certification claims are made by forestry companies, manufacturers or distributors of wood products.

2. Be specific in the writing of your specifications. If the commitment exists on the part of your client, specifying wood certified by an FSC-accredited certifier will ensure you stand a better chance of getting wood from well-managed forests. In North America the two most prominent FSC-accredited certifiers are Scientific Certification Systems and SmartWood (a program of the Rainforest Alliance). General specification language might read: *General specifications for Certified Forest Products.*

   a) All wood products available in the Canadian market shall come from third-party certified “well managed” forests. Documentation for each source shall be submitted to the Architect for approval prior to fabrication. The Architect may reject wood projects for which acceptable documentation is not submitted.

   b) “Well-managed” shall mean forestry practices which maintain the ecological health of forests. These practices seek to conserve (and in some instances restore) biological diversity, to protect water bodies from soil erosion and sedimentation, and to minimize damages to the forest when harvesting while operating within a socially responsible framework.

   c) The certifying body must be endorsed by the Forest Stewardship Council (FSC). Acceptable FSC endorsed certifiers with their programs in parenthesis shall be:

   - *Rainforest Alliance, USA (SmartWood Program)*
   - *Scientific Certification Systems, USA (Forest Conservation Program)*
   - *SGS Forestry, UK (Qualifor)*
   - *Soil Association (Woodmark)*
   - *SKAL, The Netherlands*

   d) Copies of all invoices for certified wood products purchased for this project must be submitted to the Architect.

3. During the bid process, ensure that all shop drawings specify certified wood.

4. If you are purchasing a manufactured product, ensure that the producer (e.g., cabinet maker, millworker) is chain-of-custody certified.

5. Be certain that you receive their chain-of-custody registration number on all paperwork (quotes, invoices, bills of lading). Inspect the wood to ensure tags specifying certified wood are attached. Be aware that you may have to police the process somewhat; ensure that the suppliers you’re dealing with submit the proper documentation.
References
Marcello Levy
Forest Stewardship Council - Canadian Initiative
Tel: 416.778.5568 Fax: 416.778.0044
Email: fssc@fsc.ca
Canadian Sustainable Forestry Certification Coalition
http://www.sfms.com
American Forest & Paper Association
Tel: 202.463.2700

Footnote

Ed Lowans is an environmental design and health consultant. He advises clients on the use of advanced design elements, investigates problem buildings and works on building science, product, LCA and industrial Ecology research and development projects.

Mr. Lowans frequently speaks on environmental health, building science and advanced design topics.

He has consulted on over 1500 buildings of all sizes, around the world, and has just completed a project comparing building investigation programs for the 1998 Green Building Conference.

Mr. Lowans is the author or co-author of “The Clean Air Guide”, “Building Materials for the Hypersensitive”, “Environmental Building Materials and Methods” and numerous journal articles.
Simple and elegant, subtle and extremely powerful, the sun promises a world of clean and abundant energy. Solar is the first of few energy forms that are truly sustainable, but it remains outside of the range of common energy options considered by western society. After a brief period of popularity in the late 1970’s the solar energy industry has struggled to maintain a public presence as an option for electrical power and heating. This paper will briefly review some of the reasons for the decline, and discuss why revisiting solar as a major contributor to building energy systems is relevant now. It will present a primer on solar resource fundamentals.

Although solar domestic water heating was used in North America in the 1890’s, the energy crisis of the mid 1970’s gave rise to the first big wave of North American solar design. From the beginning, solar energy was more than just the provision of electrons or units of heat. In the US, some saw solar as another chance for leadership in advanced technologies. Many more saw solar as an opportunity to escape the clutches of multinational energy corporations. The latter “conservationist” groups carried the public profile of the movement while the former did all of the technical research.

Thus the 1970’s North American solar movement was split between groups operating from within the subsidized cultures of the aerospace and defense industries, and conservationist groups who wanted to use distributed solar power as lever for other ideas about democracy, self sufficiency and community economic development. This political split was mirrored in the solar technologies the groups promoted: technophiles for active thermal systems and photovoltaic electricity (PV); and conservationists for passive solar design (allowing small water heating systems and PV). The two rarely spoke outside of acrimonious debates over government funding. This split prevented the development of a coherent voice for the industry capable of competing with lobbyists for the nuclear and oil industries.

In Canada, solar research did not lead to manufacturing of solar equipment. Much of the solar research went on under the umbrella of building science or mechanical engineering for heating and cooling buildings. Research into properties of thermal transmission, passive solar techniques, building envelope tightness and appropriate levels of insulation prepared the context for equipment imported from the US or site built by daring contractors. In the early 1990’s this research culminated in two small federal government programs, the Advanced Houses Program and the C-2000 Program for advanced Commercial Buildings, setting the stage for a return to solar design.

The critiques of the energy establishment, demonstrating the political nature of supposedly “rational” decisions on energy policy, delivered by conservationist renewable energy advocates established a socio-theoretical underpinning for the use of solar and other renewable energy
technologies. The 1970's concerns of resource scarcity have since been shown to have been overstated, but the economic and socio-political analysis is still (even increasingly) valid in the current age of transnational corporations and globalization.

While the social theory was solid, at the equipment level, the same thoroughness was not present. Technology intensive electricity generating equipment like Stirling engines, solar concentrators, and “power towers” never produced the kinds of paybacks desired. Active thermal systems for domestic hot water or steam preheat systems, delivered a lot of energy but required considerable maintenance while remaining secondary energy sources. The exception has been photovoltaic electricity where there was enough interest to sustain development through early, marginally productive stages. The simplicity, robustness and long term reliability of photovoltaic electricity generation has done much to counterbalance its initial expense and low rate of energy conversion.

The technical immaturity of solar thermal energy systems was in many ways a reflection of the lack of subtlety in the understanding of building energy requirements. Without a systemic understanding of building performance, a precise knowledge of what was required to satisfy environmental needs was impossible and the inter-relation between systems (landscape, envelope, mechanical, electrical) was not apparent. Of course, there always were buildings that were well lit without electricity, cheaper to heat, and cooled by breezes in the summer, but they relied more on the skills of the individual designer or builder and the activities of the occupants, than a generalized knowledge.

Never the less, the promise of freedom from electric and oil monopolies was a powerful stimulus leading designers to search far and wide for concepts and solutions. Looking “far and wide” introduced additional problems for the applications of solar technology.

Historically, Canadian energy costs have been significantly less, with better service, than in the US. Similarly, European comparisons are misleading due to almost double energy costs in the best case on the other side of the Atlantic. When assessed in isolation, Canadian renewable energy technologies have to produce on lower margins, or use longer payback periods than comparable US or European installations to remain competitive with conventional energy arrangements. Regardless of the problems raised by economic analysis of the true costs of our energy supplies, this “design in isolation” is the root of considerable difficulty.

Another problem was “resource confusion” where concerns with equipment efficiency took precedence over the understanding of the local solar resource. This problem manifested itself in a number of different, and sometimes simultaneous ways. One manifestation was the attempt to adopt solar technologies from locations with a much different solar resource. Not even the best Canadian solar locations, southern Alberta and Saskatchewan, have the same sun as Arizona (let alone North Africa).
Trombe walls, the French Mediterranean design of glass faced massive concrete, or water drum collectors, have never in Canada, captured enough heat to make a difference. Roof pond systems likewise, have never saved enough energy to pay back the extra structural and roofing costs. In the case of Trombe walls and roof ponds, the issue is solar exposure time. For wall surfaces, the solar exposure is only long enough to heat solid masonry to a depth of between 50 and 75 millimetres. For horizontal surfaces the received energy is higher but similar. Consequently, large thermal mass systems under Canadian conditions work as heat sinks, and only marginally as re-radiators.

The worst example of “resource confusion” is what American writer Ray Reece called “making solar in the image of nuclear power.” This is a reference to projects involving solar concentration and superheating used to boil water to drive turbine generators producing electricity. Hectares of parabolic mirrors focus sun energy on a central tower temporarily storing the energy in the form of molten salt. This type of technology has been applied with limited success in southern California and central Spain. It is an absurdity to suggest the same approaches for Canadian conditions.

To understand the character of the solar resource one turns to climatic data from Environment Canada. For the City of Toronto, one may review Figure 1, a presentation of the average daily solar energy received over the twelve months of the year, with an indication of yearly averages. The fine line “ghost zones” around each curve represent the standard deviation from the mean. Unlike a gallon of gas or chord of wood, sun energy is variable day by day and best understood statistically.

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**Figure 1:** Variations from solar (due) south to the east or west by up to 15° will normally decrease the total energy output of the array by no more than 5%.
From the chart one will see that walls receive averaged sun energy in a range between 2.3 and 3.8 kW/square metre depending on orientation. Similarly roof surfaces receive between 3.5 and 4.0 kW/square metre on average, depending on tilt and orientation. One will notice that by using supplemental electricity or heat in November, these averages can be improved significantly.

Notice also the difference between curve A which gets the highest peak, and curve D which provides the most energy through the “off seasons” of Spring, Winter and Fall. Curve D is the “classic” position for optimizing energy gain in a heating dominated (winter) climate. Most importantly, keep in mind the ranges of energy received.

By remembering the appropriate resource range, technophilic versions of “resource confusion” can be avoided. This becomes a significant issue when one reviews the ratios at which solar energy equipment can convert sunlight to a usable domestic form. Commercially available PV cells convert sunlight to electricity at rates of between 5% and 15%. Active solar thermal systems like domestic hot water heaters convert between 50% and 70% of the energy received, and solar ventilation air heating can convert up to 80%. The unused portion is lost as waste heat in the equipment.

At this point it is useful to check how much power one will need. For electrical equipment this can be easily added up as was demonstrated by Dextor Edwards in “Canadian Eco-Architecture 3.” An honest list of this sort may surprise one by the small amount of power that is used for lights and equipment. Although power is measured in kilowatt hours, amperage is what delivers the force and also how battery banks are sized. Kilowatt hours divided by system voltage give amp hours.

For space heating one first has to know what one needs to balance heat lost through the envelope. For quick assessment purposes, all that is really necessary is a “back of the envelope” type calculation. From the 1997 ASHRAE fundamentals:
Heat transfer = U-value x assembly area x (inside temp. - outside temp.)

For example, 1990 OBC insulation values in a weighted average of all windows, walls, floors and roofs for a 100 m2 raised cabin having 15% window to wall ratio and a plan aspect ratio of 2:1, produce an overall RSI value of 4.52 or a thermal transmittance coefficient (U value) of 0.22. If the inside temperature is kept at 21°C when outside temperature is -18°C (Toronto 2.5% winter design temperature), the energy used would be:
\[0.22 \text{ W/m}^2\text{C} \times 304 \text{ m}^2 \times (21 - (-18))\text{C} = 2608 \text{ W}\]

Thus to keep the cabin at the 21°C for 24 hours would take the equivalent of 62.6 kWhrs of energy (213,000 Bu•hrs). Looking back at the sun resource figures for January one would expect a south facing roof mounted collector to get slightly over 3 kW/square metre of energy from the sun in the same 24 hour period. To supply this need with a solar water heater feeding a radiant floor system converting sunlight at 50%, one would need almost 42 m2 of collector area, in addition to a cistern sized insulated storage tank.

Clearly the designer is faced with a challenge. However the analysis is also overly simplistic. If one knows the orientation of the cabin and the solar gain it receives, and the landscaping which determines the microclimate around the house, one might discover a number of situations that mitigate the severity of the calculated demand. If the heat loss was neutralized during 8 hours of the day by a good passive solar strategy the energy required for the same 24 hours would be two thirds of the original demand. If the cabin were also insulated to Advanced Houses levels and used high performance windows (overall U value = 0.14) the energy use would be less than half of the first calculation (42% or 26.6 kWhrs).

By employing passive solar load reduction techniques, high levels (by conventional standards) of insulation, and load calculations that acknowledge the linkages between environmental and building systems one can see that required energy can be reduced to levels that allow a significant
contribution from renewable energy sources. Indeed, as was suggested by the presentation from Greg Allen at the 1997 OAA Envirotech entitled “The Furnaceless House,” energy efficient passive solar design could provide a baseline shell which would be self sustaining and only require a tiny amount of “imported” energy, to keep temperatures in the comfort zone.

Let us check this assertion by looking at the history of solar energy use in Canada. To find successful and long lasting solar energy projects, one moves away from large scale technology intensive projects to rural and remote household systems. Interestingly, these projects still operating as designed in the 1970’s, perhaps with improvements over time, are in the regions with some of the lowest solar resources of Canada, namely the BC coast and Nova Scotia.

Toronto’s daily sunshine, averaged over the year, is 3.44 peak hours per day. This is not to suggest that Toronto gets little sun, but that it receives daily solar radiation equivalent to 3.44 hours at an energy intensity of 1 kW/square metre. By comparison, Vancouver gets 3.14, Halifax gets 3.38, and Winnipeg gets 4.02 peak hours. This would suggest that Toronto has an workably large solar resource.

Why then, is it not in use? One answer would be that the heating requirements of mild coastal climates can be more easily satisfied by solar means than other locations. Higher electricity prices in the east coast keep Nova Scotia’s passive solar community active, and rugged terrain with difficult access to grid wires promote alternative energy in British Columbia. Winnipeg already makes use of passive solar, but a significantly harsher climate than Toronto’s needs the passive solar supplement to keep costs of conventional systems acceptable. These observations suggest that by demand reduction through higher insulation, better natural lighting, and building form or orientation that improves solar reception, solar energy can play a significant role in heating and powering buildings in Toronto.

Additional societal issues are combining to reinforce the value of a return to solar design. The drastic reductions in fossil fuel consumption required to effect the commitments Canada made at the UN Conference on Climate Change in Kyoto, are perhaps the most pressing. Growth in the understanding of the interrelation of systems in high performance building provides a better starting point for solar applications. Deregulation of the electricity system and the concept of “distributed generation” are creating new opportunities for buildings that produce more power than they need. Finally, solar energy equipment is becoming incorporated into national standards, and promoted by existing energy companies, allowing a more consumer oriented approach to solar power and making market acceptance easier.

The economic benefits of local, employment producing, renewable energy and energy efficiency projects, have been cogently stated by the likes of “soft path” energy guru Amory Lovins, and economist Hazel Henderson since the mid 1970’s. Their voices have now been joined by researchers in the field of industrial ecology, and business writers such as Paul Hawken, who wish to see industrial processes developed to resemble natural ecosystems where one organization’s waste is another’s feedstock. In this environment of “closed resource loops,” the only energy inputs that do not use up “resource capital” are inputs from renewable energy.

Applying this type of thinking to buildings suggests we have a long way to go to build in a truly sustainable fashion. Moving buildings away from strict dependency on purchased energy through demand reduction and replacement of purchased energy with solar energy one moves closer to the goal of environmental balance.
Stephen Pope is Principal of an architectural practice concerned with green building and sustainable energy, where low energy demand buildings are offered as both the most efficient way of delivering high quality living environments, and the best expression of the unique characteristics of the particular place and program.

He is Chair of the Editorial Committee of the Ontario Associations of Architects’ "Perspectives" magazine, and contributes to the Royal Architectural Institute of Canada newsmagazine "Update." He is currently on contract with Natural Resources Canada providing technical and administrative support for the development of the whole building energy simulation software supporting the Model National Energy Code for Buildings, and for modifications to the ATHENA environmental impact analysis software.

Mr. Pope serves as President of the Solar Energy Society of Canada Inc. on whose behalf he has authored comments on various Federal Government policy initiatives in the areas of sustainable energy and buildings.
Concrete Thinking Needed to Protect Environment

Cameron C. Ridsdale, O.A.A., F.R.A.I.C., R.I.B.A.

In this era of heightened environmental sensitivity, the Architect's role in shaping the future of construction has never been more vital. Architectural associations worldwide have struck committees, task forces and working groups all aimed at ensuring this profession's role in environmental and energy-related issues is a responsible one. They have agreed that one of the most important areas of responsibility is in specifying building products.

Striking a balance
The best measure of a product's environmental impact is its "sustainability" — satisfying our current demands without compromising the needs of future generations. Concrete measures up well in this regard. It strikes a perfect balance between meeting today's needs and natural resources for tomorrow.

Concrete is the most widely used construction material in the world. In Canada, we use about 10 Kg per person per day. Concrete's global appeal is not accidental — the ubiquitous, stone-like material is produced from some of the world's most abundant resources, as is its key ingredient, cement. Concrete's appeal also lies in its physical properties — durability, visual appeal and design flexibility. It is practically inert, contains no toxic components and gives off no emissions. Concrete won't burn and offers significant acoustic resistance. It can take on virtually any colour, texture or shape imaginable.

Energy efficient production
Cement manufacturing involves grinding selected raw materials and heating them to more than 1400°C in a rotating kiln to produce clinker, which is later ground with a small percentage of gypsum to produce Portland cement. Almost 88% of the energy used is fuel to fire the kiln. The balance is electricity for grinding, rotating the kiln, moving materials and cleaning exhaust gases.

While the production of cement is energy intensive, its end product, concrete, usually contains only 9-13% cement. In fact, concrete's other major components — aggregates and water — make its production energy efficient because they are naturally occurring, low energy materials. Energy for transportation is low because concrete is produced locally. Materials for making concrete are available in abundance almost everywhere. Most concrete is made within 100 miles of the job site.

Figure 1 shows the "Energy intensity required to produce some construction materials in Canada (1975-1985)". It was derived from Environmental Auditing for Building Construction' by R. J. Cole and D. Rousseau, UBC School of Architecture. Dr. Cole defines energy intensity as the energy used to produce a unit quantity of material and the embodied energy of a component, assembly or structure as the amount of energy to produce and install the constituent materials and components of a building. The energy intensity of concrete is among the lowest of commonly
used building materials; but, materials should more properly be compared in the context of specific applications where, due to its long life, low maintenance requirements and low embodied energy concrete also displays an enviably low life cycle cost.

![Figure 1: Energy intensity to produce some construction material in Canada (1975-1985)](image)

**Environmental Life Cycle Costs**

The increased durability of high performance concrete cuts maintenance and repair expenses and can reduce initial construction costs too. On our highways, reduced maintenance saves construction energy and results in fewer lane closures which decreases user costs including fuel consumption. The use of high performance concrete bridge decks with normal steel reinforcement instead of epoxy coated steel, waterproofing and asphalt surfacing shrinks embodied energy significantly while saving construction costs.

Concrete applications are also energy efficient. For example, the thermal mass of concrete and concrete masonry can provide draft-free comfort in well-designed, well-insulated dwellings. By employing passive solar techniques, the need for electric or fuel fired heat sources can be practically eliminated as heat from the day is stored in the dense concrete materials and re-radiated at night. This thermal mass effect provides energy benefits year round by reducing temperature swings in homes and buildings.
Concrete also contributes to energy efficiency in transportation. American studies show a 20% decrease in fuel consumption for tractor-trailer trucks travelling on a concrete pavement vs asphalt. In addition to this direct energy saving, skid resistance and improved visibility help reduce accidents and the energy cost of vehicle repairs.

The use of concrete for roads and parking lots helps keep cities cooler reduces cooling loads and thus reduces carbon dioxide emissions from energy production. Combined with tree planting and painting roofs white, this strategy could reduce energy consumption for heating by 10 percent and for cooling by 30 to 40 percent in Toronto.5

**Low environmental impact**

Every building material consumes resources and is consequently a source of stress on the environment. The environmental impact of cement production is relatively low. The raw materials, limestone, silica and clay, are virtually inexhaustible. Quarrying generally takes place away from residential areas using recommended procedures to minimize dust from blasting and crushing and to control silting of ground water.

Emissions from the kiln are largely nitrogen, carbon dioxide, from the combustion of fuels and the calcination of limestone, water vapour and particulate from the ground raw materials. About 50 percent of the CO₂ is from the decarbonization of limestone. Only about 1% of the total carbon dioxide (CO₂) emissions from energy-related sources in Canada come from fuel used by the cement industry. An equal amount is released from the limestone.3 Canada and the USA together produce only about 6% of the world cement supply. Nearly 40 percent is produced in China, India and the former Soviet Union where environmental standards are much less restrictive.

During the past twenty years, energy consumption per tonne of product has been reduced nearly 25%.4 For environmental and economic reasons, the industry continues to seek improvements by replacing outdated equipment with new more efficient technology. Current research suggests that the introduction of low-cost catalysts could reduce fuel requirements and increase production by as much as 20 percent. Computers have helped cement manufacturers to improve the consistency and quality of cement; they also enable ready-mix plants to batch concrete mixes more accurately so that a tonne of cement can go much farther today than it did in the past.

**Applying the three "R"s**

Although concrete is already a low-energy, low CO₂ material, there are opportunities to further improve its environmental effectiveness. To this end, the industry has explored several avenues to reduce, reuse and recycle.

**REDUCE**

The partial replacement of portland cement in concrete by fly ash or ground granulated blast-furnace slag, by-products of coal-fired electrical generating plants and the steel industry respectively, is now an accepted practice. Work on quality control of these supplementary cementing materials, and the design of appropriate mixes has produced good results. Intergrinding limestone with cement clinker and gypsum is another method of reducing emissions without affecting the finished cement quality. It is also possible to replace natural gypsum, which requires energy to mine and calcine, with synthetic gypsum produced as a by-product of the removal of sulphur dioxide (SO₂), from stack gases in coal burning facilities.

Waste-derived fuels such as spent solvents, used oils, tires and other high energy content industrial, commercial and biomass wastes can replace a significant portion of the coal or natural gas used as cement kiln fuel. Currently, 60 percent of Canadian cement plants are burning wastes as a supplemental fuel.4 In 1995, 6.8% of all fuel used, was derived from waste; the industry continues to evaluate broader application of this practice. For many years Ontario, and some other provinces, did not allow tires or municipal waste to be burned in cement kilns.
Tests show that the high temperature, turbulence and long residence times in cement kilns completely destroy organic wastes and bind metals and other inorganics into the clinker with little change in emissions. The use of such substitute fuels benefits the environment by reducing both consumption of fossil fuels and landfill requirements as well as eliminating the CO₂ and fuel energy needed to incinerate certain hazardous wastes. The alkaline condition in cement kilns neutralizes acid gases from the burning of hazardous waste and acts a natural scrubber for the exhaust. Emissions are minimized because the ash or unburned residue is incorporated into the cement clinker in an inert, harmless form.

Some potential also exists for co-generation of electricity using waste heat from the cement making process. Current Canadian electrical rates make this option uneconomic.

Research into low-carbonate materials from which cement can be manufactured is currently underway in France and at the Portland Cement Association's Construction Technology Laboratories. Using potash or other source rocks, the production of geopolymeric cements requires only 10-20% of the energy and releases about 10-20% of the CO₂ required to produce an equivalent amount of portland cement from lime-stone. A cement based on this technology is currently available, as a premium product, from one American producer. Its rapid strength development makes it attractive for runway and high traffic road repairs.

Opportunities to reduce energy consumption also extend to concrete applications. For example, the use of High Performance Concrete (HPC), to produce thinner columns, longer beam/slab spans and a faster form work turnaround can reduce construction energy. Quebec saved five percent in construction costs on the bridges it built in 1993 using HPC. And, they will last longer and cost less to maintain. With care and expertise, specialty concretes can now be prepared to resist deterioration for long periods in the most harsh environments.

The principal characteristics of HPC — high strength, low permeability, less volume change and significantly higher stiffness than regular concrete — give it increased durability. These properties are derived in part from the use of silica fume — another industrial by-product. Such concretes may have a higher embodied energy because they contain up to fifteen percent portland cement and some admixtures. But, this is more than offset by reduced maintenance and longer life. At the other extreme, the use of supplementary cementing materials derived from the wastes of other industries can limit the total embodied energy in concrete by reducing portland cement content to as little as seven percent.

**REUSE**

Many concrete products can be reused. Concrete pavers, lifted for underground repairs, are regularly put back where they were. Precast wall panels can be reused when buildings are expanded. Concrete sidewalk slabs are reused to build “dry stone” retaining walls and often concrete pieces from demolished structures are reused to protect shorelines. The ready-mixed concrete industry reuses rinse water from truck drums. And, if a part load of concrete is returned to the plant, chemicals can be added to stop cement hydration so the material can be used even a few days later.

Using concrete minimizes construction waste. Cast-in-place and precast concrete are used only as needed. Whatever amount is left over can be totally reused or reclaimed and reused as aggregate in new concrete.

**RECYCLE**

The industry continues to explore options to recycle both cement and concrete. Cement kiln dust (CKD) is being used to help maintain soil fertility. The high concentration of calcium carbonates in CKD restores soil pH, acidified by fertilizers, while providing nutrients in the form of potassium and sulphur. In another application, CKD mixed with sewage sludge is being spread over mine tailings in Sudbury to neutralize metal sulphides and prevent ground water pollution. In
Kirkland Lake, cyanide rich gold mine tailings are being pumped into the mine as structural back-fill after being stabilized with portland cement. The use of portland cement for solidification/stabilization of waste is increasing in Ontario. In another example in Trenton, "leachate toxic" sludge containing heavy metals like barium and zinc has been converted to an environmentally secure solid at about one fifth the cost of other alternatives.

Concrete can be recycled as granular fill, as base course for pavement or as aggregate for new concrete. Control of particle size in crushing and removal of contaminants from other demolition materials is required. At present, this is easiest in road construction, where new concrete can include up to 100% recycled course aggregate and recycled fines can replace 10-15% virgin sand. At its 20-acre Lakeshore Village project in Etobicoke, the Daniels Group demolished an old multi-storey concrete framed tire plant and crushed 100,000 m$^3$ of concrete on site for use as pipe bedding and backfill.

Concrete health benefits

Concrete’s near inert qualities are ideal as a low-toxic building material. In the AIA material, nearly all concrete applications are rated as “generally low-toxic”. By contrast, products with coatings, sealants, chemical treatments or resins can lead to off-gassing. Especially vulnerable are manufactured wood products: laminates, particle board, hardboard siding and treated wood.

Building for a new age...today
As environmental concerns remain at the forefront of Canadians' minds, so too must they remain a priority with those directly involved with the manufacture and use of building materials. For the cement and concrete industries, this means continuing to seek new ways of reducing the impact of their products on the environment. For professionals who choose building materials, it means making informed decisions by assessing the environmental and energy benefits certain products have over others. In this respect, concrete has a clear advantage. It is an environmentally sound material, which, in the hands of sensitive and expert professionals, produces attractive and long-lasting structures that support and enhance our society while preserving precious resources for future generations.

1. "Environmental Auditing for Building Construction", by R.J. Cole and D. Rousseau, School of Architecture, UBC.
2. "Effect of Pavement Surface Type on Fuel Consumption", by Dr. John F. Zaniewski, PCA publication no. SR289.01P.
5. Centre for Building Sciences at Lawrence Berkeley Laboratory, California, study by Dr. Arthur Rosenfeld.

Choose it or lose it
(The Selection of Environmental Construction Materials)

Keith Robertson, M.Arch.

Abstract
Selecting construction materials based on their environmental impact can be a daunting task. One has to wade through manufacturers' claims, Material Safety Data Sheets, scientific and technical research. Often information is contradictory, exaggerated, vague, or too technical to be easily understood.

This paper will assist a specifier, designer or builder in doing a simple comparative assessment of the environmental impact of construction materials. With that knowledge, a more appropriate selection of materials can be made. This comparative assessment will look at material selection based on a number of environmental and health issues. It also allows criteria to be adjusted to suit specific project goals.

Environmental Impact
It is unnecessary to discuss in detail why environmental issues are important. A few key words can bring the point home: destruction of habitat, ozone depletion, greenhouse effect, increase in skin cancer, asthma and other respiratory ailments, loss of species, loss of resources such as old growth forests.

Our material choices affect the environment in many ways. I have broken these into three major categories: Energy, Resources, and Health. In the discussion of these topics, it will become apparent that all three issues are intertwined. While they are all important, some are in direct conflict with others, so priorities must be established by the designer/specifier.

Energy. All materials consume energy. The generation of electricity has a significant impact on human and environmental health. The combustion of fossil fuels, whether for transportation, heat, or for electricity, produces carbon dioxide, nitrogen oxides, and sulfur dioxide emissions. These gases contribute to global warming and acid rain. Natural habitat is destroyed from strip mining coal and oil pollution.

Despite strong assurances about safety, there are risks associated with nuclear power. We still don't know what to do with the spent nuclear fuels. The nuclear plant at Point LePraeu N.B. has undergone costly repairs over recent years. The cost of importing power when the plant is down is approximately $500,000 per day. It has been estimated that New Brunswick paid over thirty million dollars in the first quarter of 1997 due to repairs and down time of this plant.1

Even though hydroelectric power is often considered a green power source, issues such as loss of habitat, obstruction of migratory fish passages, production of methane, and the release of heavy metals raise questions to the appropriateness of this power source.
There are better ways to produce power: photovoltaics, passive and active solar technologies, wind power, co-generation, and geothermal to name a few.

*Resources.* One of the biggest issues with resources is whether or not they are renewable. A major distinction must be defined between “renewable” resources and “non-renewable” resources. This relates to a time-frame that is relevant to human use. Thus, petro-chemical products, even though renewable over a long time period, are considered to be non-renewable for our purposes. The concept of “sustainability” embodies the idea of meeting present needs without compromising the ability of future generations to meet their own needs. The consumption of non-renewable resources cannot be considered sustainable behaviour.

We must also bear in mind that there is a tremendous resource of materials that is stored in our existing built structures. We should treat already-created materials, products, and systems as precious commodities. Our tradition of demolishing built structures is the least responsible way to deal with this resource.

*Health.* The materials we use affect us at various levels, from indoor air quality (IAQ) to water sources to smog, particulate pollution, and UV radiation. Health and materials have had considerable coverage in the research industry, and many publications are available that discuss health aspects of construction materials.

**Environmental Assessment**

The environmental impact of materials is complex. Different requirements of individual projects dictate that priorities must be established in order to select the materials most appropriate for a specific project. For instance, a house for a person with environmental sensitivity will have different requirements and priorities than a commercial tenant fit-up for a five-year lease.

The following list briefly describes each of the criteria used in this assessment method, and gives some simple examples of issues to consider.

**Energy**

a) *Embodied Energy*

Embodied energy is usually defined as the amount of energy required to take a material from raw resources to a finished product. This energy has enormous implications for the environment because of the pollutants that result directly from energy production. It can be difficult to compare materials based on this alone. For example, even though concrete has a relatively low embodied energy, the mass of concrete used in the construction of a building makes it a significant material. Reinforcing steel can double the embodied energy of the concrete construction.
b) TRANSPORTATION
A certain portion of transportation is often part of the embodied energy figures. Many embodied energy calculations consider transportation only to the first point of inventory. This assessment method considers transportation from the first point of inventory to its final use.

c) DURABILITY
Durable materials are better choices environmentally. Durability and maintenance of materials should be based on the appropriateness for the life of the building. A material that lasts longer may ultimately use less energy even if it is initially an energy intensive product.

d) ENERGY SAVINGS
Some materials will save energy over the life of a project. Obvious examples are concrete used as a thermal mass, and insulations.

Resources
a) RENEWABLE
Renewable resources are good choices for materials. If properly managed, wood can be a renewable resource, however, in most areas it is currently harvested at a rate that exceeds reforestation.

b) ABUNDANT AND AVAILABLE
Many non-renewable materials are abundant and available resources. The raw resources for concrete are virtually unlimited around the world. The raw resources for steel are reasonably abundant but some estimates say that they may run out in the next 200 years. Avoid using materials that are from limited resources.

c) RECYCLED CONTENT
Recycling is becoming increasingly important because of resource depletion and problems with waste disposal. Steel is one of the easiest materials to recycle. Producing recycled steel requires less than one quarter of the energy for new steel. Approximately 30% of steel is currently being recycled. There is potential for greater use of waste wood in recycling or as an energy source.

d) REUSE/RECYCLABILITY
Re-use is environmentally responsible. By re-using a material or product you essentially cut its environmental life-cycle cost in half. Concrete is almost impossible to reuse except as aggregate or fill material. Wood can often be reused with careful disassembly. Steel generally requires the least effort to re-use.

e) WASTE
Waste is a major construction problem. The suitability of steel to prefabrication means that there is very little waste on site. Traditional wood construction has substantial waste in production and construction. The packaging of products also contributes to waste at the construction site.

Health and Environment
a) EMISSIONS IN USE
Volatile emissions occur in the production and in the use of materials. In use, natural wood is considered to be a healthy material but it can cause problems for people with acute hypersensitivity. Steel and concrete have virtually no emissions in use except those associated with finishes and concrete additives.

b) EMISSIONS IN PRODUCTION
In production, steel emits toxic waste from the coking process, water contaminants from the steel mill, and a wide range of stack emissions. Similarly, concrete emits gases and dust from the cement kiln.
c) MAINTENANCE
Maintenance has a direct impact on occupant health and energy required during the life of a product. It also has implications with waste, pollution and resources. For example, a high maintenance floor finish will increase IAQ emissions, resource use, and embodied energy for maintenance materials.

d) ECOLOGICAL IMPACTS
During the production of all materials there are various other negative impacts that do not fit within the categories discussed above. Consider climate change brought about by emissions of greenhouse gases. Consider the emission of CFC's, ozone depletion, and the resulting increase in ultraviolet radiation. Consider the loss of tropical and temperate forests, the altering and polluting of water bodies, the land destruction through extraction of resources, and the resulting loss of habitat and species. Consider oil and other chemical spills, the leaching of chemicals from materials and the resulting soil pollution. These issues need to be part of the decision making process.

As you can see, the issues are complex and priorities must be given to certain aspects in order to make an appropriate decision.

Things to watch out for
Products are available that reduce the environmental impact of construction. When looking at product reviews, also consider the source of the information. Claims are often biased in favour of specific products, or may emphasize certain aspects and overlook others. For example, "environmentally friendly" claims may deal with: health (might be energy intensive), natural (might not be healthy), recyclability (might be high maintenance), reduced solvent content (might be non-renewable), re-usable (might not be healthy, recyclable, or resourceful). Sometimes you will be hard-pressed to see why a material might be claimed to be environmentally-friendly. Be aware of the source of the information when looking at environmental claims.

Environmental Assessment of Materials
If we had a single comparative environmental rating system (such as the Energuide ratings for electrical consumption), material selection would be much simpler. Some standards do exist (Blue Angel, Green Seal, Green eclipse, Eco-logo, Ecomark), but due to the complexity of the impacts, most are difficult to implement and often indicate conformance to a minimum standard. Some manufacturers are unwilling spend the money and effort of certifying a material only to have it lumped together with materials that are not as good but also meet the standards.

There are resources available that have researched the impact of construction materials. Generally they are generic in nature and do not deal with regional issues. The results of any assessment method are only as good as the information known by the user. Even if information is at hand, decisions can be difficult. How can you choose, for example, between renewable wood-framed wall or recycled steel framed wall? The decision may rest on the priorities of the designer, i.e. which is more important, renewable resources, or recycled content. A method of weighting the criteria becomes an important feature of any assessment method.

Fig. 1 indicates a method of assessing materials based on the criteria discussed above, as well as a system of weighting that allows the criteria to be prioritized. This method is somewhat subjective in that it will be hard to get precise data for all of the materials. Judgment calls will have to be made for some of the criteria. (As you use the criteria you will begin to understand why it is so difficult to achieve a standard rating system).

Materials are rated from 1 to 4 for all known criteria (higher ranking indicates less environmental impact). Information that is unavailable can be left out. The rating in each category can be based on precise data, if available, or on personal experience (i.e. Product A may seem to have less odour than product B, or Product D was more durable than Product A in a previous project.)
The weighting "Factor" in Fig. 1 is based on priorities appropriate for the project and as established by the designer or client. A project for people with environmental sensitivity would have higher factors in the Health categories. A temporary project may place a higher factor on Energy and Resource categories and lower factors on Durability and Maintenance.

Figure 1: Example of comparative assessment method for flooring products.

<table>
<thead>
<tr>
<th>Notes</th>
<th>Criteria</th>
<th>PRODUCT RATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENERGY</td>
<td></td>
<td>Factor</td>
</tr>
<tr>
<td>1=high 4=low</td>
<td>embodied energy</td>
<td>3</td>
</tr>
<tr>
<td>1=outside North America 2=Western Canada/USA 3=Eastern Canada/NE USA 4=Atlantic Region</td>
<td>transportation</td>
<td>2</td>
</tr>
<tr>
<td>1=low</td>
<td>durability</td>
<td>3</td>
</tr>
<tr>
<td>0=none 4=high</td>
<td>energy savings</td>
<td>1</td>
</tr>
<tr>
<td>RESOURCES</td>
<td></td>
<td>renewable</td>
</tr>
<tr>
<td>1=non-renewable 4=renewable</td>
<td>recycled content</td>
<td>2</td>
</tr>
<tr>
<td>1=sparse 4=abundant</td>
<td>abundant &amp; available</td>
<td>2</td>
</tr>
<tr>
<td>1=high 4=low</td>
<td>recycled content</td>
<td>2</td>
</tr>
<tr>
<td>1=high 4=low</td>
<td>recyclable/reusable</td>
<td>2</td>
</tr>
<tr>
<td>1=high 4=low</td>
<td>waste</td>
<td>1</td>
</tr>
<tr>
<td>HEALTH/HAZARDS</td>
<td>emissions in use</td>
<td>3</td>
</tr>
<tr>
<td>1=high 4=low</td>
<td>maintenance</td>
<td>2</td>
</tr>
<tr>
<td>1=high 4=low</td>
<td>emissions in installation</td>
<td>1</td>
</tr>
<tr>
<td>1=high 4=low</td>
<td>emissions in production</td>
<td>1</td>
</tr>
<tr>
<td>1=high 4=low</td>
<td>ecological impacts</td>
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</tr>
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<td>Unfactored Total</td>
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<td>29</td>
</tr>
<tr>
<td>Factored Total</td>
<td></td>
<td>56</td>
</tr>
</tbody>
</table>

The factored total for each product is the sum of a material's rating for each criteria multiplied by the factor for each criteria. The higher the factored total is, the more appropriate the material is for the intended application. It is important to realize that different priorities can significantly affect the relative scoring of products.
Final considerations:

- Look at the biggest materials first. If health is the priority, focus on materials with the greatest indoor surface area such as paints and flooring. If resource use or energy is the priority, focus on massive materials such as foundations and structure.
- Reduce the amount of material first, then choose the material most appropriate for the life of the building.
- Natural is not necessarily healthy.
- In addition to the environmental aspects, the material must also be appropriate for the function. Carpet in your bathroom? Rubber in your living room?
- Cost cannot be overlooked, but I have not considered it as part of the environmental assessment of a material. Cost is rarely, if ever, an indicator of renewability, energy or health aspects of a product. It is, however, one of the limiting factors that we all have to deal with.

Summary

A major problem in the construction industry is that the people making the material selections have little time to invest in assessing a material’s environmental impact. Life cycle assessments are often impractical to perform. It is difficult and time consuming to keep up-to-date with current research and new materials.

This method provides the decision-maker with a simple system that allows her/him to compare materials based on the information that is known. The method can be informative even when only a few of the criteria are used. It is hoped that the simplicity of this method will allow a greater number of decision-makers to make more appropriate material selections.

References


Footnotes


After receiving a diploma in Architectural Engineering Technology in 1981, Keith Robertson worked for seven years as an Architectural Technologist on a variety of commercial and institutional projects.

In 1989 Keith enrolled in the faculty of Architecture at the Technical University of Nova Scotia. In his undergraduate and graduate studies he has been involved in extensive research on the environmental impact and health impact of construction and materials. In his experience as an intern Architect, Keith has worked on a variety of institutional and residential projects. Keith has continued to gain experience in Indoor Air Quality issues and the environmental aspects of construction.
Straw Bale Building

Ross Kembar, O.A.A.

A Brief History
People have used straw to build their homes since grain was first harvested. It is an abundant and renewable material which was easy to work.

Straw bales were first used before the turn of the century in Nebraska after the baler was invented. Farmers turned to straw because there were no trees locally available for building material. They would pile the bales directly on the ground and stack them the same as bricks. The walls were plastered with river mud and clay. Some of these buildings are still occupied today despite the lack of a foundation under many.

Straw bale building gradually slipped into disuse when wood became available as transportation systems improved. Straw bale building began its revival in the mid 1980's through the efforts of Matts Myhrman and Judy Knox in Arizona. There is no doubt that they have had by far the greatest impact in the rebirth of this very practical and efficient method of building.

During the last ten years, straw bale structures have been built in most States in the U.S. They estimate there will be 2,000 straw bale homes built in North America this year. Some states now have specific sections in their building codes pertaining to straw bale homes. It is only a matter of time before straw bale is accepted in all jurisdictions as a "conventional" method of construction.

In Canada there are straw bale homes in many provinces. Most of these homes have been built in the last three years. The straw bale house pictured has been built during the past two years by Patti and myself near Lakefield, Ontario. The house has gone through the full permit approval process in Smith Township and has satisfied all construction’s regulatory bodies. The house is covered by conventional home owners insurance.

Why Build a Straw Bale Home?
The difference between building a straw bale and a wood frame house is that you replace the exterior 2x6 stud wall and insulation with straw bales. All other components of your house are the same. This one difference however, will account for the list of benefits below. The material price for both systems is approximately the same.

Super Insulated
Straw bales homes have an insulation rating of R-45 as compared to the nominal R-20 value of 2x6 wood frame houses. A straw bale home will cut your heating costs in half and preclude the need for any air conditioning because of its super-insulating qualities.
You will save money during constructions as you can install a smaller heat source than in a wood frame house and there is no need to install an air conditioner. We were originally going to install radiant floor heat at a cost of $9,000.00, but changed our minds when the little wood stove we had installed was heating the entire 2,500 square foot house during construction over the winter.

**Simplicity**

The simplicity of building with straw makes it an ideal method to use if you want to get sweat equity in your home. Organizing a volunteer house raising and performing a few of the less skill-intensive tasks can easily reduce total costs by 10%. A high degree of owner involvement can result in cost savings of 30-50%. The more work you do, the more money you save.

**Fire Rating**

Fire testing done by the National Research Council has shown straw bale homes to withstand fire rating criteria twice as long as conventional wood frame houses. There is not enough air in the bales for combustion.

**Strength**

Compression testing (load bearing capacity) showed straw bale walls capable of withstanding twice the load levels of 2x6 wood frame construction.

**Save Trees**

Using straw bales in your exterior walls will save about 20 mature trees from being cut. In other words, about 3,000,000 trees have to be cut down to build the exterior walls of the 150,000 or so homes built in Canada each year.

All provinces with large forestry sectors have had to drastically reduce their cutting limits in the last few years because of logging practices of the past. The use of wood in house construction is a good material to use for roof trusses, floor assemblies and several other components; however, straw bale exterior structural walls are a viable alternative to wood.

It has been estimated that some trees will remove up to 40,000 pounds of pollutants out of the air during the course of their natural lives. The twenty trees you save by building with straw could remove about 800,000 pounds.
Using Waste Material
It is estimated that there are 200,000,000 tons of straw produced in North America every year. If you baled this amount in 50 pound bales three feet long, you could build a wall around the entire planet 210 feet high or build 20 million 1,500 square foot straw bale bungalows every year. Our house walls used 4.5 acres (450 bales) and our roof insulation used 300 bales.

Until recently, most of the straw produced was burnt in the field or ploughed under. Burning was outlawed in most areas because of the pollution hazard and the number of traffic accidents the smoke was causing. The worst accident occurred in 1988 when poor visibility caused by field burning resulted in seven deaths and thirty-seven injuries in one prairie state.

Ecological concerns should not be the only determining factor in making your decision as to the construction method you choose. However, if a superior home can be built at a lower initial cost, with substantial residual cost savings, it is an option you should consider. The fact that you are conserving our wood resource, cleaning our air and using a product that would otherwise be wasted is a pleasant bonus. Let’s do what we can do personally to stop sucking the life out of this planet.

Quietness
Once all the noise and activity of construction have subsided, you will probably find your straw bale home to be the quietest home you have ever been in. The thickness and sound absorption qualities of the walls prevent all but the loudest external sounds from being heard indoors. This is ideal near a road or a source of industrial noise.

Using Local Material
Straw is produced near most populated areas of this country. You are able to save money on transportation costs and the money you spend on material stays in the local economy.

Income for Farmers
As we previously stated, many farmers currently leave straw in the field as there is no market for it. The profit margin on their grain crops would improve substantially if they could get another $100-$200 per acre from the straw.

Farmers could see a large increase in the demand for straw as it is being developed into other products besides houses. There are currently companies making wall panels and paper from straw as well. It is important that the farmers co-operate with these potential markets, especially in their infancy.

The farmers should consider straw bales for their farm building needs as they can literally grow their own buildings.

Less Job Site Waste
Unlike wood frame construction, there is very little waste building with straw. All the loose straw and the odd broken bale are used to stuff the cracks between the bales and around openings. You are not paying money for waste material, nor are you having to pay to dump the waste.

Benefit to Volunteers
A house raising is an opportunity for your friends and family to get a first hand education in the skills they will need to build their own home.
Acknowledgments

Max Myrman and Judy Knox of "Out on Bale", 1037 East Linden Street, Tuscon, Arizona, 85719 and their periodical, "The Last Straw", still being published at P.O. Box 42000, Tuscon, Arizona, 85733-2000.

The 300 page book "The Straw Bale House" by Athena and Bill Steen. David Beinbridge with David Eisenberg, currently distributed in Canada by Janis Krawis, OAA, 38 Cedarbank Crescent, Toronto.

Clark Sanders (he started us off), Box 549, East Meredith, New York, 13757.

Linda Chapman, OAA, 27 Third Avenue, Ottawa, Ontario K1S 2J5.

As an architect for the past 30 years, my practice has lead me to different areas of the world. This has given me an appreciation of the use of locally found materials and building techniques. My work has included teaching at the University of British Columbia, a private practice in St. Lucia, a partnership with Birmingham and Wood in Vancouver and since 1983, my current practice in central Ontario.

Five years ago, I learned of the potential of straw bales as an alternative, sustainable structural building material. This was initiated in the late 80's by groups in Arizona and other western states. Two years ago I built our present home using straw as its structure.

Last year I published a 40 page booklet on the process of building with straw and by July 1, 1998, a professional video of 22 minutes will be available on the building process I went through.
New Home of Mountain Equipment Co-op

Dan Cowling, B.E.S., B.Arch.

Mission statement

Mountain Equipment Co-op is a member owned and directed retail consumer co-operative which provides products and services for self-propelled wilderness oriented recreational activities, such as hiking and mountaineering, at the lowest reasonable price in an informative, helpful and environmentally responsible manner.

The challenge was to design a retail environment in an urban location that evoked the rugged nature of the members' pursuits and actively made material and system 'choices' which, while fulfilling the need for consumption of goods, sustained and preserved the resources on which the members rely for their adventures.

The majority of retail buildings are market driven and make only the minimum required effort towards efficient building envelope and systems. The proposed new home of Mountain Equipment Co-op exceeds the minimum as prescribed by the ASHRAE 90.1 Standard by over 37%. Capital cost concerns have for the most part been set aside in favour of life cycle costing and environmentally responsible 'choices'. This is realized in the systems' materials' life expectancy, their inherent recycled and/or sustainability characteristics and a guiding responsible attitude toward the global imperatives facing today's society.

The building consists of approximately 4,600 m² of retail space on two levels. The new home of Mountain Equipment Co-op opened in March of this year.

the urban siting of the proposed new building for Mountain Equipment Co-op makes efficient use of land and is accessible by foot, bicycle and public transit.

Located at the northeast corner of King Street West and Charlotte Street in downtown Toronto, the building is an infill structure of occupying an existing parking lot to the full extent of the allowable building footprint on the site. The building is within walking distance of the financial core, Skydome, Air Canada Centre, the theatre district, the waterfront, the shops of Queen Street West and other attractions. The site is on the King streetcar line, one block from the new Spadina Light Rapid Transit and is a short distance from the Via Rail and GO commuter stations located at Union Station.

typical wall sections were developed to minimize the use of material and the energy used to produce that material.

The typical cavity wall used concrete block as both the backup to the masonry veneer and as the finish material for the inside wall surface. The R-value of the typical wall section was developed using an oversized masonry tie that increases the cavity space to 125 mm, allowing 88 mm of
cavity insulation to be used. This section design exceeds the prescriptive ASHRAE 90.1 criteria by approximately 60%. The typical insulation used in both the walls and the roof utilizes a high recycled content and, hence, a low energy consumption ratio for the R-value provided.

Finishing of interior surfaces was virtually eliminated by exposing raw systems materials and, where required, incorporating recycled and/or ecologo products.

Some concrete floors are exposed and finished with a waterborne acrylic sealer. Poured concrete and concrete block walls are typically exposed and finished with a latex based paint as the finished wall surface. The poured concrete structure was left exposed and finished with a light sandblast finish and a waterborne acrylic sealer. The underside of the second floor slab is exposed as the ground floor finished ceiling and was painted white with a latex based paint to achieve maximum light reflectance. The steel roof structure is exposed unfinished and unprimed as the second floor finished ceiling. The exterior wood structure of the canopy on King Street West is exposed and finished with an ecologo clear protective sealer. The interior wood structure of the skylight on the second floor is exposed unfinished. Gypsum board partitions were finished with latex based paints. Carpet tile contains a natural base content and was chosen for its long wear capabilities, the
case with which it can be locally rotated and/or replaced and the elimination of environmentally harmful adhesives in laying and/or replacing carpet. Linoleum sheet flooring was used for its natural base content and long wear capabilities. Mechanical ductwork and electrical conduits were installed exposed, unfinished and unprimed.

skylights bring natural light into the centre of the space.
openable clerestory windows provide free cooling and natural ventilation.

The skylights introduced into the sloped roof structure serve to reduce the artificial lighting requirements in the centre of the space by bringing in natural light as well as visually and spatially organizing the interior. The clerestory windows at the base of the sloped skylit roof over the two-storey floor opening also admit natural light into the centre of the space, thereby further reducing artificial lighting requirements. Some of the windows are operable, allowing free cooling. This eliminates the capital and operating cost of installing return air fans in the air handling units. Further, the natural ventilation provided by these windows serves to improve indoor air quality.

The base glazing design for the project incorporated an Argon gas filled space between the glass lights, an oversized air space and low emissivity coatings which significantly lower the U-values of the glazing. These values are approximately 40% below the prescriptive ASHRAE 90.1 criteria.

reclaimed wood was used for structural members and decking.

The wood used for the structural members and decking of the canopy on King Street West as well as the sloped skylit roof was reclaimed and milled specifically for this project, eliminating the cutting of virgin growth forests as well as the associated environmental impact on natural habitats. The structural members originated in the Ottawa and Lachine Rivers where they were abandoned and sank from log driving over a century ago. The structural decking originated in the abandoned Marconi Radio manufacturing plant in Montreal. The re-milling reveals a wonderful patina of
history, from the holes in the structural members from their days as log booms to the warm colour variations of the decking above.

*a recycled content was specified in the concrete mix, thereby reducing the portland cement content*

Ground granulated blast furnace slag, a by-product of coal fired generators, was used in quantities of 35%–50%. This reduced the portland cement content in the concrete mix and the energy required to produce that material. Further, it utilized a waste product of another energy process.

*energy efficient light fixtures are computer controlled through the building management system and daylight sensors.*

Light fixtures specified were high efficiency to minimize energy requirements. Controlling these fixtures through the building management computer system and daylight sensors reduces the use of energy to light the space as well as increasing the life cycle of the materials involved. Occupancy sensors provide similar benefits in occasional use areas such as the staff kitchen, showers and washrooms. Further savings should be realized by the use of standard water conserving plumbing fixtures throughout the building.

*photovoltaic panels reduce energy requirements in the building and demonstrate emerging technologies.*

Six photovoltaic panels form an array canopy over the natural stone wall on King Street West. The energy produced from these panels is monitored through a converter as supplied by Ontario Hydro. Placed near the entrance to the store on King Street West, the converter is an informative demonstration piece for the membership of Mountain Equipment Co-op. Apart from the obvious benefit of reducing energy requirements in the building, the installation is intended to introduce members to this evolving technology, that they may apply it to their personal environments.

*custom premium rooftop HVAC units with economizers increase efficiency by up to 16% and utilize environmentally friendly refrigerants.*

In order to further reduce energy consumption, interior temperatures are extended into the upper design comfort levels as referenced in ASHRAE 90.1. While this may result in the store interior being a few degrees warmer in summer and a few degrees cooler in winter, the conditioning load is projected to be decreased by approximately 17%.

The mass of the poured concrete structure in addition to the mass of the masonry veneer and associated concrete block back-up is expected to provide thermal storage for the building, holding the heat of the sun during the day, radiantly warming the interior gradually in the evening and thereby reducing the heating requirements of the space.

*A direct digital control system allows monitoring and customizing of the scheduling of equipment and lights.*

This extremely important feature allows Mountain Equipment Co-op not only to monitor the building’s energy consumption, but to continually 'redesign' it according to season, use and need. It means that the system as installed may be perpetually refined in place.

*the roof system reduces ballast, allowing for smaller structural sections.*

The roof membrane was chosen in part as it virtually eliminates the need for ballast, thereby reducing the dead load of the roof and allowing for reduced sizing of structural members. This reduced material cost and the energy required to produce that material. The roofing system is also
friendlier than conventional environmentally harmful built-up roofing. As the roof membrane was torch applied, no hot kettles with their associated toxic odours were required, thereby eliminating not only the harmful odour, but the volume of material as well.

The roof will be planted as a 'mountain meadow'.

A major feature of the new home of Mountain Equipment Co-op, the roof will be planted as a 'mountain meadow'. Using Sopranature, a unique system of planting developed by Soprema, a series of perennial grasses, flowers and shrubs will cover approximately 50% of the exposed roof area. The addition of this layer of soil plus planting is expected to increase the insulation value of the roof and greatly reduce storm water run-off typically associated with urban development by the absorptive capacity of the system. The plant material should significantly reduce heat gain in comparison to conventional roofs and thereby the loads on the mechanical systems. This is expected to reduce not only the energy consumption and costs, but should also increase the life expectancy of the system. The introduction of a living, 'breathing' roof plane to the urban situation will aid in absorbing pollutants and producing oxygen, thereby helping to improve the air quality. Finally, the roof planting will visually respect and enhance the view of this building from adjacent taller buildings.

The ultimate benefit of these and other 'choices' made by Mountain Equipment Co-op for their new home is to demonstrate to their membership and, indeed, other retailers the sustainable development features which may be incorporated into building design.

Acknowledgement
Stone Kohn McQuire Vogt Architects

Sustainable Community Development in South Africa

Peter Duckworth-Pilkington, B.E.S., B.Arch.

When concerns over the environmental impact of architecture were first raised in the early 70’s, the solution to negative impacts was seen as primarily a technical question. Designers specified more energy efficient HVAC systems, buildings were designed to maximize or minimize solar gain, and building envelopes were detailed for high insulation and low air leakage. Designing for energy efficiency was justified by cost savings (realized through reduction of fuel consumption), and driven by fear of rising energy costs. A "techfix" approach ruled. Each advance in building science was thought to be a step closer to a more sustainable planet.

To an extent, this approach worked in reducing the energy requirements of individual buildings. However, the technical approach has been less successful at addressing the wider environmental impacts of architecture. Issues of urban sprawl and how to reduce car use are rarely addressed by the super energy efficient model homes produced for government departments (the Healthy House being the notable exception). Construction waste, a significant portion of waste sent to landfills, is yet to be dealt with in a substantial way by the building industry. The integration of reuse and waste reduction into the design process is still far from the mainstream. Materials from sustainable sources, that are low in embodied energy, or are nontoxic, are mainly found only in "flagship" environmental buildings such as the Greenpeace England headquarters in London.

The world is not beating a path to our door even though Architects have been designing environmentally better buildings. "Off the grid" projects such as the Boyen River Science School and the Healthy House, prove that it is technically possible to design and build environmentally superior buildings that are affordable and provide acceptable levels of maintenance and lifestyle. Yet few building have followed these practical examples. For sustainable architecture to have a wider impact and to have a significant contribution to a sustainable society, other approaches must be added to the “techfix” approach.

Sustainable development is becoming a more important issue for architects. Originally, sustainable development concerned only those practitioners who realised the existing consumption and development patterns were threatening the existence of our species, and many of those with whom we share the planet. However, as greater consensus is reached and international agreements are signed, new sustainable regulatory frameworks will begin to impact on the profession. An imposed reduction in “greenhouse gases” emissions, proposed at the Kyoto round of the United Nations Framework on Climate Change, is only the latest of international environmental agreements Canada has accepted that affect the practice of architecture. HVAC systems, the transportation, production, and extraction of building materials and urban design all are significant sources of or contributing factors to “greenhouse gas” emissions.
In 1987 the Brutland Commission’s report Our Common Future was the first to popularize the need to link environmental and economic development issues in the concept of "sustainable development". The commission’s work was the start of a process. In the Rio summit of 1992, with the acceptance of Agenda 21 by 179 countries (including Canada), sustainable development was made a global objective. Agenda 21 added social aspects to sustainable development. It recognizes that current models for development are not environmental or socially sustainable, and thus ultimately undermine the very basis for future economic development.

BESG - A Case Study for Sustainable Architectural Practice

The Built Environment Support Group (BESG), a South African Non-Governmental Organization, is piloting an approach to implement projects that are sustainable. Using a broadly based community process and creating new professional partnerships, BESG is grappling with integrating the principles of sustainability into their work for a number of years. Although the South African context is very different from the one in Canada, and BESG is different from most architectural practices in structure and client base, BESG’s experience will provide a useful insight to Canadian professionals attempting to integrate sustainable development into their practice.

The Built Environment Support Group was founded in 1981, in the dark days of the apartheid era, by staff of the Faculty of Architecture and Allied Disciplines at the University of Natal in Durban. Durban is a large urban centre of approximately 3 million people on the Indian Ocean. In the 80’s, most of BESG’s activities focused on supporting communities in struggles relating to the built environment, such as fighting against forced removals and for better services. With the dawn of a new South Africa, BESG began implementing community driven housing and building projects, developing and testing approaches to housing delivery, and proposing and reviewing housing policy. BESG provides professional assistance to low income communities to facilitate housing and building projects. BESG’s staff is a diverse group of professionals – architects, engineers, adult educators, urban planners and community project workers.

To borrow the South African Tourist Board tag line, South Africa is “the world in one country” – it faces the problems of developed and developing nations. South Africa is composed of a wealthy, urban, well educated, primarily “white” minority who fully participate in the global economy and an almost exclusively “black” majority who live in rural poverty, whose participation in the global economy is limited to that of a low-cost wage source. The country faces many of the problems encountered in developing nations: large scale urban migration, rapid population growth, lack of basic services for a growing population, and environmental degeneration. Yet South Africa must also confront the problems of a developed country: high expectation of services, global competition, consumer culture, and environmental pollution.
South Africa is facing a number of local and global environmental issues. It is a semiarid region with a growing population and an agricultural sector dependent on irrigation, making water conservation a priority. Indoor air pollution results from burning “cheap” solid fuels in poorly ventilated spaces for cooking and heating. Outdoor air pollution arises from the “developed” industrial sector and a transportation sector which is increasingly truck and personal car based. Top soil loss and erosion are already limiting food production, particularly on small holdings and for subsistence farmers who can’t afford remedial measures. Global climate change has recently caused severe weather changes, stronger storms, long droughts and floods. Toxic waste disposal from local and international industry, ocean pollution and over fishing directly threaten South Africa’s food sources. Despite pressing issues, South Africans as a whole have little awareness of the environment. There is a fledging environmental movement, but eco-concerns still do not rank on the national agenda.

This lack of emphasis is understandable when many citizens lack access to basic needs or employment. For the poor, environmental concerns seem to be a luxury. In fact, 20% of the wealthiest people on the planet consume 80% of the nonrenewable energy and resources. Small alterations in the amount of resources consumed by the wealthy would have a far greater impact of the continued livability of the earth than even a radical reduction of consumption on the part of those who can least afford to cut back on their meager resource use.

However, it is those who benefit least who suffer the most from environmental degradation. Those with the least are the most dependent on “free” resources provided by a healthy ecosystem. Often located near transportation corridors, lower income communities suffer the air, noise and visual pollution for the mobility of others. Because of the lack of political power and a need for inexpensive land, low-cost housing is frequently found near noxious industrial uses such as refineries and dump sites. Again, the community is paying the environmental and health price for products that they are not the primary consumer.

Another area of concern must be the lack of services. Waste removal and cheap, reliable, energy and water supply for poorer communities is never given priority by officials. Yet it is in these areas where outsiders are most likely to illegally dump and it is these people who can least afford expensive fuels or the time to collect water. The impoverished 80% who cause only 20% of the problem live with the consequences. Unsustainable lifestyles damage more than just the environment — they hurt people socially and economically.

A sustainable approach to development provides many community benefits, such as cost savings. A low income household will spend anywhere between 10% to 15% of its income on energy and water costs. Shelter costs take up another 20%. In total, 35% of a household's income could be positively affected by using low cost alternatives. Sustainable development is beneficial to health — lower income communities generally face high exposure to pollutants and unhygienic conditions. Renewable alternatives are local and community based, resulting in more money staying in the community and new jobs. Time is very valuable to the working poor. A large portion of time is spent by people “hunting and gathering” for fuel, water, food and other essentials, time that could be spent on other productive activities. Community installed systems could sidestep long waits for large utilities to bring essential services to a community. Small scale systems provide solutions which can be flexible to match the income and need of a community better than blanket regional or national infrastructure. Finally, a community based, sustainable development approach is of psychological benefit. It is important for a community to feel “in control”, to have some say, and to address feelings of entitlement.
BESG recognized the potential benefits of creating a sustainable development programme as a method of addressing current and future environmental problems. The challenge was to develop a programme that would be practical within the limitations of the organization. Faced with a limited budget, a lack of accessible skills and resources and lack of understanding of environmental issues by local communities, BESG needed a workable strategy. The first step was to look back at the experiences of BESG and others in this area.

**Case Studies**

By the late 1980's BESG recognized the need to make low cost housing sustainable. The organization proposed PV panels for rural community centres, solar hot water heating and construction with low embodied energy soil block and adobe walls. None of these proposals were realised.

The Gum Pole House was constructed in 1991 as a cost effective and environmentally friendly alternative to two room concrete block houses. The Gum Pole House combined a cheap and sustainable structural system with a reused and low-embodied energy wall system. Gum trees are very straight growing, and the trunks do not need to be planed or finished. Gum trees are very fast growing and can be sustainable farmed. The gum poles were used as a structural frame for a shed roof and platform wooden joist floor. The walls were made from metal grid finished with stucco, and infilled with used pop cans. Gum pole construction also allowed for building on sloped sites without cutting and filling for a standard strip foundation. The design had several advantages over the standard two room stuccoed concrete block house: a larger house at a fraction of the cost of the concrete block version; cheaper materials; and avoiding a strip foundation (the pole foundation made building on steeply sloped sites viable).

Despite its technical advantages the Gum Pole House met with very little community acceptance and was ultimately rejected. Reasons expressed for the rejection were mistrust of different construction techniques, unconventional appearance (looked more like a shack than a suburban block house), and fear of combustible construction (fires from paraffin stoves are common in informal settlements). Often, professionals can only see technical priorities. We must be able to see through the communities eyes, and accept or understand communities priorities. This problem could have been avoided by community consultation, focus groups, surveys and other methods of gauging reaction.

The following two case studies are projects undertaken by other NGO's in South Africa, which have successfully integrated community aspirations and environmental concerns.

Maphephethe Solar Electrification Project, started in 1994, is a partnership between the Valley Trust, the Solar Light Fund, Solar Engineering Services and the Chief of Maphephethe. It involved community workers, adult educators, engineers and financiers. Maphephethe is a remote village in the Valley of a Thousand Hills area of KwaZulu Natal. The electricity system consists of photovoltaic electric panels and a lead acid battery system. A photovoltaic panel (PV) is a solar panel which covert's the sun's radiation into DC electricity. At first, the PV system met with skepticism. However, community acceptance increased with an education programme, a long term "display" installation, and supportive community leadership. The cost to each participating household was partially subsidized by the government. The balance was financed at prime rate. Villagers who bought a system received a commission on each system sold by a referral. Community members were also trained to maintain the system, thus providing local jobs. The PV systems proved to be a great success with over 60% of households installing a system. Economic sustainability was ensured by the maintenance training and the continuing low cost of electricity. Social aspects were addressed through education programs and the prompt provision of improved services.
The Khayelitsha Business Association (Khaba) started the Inkubela Recycling Centre in Khayelitsha, Cape Town. The centre acts as a depot for recyclable material which is subsequently sold to a recycler. Started in 1996, the programme employs over 300 formerly unemployed local residents and has helped remove solid waste from the area. This programme demonstrates a ecological, social and economic solution to a very real community problem. Ecologically, removal of recyclable waste has health and environmental benefits. Socially, the recycling programme provides jobs and new skills to. Economically, the community gains income from the recycling project and it saves government resources by eliminating some waste that would otherwise go to a landfill.

BESG's experiences and the above cited case studies demonstrated that the following principles of linking economic, environmental, and social components of sustainable development increases the likelihood of success.

Below is a list of criteria BESG has developed to evaluate technologies and identify challenges to implementing a project using a specific technology in a specific community.

1. **Acceptability**: of a method/technology to a community and what it values
2. **Cost**: does the method/technology increase upfront cost and if it does what is the pay back period or other benefits.
3. **Resource Protection**: does this method/technology reduce demand for a nonrenewable or scarce resource.
4. **Import Replacement**: will this method/technology replace the need for an imported or non-local good or resource.
5. **Local Development**: any method/technology should be producible and maintained by the local community.
6. **Understandable**: the benefits and limitations a method/technology must be demonstrable and understandable to the community and the method/technology should be understandable to the community.
7. **Stress Reduction**: a method/technology should be implemented in conjunction with a time/labour study and should not increase work loads of those already over worked.
8. **Proven**: any method/technology should be proven and approved by all relevant bodies, unless it is described as experimental and proper backup is in place and the community is fully aware.

The Nthuthukville self-help housing project in KwaZulu-Natal provided housing for 22 families and was completed in 1996. BESG acted as the architect but also construction trainer and project manager. Upon completion of the project, the community was informed the municipality of Pietermaritzberg would not be able to extend waste collection and maintenance to the area because of budget restraints. With BESG's assistance the community is putting in a proposal to do the maintenance on the local road, sewage, and water supply systems. Since it was members of the community who built the infrastructure in the construction phase, they have the skills to maintain it. The community also proposed running a waste collection and recycling programme and planting to prevent erosion and provide shade. These services would be provided under contract to the city. Nthuthukville's proposal would generate cash for the community and save the city the normal cost of extending services. This project involved working with the community, local government, and other NGO's.

BESG also provides training courses to teach community members basic house construction. Graduate "housing advisors" assist other community members in working with contractors, designing their house, siting, and DIY problems. The housing advisors are also trained in environmental issues such as natural ventilation, using plants for shading and soil retention, alternative construction materials and passive solar design. In this way a lot of practical basic environmental design and construction techniques are passed directly to owners and contractors.
BESG has developed a very pragmatic yet effective and wide reaching environmental programme that recognizes the budget limitations of poor communities, the difficulties of getting people of different backgrounds to speak a common language, and the lack of public awareness of environmental issues. The programme has been implemented, and local communities are starting to reap the benefits of sustainable development.

Peter Duckworth-Pilkington graduated from the University of Waterloo in 1995, and has been pursuing his interest in sustainable development ever since. He has consulted for a number of groups working to create healthy, sustainable communities by addressing issues of architecture, urban design, transportation, and economic/community development. Peter's work attempts to realize: "...development that delivers basic environmental, economic, and social services to all without threatening the natural, built, and social systems upon which these services depend." —International Council for Local Environmental Initiatives, 1995

Currently, he is a member of the "Moving the Economy Conference" steering committee, and is working in Martin Lioleheber's office (where he previously worked on the Healthy House project in 1992). Peter recently returned home from a 6 month stint at the Built Environment Support Group (BESG) in Durban, South Africa, for whom he developed a Sustainable Development Plan for low cost housing. This paper is largely based on his work and experiences at BESG.

Peter's placement at BESG was funded by the Canadian International Development Agency, and administered by Rooftops Canada.
Eco-Tube – a Solar and Emission Collector Roof for the Gardiner Expressway

Frank Hamilton, B.Arch., O.A.A.

One of the most unique properties in the city of Toronto is the 3½ mile long right-of-way that contains the Gardiner Expressway. Most city properties are relatively small rectangles surrounded on three sides by similar rectangular properties, the fourth side having access to a right-of-way, the street. In general, these properties are privately owned. The Gardiner property is an extended rectangle 20,000 feet long by 100 feet wide. It is publicly owned, and being a right-of-way itself has access to all other properties and all other right-of-ways along both sides of its length. The property is uni-functional, having the one purpose of providing a vehicular pathway, 25 feet or more above the city, from the east to the west of downtown Toronto, in the form of an elevated expressway.

The interrelated growth of the suburbs around Toronto and use of the private car by the 1950’s resulted in unprecedented congestion of the street and highway system. Metropolitan Toronto’s first chairman, Fred Gardiner expressed the dilemma thus: “350,000 motor vehicles were domiciled in the metropolitan area and an additional 100,000 came and went each day. We were trying to accommodate this cavalcade of 450,000 motor vehicles on streets laid out a hundred years ago.” One of the implemented solutions to this pressure was the Frederick G. Gardiner Expressway, officially opened in 1958, 40 years ago this year. Now one and a half million vehicles enter Metro Toronto daily, and the city has come to rely upon the distributors of traffic which include the Gardiner.

The elevated portion of the Gardiner runs 3.86 miles (6.2 km) from the west abutment at the foot of Dufferin Street on 330 sets of columns, east to the Don Valley Parkway, and continues for another 1½ miles, as possibly the world’s longest on/off ramp, to Leslie street. In several ways the act of elevating the expressway 25 to 50 feet was a brilliant stroke. The railway lines and the highway to the west of the Dufferin bridge are sunk down below the level of the CNE grounds and surrounding grades. To the north, tall houses appear to be precariously hanging on to the edge of this drop and the streets come to a dead end. This instance of the transportation corridor acting as a barrier is clearly visible. In retrospect, the one and a half miles of elevated expressway ending at Leslie would be more appropriately located here, allowing connection to Lake Ontario under it, almost all the way to Jane street.

The proposal in this paper seeks to take advantage of the unique nature of the Gardiner, its location, extent and elevation above the ground, and eliminate its negative impacts by enclosing it with a solar and emission collecting roof. At a time of budget restrictions, social and economic difficulties, slowed development and, when one of the development controversies in Toronto involves the demolition of the Frederick G. Gardiner Expressway, it may seem presumptuous, even preposterous, to propose an improvement to infrastructure on such a large scale.
Though somewhat peripheral to the idea of roofing the Gardiner, it may be relevant, at this point, to review some perceptual issues related to it. This may help to see more clearly the present role of the Gardiner, and its potential for playing a part in environmental, economic and developmental improvements to Toronto, as well as to support the logic and feasibility of this proposal.

**Perception as Grand**
The grandness of the Gardiner Expressway is readily perceived by those who drive upon it and to some extent by those who frequent its adjacent downtown areas. Physically, it has similar characteristics to such historical monuments as the Roman viaducts. Were we to look at the Gardiner Expressway as a building, because it is populated over the day by something like a half a million people, it would be Toronto’s largest building. Using this ‘building’ involves getting to a destination quickly, safely, and at best pleasurably, through a glamorous elevated ride past the towers of the Central Business District, the CN Tower and the SkyDome. From the street level its grandeur has been noted by John Bentley Mays in his book Emerald City, 1994, in the chapter called ‘Concrete Dreams’ where he writes about the lore of the car, the Gardiner and related historical and cultural issues.

**Perception as Barrier**
So the Gardiner is both grand and convenient! However, in spite of the convenience and pleasure it provides, there are general misgivings about the Gardiner – conflicted feelings, perhaps even embarrassment, both on the part of the design profession and among the general public. It appears, both conceptually and visually to be a slash through the city fabric, a separator. The original physically and socially traumatic gesture of clearing the right-of-way for the highway in the 1950s; the historic industrial development along its path; the memories of the civic battles to stop further highway intrusions into the city; the parallel locations of railway lands; the present location of Lakeshore Drive directly under the Gardiner in the downtown area; the difficulty for standard planning techniques to deal with the uniqueness and invasiveness of this type of continuous right-of-way and its pollutive aspects; all contribute to our perception of the Gardiner. Possibly, even our misgivings about, our dependance upon, our love of the car and our need for the aspects of freedom and privacy it provides, contribute to our dichotomous perception – “I love to ride it – I wish it was not there!” Certainly, all this is enough to create a state of perceptual confusion. Further, at this point, the physical isolation of the Gardiner still essentially exists and it is perceived to be a barrier.

There are those who see this structure and its 330 openings (the spaces between its column supports), as 330 opportunities for access and use. Architects, planners and community leaders have made attempts to deal with the isolation/barrier aspect of the Gardiner in order to seek more purpose, meaning and physical relationship with the city, than the single uni-function that it has historically performed. Two examples of such efforts are, “A Charrette in the City”, The Gardiner
Expressway, organized by the OAA in 1987 and "Urbanizing the Gardiner" by Paul Reuber, Architect, October, 1986. These studies suggest many varied notions and opportunities for urban development strategies related to the Gardiner. As well, several other groups; The Toronto Atmospheric Fund, the Waterfront Regeneration Trust and the Gardiner Lakeshore Task Force, all take a continuing interest in the Gardiner and its relation to the environment and the development of Toronto.

The intention of this paper is to examine the potential of the Gardiner for transformation into an environmentally conscious device. Perhaps by reinventing the nature of the Gardiner itself, the negative perceptions of it will dissolve. Then, the integrative potential of a closer physical relationship between this powerful deliverer of guests and goods and its host, the rest of the city, may become apparent.

**Environmentally Stressful Impacts and Other Related Concerns and Conditions**

Though many of the Gardiner's environmental impacts occur on all roads and streets, what makes these impacts of special importance are the matters of scale and location. On the Gardiner 250,000 vehicles per day move east and west across southern development of Toronto, through the existing commercial, financial, recreational and entertainment and residential development which addresses the Toronto waterfront. Except for the times of congestion during daily rush hour periods, when concentration of emissions peak, this movement occurs at the intensity of highway speeds.

**Air pollution**

Airborne pollutants consisting of automobile engine emissions (carbon dioxide, carbon monoxide, lead, hydrocarbons, nitrogen oxides, etc), tire wear particles, other elemental (dust) and organic particulates, and associated odours waft from the Gardiner and add to adjacent air pollution. Airborne exhaust emissions also rise to interact with sunlight creating local smog conditions and further afield, lakes degenerated by acid rain. Certain gases such as carbon dioxide, methane and nitrous oxide are distributed into the global air flow. To give some sense of scale, 90,000 tons of carbon dioxide, a major contributor to the human-induced greenhouse effect, is contributed by the traffic on the Gardiner each year.

**Sound pollution**

Noise from engines, vehicular movement through the air and tire contact with the road surface add to the urban soundscape, particularly affecting adjacent medium and high rise buildings with the hum as well as in the immediate environs of the transportation corridor. Toronto planners recommend acoustical buffers using building and land form, triple glazing and the locating of noise sensitive land use away from areas close to the Gardiner.

**Dust pollution**

Dust and other chemical and organic particulates, as well as the runoff solution of water and salt placed on the road surface in winter pollutes the adjacent soil, planting, groundwater as well as Lake Ontario.

**Deterioration**

Snow falling on the Gardiner results in accident risk and impedance to traffic flow, and the salt is applied to the road surface. This is effective in quickly melting the snow and ice. There is the direct cost of the salt and its application involved in this practice as well as the deteriorative effect on vehicle bodies. Further, according to the report, 'Strategic Plan for the Elevated Section of the F. G. Gardiner Expressway', by Morrison Hershfield Limited, Consulting Engineers, "The 25 year old Expressway has deteriorated extensively, mainly because of the use of de-icing salt on the roads. The curbs, parapets, and median wall have deteriorated from direct exposure to salt. The steel girders and reinforced concrete bents have deteriorated mainly from the leakage of salty water through deck joints, which occur at each bent." This 1986 report recommends a 20 year plan,
involving an average yearly expenditure of $4.1 million for a total of $82 million. Evidence of the deterioration of the Gardiner structure has been visible in the last years in restoration and replacement activity, costing, according to a more recent study known as report 15, published by the Royal Commission on the Future of the Toronto Waterfront an estimate of $15 million per year for a 10 year period, or $150 million. Whichever figures are accurate the costs involved are substantial. Also the work disruptive to traffic and produces more noise and pollution.

Control over Impacts of the Gardiner

Although today treated as a romantically nostalgic and of historical interest, the covered bridge provided a very practical solution to deterioration in the days when bridge structures were built of wood. By roofing the Gardiner using current technology, it is possible to go beyond protective maintenance measures. Optimum and effective control over noise, emissions and de-icing salts becomes possible by enclosing the expressway with a roof. A roof enclosing the highway protects the surroundings at the source of these pollutive activities as opposed to more universal measures dependant on complex and unpredictable factors, such as increased vehicular emission controls and developing minimally pollutive transportation technologies. The enclosure, by isolating emissions, can also protect the regional and the global air, through collection and purification.

Other Benefits and Opportunities

- Increased safety and comfort during inclement weather with a reduction in traffic accidents.
- Collection of heat from vehicles and the incoming sunlight for use elsewhere.
- Linking parking constructed beneath and adjacent to the Gardiner, reducing downtown city traffic and pollution.
- A developmental strategy of linking and integrating adjacent undeveloped areas with high density nodal development, public transit and the existing street grid system under the Gardiner.
- Introduction of intelligent traffic control technology to reduce congestion and pollution.
- Making a local gesture and statement towards global environmental concerns.
- Making an elegant urban gesture increasing the glamour and sophistication of Toronto as a city.

Cross Section of Gardiner with Solar and Emission Roof

The cross section shown here is not necessarily definitive in that alternative structural, air handling, purification and solar panel systems and materials need to be examined in the light of the latest available and developing technology for each component. The cross section is an outline description aimed at optimizing the intent of the concept.
Structure:
The existing elevated roadway deck is supported by steel girders spanning an average of 70 feet and 330 reinforced concrete frames, generally, 3 columns under a massive beam. The structural supports for the proposed roof structure are set at the concrete frames. They consist of a truss from each side, north and south, connected above. The north truss supports the main roof span, the emission collector. The south trusses support the framework for the array photovoltaic solar panels.

Emission Collector:
Between the north trusses, a transparent pneumatic roof is suspended. The tube-like components of this roof will contain air collecting ducts to draw off the vehicular exhausts from the expressway. Air handling equipment within the truss frames directs the air to periodic purification stations where filtering, precipitating and other devices clean it.

Solar Collector
The photovoltaic panels mounted on the south side are 36 feet in height for the length of the 20,000 feet of elevated highway, providing 720,000 square feet of solar collection surface. An array of currently available panels of this size, installed in the Toronto region, would generate eight million kilowatts per year. Solar technology is a rapidly developing field, the output of systems is increasing and the cost is decreasing. Besides contributing to the production of ‘clean’ electricity, the installation supports the cost of the construction and the operation of the roof.

Other Possible Features of a Transformed Expressway
- A bicycle path mounted outside the highway enclosure on the south side for pollution free human powered mobility. Intermittent viewing platforms for pedestrians and cyclists.
- A continuous planter on the south side enhances the highway and collects and filters the rain runoff from the roof.
- A parking system beneath and adjacent to the Gardiner for convenience and to reduce city street traffic and pollution.
- Adjacent public transit locations on north side connected to intermittent high density development at nodes where the Gardiner intersects major north south city streets.

Obviously, there is much conjecture and speculation involved in this idea. Feasibility studies and research and development of systems and materials might demonstrate its practicality, desirability, affordability and long-term environmental and urban and economic benefits for Toronto. However, whether this idea/device is worthy of, or achieves implementation is, perhaps, irrelevant. As a proposal it brings awareness to the nature of the car and particularly its instrument, the highway, both for its glory and the negative stresses it puts on our environment. Perhaps it is useful enough just to contemplate this idea as an idea, and as an example of a way of thinking about our environmental challenges. It is in this spirit that I share this idea, and place it into the public realm for review, assessment and reflection.

Frank Hamilton has worked in the ‘architectural trenches’ with many architects, including Ron Thom and Arthur Erickson across Canada and in the West Indies, since 1961. He has come to believe that, as every building is a new device that has to be fully described in order to build, the process of architectural design is a thorough training in invention. More recently he has come to see how all of our designs, products, inventions and especially activities are interconnected with the operation of our earth and that Nature distributes its wastes and holds fast to the sacred law that turns all waste into nutrient. He is devoted to promoting the inventive aspect of planning and design that integrates human activity to Nature’s ways.
Unholy Alliances: Building Creative Partnerships for Sustainable Developments

Paul A. Stevens, B.Arch., O.A.A.

To the jaded and the cynical, the term ‘sustainable development’ in combination with ‘partnership’ is a dangerous liaison of slogans; a mantra for the 1990s which has come to signify the unfulfilled promise of new answers to old problems. Indeed, we have heard much about the need for sustainable development and partnership, yet rarely is this supported by specific guidance, tangible examples or strong direction. However, when defined responsibly and meaningfully, sustainable development can be a powerful term whose strength, paradoxically, lies in its wide embrace of economic, societal, and ecological and environmental issues. In short, sustainable development is a comprehensive concept that touches on all domains of life, and as such, it requires reconciliation of these traditionally polarized issues (Dale, 1997). In the planning and architectural contexts, this means we must make fundamental changes to the shape, structure and approach to both our practices and our designs.

All too often, our professions struggle to ‘green’ their practices by adding sometimes legitimate and other times superficial environmental criteria to the palette of design issues. This tends to perpetuate the mistaken belief that sustainability is about being environmentally sensitive first, potentially at the expense of form, beauty, cost, or other equally important design issues. Without doubt, this entrenched myth is a significant obstacle to those of us who seek to initiate more sustainable developments. Indeed, the jury for the 1997 Canadian Architect Awards unanimously lamented the inability of entrant design teams to fully integrate environmental issues into their projects, remarking that the teams fell into one of two extremes: they either resorted to ‘green-washing’ conventional projects or they compromised design integrity through a radical environmental orientation (Shades of Green: Canadian Architect, Dec. 1997).

Clearly, as professionals bound by our clients’ demands, we strive to find new ways to capture the imagination and the marketplace through attention to emerging issues. Yet how do we reconcile seemingly opposing design imperatives from environmental to economic? How do we find the balancing domain that is sustainability? Enter the notion of partnership into the on-going debate on sustainable development.

Partnership is an essential component to sustainable development, which is principally about doing things differently. In this sensibility, partnership is a vital element that creates new possibilities by breaking barriers and forging new paths beyond the status quo. In this paper we share our experience in developing creative partnerships, which allow us to integrate environmental, economic and social design issues for more sustainable developments. Through the creation of sometimes unconventional alliances, we find we can build new and exciting bridges over the waters of adversity and conflict that too often force us to choose convention over innovation.
Motivation for Partnership

Ironically, in this era of fiscal restraint, shrinking budgets, and escalating land costs, there is fertile ground for unexpected, and oftentimes unholy, partnerships that offer greater potential for innovative and meaningful sustainable development to occur; i.e. developments in which the design reflects the integration of social, economic, aesthetic, and environmental issues. Quite simply, by embracing a wider range of interests through a partnership, a greater diversity of issues must be addressed. Furthermore, if the design team itself is based on a partnership or collaborative model, there is a greater potential for meaningful and elegant integration of interests and issues into project design.

In our experience, the benefits of partnerships are rich and varied. Depending on the players, type and extent of the partnership, they may include: project realization (e.g. following a feasibility study); increased funding; job creation; a prestigious community profile; a more cost-effective quality project; a better integrated design; more efficient use of land, water, energy and other resources; the ability to innovate e.g. by using alternative technologies; the opportunity to educate and influence clients' interests regarding sustainable development; and long-term stewardship of the project by its user community.

In particular, we discuss 2 general types of partnerships that can operate as a bridging mechanism towards more sustainable developments:

1. Design Team Partnerships, based on interdisciplinary collaboration among a variety of professions, to facilitate an inclusive and holistic design process that integrates a diversity of issues from the project’s outset; and;

2. Client Partnerships, based on several clients representing different interests from the private and/or public sectors, in which they come together to share resources, space, maintenance, programming, and/or to secure funding for projects that would not otherwise be realized.

Design Team Partnerships: Towards Collaborative Practice

We begin our discussion of partnership from the ‘inside’, by looking critically at the organization of our practices and approaches to design.

Traditional organizational structures for design consultants usually places the architect at the top of a decision-making hierarchy, from which directions flow to subordinates and sub-consultants. This organizational structure reflects the dominant paradigm of top-down control that permeates our corporate and government cultures. However, this conventional organizational structure is not well-suited to planning and design for sustainable developments, which must consider a diversity of community, social, environmental, ecological and economic interests equally. Like a marriage, partnership implies equity in the relationship, and this can be achieved in part through
collaboration among and empowerment of different 'voices' in the design process. An alternative and indeed emerging framework of organization that has been advocated for sustainable developments is based on interdisciplinary collaboration, feedback, and learning (see for example, Dale, 1997; Senge, 1990). The alternative is a collaborative partnership, in which an integrated team of professionals from a wide range of disciplines (including e.g., architecture; landscape architecture and ecology; engineering; social, urban, and environmental planning; financial management; etc.) works together from the project's outset towards a holistic design solution. The benefits of this type of organizational structure include:

- All design issues are explicit and on the table from the start, which reduces miscommunication and enhances the potential for an integrated design;
- All disciplines are present throughout the process, so less time is spent re-iterating key issues and cost-efficiency for the client and the consultant team is maximized;
- Accountability and responsibility are clear – the Principal-in-Charge remains the front line of client contact, yet all design team members maintain a visible presence and are available to the client(s);
- Collaboration occurs in 2-tiers: at the first level, it is internal among design team members who represent various design-related disciplines; at the next level it is external, among and between the client, users, and the wider community at the discretion of the client(s);
- Internal team collaboration results in a single best design solution that fulfills the clients' goals and objectives without the need for generation of several alternative scenarios, which can increase costs;
- External collaboration with the client and the users means a thorough understanding of the design issues and a more tailored, satisfying facility in which the user community is emotionally as well as financially invested;
- Long-term stewardship through community support, and a lasting commitment to the community are the value-added benefits of a rewarding cooperative design process; and
- Overall, less fragmentation and more integration in decision-making results in a better design.

Figure 1 depicts an example of a design team partnership in which a representative from each relevant profession – whether an architect, engineer or planner – shares meaningful input into and responsibility for a unique design that is generated through synergy between the team, the client, and the community of users. This is the organization we have found works best in our multi-use and partnership-based projects, including the Humberwood Centre (profiled in Ontario Eco-Architecture 2, Lister & Stevens 1996) and the Jack Pine Hill Facility discussed here.
Towards a Collaborative Design Process

Most experienced practitioners would agree that the design process is a collaborative exercise. When design is a joint effort between the consultant team, the clients and users, the end result is a successful project that is more likely to be proudly owned, emotionally invested in, thoughtfully cared for, and potentially more widely enjoyed. Legitimate participation, and ideally, collaboration, of all parties should shape the design and can only occur meaningfully from the outset of the process. In our experience, collaboration in the project vision, the goal-setting, and design development almost always results in a sense of stewardship by the facility’s users. This sense of stewardship is implicitly imparted to visitors, and has been credited with resulting in lower rates of vandalism, increased security and improved maintenance of the facility.

Multi-use projects in particular, which are based on a partnership between diverse clients, can benefit when the consultant team adopts a collaborative design process. In essence, this means recognizing and harnessing the dedicated energies of the wider community through formal involvement in the design process. These energies can be strategically facilitated and input creatively into a proactive planning and design process – a flexible process that is interactive and iterative, rather than prescriptive and linear.

As shown in the Figure 2, there are strategic points for collaboration with the user community in any design process. Notably, in the early stages, we often recommend holding an interactive Ideas Workshop, through which a vision and specific project goals and objectives can be professionally facilitated. From these and through iterative feedback with the community, design criteria can be established. The conceptual design results ideally from a design workshop or charrette in which selected community members participate with the design team. This is also an interactive event,

Figure 2 - A Collaborative Design Process: A Learning Process

...
team is formed, and a creative synergy results in a design that addresses and integrates successfully a diversity of issues — from economic to social, ecological and environmental. As such, the design process itself becomes a model for sustainable development.

**Client Partnerships: The Jack Pine Hill Facility, North Bay**

To illustrate an example of the range of client partnerships possible, we share our recent experience with an innovative facility under development in North Bay, Ontario, in which the partnership arrangements were orchestrated by the design team in collaboration with the clients. With the Jack Pine Hill facility, we are building on our experiences learned from the Humberwood Centre, the Province’s first shared-use facility owned by four public sector clients (profiled by the same authors in Ontario Eco-Architecture 2, 1996).

The Jack Pine Hill Education/Recreation/Tourism facility represents a unique and progressive public sector partnership in Ontario. This project will provide educational, conservation, recreational and tourism facilities on a highly central and visible escarpment site forming a northern physical boundary in the City of North Bay. The site location, on an environmentally sensitive and ecologically significant site at the top of the Laurentian Escarpment, overlooks Trout Lake and Lake Nipissing and offers significant motivation for the design of a sustainable development. Situated within a single accessible public park setting, the facilities will include: a new elementary school; links to conservation areas, outdoor education programs and interpretive trails; and recreation facilities, such as alpine skiing, snowboarding, snow-tubing, walking trails, and mountain biking. In addition to facilitating the clients’ partnership agreement, the design team’s role in the $9.5M project includes the design and construction documentation for a new, integrated 50,000 s.f. facility and outdoor public space adjacent to 135 acres of ecological landscape design and recreational terrain development along the face of the escarpment.

Bringing together a school board, a conservation authority, local fundraising groups and the community for the purpose of constructing a single structure to serve all partners has been both a challenge and an exciting opportunity for us. The multi-client group, a unique shared-use program, and a magnificent and unusual site has created a range of opportunities that will benefit all partners, users, and the taxpaying community. These opportunities include: conserving resources; influencing and changing the usual planning process; sharing spaces, operational costs and programs; and creating a community place through early involvement of students, teachers, conservationists and the wider public. Unquestionably, much of the project’s success to date can be
attributed to a deliberately structured and methodical collaborative design process from the start. Building consensus is a vital aspect of this process and has, with some effort, been achieved at all stages. Despite regional political restructuring, the owner-representatives assigned to the project have remained in place, ensuring continuity and commitment between the partners. Community involvement has included the teachers, students, conservation authority members and various service clubs.

For over fifty years Laurentian Ski Club (newly renamed Jack Pine Hill) operated a popular alpine ski facility on this western edge of the Laurentian escarpment. In the mid 1990's, financial difficulties led to its closure, depriving North Bay of a significant city-wide outdoor recreation amenity. The community had always recognized the importance of this open park space as an historical, visual, recreational and environmental amenity. Following the closure of the Laurentian Ski Club, concerns about the future development of this property began to emerge. In particular, fears of suburban single family residential housing sprawling across the face of the escarpment served as a catalyst for action. Local community groups, including the North Bay-Mattawa Conservation Authority and various service clubs, began to mobilize. They commissioned a development study to re-vitalize the site as a multi-purpose all season recreation, tourism and conservation park. The study demonstrated opportunities for cultural and natural heritage preservation as well as a vision for multi-purpose use and a detailed business plan.

In 1994, the Near North District School Board had received Provincial approval to proceed with the building replacement of the Vincent Massey Elementary School on a new site to be located directly across the street from Laurentian Ski Club. In 1997, after the Provincial moratorium on new school construction in Ontario was lifted, the School Board initiated development plans for their project. The timing coincided with the preparation of the Conservation Authority's feasibility study and the idea of a single, joint-use development was proposed to the School Board by the Conservation Authority and their consultant architect. Motivation for these discussions was based primarily on improved programming opportunities and, through sharing land and resources, more effective use of capital funding. Informal discussions between the Conservation Authority and School Board indicated that there were potential benefits and opportunities for both partners and the community.

To further facilitate the development of the school portion of the joint-use project, our team was commissioned in late 1997 as the prime design consultants. As we began discussions with our clients, it became clear that the partnership was still in its infancy. Specifically, the priorities and objectives of the partnership had not been discussed with sufficient detail to allow us to proceed with a schematic design. From this point, our role became that of facilitator between the partners. Only later, once the details of the partnership were established and a project vision, goals and objectives stated, could we begin translate these into a unique collaborative design.

In our experience, this situation is not uncommon in the development of multi-owner, joint-use facilities. Unfortunately, in too many similar projects, the tendency has been to proceed well into the design and construction documents without a clear vision of the partnership and the principles governing its foundation. The results can often lead to a project that suffers from 'cascade failure'; i.e. communication between the partners is weak or poor, community members aren't brought into the process, controversial issues are discovered too late in the process, project opportunities are met with a negative response, and ultimately, the optimal design is compromised. Worse yet, once the facility is operational, the partners' building managers may be incapable of operating the facility to its full programming potential. Furthermore, the end-users, if excluded from the process, will not have a community sense of 'ownership' through stewardship or pride in a facility that is 'their place'.
To avoid this potential scenario, we adopted a collaborative design process similar to that described earlier (see Figure 2). We initially conducted a series of combined workshops to determine the viability of this partnership by investigating the needs of the partners and the principles governing their relationship. This phase was an essential first step in the process of defining a viable joint-use facility and the compatibility between the partners. These workshops included topics such as Partnership Principles, Vision for the Multi-Use Facility, Planning and Design Goals and Objectives, and Construction and Operational Considerations.

As a result of these workshops and a collaborative planning process, the beginnings of a unique and progressive public sector partnership began to materialize. The results of the partnership discussions indicated there was a high level of commitment on behalf of both partners to demonstrate a sustainable development: a unique, cost and resource-efficient example that would best serve both partners and the local and regional community alike. The combination of educational, recreation, conservation and community services exemplified by the partnership would undoubtedly improve program opportunities as well as generate capital and operational cost savings, while demonstrating an innovative example of public partnership, and cultural and natural heritage asset preservation. At the time of writing this article, the Jack Pine Hill project is in the design development stage. A construction manager has been brought into collaborate with the design team to ensure cost control and optimal design realization.

Our experiences during the development of this project reinforce the fact that a high level of planning, and communication must take place before the development of a joint-use design can proceed effectively. A comprehensive work plan and realization process should be followed in order to produce a clear, and unified vision for the partnership development. This work is key to successful results and should not be underestimated or marginalized. Without an explicit understanding of the partners’ goals and objectives, any further partnership discussions are unlikely to produce consensus and may jeopardize further progress and a realistic sustainable development. The amount of initial planning work, extent of communication, and number of meetings can significantly affect the overall project timeline. These must be accounted for from the beginning of the process, and notably, considered in the design team’s fees. Because this type of jointly planned project differs radically from the traditional planning process, the clients, relevant stakeholders, and the community must be involved and educated as to the benefits of this unique project development model. Specifically, clear communication and meaningful dialogue are essential so that all parties understand how this model can produce more successful results. Only when this has occurred will a truly successful facility, and ideally, a more sustainable development be realized.

We find this type of jointly owned and operated facility has proven to be an ideal basis on which to pursue more sustainable developments. As such, these facilities are a realistic response to integrating and improving programs and services through conserving land, maximizing facility use, minimizing capital, resource and operational costs, and perhaps most importantly, considering community, economic, ecological and environmental issues in a single, holistic design. From this and other similar experiences, we emphasize that partnership-based developments can be a practical and efficient alternative to that of stand-alone or separate facilities, given that there is compatibility between the partners’ needs and programs. Overall, shared-use projects founded on the principle of partnership and based on collaborative design offer exciting and challenging new opportunities for designers to demonstrate truly sustainable developments in practice by integrating a diversity of needs, issues, and ‘voices’ into the design process.
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Nina-Marie Lister holds a Master of Science degree in Environmental Planning from the University of Toronto and is an Associate with Zawadzki Armin Stevens Architects Inc. She teaches Environmental Planning at Ryerson Polytechnic University, and is finishing a Ph.D. in ecology and planning at the University of Waterloo. Nina-Marie’s research, teaching, and practice are based on exploring and expressing the inter-dependent relationship between ecological dynamics, planning and design. She can be reached by e-mail at: nm.lister@utoronto.ca

Paul Stevens, OAA, received his Bachelor of Architecture from the University of Toronto, School of Architecture, and is a Principal with Zawadzki Armin Stevens Architects Inc. He is the Design Architect for a variety of the firm’s award-winning designs and completed projects, as well as the Jack Pine Hill facility featured here. Paul’s design interests include community-based multi-use projects, innovative and multi-disciplinary partnerships in design, building/landscape integration, and ecologically-responsible design. He can be reached by e-mail at: pauls@zasa.com

References


1. ‘Partnership’ in this sense does not refer to the legal definition of “limited partnership.” Rather, we mean an informal and flexible association of design-related professionals who come together in a unique combination as appropriate to each project. They may represent various firms in joint venture or association, or they may join an existing architectural practice on a consultant basis — the underlying idea here is that the partnership is dynamic, flexible and evolves according to each project’s needs and context.
New Biological Treatment Centre, Vaughan, Ontario


Introduction
In a struggle with nature a community with a conscience feels bewildered, wondering how to save a rolling meadow now damp and spongy, occasionally fated with a blue/green ooze, but certainly failing to be environmentally friendly. About 10 acres of green lush lawn that once aerobically aerated six thousand lineal feet of waste charged weeping tile carrying off the remnants of 130,000 visitors annually.

Designed for more modest visitations the centre, grown in reputation and ability to educate the public on the symbiosis of nature and man was somehow ironically poisoning its own landscape. Recognizing its own vulnerability it quickly searched for a way to recover its conscience and improve its operation for bigger and better opportunities.

Evidence of environmental harm from nitrogen and phosphorus; the main ingredients of waste runoff; flowing into streams and rivers is well documented. So it must be averted and surely not with a larger replacement of similar structure, bound to fail again in the future when new and increasing demands are put on it.

Surely, it is agreed, there is a means in this sophisticated age fast approaching a new millennium where technology will provide all the answers to waste management, global warming, pollution of all categories. Surely it is not necessary to invest again in a thousand year old technology to solve our waste disposal problem and restore our meadows.

Research
Not many years ago a Canadian scientist now living in the U.S. developed a biological ecosystem that simulates a natural wetland.

It is designed to accept of our own excrement and convert it by recycling into useful elements without disposal of any kind. No more over charging expensive sewer and waste treatment systems. No more polluting the local environment with putrid odours and grey biomass destined to end up in the streams of our water shed. Progress, though slow and expensive looked to the means, the commitment to demonstrate a friendly answer of saving and reusing our waste water. His answer: "The Living Machine" waste water treatment system.

In its search for an answer to the pressing problem at hand the community searched out this new technology and began to explore its potential. Would it be more expensive? Would it be compatible with the goals of the community? Could it be used to enhance and educate the many, many visitors to the centre? In other words could this new technology not only solve the present terminal problem but educate and even create new revenue for the centre.
Bio-technology is so simple because it replicates the cycles of nature itself. You take human waste mixed with water, digest it until it breaks into a biomass, percolate it, pour the nutrients into a natural swamp of plants and fish to further use its properties to grow life, add a heavy dose of sunlight, drain off the naturally treated excess water, radiate it to kill harmful microbes and return the grey water to the water mixer; a continuous circle or loop with a life sustaining cycle that only ends when the waste is no longer generated.

The technology is expensive to build and requires a house to sustain the life of the green plants in all weather.

How to accomplish this on a small budget? Go public! Find a reason that industry should help; use the marketing forces of the community to convince industry that this is a cause worth exploiting to its own benefit; that is, make it their demonstration for industry too. Recycling was the answer; just like the need to reuse the water waste to take the pressure off the present dying septic system, present a case that demonstrates the recyclability of all materials needed to be employed in a whole project. Materials that come from used and thrown away products, redevelop into new materials that in themselves are recyclable. Appeal to industry looking for attention to its own aims to improving the environment by reducing waste and pollutants.

The program was set

- employ the best bio-technology available
- use the sun to power it
- employ only materials that are recycled or recyclable
- set a theme to promote green technology
- find the sponsors and donors to get behind a unique experience that will provide continuing education for the public.

Location
The Kortright Centre for Conservation is located on a pristine wilderness along the Humber River, north of Toronto, this Centre promotes the use of renewable energy and will house Canada's largest renewable energy demonstration with the development of the new Kortright Biological Treatment Centre. Financed through the gifts of materials, labour, and the money of government and industry sponsors, the project would be self-sustaining through its reduced energy costs and paying patrons.

Methodology
That Was Then and This Is Now: In the late summer of 1997 progressive International Industries and the Environmental Centre came together to develop a green project designed to be a World Class Environment exploring new technologies and converting old and used materials into new
and recyclables, for the purpose of correcting a present day pollution deficiency in the life system of the community and providing an education for thousands of young and old on the New Age of Naturalism.

A partnership commitment between the Centre and the Industry, to see the project through was stimulated by the first ever Canadian Conference of the International Zinc Association and the Canadian Sheet Steel Building Institute to be held in Toronto on May 20, 1998. The first design parameter established beyond the limited budget was that the building open for this conference on May 19, 1998. Beyond these the materials for construction must be recycled or recyclable and be self-sustaining in terms of energy characteristics. There must be a payback.

The question in December of '97 was how to build a complex building with state-of-the-art technologies in the dead of winter for an opening in the middle of May, giving full attention and consideration to donors offering unconnected gifts. “Thank God for El Ninio”. Critical was project management and a quick response to the building enclosure while taking the time to design the appropriate technologies.

Design Considerations
A building that acknowledges the sun must be oriented to take full advantage. The light and heat accepted is determined by the window opening. A major expanse of glass to let the heat and light in for passive gains and support the solar appliances for active hydronic and voltaic energy was a prerequisite to the southern orientation.

Aesthetically the natural environment of the site in the location of a great wood structure in the bush required no mere condescending look to nature or the existing visitor centre built in 1987. Through strong ascending, vertical elements clothed in green, standing in a row like yawing spruces, provided a distinct yet conciliatory answer to a symbiotic relationship, in tension, yet at peace.

The plan of three served as transitional steps through the floor space from entrance on the west next to the existing visitor centre, to the technology area and finally to wetland and greenhouse.

Structure
Slab-on-grade eliminated basement space heating loads, reduced construction costs and created a thermal mass for the solar heat gain. Reuse of foundation excavated materials for landscaped berms was another nod to recycling.
The superstructure selected was pre-engineered steel that is easily assembled in all weather, good or bad. Pre-engineered buildings are like children’s Mechno Construction Sets. Each part is prescribed to size and strength in the factory, sent to the site in a packaged kit to be bolted together and assembled to a plan book with little reliance on site labour. Steel, the prime material, factored from recycled materials and being recyclable in itself was the natural selection. Added was life preserving galvanizing to all structural elements. Zinc occurring naturally in nature is recyclable and necessary in this instance because of the high humidity climate created by the greenhouse effect created by the simulated natural wetland.

Waste Water Treatment

Waste water treatment, the raison-detré for the facility, cycles waste water from the existing visitor centre toilets into the existing septic tanks. From there it is pumped through closed aerobic reactors into open aerobic reactors, through a clarifier and finally into a simulated wetland, showered with sunlight. The effluent is again radiated with ultra-violet light to kill the bad microbes and return to the visitor centre as grey water to be introduced into a completely new installation of low volume water closets. A complete cycle without waste. During a shutdown for maintenance or possible overflow periods a transfer shunt is provided to dump excess effluent into the now dormant weeping tile system.

a) Heating

The building Passive Solar Design accepts direct sunlight through the south facing glazing and is stored in the thermal mass of the concrete floor and approximately 30,000 tons of lime stone rock below it. The floor radiates this stored heat during the grey and black hours. The solar light also contributes to the growth of all the varieties of plant life grown in the moist green house climate created by the simulated wetland that also feed off the biomass of the waste water treatment. The passive heat gain is assisted by a ground source heat pump in conjunction with a solar water heating system circulated through the thermal mass floor by an hydronic radiant floor heating system. Active solar design is combined through a solar array to contribute to the heating mode.

b) Cooling

The ground source heat pumps extract heat and cooling energy from the outdoor loop system of 73,000 square feet of buried piping.
c) ELECTRICITY
Photo Voltaic cells arrayed on the south face elevation will provide 4kw of electric power for lighting, appliances and the 3 ground source heat pumps. A connection to Ontario Hydro's new micro-power conditioner will eliminate the need for battery storage of power during solar down time and run their metre backwards during solar active times.

Statistics “In a Nut Shell”

- Located on 800 acres of pristine wilderness north of Toronto
- Use: Education Centre with 130,000 visitors annually
- Gross Budget: $1M dollars
- Building Area: 3,000 square feet
- Building Height: 68 feet
- Orientation: parallel to the existing reception centre facing almost due south
- Foundation: slab-on-grade and foundation concrete, 170 cubic yards
- Solar Mass: crushed stone under concrete, 900 tons
- Structure: Pre-engineered Galvanized Steel, 86 tons
- Subgrade Insulation: 4 inch expanded polystyrene, R-10 to R.20
- Above-Grade Roofs and Walls: 7 ½” thick, R-26
- High Efficiency Solar Glass Area: 2400 square feet, R-3 to R-17
- Air Tightness: Continuous Galvanized “V” rib steel sealed vapour barrier
- Quilted Window Shading: R-3.5
- Heating and Cooling: 3 ground source heat pumps, 150,200 BTU/hr heat & 245,600 BTU/hr cooling; radiant hydronic floor heat, 30 BTU/hr/square foot; ground loop system, 73,000 square feet
- Lighting: Energy saving compact fluorescent luminaries with 85 to 90% efficiency over the life of the lamp with 80% savings in energy costs.
- Water Treatment System: 24m³/day of waste water, 70% reduction in water consumption for the whole centre.
- Plumbing: 6 litre water conserving toilets.
- Photovoltaic array: 4 arrays of 12 photovoltaic modules.
- Solar Hydronic: 1 array of 6 panels to supply hot water for heating and consumption.

Results
A facility for the presentation and promotion of conservation practices with cutting edge technologies for renewable energy; energy efficiency, alternative waste water treatments, applications for recycling, and new visions for environmental consciousness within an urban region.

This is the newest and premiere presentation of recyclable construction materials, alternative waste water treatment and solar enhanced energy savings; a facility designed for public access and educational uses. This will be Ontario’s only public demonstration program of its kind; Opening scheduled for May 19, 1998. Completion June 30, 1998.
Contributors
The Toronto and Region Conservation Authority, “Program of Needs”
The International Steel Industry, Dofasco Inc. Canada, “The application Of A Life Cycle Approach As A Model Residential Steel Form”
The International Zinc Association, Noranda Metallurgy Inc., “Galvanized Steel: Recycling The Zinc Coatings”
The International Energy Agency, Ontario Hydro, “Building With Photo Voltaics”
EcoWerks Technologies Corporation, Toronto, “Biological Solutions For Waste Treatment”

Architect Dr. Edward D. Russell has created innovative and practical designs that can be seen throughout Canada and the United States. Among his designs are the Military Electronics Research and Development Centre in San Diego, California, Armco Canada’s headquarters in Guelph, Ontario and the All Pro Sports Camps in Orlando, Florida. Russell has received many honours and awards including the Ford Travel Fellowship from Cornell University, the Canada Council Fellowship, and the Central Mortgage and Housing Fellowship for City Planning Work in Canada.
Preface
The recent focus on Canada's native policy and an attempt at reconciliation with First Nation's for past actions of the Federal Government are part of an official response to the Royal Commission on Aboriginal Peoples.

In a landmark statement Indian Affairs Minister Jane Stewart has offered Canada's profound regret for racist attitudes and policies that have suppressed aboriginal peoples.

"As a country, we are burdened by past actions that resulted in weakening the identity of aboriginal people, suppressing their languages and culture, and outlawing spiritual practices."

In the past Ontario Hydro used a legalistic approach to deal with issues affecting First Nations and addressed most issues indirectly by arrangements made through the Federal Government. First Nations were dissatisfied with agreements reached in this manner and sought a new approach. As an alternative to the adversarial and legalistic process, Ontario Hydro developed a team-based, problem solving approach for resolving First Nation's grievances. It involves representatives from both parties directly, in consensus seeking, non-adversarial positions, which builds on positive relationships and respects Aboriginal peoples traditions and culture.

This paper examines the potential role of environmental design in reconciliation by initiating trust and good faith in the healing process. The case study involves ongoing negotiations to settle past grievances between Ginoogaming First Nation near Long Lac, Ontario and Ontario Hydro for on-going flood damages initiated in the 1930s.

Historical Setting
There are strong indications that the Long Lac area has been continuously inhabited from the early Palaeo-Indian period of 5,000 to 8,000 BC. In the beginning, First Nations lived a sustainable lifestyle in relative peace and harmony with nature throughout the Archaic and Woodland periods, until early in this century.

In its natural state Long Lac drained into the Arctic watershed with a small drainage flow into Lake Superior, and therefore provided an obvious passage between two watersheds. As a natural passage between the Albany River and Lake Superior, Long Lac became an active outpost for the fur trade in the 1700's.

The people of Ginoogaming First Nation maintained many camps on the entire lake and adjacent river system. However, with advance of European settlement in the late 1800's and early 1900's there were several locations towards the north end of Long Lac where more permanent dwellings were built close to the Hudson's Bay Post.
In 1906, the Treaty Commission arrived at Long Lac and signed Treaty Nine with the ancestors of Ginoogaming First Nation. The reserve of Ginoogaming First Nation was agreed at the time of signing as having four miles of frontage on Long Lac, with sufficient depth to yield an area of 27 square miles.

Completion of the CNR line across the north end of Long Lac in 1914 made supplying the people much easier. After the arrival of the CNR, the Indigenous traders added rail to their traditional routes often following complex circular routes which combined travel by canoe, dog sled, CPR and CNR which included activities such as trapping, trading, hunting and visiting.

Inevitably there were many hardships for the people, but the changing seasons brought different gifts from the Creator. The land was rich with game, and fish abounded in the lakes and rivers. In summer, families would gather at Long Lac for Treaty days; these were days of leisure, feasting, meeting, gossip and marriages. These were also days of remembering those who were no longer physically present, and passing along information about where they had been buried.

By the 1930s, the traditional life of the people of Ginoogaming First Nation was starting to change. Children were in residential schools. Centralization efforts by the Department of Indian Affairs resulted in houses being built on the Reserve, although initially the people continued to live on the land during the winter. Up until this point the Elders say that the people of Ginoogaming First Nation had been affected only to a limited extent by resource based industries.
The relative remoteness of Long Lac and the extremely rugged terrain of their traditional lands had acted as a type of "insulation" to the outside world.

However, at about this time 60 years ago, the Hydro-Electric Power Commission of Ontario (the forerunner of Ontario Hydro) undertook studies of the watershed with the Province to assess opportunities for logging and future generation and decided to build a dam on the Kenogami River about 15 miles north of Long Lac.

A channel was dug at the south end of the lake and the diverted northern river flowed into Long Lac and Lake Superior.

As a result of the diversion, the Kenogami River became a dry river bed downstream from the dam, and the Kenogami River, the Making Ground River, and other rivers and streams upstream from the dam were flooded.

The transport of logs to Lake Superior with completion of the diversion dam brought a sudden increase in logging activities, flooded lands and eroded shorelines and with it the undermining of Ginoogaming First Nation's traditional way of life. Although the Canadian and Provincial Governments knew there would be major environmental impacts on the Kenogami watershed there were no Federal or Provincial requirements of OH (outside of the normal Federal/Navigable Waters Protection Act & Provincial/Lakes and Rivers Improvement Act) to assess impacts on human settlement or provide compensation related to Ginoogaming First Nation. The project was built under authority of the Provincial, Order-in-Council (OIC)

The combined or cumulative effects of the diversion project had direct cultural and environmental impacts that upset the delicate balance that had existed between the people, the water and land. The effects of these losses or damages needed to be acknowledged within the wider community.

It was not until 1975 that Ginoogaming First Nation formally requested an investigation by Ontario Hydro into the impacts of the diversion project to their land base.

Over the years and after repeated attempts by Ginoogaming to seek compensation an agreement was reached with Ontario Hydro in 1994 to negotiate a resolution of "past grievances".

To support principled negotiations background information from the people of Ginoogaming was collected through two hearings, design and research workshops, interviews with willing Elders and community meetings. A Committee appointed by the Chief and Council coordinated these activities and provided guidance to technical advisors who documented pre-project conditions and the post-project impacts of the diversion on the community. The result is a cooperative negotiation process with a substantial information base, thus setting the stage to finding an equitable resolution to long-standing grievances.

Monumental Plans and Processes
Early in 1996, the Landscape & Architecture Office, a part of Ontario Hydro's Network Services was asked by the Corporate Aboriginal and Northern Affairs Branch (ANAB) to assist in the design of a monument that would become part of the overall settlement package.

In hindsight, it was realized that the monument would play a pivotal role by enhancing what would be referred to as the "Settling of the Grandfathers (Keemeshomnishanak)" agreement package.

Working closely with Mr. Arnold May, Aboriginal Affairs Senior Analyst preliminary landscape research was undertaken in native mythology and spirituality to develop a design concept for the monument that would honour burial and sacred sites lost due to the diversion dam and subsequent flooding.
The design constraints included, a tight budget, schedule and a design that could be constructed by the local community. Initially, the negotiations focused on the more traditional design option of a granite marker and dedication plaque. However, what developed through the co-design process with the guidance of the Elders, Spiritual Advisors and the Community was a monumental earthenworks or land art in the shape of a turtle reflecting symbolic archetypes based on First Nation mythology and spirituality.

To begin, a preconceived design was developed in sketch form and simulated in 3-D Studio and presented in the first workshop with Ginoogaming Elders and their spiritual advisors on March 3, 1996. The initial design was accepted in principle and left with the community to review. The acceptance of the turtle motif recognized this element as the mythical and spiritual underpinning of First Nations beliefs surrounding “Turtle Island and the Creator.” With the designer acting as facilitator, design features reflecting native traditions and heritage were further enhanced by the Elders at a follow-up workshop in May 13, 1997. Working drawings were prepared for the final design for submission to the Ginoogaming community on June 15, 1997 as partial settlement to the final agreement.

The monument is located on Sawmill Point, a peninsula or spit of land jutting out into the lake. It is seen from a wide prospect to vantage points across the lake. The site is fitting, as the monument literally and symbolically reclaims the earth formerly occupied by a Kimberly-Clark sawmill, a resource based industry. The peninsula was also a former burial site and retains its sacred ground.

The site selection process for the preferred location from three (3) recommended alternatives was conducted in the May 13th workshop and site tour with the Elders. The preferred site was determined by consensus through an intuitive process that involved a sense of balance and harmony with the earth, wind and sky.

The monument located on the edge of the shoreline on a rocky promontory is splendid in that one can visit the site for silent reflection and meditation in remembrance of the Grandfathers and the disinterred. Although the shoreline is steep in this location there is a pathway linking the monument with the ruins of the logging slips. This area will be restored to provide a safe swimming area for the band’s youth. The regenerating successional woodland provides enclosure and partial shelter from winds to the monument which is first seen across an open meadow on approach to the site.
The site is accessed through the reserve by following the main road which ends in a loop on Sawmill Point. Several enclosed woodland and more open shoreline landscapes are traversed on the approach to the monument adjacent to the Chief David Charles Gathering place where POW-WOWs are held annually.

In early July 1997 the monument was built by the newly formed “Making Ground River Development Corporation” and commemorated in a dedication ceremony on August 16, 1997 at the annual Chief David Charles memorial POW-WOW and clan gathering.

Environmental Design
The initial design concept was developed out of two basic archetypes in First Nation’s Mythology which manifested themselves in the design of the monument. These two archetype or symbols included:

1. A brief exploration of the mysterious mounds and sacred earthworks left behind by First Nations over 2,000 years ago (although many of these sites were destroyed over 10,000 still remain in North America). The Hopewell culture and Serpent mounds and Ginoogaming’s own mounds were the vision for the monument design. Most of the larger mounds were denied by Western culture for centuries as being built by early aboriginal peoples until archaeological study early in this century proved their origin.

2. An investigation into petroglyphs or rock carvings of symbolic shapes and figures by Algonkian speaking peoples 1,000 years ago provided the idea for the basic form and structure of the monument. The turtle, the emissary and communicator in the spirit world, is a recurring petroglyph carving and is a central figure in First Nation Mythology.

By combining these two archetypes the basic concept for the monument was conceived and ultimately enhanced by the Elders and the Ginoogaming community. All other design features, although integral, were spin-offs and refinements to the basic concept as follows:

1. The Turtle Symbol – was the primary archetype and form giver for the earth sculpture. The petroglyph carving of the turtle symbol from Ojibway mythology at sacred sites in Ontario has profound meaning to the carvers. These rocks that teach have an important meaning to all Nations. The turtle is a spiritual emissary and communicator who supports sky woman and the earth (turtle island) at the beginning of the gift-seeds of life.

Turtle Island and Skywoman mythology teaches cooperation and self-sacrifice for the good of the community, as well as our dependency on other creatures and the special re-creation power of all women.

2. The Circle – forms the inner and outer rings within and outside the turtle earth sculpture. The circle is the most powerful symbol, the universal archetype of the sub-conscious mind, it is found in almost every culture. In Oji-cree culture the circle is the symbol of life and family. It represents the interconnectedness of all things – where everyone and everything belongs equally – has a soul, a life form, an energy flow. The inner circle represents life and death while the outer circle represents day and night.

The sacred centre of the circle represents the centre of the universe and life, the eye of the Creator or Great Spirit. The sacred drum is the heartbeat of the nation and the earth. Movement within the circle is clockwise.
3. The Moon Calendar – is marked by twelve sacred stones at the outside perimeter of the inner circle. The moon wheel calendar marks the passage of the seasons and connections to nature and life cycles. The calendar is based on the mythology of Grandmother Moon the first woman to return to the skyworld to reappear as the moon.

4. The Sacred Quadrant – is marked by four sacred stones on the inside perimeter of the inner circle. Four or “Nao” is a sacred number which parcels the passages of time and elements into quadrants such as:
   Life Cycle – Infant, Child, Adult and Elder
   Elements – Earth, Wind, Fire and Water

5. The Four Sacred Medicines – are to be planted within the quadrant and include cedar, sage, sweet grass and tobacco. These plants are central to First Nation spiritual, medicinal and ceremonial traditions as life sustaining and enhancing gifts from nature and the Creator.

6. The Sacred Cairn or Central Altar Stone – marks the center of the universe where the family names of those disinterred by the OH diversion are remembered and the dedication plaque (see next page) are located for future generations.

7. The Teepee Structure – provides the vertical reference at the centre of the circle and emphasizes the universal need for sustainable shelter for all peoples. It also represents the adaptability/innovativeness of our First peoples to integrate with nature and life cycles, thus leaving a minimal impact on the ecosystem of the planet.

Four coloured banners fly from the top of the structure, representing the four corners of the earth and the four races (red, black, yellow, white)

8. The Gateway Arches – are located at the major entries to the monument and represent the spiritual entry or gateway to a sacred site or landscape. The gateways are supported by post totems and the clans’ eagle perched at the crest of the rainbow arch which has special meaning to the Ginoogaming band.

9. The Wolf & Bear Clan – are denoted by cobblestone motif reliefs and represent the marriage of two clans (Cree and Ojibway) together integrated as one people within the earth sculpture.

10. The Tree of Peace – is a ceremonial planting within the monument and is the living symbol of peace based on justice for all peoples. The Chief and a representative of OH were involved in the dedication towards resolution of grievances.

A series of ramps and circular pathways of crushed stone will carry the heavy traffic over the earth sculpture to the centre of the monument. The inner circle area is meant to be used for commemorative ceremonies, while the mounds of the turtle can be used for sitting or as a teaching circle when facing the centre.

Combining all of the above elements within the two primary archetypes with spatial layout, sequential approach and orientation of the monument to the east (the rising sun) and it’s peninsular setting, we have worked together with Ginoogaming First Nation through the co-design process to hopefully achieve a monumental settlement that heals, endures and is mutually beneficial to all parties.
In conclusion, the lessons learned from First Nations and its rich symbolic language and spirituality based in nature could benefit our own short sighted temporal culture.

The post market global economy is creating a world where we are becoming further removed from nature in our quest for greater profits, and new advances in science and technology.

The natural world is being further fragmented and deconstructed leading to further dysfunction where the importance of family and community is continuously being eroded. In short, our material needs are no longer balanced or sustainable with our natural heritage which we are umbilically connected too, for our own spiritual well being if we and our children are to have a future.

Aboriginal peoples have harmonious connections with nature and can assist us in finding our way out of the great paradox we find ourselves in as we hastily approach the next millennium.

If we look closely at our cities and suburbs we will find that the amount of effort that goes into denying life and wasting energy is truly astounding. Our cities are the antithesis of nature. Being close to nature is being close to the Creator.

As William McDonough, Architect so aptly stated in Restoring the Earth...design leads to the manifestation of human intention, and if what we make with our hands is to be sacred and honour the Earth that gives us life, then the things that we make must not only rise from the ground but return to it – soil to soil, water to water, so everything that is received from the Earth can be freely given back without causing harm to any living system. This is ecology. This is good design.

As First Nations are very much aware, “The natural world is subject as well as object. The natural world is the maternal source of our being as earthlings and life-giving nourishment of our physical, emotional, aesthetic, moral, and religious existence. The natural world is the larger sacred community to which we belong. To be alienated from this community is to become destitute in all that makes us human. To damage this community is to diminish our own existence.”

— Thomas Berry, The Dream of the Earth

We need to design more places for the soul.
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Trevor Falk, Principal
Heather Ross, Independent Technical Advisor
Stanley Consulting Group Ltd.
Butch Adamson, Archaeologist/Geologist
ONTARIO HYDRO
Arnold May, Senior Analyst, Hydroelectric
John Arciuch, Aboriginal Program Officer, Hydroelectric
Mike Boulter, P.L.M. Operating, NW Hydroelectric
Paul Shelton, Landscape Architect, Network Services
Chris Rumun, Architectural Technologist, Network Services
Peter Hassan, Geotechnical Engineer-Specialist

Paul Shelton is a Landscape Architect with “The Landscape and Architecture Office”, at Ontario Hydro.
Paul is a graduate of Ryerson Polytechnical University and the University of Toronto with a recognized expertise in regional planning and environmental assessments related to visual impact and cultural landscape assessment; greenway and regeneration planning, as well as environmental design that promotes energy conservation and renewable technologies.
His present interests relate to applying Greening and Biodiversity Conservation Strategies to Land Management concerns, by utilizing an Ecosystems approach for integrated design and planning solutions.
A Step Towards Sustainable Rural Development

Charles Simon, O.A.A.

"Buy land, they ain't making any more of it." Will Rogers

"What is the use of a house if you have not got a decent planet to put it on?" Walden

Canada traditionally has been a nation of haulers of water and hewers of wood. But we are depleting our forests and polluting what water we have left. As for land, we may be taking Will Rogers' advice to buy it, but we certainly are not heeding his reminder that it is a finite commodity.

For the past few decades we have been both legislating and subsidising sprawl, a pattern of development which flies in the face of sustainability. What is the point of building R.2000 and Advanced Houses if to provide them we drain our wetlands, pave over our best arable land, pollute our water, soil and air and impose a development pattern which forces us to slump into a car every time we need to buy a carton of milk or take the kids to hockey?

This country has done a respectable job of upgrading the energy performance of its buildings in the past few years, particularly its housing, but broader environmental considerations are just beginning to be addressed. And our planning practices are outrageously unsustainable. Yet even relatively minor modifications in the development patterns of our cities, suburbs and rural areas could have a leverage effect on the environment which would be far more potent than a string of Advanced Houses.

As with many areas of contemporary life, it just may be that economic imperatives will engender change. Shrinking government budgets, coupled with the expedient tactic of 'downloading' liabilities to ever lower levels of government, are creating fiscal crises in many municipalities. The subsidisation of waste, pollution and inefficiency continues (neatly called 'external costs' in the economists' lexicon), yet even some of these are bowing to burgeoning debts. Very soon we will start paying down Ontario Hydro's staggering debt, a debt which puts many Third World countries in the pale.

Hopefully, the silver lining to the cloud of hardship caused by these economic events will be the re-evaluation of the real costs of unsustainable practices. The subsidisation of sprawl does not simply include capital costs (sewers, highway construction, etc.), but ongoing operational and maintenance costs which in the long run can have a far more punitive effect on municipal taxes. Longer hauls for school buses, snow ploughs, fire trucks and ambulances, needless miles of pot holes to repair, pollution, health impairment, productive hours lost...all add up to 'hidden costs' which are no longer economically sustainable.
These costs may be hidden but they are not impenetrable. As long ago as 1974 the ground-breaking study The Costs of Sprawl provided an excellent model of measurement. An updated Canadian version of this study is long overdue, although analyses by CMHC and Dr. Pamela Blais (The Economics of Urban Form) bear out its general conclusions. But we do not have to wait for such statistical buttresses before we start to change our ways: we need to explore alternative development patterns now. Even if the subsidisation of sprawl, waste and pollution should diminish, we will still be left with theoretical and legislated planning thinking which will lock us into our unsustainable ways.

Summary
The proposal for Chestnut Village represents one such exploration in a rural context. It demonstrates that attractive alternatives to typical North American sprawl exist; that the village and hamlet character of many Ontario townships can be preserved and even enhanced within a framework of appropriate growth and imaginative planning; and, above all, that the enthusiastic embrace of ecological principles and technologies is practical, economical and can produce very attractive, livable communities. These ecological principles are applied in the site design, the architectural form and the integration of appropriate technologies. After a promising early reception, policies in the Township changed and so the proposal is in planning limbo at this time.
Concept
The concept for Chestnut Village is both highly innovative and extremely old-fashioned. It illustrates that attractive development choices exist which can ensure that an existing settlement’s rural village and hamlet character can be preserved and even enhanced within a framework of appropriate growth and imaginative planning. And it demonstrates that the rigorous adoption of ecological principles is practical, economically viable and can create attractive communities.

Located at the edge of the existing village of Rockwood, the proposal is future-oriented in incorporating the most up-to-date research and techniques to create an environmentally sensitive development and technologies to produce low energy non-polluting buildings. It is old-fashioned in demonstrating that the more compact forms of our traditional village settlements provide wonderful clues as to how to integrate development within a broader rural open space setting.

From a social point of view, the aim is to create a community, not build a subdivision. The community will establish a close web with the existing village and will contribute major amenities to all residents of Rockwood. Over fifty percent of the site will remain in large inter-linking blocks of open space in perpetuity. And much of this will be open to the wider population through trails, a major park, allotment gardens and other recreational facilities.

The houses will be distributed in a variety of groups, clusters and individual lots which will all have views over open space and be generally orientated to the south to maximize solar radiation. A full range of house sizes and types will be provided to ensure an integrated mix of people of all ages and all income levels (a least 25% of the houses will be in the affordable range). The proposal incorporates seniors housing located close to a proposed community centre in a renovated heritage barn.

The ultimate overall density proposed for the 77 acre site is 2 units/acre (154 houses). While densities of double or more than this figure exist or are being suggested in the Township, the over-riding wish of the owners was to leave a legacy in which their grandchildren and their community could take pride.

There is a general concern amongst many in the Township, as elsewhere, for the preservation of its heritage. This proposal aims to create a future heritage which their grandchildren may be able to look back on equally fondly.

Natural Features Inventory and Analysis

Introduction
The ecological thrust of the proposal led to the preparation of a very detailed analysis of the natural and ecological characteristics of the site as a precursor to all other planning work. These characteristics then served as major determinants in the generation of the development form.

The Objectives included:
• preservation of the major vegetation on the site
• protection of wildlife habitats and corridors
• respect for the existing landscape character (including minimization of the visual impact of the development on surrounding areas)
• preservation of the existing heritage homestead and farm buildings on the site
• protection and enhancement of the highest grade soils
• zero impact on ground water quality and supply
• creation of favourable micro-climatic conditions for people, buildings and plants
Guidelines for Development Concept/Character

GENERAL
Figure 1 illustrates one development scenario for the site. The particular forms and layout will further evolve through later stages of the planning and market analysis process. It is unusual to develop a site design to this level of detail at a preliminary planning stage, but this reflects the proponent's conviction of the importance of offering a realistic portrayal of how the community could look due to its unusual features. While the details will evolve, the following guidelines will govern and shape its evolution to the final site plan development stage.

EXISTING SITE FEATURES
- Retention of topography, vegetation and natural drainage, wherever possible, much as it is at present.
- Extension of the official Hazard Land designation shown to the north in the municipality's Official Plan to include the wetland area traversing the site.
- Siting of buildings to minimize their visual impact viewed from outside the site.
- Retention of areas with the best soils for intensive agricultural uses.

OPEN SPACE
- Retention of over 50% open space in large interconnected blocks in perpetuity.
- Lots to be modestly sized to provide the greatest amount of shared open land.
- All housing units to have a view over open space and towards other natural views.
- Open space to be used for visual amenity, recreation, environmental protection, working and edible landscapes (allotment gardens, demonstration farming, tree farms, sustainable woodlots...).

ENVIRONMENTAL
- Wetland area, wildlife habitats to be protected and enhanced.
- Erosion and sedimentation control to be carefully designed and rigorously enforced.
- Intensive new tree planting to encourage wildlife habitats, provide windbreaks, sustainable woodlots, possible arboretum....
- Optimum aquifer recharge through minimum hard surface paving (including narrow roads), clustering of development, provision of detention ponds. Zero discharge of rain water from the site.
- Water conservation rigorously applied throughout the project (see Infrastructure below).
- Use of native and drought resistant grasses and plants for low maintenance, water and energy conservation. Emphasis on an edible landscape.
- Tree farm to ensure availability of appropriate and high quality landscape materials for every phase of the project.

COMMUNITY AMENITIES
- A public park, tennis courts and playing fields for use by the broader community living outside the site.
- Provision of a convenience/general store for this community.
- Allotment gardens/orchard/demonstration farm area to be located in the area of highest quality soils. For use by residents, the broader community and possibly city residents.
- Feasibility analysis of direct sales to the public of fruits, vegetables, preserves, etc.
- Trails and walks to be designed and located in ways which will encourage public access and linkages to surrounding areas.
HOUSING MIX
- Provision of full range of housing sizes and prices, with minimum 25% in the low price range and the remainder in the mid-range.
- Integration of social and income mix, including single parents, retired farmers and other residents who wish to remain close to the land and the area.

HOUSING CHARACTER
- Housing to be grouped together in clusters of 2-12 units, each cluster having particular design features to give a sense of place.
- Each dwelling to have its own adjoining private space. Front yards to be landscaped by the developer. Rear yards to be landscaped according to the taste of the owners. Guidelines to ensure ecological design and practices.

ENERGY CONSERVING HOUSE DESIGNS
- Construction materials chosen for optimum use of re-used and recycled content and healthy indoor air quality.
- All buildings to be orientated to take advantage of passive solar space heating and cooling, active domestic hot water heating and future use of photovoltaics (when economical).
- Water conserving fixtures and rainwater cisterns.

INFRASTRUCTURE
- Optimization of cost-effective off-grid services.
- Preference for on-site biological waste treatment plant (e.g. Living Machine developed by Dr. John Todd). This is subject to local approval, has been approved in several Ontario communities including in a project designed by the author. Using no chemicals, its end products are plants, fish and drinking quality water.
- Storm water management system designed to return filtered rainwater to the aquifer, ensure zero runoff from the site. Water cisterns for all buildings.
- Investigation into feasibility of a (preferably wood-burning) central boiler/cogeneration plant.
- Investigation into feasibility of windpower.
- Energy needs radically reduced by optimum thermal envelope designs, orientation of all buildings for passive solar space heating, active solar, domestic hot water heating, future use of photovoltaic panels. Electrical and other cable services underground.

TRAFFIC AND CIRCULATION
- Encouragement of walking and cycling as safe, attractive alternatives to the car.
- Provision of a mini-bus service to Rockwood Village, Acton commuter rail (GO) station, special trips (for seniors, children and other groups).
- Shared care ownership systems to be investigated in the early development stage.
- Trails designed for cross-country skiing, bicycling and jogging/walking to weave through and interconnect housing clusters, open space and amenities.
- Internal road layout and access/exit points designed to minimize traffic impact on the Village of Rockwood.
- Paved roads to be kept narrow, with soft shoulders, promoting a sense of “country lane”, reducing amount of impervious paving and integrated with zero stormwater runoff scheme.

COMMUNITY ATMOSPHERE AND FOCUS
- Optimum level of tenant management.
- Common open land to be guaranteed and maintained through one or more of a number of measures currently under investigation. These include: administration in perpetuity by the Municipality, turning over the lands to a Trust to administer the 154 units in perpetuity; ownership by a Shareholders’ Group in perpetuity.
• Shared community buildings for meetings, celebration, recreation, workshops, crafts, etc. 
  Shared ownership of large expenditure tools and implements.
• Outreach to broader community through provision of trails, parkland, allotment gardens, 
  recreation facilities, etc.
• Minimum tenure of five years to be a requirement of purchase to eliminate speculation on 
  properties in the affordable range in particular and to encourage a sense of community.
• Special regulations to limit noise, restrict off-road motorized vehicles and secure the natural 
  and living environment proposed.

Conclusions
With the acceptance of the above guidelines and concepts, Chestnut Village presents an exception-

al opportunity in an appropriate location to implement a demonstration project which is truly 
forward-looking and backed by community-oriented owners.

And yet, for the time being at least, it has joined the ranks of far too many progressive North 
American proposals which are condemned to the impotence of planning purgatory.

Why are we as a society so consistently and gloriously successful in stifling innovation?

There is not a single system or item of technology which has not been employed successfully by (among others) the author. Further, nothing is proposed which is not economically viable. No forms of social organization or land tenure are required which have not been tried and tested.

Obviously such a large question cannot be answered in a brief paper. However, I would like to 
suggest that a large proportion of the blame has to be laid at the door of my “other” profession – 
planning. We planners – educators, theorists and practitioners – have tended to be far more 
successful in fueling bureaucracies than in improving our environment (social, physical, ecological or whichever). It is ironic that the profession specifically charged with preparing us for the future is so often caught unawares by events (events generally first chronicled by other professions or lay people).

Amongst others, the ecological practices which our society has been indulging in for many decades 
have been clearly unsustainable. Yet it is relatively recent that it has become fashionable for either 
the architectural or the planning professions to even discuss this topic without fear of ridicule or 
(more likely) obscurity. And even now, to paraphrase Mark Twain’s comment about the weather, 
it seems that everybody is talking about the environment but no one is doing anything about it.

Chestnut Village’s current status in planning limbo is due in part to a variety of quite particular 
local political circumstances. But in part it is also due to a set of bureaucratic planning policies and 
procedures which favour the status quo and impede possible progress. The status quo all too often 
propagates suburban sprawl, the profligate use of energy, the employment of polluting technolo-
gies and a loss of community. It is encumbent on all of us professionals to bend our energies and 
imaginations to realise a few demonstrations which may carry the seeds of more sustainable develop-
ment patterns in the future.

Charles Simon, principal of Charles Simon Architect Inc., is an architect and planner, and is the only practicing architect to have been 
granted an honorary membership in the Ontario Association of Landscape Architects. His work has been widely recognized in energy effi-
cient building, environmentally sensitive site planning and resource efficient planning. His inter-disciplinary training and experience has 
led to a wide variety of community and urban design projects.
The Gamble House: Environmental Before Its Time

Agnes Vermes, O.A.A., M.R.A.I.C.

In the past decade, environmental awareness has reached new heights. As public concern has grown over air and water pollution, dramatic swings in climate and threats to the survival of wildlife, some architects have grown increasingly aware of the need to take environmental factors into account in the design and execution of their projects.

A constant theme in the evolution of the modern environmental movement has been its opposition to established social and institutional structures—a “counter-cultural” focus, in other words. Sometimes manifesting itself as eccentricity for its own sake, this aspect of environmentalism has blinded us to the more authentic roots, both in indigenous architecture and in design movements of the recent past.

In this paper, I will discuss the Gamble House built in 1907-8, widely acknowledged as the masterpiece of the “total design” philosophy of the American Arts and Crafts Movement. For the architects Charles and Henry Greene, the concept of “total design” meant control over the building and furnishings, using site, climate, kinds of materials available and owner’s lifestyle as design determinants. Here is one instance of early twentieth-century design awareness of what we have come to call environmental factors.

To the Greenses, it was all a matter of sound design.

In 1908, Charles Greene cited four aspects of design as essential:
“First – good work costs much more than poor imitation or factory product. There is no honest way to get something done for nothing.

“Second – no house, however expensive, can be a success unless you, the owners, give the matter time and thought enough to know what you want it for. By success, I mean all things necessary to your comfort and happiness in the life you are obliged to lead.

“Third – you must employ someone who is broad enough to understand and sympathize with you and your needs, and yet has the ability to put them into shape from the artist’s point of view.

“The style of the house should be as far as possible determined by four conditions: first, climate; second, environment; third, kinds of materials available; fourth, habits and tastes, i.e., the life of the owner.

“The intelligence of the owner as well as the ability of the architect and the skill of the contractor limit the perfection of the result.”
The Client - The Gambles
The story of the Gamble House begins in 1907 with the collaboration of a wealthy, enlightened client, David Gamble, and two visionary architects, Charles Sumner Greene and Henry Mather Greene.

Gamble was one of ten children of James Gamble, founder of the Proctor & Gamble soap empire. Like many Midwesterners of the turn of the century, Gamble and his family every year escaped the harsh winters of their Cincinnati home by going to sunny Pasadena, California. By 1907 tiring of resort hotels, but fond of the climate and the community, Gamble bought a lot on Westmoreland Place, a short street somewhat removed from Orange Grove, Pasadena’s “millionaire’s row”. Westmoreland was an enclave of upscale, spacious yet unpretentious rustic-style bungalows. Gamble’s lot, distinguished by two mature eucalyptus trees, commanded a spectacular view of the Arroyo Seco Valley (today, the home of the Rose Bowl) and the San Gabriel Mountains.

Gamble sought a spacious and comfortable home, feeling no need to display his enormous wealth. Impressed with Charles Greene’s own house nearby, and with a Greene-designed house under construction next door on 2 Westmoreland, Gamble commissioned the brothers to design and build his own winter retreat.

As was the Greenes’ preference, client and architect worked closely together. Gamble fully supported the Greenes’ concept of “total design” in which the architectural design would cater to the climate, the natural setting, availability of materials, the client’s way of life. All aspects of the house were meticulously designed and crafted in service of this goal – questions of structure, finish, furnishings, lighting, hardware and landscaping were all subsumed to the quest for harmony and balance. Nothing was to be arbitrary or left to chance.

Design and construction proceeded smoothly, subject to only one major redesign and a minor adjustment, required by the Pasadena Improvement Society, that the house be rotated so that the front door faced onto the street. At all stage, the huge eucalyptus trees were dominant features of
the design. By 1908, the plans were complete and Peter Hall, the Greens’ regular contractor, saw the construction through to completion a month ahead of schedule in February 1909.

The Architects – Greene and Greene
Born in Ohio, Charles Sumner Greene (1868–1957) and Henry Mather Greene (1870–1954) spent their childhood years on a Virginia farm, where they grew to appreciate nature. During their teens, their father, on finishing his medical studies in respiratory ailments, set up practice in St. Louis. The brothers were enrolled in the Manual Training High School at Washington University where the director was Calvin Milton Woodward, an enthusiastic disciple of Ruskin and Morris, the leaders of the English Arts and Crafts movement. The curriculum required students to spend two hours each day doing manual work in carpentry, metalwork and machine tool making in addition to academic studies.

The school catalogue, entitled, “The Cultured Man, the Skilful Hand,” extolled manual training: “even in manual education the chief object is mental development and culture... the primary object is the requirement of that mental clearness and intellectual acumen which is the natural outgrowth of a thorough mastery of materials and typical tools of logical process fully comprehended and intellectually executed.” The philosophy had a profound and lasting impact on the Greens’ approach to architecture.

After graduation from high school in 1888, they enrolled at the Massachusetts Institute of Technology (MIT). MIT’s historical, beaux-arts approach was particularly troublesome for Charles. In their final year both brothers fell ill, and only completed their studies after persistent urging from their father who placed great importance on earning a degree.

Following graduation in 1891, the brothers apprenticed in several Boston firms, notably the successors to H.H. Richardson, where they were introduced to the concepts of open planning, use of natural materials and the avoidance of applied decoration.

In 1893, while travelling from Boston to Pasadena, where their parents had settled, the Greens took in the Columbian Exposition in Chicago. Their visit to the Ho-O-Den pavilion exposed them for the first time to Japanese architecture and landscaping. The themes of Japanese design – the low sloping roof, carefully carved timber beams with exposed joinery, decorative yet useful – would emerge as a distinguishing feature in their Pasadena bungalows.

The Arts and Crafts Movement in America
Gustav Stickney (1858–1942) vigorously promoted the Arts and Crafts movement in America, chiefly through his magazine The Craftsman, published between 1901 and 1916. His advocacy of simple, unpretentious houses and practical, unadorned furniture had a profound influence on American taste. In contrast to the English movement, Stickney championed the role of machines in making affordable products available to the general public. The Greens’ approach was similar, but relied more on handwork, especially after Charles’ trip to England with his new bride in 1901.

Much of the success of the Greens between 1907 and 1911 can be attributed to the availability of highly skilled craftsmen and their collaboration with stair maker Peter Hall, cabinetmaker John Hall, and Emile Lange the stain and lead glass maker who apprenticed in Tiffany’s studio, all of whom were able to meticulously execute the Greens’ designs.

The Gamble House
The Gamble House is the summit of both the Greens’ works and the Arts and Crafts movement in America. It is grand in scale, yet cozy and intimate within. Its design is decorative, yet highly functional and free of applied ornamentation. Its overall impression is at once elegant and homely.
It embraces the California climate and environment, obscuring the division between house and nature. It shuts out the piercing heat of the midday sun with its deep low caves and it catches the cool evening breezes with its numerous penetrations of windows, doors and porches. It brings nature right to the house with its landscaped terraces and planter boxes hanging from under the windows and off the porches.

The house was designed to the state of the art at the beginning of the century (central forced air heating, electric lighting, full bathrooms for almost every bedroom).

The house is three stories with a full basement, where the laundry is located. It is formal in plan, with a wide central hall on the first and second floors. At first impression, the house appears asymmetrical, as the rooms were sized in accordance with their function, rather than confining them to fit an overall box-shaped plan.

The ground floor is comprised of a den, living room, dining room, kitchen and guest room. Upstairs are the parents' and children's bedrooms, a room for Mary Gamble's sister, called Aunt Julia, another guest room and two servants' rooms. The top floor consists of one large billiard room. The detached garage, located at a lower elevation at the north end of the lot, is connected to the house by a chevron-patterned brick driveway.

The house is situated on the highest elevation of the site, commanding a spectacular view of the mountains and the valley below, sited to capture the cool prevailing California breeze. The low caves, with deep overhangs, shield the windows from the glare of the midday sun of Pasadena's semi-arid climate and serve to reduce the imposing mass of the building.

The Construction
The construction is wood frame with tongue and groove boarding faced with unpainted split shakes. The roof is heavy timber beams, trusses and rafters with three-ply asphaltic felts and copper rain-water leaders. The house stands solid and was unaffected by the recent earthquake except for the collapse of the masonry chimneys which has been rebuilt.

The Terraces
The house is surrounded on three sides by spacious terraces with walls made of brick and stone and paving of pressed brick and terra cotta tiles. On the south side, there is a screened-in porch off the kitchen. The east porch, at the front of the house, serves to bring people inside, while the other terraces lead out to the garden. With the exception of the guest room, each room on the ground level has a door to the terrace, blurring the distinction between inside and outside. The rear (west) terrace, in contrast to the angular shape of the front of the house, is curvaceous and reminiscent of a Japanese garden, complete with a fish pond. With walls made of stones and clinker brick and overgrown with vegetation, the terrace appears to be growing out of the ground.

The Sleeping Porches (Outdoor Rooms)
Upstairs, each family member's bedroom has its own private balcony. The guests have access to one of the porches through a double door at the end of the hallway. These balconies, located on the north side, are like outdoor rooms with a roof overhead, lantern-shaped lights similar to those indoors and high railings softened by planter boxes. The walls of the porches are treated differently from the rest of the elevation, faced with board and batten, instead of split shakes.

The Living Room
The living room is a microcosm of the Greene philosophy of functional beauty and total design. It is a large, open cross-axial room with no door to bar entry, designed to accommodate a wide range of activities - playing the piano, reading a book in the window seat or on the bench by the fireplace, playing cards, or having a conversation. Five rugs in the room help define the location
of each activity. Furniture was rearranged with the seasons, with the chairs being placed closer to
the hearth in winter. The large windows to the west and north catch the sunlight and the cool
prevailing breezes, while a screen door offers access to the garden.

The Dining Room
This room exemplifies warmth and comfort and invites nature indoors. The room is open to three
sides of the house. A three-part screen door leads to the west terrace. For intimacy, the table folds
to accommodate the number of guests for dinner. For the window over the buffet on the south
side, having no view of merit, the Greenes designed a leaded glass window depicting a tree set
against a yellow background. In daylight hours, golden light floods the room through this window.

Although the house was centrally heated, every room had a fireplace. Unlike the others, the
dining room fireplace was gas burning for cleanliness and minimal maintenance.

The Kitchen
Both serene and highly functional in design, the kitchen illustrates the Greenes’ progressive atti-
dude to providing a comfortable working environment for the Gamble’s household staff. A
screened-in porch with a continuous band of double-hung windows on three sides provide fresh
air and sunlight. Concern for light and ventilation extended to the basement, where light wells
enlarged the windows down in the laundry area.

Kitchen cabinets were fashioned from bird’s-eye maple with the same care as the cabinetry in the
living room. Corners were angled for ease of circulation and upper cabinet doors were glass to
expose their contents – just two of many subtle design features. A pantry, cold room, vestibule
and stairs surrounded the kitchen proper, creating a buffer zone confining the noises and smells of
the kitchen to that room.

The Family Quarters
The upper level was the domain of the Gamble family, and was a more modest and informal envi-
ronment than downstairs. Although the themes of sunlight and fresh air, and the running hori-
zontal picture rails continue on the upper floor, the walls are painted plaster on this level in
contrast to panelled on the ground floor. Doors, baseboard and trim were left in their natural
finish. As on the lower level, the windows are multiple casements that fully open. To achieve
maximum ventilation, each room has windows on at least two sides, plus a screened door that
leads to the sleeping porches. The seats below the windows serve multiple functions: storage, sit-
ting and reading. The parents’ room, the boys’ room and Aunt Julia’s room each have sleeping
porches which face north to catch the breezes of the Arroyo Valley. This stress on sunlight and
fresh air was clearly a legacy of the Greenes’ physician father. To maximize interior airflow, they
provided interior windows between bedrooms and hall. Even the closets have ventilation ports to
counteract stale air.

Personal hygiene must have been of great importance to the Gambles. All bedrooms – even the
servants’ – have ensuite bathrooms, an extraordinary luxury for the times.
The Attic
Originally designed as a billiard room, the top level was only used as an attic by the Gambles. Encircled by a continuous ribbon of operable windows, only interrupted by two chimneys on the south and north elevations, this room not only offered a spectacular view in all directions but also serves to provide the primary means of ventilation for the whole house, letting out stale air in the morning and hot air in the afternoon.

Another unique feature of this room is its construction, which displays the artistry and beauty of the exposed structure. The roof is supported by two king post trusses of solid pine beams with mortise and tenon joints along with exposed Oregon pine and white cedar rafters, which pierce the exterior walls and terminate at the eaves.

Conclusion
The Gamble house is extraordinary in design and execution, and repays continued study. It exemplifies homeliness, comfort and functionality in a rare blend of exquisite design and workmanship unmatchable today. It is a building which does not seek to conquer or defy nature but almost seems to be organically rooted in its site. Symbolizing comfort, family life, hearth and home, it achieves a rare synthesis of life, work and nature, exemplifying the Grene’s understanding of climate, natural setting, materials and the needs of the client.

Notes

Agnes Vermes graduated from the University of Toronto School of Architecture in 1977 and became a registered member of the Ontario Association of Architects in 1984. She currently manages the specifications and standards division of the Toronto Transit Commission. Her interest in the environment began while working for the Ontario government. She has been a member of the OAA Committee on the Environment for four years.
Green Building

Terence J. Williams

Summary
The Engineering Laboratory Wing is a four storey building incorporating sophisticated Electrical and Computer Engineering, Mechanical Engineering and Computer Science laboratories. It is located on the south sector of the University of Victoria’s Ring Road and linked to the Engineering Office Wing. The $19.3 million dollar structure is extremely energy efficient. The total area of the building is 11,874 meters squared (127,815 square feet) and the total construction cost is $19,344,744.

It is appropriate that advanced and sophisticated architectural and engineering systems should be used in the engineering research building. For instance, the exterior glazing is a high performance glazing that reduces heat gain and all but reduces the heat loss from the interior of the building. As a result of this extraordinary efficiency to the perimeter of the building, no perimeter heating is required. Because of the efficient exclusion of solar gain, the need to air condition the interior of the building has been eliminated. Increased ventilation velocities have been incorporated in order to maintain better than average comfort conditions in the interior. The high performance glazing provides a superior acoustical baffle to the noise generated on the adjacent Ring Road.

The exterior of the building incorporates light shelves that work with interior light shelves to bounce natural daylight deep into the research laboratories. Used in conjunction with the lightsensitive photocells, the interior lights are automatically switched on or off according to need. Also, infra-red sensors adjust the need for ventilation dependent upon the number of people in the room. If there is no movement within the room, lighting and ventilation systems are switched off. These systems will dramatically reduce operating costs and reduce energy consumption. Indirect lighting is used throughout the building where VDT screens are used and these indirect lighting fixtures use energy efficient florescent tubes and electronic ballasts.

The plan of the building on the south side is canted to relate to the Ring Road and, at the same time, preserve the many mature trees that exist on this south side of the Campus. This building was seen more as a building in a forest rather than a building with trees planted around it.

Architectural Energy Efficiency Measures
A holistic approach to planning the architectural, structural, mechanical and electrical systems was adopted in order to create the most system-efficient, cost effective, low operating cost, energy efficient building.

The design concept envisaged the use of a High Performance, low impact, glazing system with opening windows and integral light-shelf shading devices. Based on recent experience with the adjacent Engineering Office Wing and a commitment to a building envelope with high R values and a low shading coefficient, the perimeter heating system was eliminated and the need for mechanical chilling was rejected.
Design decisions were made at the schematic design stage requiring coordination of the Architectural, Structural, Mechanical, Electrical, and Costing disciplines as follows:

- The building plan is narrow in order to allow effective daylight into most laboratories and offices.
- Interior and exterior light shelves are used in conjunction with high reflectance ceiling tile (LR-I) to reflect daylight deep into offices and classrooms.
- Computer modeling of light shelves for greater efficiency.
- Daylight is sufficient, 8 metres from the window wall, for use in labs and offices up to two hours before sunset and after sunrise.
- It is estimated that 80 percent of usage time and the areas will need only 10 percent of the base lighting.
- Interior light shelves are integral cable trays and perimeter light fixtures.
- The heavy concrete structure offers large thermal capacity which is actively utilized by cooling at night to reduce daytime summer temperatures.
- External light shelves provide shading of window to reduce solar gain.
- The heat from distributed isolation transformers is captured by the return air and allows a higher proportion of outdoor air to be circulated.
- The systematic location and distribution of supply air and return air shafts and the designated separation and layering of electrical and mechanical services allow short duct runs with less pressure loss.
- The selection of windows with a very high thermal resistance and very effective shading coefficient substantially reduce heating and cooling loads.
The structural, mechanical, and electrical systems are designed to be as simple and as efficient as possible and planned to avoid conflicting demands for space and volume. The corridors traditionally given over to horizontal ducts are devoted to electrical communications and power distribution. People, electrical power, and fibril cables use the corridors as shared circulation routes.

Exterior ventilation shafts are located at the centre of gravity of each wing and are clearly expressed on the exterior of the building. Interior shafts collect return air within each laboratory space and return it directly to the mechanical rooms situated on the roof. The integrity of the fire rated corridor is not breached and the need for expensive fire rated dampers is all but eliminated.

Light shelf-shading devices are used on all elevations of the structure.

**HVAC Energy Efficiency Measures**

Although this building has high occupancy and a high internal heat gain from computer equipment, outdoor air provides “free cooling” for the entire building, i.e. there is no mechanical cooling (except five special equipment rooms comprising only 1.2 percent of the building floor area). The main ventilation system has a capacity of 102,000 L/s (215,000 cfm) with fan motors totaling 225 horse power and has a number of energy efficient features, some of them unique.

1. The building is divided into six sections each with an air handling system. This reduces duct run lengths and, along with generously sized louvres and filter banks and low velocity design, keeps duct pressure losses low and saves fan energy.

2. Each system is divided into nine zones with a motorized control damper in the supply and return duct to each zone. The energy management controls reduce the individual zone air flow to the minimum to satisfy room temperatures while still maintaining ventilation requirements. The control dampers require much less upstream pressure than typical variable volume boxes and so reduce fan pressure and energy.

3. Each supply fan motor and return fan motor is driven by a variable frequency drive providing the greatest possible energy saving for reduced air flow. Each fan also has an air volume probe so the return fan is controlled to exactly track the supply fan. This flow measurement also allows calculation and control of the outdoor air volume to ensure adequate ventilation rate during cold weather.

4. High volume air flow is required for “free cooling” when the outdoor air is warm. As outdoor air temperature falls below 19 degrees Celsius the air flow is proportionally reduced to about half at 12 degrees Celsius. For most operating hours, the system runs at reduced volume, greatly reducing fan power requirements.

5. Each room is heated by a hot water heating coil thermostatically controlled through the energy management system. This applies only the specific heat required for each room. The occupancy sensors used for lighting control in many rooms also set back the room temperature set point when the room is unoccupied.

6. The ventilation system is off when the building is unoccupied except to come on at low speed if heating is required to maintain the setback temperature. During summer hot spells, the system runs during unoccupied periods to subcool the building structure with cool night air. This effectively reduces daytime indoor high temperatures making “free cooling” more viable.

7. All motors are high efficiency type and the drives are high efficiency synchronous belt type.
This building incorporates a new boiler plant which will be in the primary plant serving the Campus system. The four, 400 hours power boiler plant is likely the best performance plant of its type in Canada comining 84 percent efficiency and less than 35 ppm NOx emissions throughout the 8:1 turndown range for each boiler. The campus heating water is circulated by running one or two of the three pumps, two 125 horse power, one 40 horse power each on a variable speed drive. Campus demand can be met by modulating the flow from as high as 250 Gph (4000 gpm) using 250 pump horse power to less than 50 Gph (800 gpm) using about 7.5 horse power. constant feedback from the two way primary heating control valve in each building through a Campus-wide energy management systems ensures that only the minimum necessary heating water is circulated to meet the heating demand of each building on Campus.

**Electrical and Lighting Energy Efficiency Measures**

This project incorporated a variety of energy efficient devices and lighting design innovations to provide an outstanding quality of lighting at a significantly lower energy cost. Some examples are:

- A completely integrated computer controlled system, using a stand alone system to control all lighting relays as well as utilizing electrical occupancy sensors for mechanical systems.
- Extensive use of occupancy/daylight sensors in all classrooms and offices as a means of turning off lighting. turning on of lights is overridden by the sensors, if daylighting is available.
- Daylighting shelves (indoor and outdoor) were extensively modeled to optimize both size and location to produce effective daylighting in most of the labs and offices, for both direct sun, partial cloud and full overcast. The resulting system has been measured to meet the expected levels, even on north faces due in part to reflection off adjacent buildings. Automatic light control is installed to make best use of daylight.
- Offices and classrooms meet RP24 preferred requirements in all general areas.
- Lighting was designed as an integral part of the building architecture, including close coordination of shapes. Many effective lighting examples are evident in the building, including a vaulted corridor ceiling.
- The general lighting theme is the extensive use of indirect/direct lighting in a cost effective manner.
- Decorative luminaires are fluorescents (PL) or metal halide.
- Close coordination between the lighting designer and the architect to ensure the proper choice of ceiling and wall colours. This included a review of ceiling tile to establish good reflectance, while at the same time retaining the acoustic effect.
- The use of task-oriented office type lighting, with low glare indirect luminaires situated over tasks.
- Indirect/direct system of lighting designed for the labs to provide safe, low glare lighting for detailed task work.
- The special custom designed indirect/direct metal halide luminaires utilized in high spaces are decorative, match the style or architecture and are extremely effective.
- The site lighting utilized HPS downlights and globe type on relatively low poles to provide uniform low level illumination.

**Renewable Energy Measures**

With a commitment to a High Performance exterior building envelope, the following benefits were realized:

- Reduced heat gain due to exterior shading.
- Reduced heat gain due to thermally efficient window system.
- Reduce heat loss due to thermally efficient window system.
- No perimeter heating required due to efficient window system.
- Reduced glare in offices and labs due to exterior shading.
- Effective use of daylight.
Non Operational Energy Benefits

Most similar buildings would incorporate air conditioning (mechanical cooling) which includes reducing outdoor intake to a minimum when it is warm outside. In this building, the "free cooling" strategy maximizes the outdoor air intake year-round, resulting in high ventilation rates. Also, the few fume hoods are exhausted through high velocity discharge stacks rising 3600 millimeters above the highest penthouse roofs and the relief air is all at roof level while the outdoor air intakes are near ground level providing the maximum separation of intake and exhaust. These factors result in high indoor air quality throughout the building.

- Opening windows to assist with "free cooling" and individual control of air quality.
- Greater occupancy comfort by eliminating draughts.
- Greater occupancy comfort by increasing the STC acoustical separation from interior to exterior.
- Improved daylight in offices and labs due to light shelves.
- 90 percent reduction of light fixtures use 80 percent of the time.

The windows and curtain wall systems were specified to be high performance glazing systems with a shading coefficient of 0.18 or lower, a glazing U value of 0.15 BTUs per hour per square feet per degree Fahrenheit. These performance criteria were obtained by using LOF “Evergreen” high performance tinted float glass as the exterior glass. Evergreen glass blocks 76 percent of the UV light, transmits 66 percent of the visible light yet offers nearly 20 percent less solar heat gain than other green tinted glass.

The Visionwall Technologies window system incorporates two stretched optically clear Low-E films, incorporating three air spaces and a desiccant chamber with inner and outer aluminum frames linked with Fibre reinforced polyamide plates. The centre of glass rating is R.8 and complete window (glazing unit and frame) rating is R.6-5. All perimeter offices and laboratories have opening tilt and turn windows.

The building was designed by Wade Williams Young+Wright Architects in Joint Venture. These two Victoria firms have collaborated on several important buildings in the city including the 1994 Commonwealth Games Stadium. Terence Williams was the Principal Architect responsible for the project which included the Victoria firms of Wayne Blohm & Associates, Structural Engineers, D.W. Thomson, Mechanical Engineers, F.N. Fenger & Associates, Electrical Engineers, and the Thorne Group Cost Consultants. Sandbar Construction Ltd. was the General Contractor for the project, also from Victoria.

Terence Williams is an architect and President of the Wade Williams Corporation, Architects. He move to Victoria, from Vancouver, in 1971 after working in New York, London, Helsinki and Bristol (England), to join John Wade in Victoria, British Columbia, Canada, who had started a practice in 1946. The work of the firm has been widely published and has received numerous design awards. Terry is a Past President of the Architectural Institute of Canada. He is a Fellow of the Royal Architectural Institute of Canada, an Honorary Fellow of the American Institute of Architecture and current Chancellor of the College of Fellows of the Royal Architectural Institute of Canada.
Piercing Skin: Significance-Light-Tectonic

Professor Terri Meyer Boake, School of Architecture
University of Waterloo, Ontario

skin piercing — the creation of openings in the body...

The burning of fossil fuels to heat, cool and light buildings is a major environmental concern as it continues to deplete non-renewable resources and cause environmental damage. Since the 1970’s, the thermal performance of the non-vision portion of the building envelope has been maximized and has succeeded in creating more energy efficient buildings – decreasing fuel consumption and emissions. Engineers continue to develop new glazing coatings and window systems which have increased the thermal performance of windows. High performance windows, however, do not provide the total solution to environmental envelope problems. For the architect, ground remains to be gained in handling the piercing of the skin of the building. Students and practitioners develop projects which fail to treat sunlight as a valuable commodity. The cause of this is a failure to understand or take advantage of the environmental aspects of building openings.

Where the body is a building, the piercing of the skin has a profound effect on the act of design. Likewise, the critical attitude taken towards environmentally conscious design can have a tremendous impact on the successful articulation of openings in the building envelope. Apertures effectively puncture the building skin, resulting in a discontinuity of the integrity of the envelope. Piercing creates a thermal hiatus. Environmental concerns arise out of the loss heat through these openings as well as the control of solar gain and daylighting.

The creation of apertures requires the concurrent resolution of often conflicting design criteria – formal pedagogy versus experiential and thermal/environmental concerns. The making of openings addresses as well as connects themes of design, culture, technology and the environment. The act invokes the coordination of a complex set of issues including, significance (proportion/style), light (experiential) and tectonics (material resolution of envelope and thermal performance). From a technical viewpoint architects must manage the sun to control heat and light.

Light is the double edged sword. It is simultaneously a design and a technical issue! It is the essential thread which connects/mediates/arbitrates formal design criteria and tectonic/environmental concerns. Light is an architectural element akin to structure and materials.

Manipulation of light has always been a concern of vernacular architecture – i.e. light = heat. Daylighting also reduces the need for artificial source lighting, thereby effecting environmental gains through a reduction in the use of electricity. Northern architecture developed to increase light penetration into buildings. Light renews the spirit during the short winter days and simultaneously creates heat. Mediterranean and arid architecture traditionally developed building styles which excluded large quantities of direct sunlight – often in deference to capturing reflected light. This allowed for brightness without heat (UV). Perhaps this is why museums and galleries tend to
take a more Mediterranean approach to natural light? Smaller openings, reflecting devices (Kimbell, Menil Gallery) and white surfaces simultaneously provide a sunlit atmosphere while avoiding both UV and solar gain.

There are no truly great pieces of architecture that do not take full advantage of the interactive dynamic potential of daylight.

"The interaction between light and climate is multidimensional. It has to do with the spirit of the place, with thermal comfort, and also with culture, since climate affects people, their habitats, and their rituals. The character of light, its colors and rhythms, is one of the great contributors to genius loci. ...Light can convey a visual message that transforms the uncomfortable realities of a particular climate condition. For example, the admission of even a small beam of sunlight into a building in a northern climate on a cold winter day can add a sense of vitality and sparkle to the interior. ...there are many buildings in northern climates that exclude sunlight, or conversely, admit it unrestrained so that it presents a visual burden due to its intensity and the glare conditions it creates as well as a thermal burden through the heat that accompanies it."


The sun, if properly controlled, is capable of supplying buildings with free heat energy. If improperly managed, the sun can overheat a building and necessitate excessive cooling expenses. Apertures must be geometrically designed, according to winter and summer solstice sun angles, to maximize the entry of the sun in the winter and shade the interior from the sun during the summer. During the winter months, solar energy must be able to be stored within thermal mass on the interior of the building. This allows for the storage of excess heat during the day and slow release during non daylight hours. If thermal mass is not available (as is the norm in wood frame buildings), heat builds up in the air and comfort cannot be achieved. Venting is required and the free energy is lost. External shading devices are required during the summer months to prevent heat gain from entering the building. Light shelves can both enhance the penetration of daylight and provide external shading.

the aspiration lies in the desire to eradicate thoughtless rectangles... spots and dots on the elevation...

It is not possible to consider the effect of the sun on the openings in a building without constructing a three dimensional model and testing the model in either real or simulated light conditions. Physical (versus computer) models when tested on a heliodon provide a quick and fairly accurate impression as to the general effectiveness of the method of fenestration, penetration of light into the building at varying times of the year and geometrical correctness of solar shading devices and light shelves.
the formulation of the studio project...

There typically comes a point in the design process where the early design student is somewhat satisfied with the plan of the building and commences to create elevations. It is often an awkward move and often tends to result in graceless diagrams symbolizing facades. Where the initial locations for windows and doors were attached to the plan, dissatisfaction with the facade seems to necessitate an absolute detachment of these elements and their subjugation to a pattern. Windows are added or deleted, enlarged or reduced, raised or lowered – without regard to orientation and the functional or experiential requirements of the plan or cross section – to satisfy the aesthetic quality of the facade.

The program of study in the second year design studio at the School of Architecture at the University of Waterloo created a new project in the Fall of 1997 to highlight the specific issues associated with piercing the building envelope. The project was affectionately called “The Lightbox”. Central to the exercise was the development of physical models which were tested using a pair of heliodons – set at winter and summer solstice. This allowed for a live demonstration of the changing effects of the time of day and time of year. The ability to manipulate orientation and see its the direct ramification was paramount to appropriate design development. The models were designed to be easily modified in order to enrich the design process.

The studio project recognized the predisposed “design” position of elevational studies and expanded it to address daylighting and solar geometry (insolation and shading). Current issues relating to environmental concerns, building science and daylighting demand the development of a critical pedagogy to inform the articulation of the facade and building envelope. This pedagogy must connect the technical/environmental issues to “design”. This was done by examining the experiential qualities associated with light and the material and thermal aspects of the interior environment. As you manipulate light you create dynamic space, you play with textures and the reading of materials, you control solar gain, you manipulate shading devices, you control glare and visual comfort, you alter thermal comfort.
The “Piercing Skin” studio project was designed to address some of the following concerns:

- the point in the students’ design process when windows appear as a silly pattern of rectangles (and other shapes) on an elevation — a geometry and patterning game — extruding plans and adding spots and dots...
- recognition that light and its manipulation has the potential to create fabulous, versus, mediocre, space — remembering fondly the Pantheon, Chartres, Kimbell, Carpenter Center...
- experiential architecture

- sections!! draw a section of the window in the room with people in it — why are the head and sill height where they are? can I see out of it? is it suitable to the function of the room?
- will the experience of the space be better because of the manipulation of light and view that results from the design of this window?

- students (and practitioners for that matter) must not continue to ignore orientation — south, east, west and north light are all very different — in terms of heat, color of light, angle of penetration, character, time of day as connected to function of the room

- windows are a major cause of energy expense in a building — but can be designed for solar gain and controlled with shading devices (shading devices and light shelves need to be modeled in order for students to appreciate their effectiveness in varying circumstances)

- apertures can provide ventilation, breezes — the way in which a window opens alters the breeze and feeling of connection to the exterior — you can leave certain windows open when it is raining but not others — who needs all the windows shut on a rainy hot summer day?

- the project is about getting students deeply involved with 3 and 4 dimensional studies of these issues — get them off the drawing board

The “Piercing Skin” project formed a detailed lead-in to a larger multi-family residential design project in the first half of the second year Design Studio. Initially the students were assigned one of three building elements to study — window, balcony and threshold. They first created a small scale (1:20) rough “light box” out of foamcore to examine (with the aid of a heliodon) the issues of orientation, solar shading and aperture size. Subsequently, they developed a detailed model (1:10) which showed the material nature and specific tectonic aspects of their proposal. Students were asked to incorporate a selection of these detailed building envelope elements into their final project. The process was intended to reverse the normal design process — that of working from the plan to the elevation — in order to ask that the students think more deeply about apertures and orientation. The architectural significance of threshold, window and balcony can allow for a discussion of environmental contrasts: daylight and thermal. The design of these elements has direct ramifications on the experiential quality of the space, the condition of comfort and the condition of human occupation.

Outcomes

The Piercing Skin project exposed the students to a “fourth dimension of architecture” — that of the experiential. Although there are aspects of the project that could be strengthened, its overall impact was successful. The students (and the guest critics) were visibly excited when they could
see how their building elements performed (or not) when tested on the heliodons for summer and winter conditions. Many of the students had performed sun angle calculations to design their openings and shading devices and were eager to be able to verify the effectiveness of these aspects of their building elements.

Introducing this project at an early point in the curriculum provides the students with a working tool with which to develop projects in subsequent design studios and during their professional career. Students in a current third year studio with "light" as its central theme are carrying out independent tests of their models for light quality on the heliodons. Another group of students involved in conducting detailed building performance case studies in conjunction with our entries into the University of California at Berkeley's "Vital Signs Student Case Study Competition" have constructed building models to conduct year round lighting and shading device studies to support data collection and provide images for their web documents.

**Environmentally speaking**

Sunlight is free and entirely renewable. It is irresponsible to continue to design buildings without regard to the potential benefit of solar energy and daylight. Numerous studies have been carried out which outline the health benefits and energy savings of daylit buildings. Computer programs are available to assist architects in applying basic principles to design passive solar buildings. The Piercing Skin Project is designed to initiate the education of the architect with regard to the design of apertures and to introduce a pedagogical stand in regard to the relationship between the building and the environment. Students and practitioners are constantly building models. It is not a great leap to suppose that these should be examined under realistic lighting conditions. Current issues relating to environmental concerns, building science and daylighting demand the development of a critical pedagogy to inform the articulation of the facade and building envelope. The basis for this pedagogy is light.

Terri is a Professor at the University of Waterloo School of Architecture. She is responsible for core curriculum development and teaching in the Technology Theme Area, including Building Construction, Theory, Design and Passive/Sustainable Applications and Principles.
Redesigning Confidence: Opportunities for Environmental Change

Ian Chodikoff, M.Arch.

Introduction
The intent of this paper is to communicate sustainable approaches in the public and private realm affecting citizens who are not exposed to environmental principles due to socio-economic circumstances. Issues of sustainability are often displaced by other priorities such as crime, employment and health issues. There are strong linkages between awareness in sustainable design and improving socio-economic conditions in lower-income communities. Planning and policy initiatives introducing values of stewardship and responsible design in an urban environment nurtures community pride and place due to increased levels of participation, thus maximizing human resource potential and existing physical components within the public realm. These issues are required so that the community, local government and business can begin to set out targets for change. Precedents in areas of architecture, planning and landscape architecture identify problems and opportunities integrating useful sustainable design criteria for economically constrained communities.

Questions of Sustainability
Sustainable design defines “...those paths of social economic and political progress that meet the needs of the present without compromising the ability of future generations.” (Steele, p.5) while “...sustainable development implies the adoption of policies that minimize both local resource consumption and pollutants.” (Breheny, 1992, p. 138). A sustainable community relies on the skills and abilities of its people. Citizens cannot live in isolation from the public realm, which is an extension of their home and which offers vast potential for increased livability. There is evidence that “...our public space lacks identity and is largely anonymous, while our private space strains towards a narcissistic autonomy. Our cities and communities are zoned black and white, private or public, my space or nobody’s space.”(Van der Ryn, p.xiii). Maximizing potential regains confidence through positive change. While these changes can be economically and socially beneficial, they contribute to sustainability. Levels of increased confidence in lower-income groups can be derived from: (1) small and innovative architectural interventions; (2) mixed-use planning principles and (3) employing models derived from creating community parks and greenways.

An Architect’s Initiative
Samuel Mockbee, a Mississippi architect and educator who founded The Rural Studio in 1992 at Auburn University’s College of Architecture, set out to extend the study of sustainable architecture into a socially responsible context such as the impoverished “Black Belt” of Western Alabama. Mockbee and his students bring to the community an awareness of the value of everyday objects and basic building skills. As part of their curriculum, students confer with clients, build, and manage the projects all through a tight budget and student labour. Funding is provided by a small number of corporate sponsors which include the Alabama Power Company (Zook, 1997).
Utilizing straw-bale construction, salvaged materials, rain-water recycling, and other low-cost techniques, a regional identity through vernacular design redeems local pride and creates positive social gains as a result of better housing (Zook, 1997). For example, a rain water recycling innovation gave some families of Mason's Bend, Alabama running water for the first time in their lives. Achieving such projects on a larger scale is more difficult but these initiatives can be brought to many communities, providing an increase in health and quality of life while instilling a sense of pride to its members.

Mockbee's approach outlines the importance of a lateral approach to design. Students understand that these projects are part of their learning experience, corporate sponsors enjoy public awareness and the resident population can recycle their own resources while maintaining a voice throughout the design process.

Mockbee initiates change at a rural, grassroots level, while providing a means for economically-privileged students to understand the needs of a poor community. Understanding class relationships provides a means to maximize existing resources which in this case, are marginal. Students return to the city realizing that much can be accomplished with simple energy-efficient design providing significant savings and increased quality of life.

**Mixed-use planning initiatives**

The approach of mixed-use planning enriches a community through strengthening relationships between public and private space. It is a strategy for lateral thinking and a process which combines available land, human and energy resources. The home, rather than being merely the site of consumption, might produce some of its own food and energy in addition to being a place of work. Reducing transportation and energy needs, providing a safer public environment and increasing economic diversity are all benefits from thinking responsibly and collectively.

Recent mixed-use planning strategies have often been attributed to New Urbanism whose implicit strategies provide mixed-use in communities which are often designed for the middle-class (Dunlop, 1997). Strategies of mixed-use can be applied to any income group that examines a community in its entirety, and not in pockets, or zones, which impede a symbiotic environment. A mixed-use approach in urban communities is clear when public spaces become 'atrophied' (Van der Ryn and Calthorpe, 1986). As public space is lost, neighbourhoods develop fences, social forms become more private and the sense of isolation and defensiveness increases (Calthorpe, 1993, p. 37). Narrow streets, smaller parking lots, more parks, public squares, and greenways aids in recreating a sense of pride of place and reverse alienation from the public realm.
Consumers who aspire to live in a natural setting, to own and control property, to have constant freedom of movement and privacy work against the development of livable communities (Duany, 11). Canada is not immune to ecological and social strains resulting from material demands caused by technological and economic adjustment which undermine basic functions of community. Ecosystem planning depends on the broad support of the community. Motivations realistically hinge on self-interest behaviour such as increased property values, good public image, job loss, crime and the hope for new commercial, social or professional opportunities (Gibson et al., 1997). The challenge is to move beyond self-motivated behaviour and into community action.

Urban areas depend on healthy environments with vibrant economies. There is no environmental benefit to a community when a plant or business closes. Sustainable industries which initiate good environmental practices are viable and effective interdependent urban environmental strategies (Skinner, 1997, p. 75). For example, in Sunnyvale, California, a sewage treatment plant doubles with garden areas and a recreational lake, turning wastes into fertilizer and food while recycling the water and providing a park. In Golden, Colorado, a small-scale woodchip gasifier produces methane for neighborhood co-generation plants. These small-capitalization techniques provide more efficiency than common utility practice and a source for local employment and small business opportunities. They also present a relief on the tax burden of a given municipality through the reduction of landfill operations and sewage dumps (Van der Ryn & Calthorpe, 1983). In a community like Berkeley, California, each 10 per cent improvement in the energy efficiency of commercial and industrial building stock could save the community US$6 million. These savings could be spent within the community for business expansion, job creation and new products and services (Skinner, 1997, p. 73).

In the ‘inner-city’ a “...lack of confidence historically breeds lack of investment, loss of population and reduced economic activity, creating a downward spiral that only determined action, injection of funding, pragmatic planning...can correct.” (Parfect and Power, p. 160). One example of turning a community around occurred in the expansion of the industrial and manufacturing base in West Berkeley, California. City and business representatives negotiated reductions in production and handling of toxic and hazardous materials through “good-neighbour” agreements between industry, institutions, adjacent residents and business. Employing local residents reduced commute times, improved pedestrian access, and promoted the construction of new bikeways (Skinner, p. 76-7).

Such a successful environmental program saves money for residents who can then spend their increased disposable income within their community. A positive cycle ensues, increasing employment, quality of life and social equity.

In Laguna West, California (Calthorpe, 1993), a plan of high-density affordable housing was developed in combination with commercial space, a day-care facility and landscaped areas that would provide recreation, privacy and cooling microclimate effects for a sustainable, low-income community. These buildings would be oriented to the south and spaced to allow winter solar access to each unit. Passive solar features included canvas shades, balcony overhangs, night insulation curtains, and plaster on the interior walls to act as a thermal mass for cooling and heating. As heating and cooling can represent 40 per cent of a family’s income, reducing energy expenditures increases disposable income, in addition to the quality of life (Calthorpe, p. 13).

The street is an invaluable component of urban life. It serves as a means of employing a variety of sustainable initiatives beautifying the environment and providing a sense of place. Another aspect of mixed-use sustainable planning is the treatment of the street. A hierarchy of traffic pat-
terns, based on street dimensions can direct and alleviate traffic allowing for public spaces to inte-
grate with the street. Calthorpe suggests widening sidewalks that are north-facing in order to
attach greenhouses, and food-producing gardens, along with trees and benches. These amenities
can be used by residents in the summer promoting increased outdoor activity and neighbourhood
communication, instead of presenting a cold face to the pedestrian (Calthorpe, p. 27). Reinhabiting streets throughout the neighbourhood alleviates security issues as more public space is incorporated into the daily lives of the residents. Reclaiming local streets for bicycles, and
having a general street plan are ways in which the environment can be reclaimed for children as
well as increasing awareness of environmental impacts caused by automobiles (Quayle, 1997).

Creative educational initiatives can sow seeds of sustainable activity within lower-income
communities. In Berkeley, California, local community colleges have established training cur-
riculum to develop job skills in environmental service areas such as energy conservation and haz-
ardous materials management. The city sponsors youth employment training programs which
teach young adults how to conduct energy audits, weatherization, insulation and other energy
conservation improvements which are available free to low-income households (Skinner, 1997).
This is an example of a cost-benefit and cost-effective policy that has the potential for much
lateral integration into the community.

Greenways and Parks: approaches to community design and awareness
Parks are the territory of the people. Community involvement at the design stage reinforces the
sense of 'ownership' and achieves designs suited to local needs through a process that resolves
different viewpoints within the community. Raising awareness of parks can be an effective tool
against problems of vandalism and security issues while building skills and confidence (Stamp,
1996, pp. 34-5). Community landscape design can provide an effective forum to understand situations which can derail the design process as well as leading towards greater community empower-
ment resulting in improvements to the public realm.

Areas where citizens are committed to improvements are those which have a perceived value and
accessibility to its users, such as school facilities. Areas such as parks are more problematic as long-
term management issues become acute. It is unrealistic to expect people to manage the property
unless there is effort from a particular group or individual who can organize adequate manage-
ment structures. A paid manager for the site will maximize the potential for the park in educa-
tional, recreational and conservation terms, but might meet with community opposition where
funds are scarce. Demonstrating the values of public space become easier once the project is
realized (Stamp, 1996).

Investing in one's own public space involves uncertainty and entails a greater level of confidence
with an assumption of community risk and responsibility. Having a clear outline of community
participation will assist in establishing the necessary confidence. The first stage establishes ground
rules through drawings of the buildings, site boundaries, existing services, trees and what is avail-
able for change, the next stage is followed by determining community needs and wants.
Brainstorming sessions, the formation of interest groups, and conducting surveys can then encour-
age useful solutions while identifying problems. The third stage involves the visual presentation
of ideas and possibilities through slides, photographs and illustrations. The fourth stage involves
designing with a site plan and moveable pieces, all to scale so that community members are com-
fortable with designing different layouts. The final stage is one of decision-making and refinement
involving a smaller working party of local planners, parks department officials and those that will
be managing the project (Stamp, p. 34-7).
It is essential to exchange a close educational dialogue between members of local authorities, designers and community. Being comfortable discussing unfamiliar design and planning concepts will assist in achieving successful ideas well-suited to the community’s needs, especially in lower-income groups.

The Vancouver Example
Maura Quayle, who chaired The City of Vancouver’s Urban Landscape Task Force and the report Greenways-Public Ways, published in 1992, set out to discover what the public values in the urban landscape. Its report recommended fifteen essential actions which included: accommodating growth and density in neighbourhoods; meeting the needs of diverse ethnic populations; achieving equity in access to open space across the city; providing different kinds of public open space; improving safety and security; balancing rights and responsibilities; monitoring our natural ecosystem; planning for transit; managing the scale of change; respecting people through public process; clarifying the private and public realm and gathering better information for coordinating planning and management (Quayle, p. 466).

The study provides a valuable structure useful in defining a sense of place which can be applied in lower-income communities where the goal is to achieve a maximization of given human, public and physical resources. The points raised by the study present a useful and comprehensive model identifying obstacles and potential linkages between politicians, community members and the business community. Through the study it was determined that understanding the value of the urban landscape was the primary mandate, as well as the primary difficulty for all members of the process.

Other serious blockages to levels of sustainability exist in an overloaded public service and a loss of identity within the public realm as a result of visual and ecological illiteracy. Overloaded public service provides no long-term goals. Issues are viewed on primarily a reactive and not a proactive role (Quayle, p. 471). Loss of vision results when there are too many ethical systems in conflict due to the diverse forces of politics, community and business interests. This lack of control can be alleviated through consistent and open dialogue. Processes involved in the creation of gardens and greenspaces provide clear examples of impediments to sustainability.

Conclusion
Designers are essentially interpreters of culture. Just as physical plans can be an expression and catalyst for new social organizations, good design solutions are most effective when they are kept simple. Relationships of social organizations are physically expressed in the community’s primary goal to provide shelter and “[since] most reform movements tended to favor social organizations of a highly simplified or utopian character, their community designs were equally simple or utopian” (Lozano, p. 33). This is a hopeful reminder. Simple initiatives through understanding the dynamics of how the community integrates its public and private realms can provide successful sustainable initiatives.

To redesign confidence amongst lower-income groups, policy and action surrounding environmental change should include educational and community design processes which recognize a lateral approach to mixed-use planning. Gaps are filled through action and ideas reached through a community’s understanding of the significance of an ecologically sensitive framework. This framework will permit a community to increase the quality of life and sense of place regardless of income levels, and can prove exceptionally attractive in aiding lower-income communities.
References


Originally trained in public administration and political science from the University of Western Ontario and Carleton University, my interest and approach to architecture and design has always been concerned with context in a variety of aspects which extend beyond immediate site characteristics. The impact of architecture and urbanism within its community is inextricably linked to forces of political, social and economic forces. These impacts, in relation to attitudes of conservation and environmental sustainability is one in which I intend to make a lifetime pursuit.

Having received a Master of Architecture at the University of British Colombia, studying and working on the West Coast exposed new horizons for me in terms of the significance of strong symbiotic relationships between site, context and community. Working with Professor Raymond Cole while a student in Vancouver was an important influence on developing a vocabulary of awareness and priorities in sustainable design. After having graduated from architectural school in 1996, moving to Singapore and working in an architecture office clearly demonstrated the strong relationship of political and economic cultural awareness on the built environment.

Presently working at the Kirkland Partnership in Toronto, and working with Quadrangle Architects before that time, my design education continues to explore many aspects of the impact of design and planning decisions on the environment.
Measuring a Building’s Vital Signs

Professor Terri Meyer Boake, School of Architecture
University of Waterloo, Ontario

The Vital Signs Curriculum Materials Project examines the physical performance of buildings, their energy use and their impact on occupant well being. The goal of Vital Signs is to encourage the next generation of architects to create energy efficient and environmentally responsible buildings. The Vital Signs approach to education involves experiential learning opportunities. The U.S. based project is supported by The Energy Foundation, Pacific Gas & Electric, The National Science Foundation, The Nathan Cummings Foundation, The Educational Foundation of America, The U.S. Department of Energy and the Society of Building Science Educators. It is operated out of the Center for Environmental Design at the University of California at Berkeley. Students at the School of Architecture at the University of Waterloo are currently engaged in building case study research connected with the Vital Signs Project.

The Vital Signs Project feels that architects must be targeted for education about energy and environmental issues. Energy issues ought to be considered and balanced with other aspects of the architectural design process at the earliest point of the project.

“The link between poor design decisions and global environmental problems is a strong one. Coal burning power production is a primary source of acid rain. The carbon dioxide that results from the burning of fossil fuels is a major factor in global warming. The demand for more power, (to heat and cool our buildings), and the accompanying nuclear power plants, new large scale dams, and new oil exploration and mining sites, all contribute to environmental destruction.”
— Vital Signs Manifesto

The United States with only 4 percent of the global population, accounts for 24 percent of global energy use. U.S. buildings account for approximately 38 percent of national energy use and thus 10 percent of global energy use. The energy patterns of Canadian buildings are similar. The architect’s initial quick sketch or model will affect energy consumption, for better or for worse, for many years to come. Thoughtless decisions with respect to building orientation and glazing systems will incur needless heating and cooling costs for the life of the building.

Many architects still see energy planning as something to be handed off and resolved by mechanical and electrical engineers. Many high-profile architects and senior design faculty were trained during the energy rich decades of the 1950s and 1960s and developed a design methodology which devalued building performance and environmental issues. While consulting engineers can condition almost any space that an architect might design, there are high energy costs associated with buildings which do not properly respond to their specific climate and site requirements. Mechanical systems and cheap energy promoted an “International Style” of building – one that allowed architects to ignore climate. The United Nations Building, for instance, heralded this new way of building. The skyscraper’s flush skin, made possible by 2,300 tons of cooling, the daytime use of fluorescent lamps, and solar control glazing, foretold an energy intensive approach to design that remains engrained in architectural practice.
The Vital Signs Method for Building Performance Evaluation

The main challenge of the Vital Signs Project is to restore an appreciation and understanding of the physical environment. Consideration of appropriate building design according to bioclimatic concerns should become one of the basic notions that governs the design process. Building performance, both from energy and occupant comfort points of view, needs to be brought to the forefront of architectural concerns. Understanding energy issues must be a key part of architectural education.

Such studies cannot be accomplished without adequate field work. Data must be collected to verify assumptions and hypothesized performance criteria. The Vital Signs Project requires that students engage the building to assess its performance. This approach integrates abstract conceptualization with reflective learning, concrete experience and experimentation.

As part of the Vital Signs Project, twelve teaching “Resource Packages” have been developed by architecture faculty in the U.S. and Canada. These units address physical building performance issues such as energy use, the experiential quality of buildings and occupant well being. Each resource package is available for free download in PDF file format at the Vital Signs Website (http://www.berkeley.edu/cedr/vs/). The specific topics include: whole building energy use, the dynamics of solar shading devices, natural ventilation, occupant thermal comfort, thermal mass, health in the built environment, indoor illuminance, and glazing performance. Each package includes a variety of materials, including:

• an introduction to primary physical principles
• a discussion of how the topic affects design decision making
• coverage of applicable standards and practices
• an annotated bibliography and
• protocols for field observation and evaluation

The protocols for field evaluation fall into three levels. The first level is based on document based research, occupant interviews and observation. It does not require any equipment. The second level involves minimal equipment for data collection and uses simple site experiments to understand building processes and performance. The third level requires a significant equipment component and involves data collection and analysis over a period of time.

The resource packages are not intended to be adopted as a model course, but are to be adapted to the specific needs of various types of architecture programs and instructors. The suggested protocols are adaptable to varying class sizes, different building types, for undergraduate as well as graduate level work in addition to independent study.
Vital Signs has carried out a series of three training sessions to introduce architecture faculty to the resource packages, protocols and equipment. The training sessions focus on the connection between design intent and building performance. Participants engage in practicing methods for carrying out building work-ups and case studies. A fourth faculty training session is scheduled for July 1998.

**The Building Case Study Library**

A series of retreats held by the Society of Building Science Educators during the late 1980s concluded that there existed a rarity of good building case studies for students to study. A substantial amount of information is published about buildings when they are first constructed, and often unoccupied. Documentation is based design intent rather than “post occupancy evaluation.” Buildings are seldom “followed up” to assess their ability to perform as predicted.

In addition to providing a general environmentally based teaching benefit, the protocols are intended to assist students and faculty in documenting “case study buildings.” Vital Signs has granted a series of faculty awards towards the development of case studies and is currently running its second Student Case Study Competition. A library of building case studies, available for public use, is growing at the Vital Signs Web Site. In addition to the web publication of these peer reviewed examples, non peer reviewed case studies from other University sites are also linked to the Vital Signs Case Study page.

Vital Signs encourages the development of building case studies in the following categories:

- buildings of historical importance (such as the Robie House by Frank Lloyd Wright, or the Glass House by Philip Johnson)
- widely known and influential contemporary buildings (such as the High Museum by Richard Meier)
- buildings known for energy efficiency and environmental responsiveness (such as The Institute for Asian Research at UBC)
- projects representative of specific building types

Case studies currently posted on the site include the Phoenix Central Library, Mt. Airy Public Library, Philips Exeter Academy Library, Museum of Anthropology at UBC, Monterey Bay Aquarium, San Francisco Museum of Modern Art, Yerba Buena Center for the Arts, Taliesin West and the Rock and Roll Hall of Fame.

**University of Waterloo Student Case Studies**

The School of Architecture at the University of Waterloo, through the course Arch 366: Energy in Design, is currently working with the Vital Signs Project. As the result of a Request for Proposals in the Spring of 1997, the school was one of 9 in the United States and Canada to be awarded the loan of a “Toolkit”. The toolkit includes approximately US$35,000 of data collection equipment. The equipment sets include small microprocessor data acquisition systems that can measure temperature, humidity and light levels over time (Hobos); an infrared thermometer to measure surface temperature; photometers to determine luminance and illuminance levels; a sling psychrometer to measure humidity; an anemometer to calculate wind speed; carbon dioxide, ozone and VOC monitors to make preliminary evaluations of indoor air quality; a digital camera for web documentation; and a laptop computer for field use.

Students at the University of Waterloo are currently involved with the use of testing devices to carry out a series of four detailed building case studies which will be hot-linked to the Vital Signs Website and entered into the 1998 Student Case Study Competition. Students are employing all three levels of evaluation protocols. The performance evaluation falls under 3 primary categories: thermal performance, lighting and air quality.
Within the confines of course work and the curriculum, data collection has been limited to a one month period. In spite of time limitations, this does provide a discrete picture of building performance during a certain time of year. In order to create a more complete picture, the students are creating daylighting models to allow for visualization of the year round solar and lighting characteristics. These models will be tested through the use of a heliodon. Some projects will also make use of energy design software, such as Energy-10 and Solar 5.4 to examine predicted annual energy use and performance issues for discrete portions of their buildings. Energy software is also employed to highlight the difference between simulated or predicted performance and actual measurement.

The buildings which are being evaluated are:

**THE BURROWS RESIDENCE: YMCA ENVIRONMENTAL CAMP, PARADISE LAKE, ONTARIO**
CHARLES SIMON, ARCHITECT
This camp building was designed to be entirely energy and systems independent. It has sleeping accommodation to house 40 campers. The building is heated via passive solar in combination with a large wood burning custom designed masonry heater. Students will investigate heating patterns during the winter for both sunny and cloudy days; the effectiveness of the masonry heater; and daylighting for both the large common room and clerestory lit sleeping quarters. The primary structural, floor and finish material used in the Burrows is reclaimed wood. This is an excellent material choice when sustainability is a central concern, but fails to provide thermal mass for passive solar storage. Key questions that the students are studying include the distribution of thermal mass and the effectiveness of earth bermsing in reducing energy requirements.

![Image of Burrows Residence](image1)

**THE DAY CENTER: YMCA ENVIRONMENTAL CAMP, PARADISE LAKE, ONTARIO**
CHARLES SIMON, ARCHITECT
This building was designed to display a number of passive systems, including solar and water filtration. It is used as a demonstration facility and learning center for environmentally sensitive design. Students will investigate the daylighting of both the large solarium as well as adjacent classroom areas (one south facing and one north facing); patterns of heat in the building; the effectiveness of the ventilating system at the top of the solarium which is designed for prevention of overheating; and the effect of sun vs. cloud on the comfort and heating conditions of the building.

Passive solar design requires a careful balancing of the various components of a building. If certain components are eliminated or greatly altered mid-construction, it can seriously affect ultimate building performance. The greenhouse portion of the Solarium was intended to house a water purification system (living machine). To date, because of monetary constraints, this has not
been installed. The students are studying the impact this has on spatial performance. Most obviously the water element would have acted as a thermal mass. Currently the interior is finished with wood and is subject to overheating.

The flooring material in the Solarium is a recycled tire product. Air quality testing equipment is being employed to test for VOC offgassing.

GREENING ON THE GRAND: CANADA’S FIRST C-2000 OFFICE BUILDING
This low rise office complex was designed to maximize daylighting and also uses various sustainable and low energy practices. The principal focus of this case study focuses on the effectiveness of the daylighting strategy. In order to maximize daylight, the building envelope is 30% glazed and has uniformly distributed windows on all orientations. A high performance selective spectrum low-e glass was used in lieu of solar shading devices. The students are conducting an occupant survey to examine comfort levels for the various orientations and will also look at issues of glare that may result from winter sun penetration at this latitude. They are fortunate to have the cooperation of Enermodal Engineering who is a tenant of Greening on the Grand and who was involved with the energy design of the building.

BOYNE RIVER ECOLOGY CENTRE: DOUGLAS POLLARD ARCHITECTS
The ecology centre houses classroom space for up to 200 students who visit weekly for lessons on the environment. It creates all of its own power from wind and sun, including water heating, cooling and ventilating by natural methods. It is fitted with a sod roof and relies on natural daylighting. Students are examining the impact of significant post occupancy changes to the heating system. The building was designed to be heated through the use of a central fire place. This was removed and replaced by alternate heating which has modified the energy consumption of the building and modified the design focus of the central fire place. Other curious issues include the limited student use of composting toilets – which do not work properly unless adequately fed.

Outcomes
Feedback from students involved with the Vital Signs Toolkit at the University of Waterloo has been extremely positive. The students feel that field work and the experience with data collection equipment presents a more meaningful way of learning and appreciating building performance issues. The School is looking into acquiring funding to support the purchase of equipment to create a University of Waterloo Vital Signs Energy Lab. The Energy Lab will be operated by the School of Architecture. The Energy Lab will enable the students to engage in more detailed research, allowing building performance to be studied over an extended period of time. The lab
will be used to support energy related teaching and will create additions to the Vital Signs building case studies library on a continuing basis. The equipment will also be available for independent undergraduate student research projects, thesis projects and faculty research.

Credit

Much of this information is excerpted from the Vital Signs Web Site. The key people involved at the Center for Environmental Design Research at the University of California at Berkeley with the development of the Vital Signs Project are: Cris Benten, Gail Bragar, Bill Burke and Alison Kieck. More information, including the case study library, is available on the website at http://www.berkeley.edu/ced/vs/ or by contacting vitalsigns@ced.berkeley.edu.

Terri is a Professor at the University of Waterloo School of Architecture. She is responsible for core curriculum development and teaching in the Technology Theme Area, including Building Construction, Theory, Design and Passive/Sustainable Applications and Principles.
Putting Humpty Dumpty Back Together Again – Redesigning the Designer

Douglas B. Pollard, B.Arch, O.A.A., M.R.A.I.C.

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Introduction
At the beginning of Architectural history there were no architects to get in the way. Natural determinants such as wind directions, temperature swings, solar access, materials on hand, the limitations of the human body to carry, lift and lever and so on were the prime design determinants and man followed the rules they laid down.

Structures, for the most part designed as basic shelter, functioned with varying degrees of success. They were often elegant in their expression, efficient in their use of materials and remarkable in their ability to capitalize on the benefits of orientation, thermal storage and wind direction etc. They also often leaked, got too hot or cold, caught fire or blew away in the wind.

Experience taught man how to overcome many of these limitations without losing the natural benefits and at the same time to use buildings to raise the human spirit and enhance the human adventure. Architecture became the means by which a society wove together the natural and cultural environments and the means by which it inspired, threatened, humbled, comforted and spoke in a permanent manner. Architects, who emerged as the prime designers, became important as cultural spokespersons, archivists and constructors.

Over the centuries the picture became more complex. Our numbers grew exponentially. Our values and economics shifted. Numerous technologies emerged, many of them establishing a misleading picture of short and long term comfort. The design community fragmented as the issues it dealt with grew and grew and the ability to deal with this ever increasing complexity exceeded the capability of a single master builder.

The designer became a broken egg, so to speak, the pieces being represented by numerous professionals and specialists. This is in itself not a problem. The problem is that all the pieces are seldom re-assembled when a design project is undertaken.

We know that the natural world to be extremely complex and difficult to grasp at a glance. We also know that this complexity embodies many interrelationships and interdependencies which are not only mutually supportive but in fact absolutely vital to the continuance of nature as it exists.

The necessity of completeness also applies to the world of design.

The Opportunity
Both the strength and the fragility of nature can be found in these interdependancies. If one thread is snapped others are stressed sometimes to the point of failure. Similarly the design profession when it is fragmented and disconnected loses much of its strength and ability to produce true elegance, efficiency and beauty and to construct an enduring environment of significance.
From the concept of strength as found in interdependencies comes an opportunity for the design profession to reconstruct itself, not as collection of individuals dealing with single issues but as a collaborative team with a common vision. By working in a holistic way to weave together an appropriate built environment the profession can re-empower itself to become a truly significant contributor to society at large. Architects as major contributors have the opportunity to become the master weaver and perhaps the weaver whose role it is to integrate the golden threads that make the tapestry special.

It is often feared that the team or collaborative approach to design suggests conflict, confusion, contradiction and compromise. In actual fact this would seem to really be the result of professionals working in independent environments, guarding their territories, ignoring one another, ducking and pointing to avoid blame where it is directed and rushing to accept singular acclaim if it is offered.

It is true that we now design in teams. It is the manner in which we create these teams, their composition and the manner in which the teams behave that requires reinventing. The traditional team has a lead designer who proffers a vision which the other team members are asked to support or “make work”. The lead designer is often the developer or client who brings forward a program based on reactions to previous situations, short term economics or projects he saw on vacation in a different country and context. This leads everyone down the garden path from the outset.

If instead, the design process begins with the complete team conceptualizing the issues at hand in unison the opportunity for design success and relevance increases exponentially. To illustrate this point there follows some twenty or so examples which illustrate the rich and varied vocabulary of architects, artists, engineers, biologists, residents, rulemakers and others expressing themselves harmoniously through construction. This catalogue of structures ranging from huts to cathedrals underscores the notion that the designers who embrace natural determinants at the origins of design thought and integrates all appropriate disciplines into the design process achieve a greater freedom of expression and are not fettered by strict rules of a narrow fuzzy green vocabulary as is so often feared.

It is important to note that the approach to design which is manifest in these works is also precisely the approach required to create what is currently considered to be a sustainable environment. It is of no small significance that the establishment of a truly “sustainable” design approach is precisely what is required if we are to arrest environmental degradation and begin regeneration and restoration.
THE BEAVERTANK PROJECT (NEAR HALIFAX)
This small shelter is a collaborative project between the students at the Technical University of Nova Scotia and the Nova Scotia College of Art and Design. It was assigned by architect Richard Kroeker. The structure evolved without drawings and in total response to materials at hand and dialogue between architects and artists and the knowledge accrued from one mutual experiment.

HOUSE BY GLENN MERCUTT (AUSTRALIA)
Ron Mercutt, known for usually working by himself, established a dialogue with the site and its breezes and with the artist client, an engineer and a supplier of the steel frames for this house. It derives its form from the most humble beach shelter but is reinterpreted as an elegant (although admittedly expensive) sculpture for living.

HOUSES BY THE JERSEY DEVIL (BAHA CALIFORNIA AND FLORIDA)
An architect known for building his own works finds a totally different vocabulary for expressing the same design determinant of capturing and manipulating breezes. The projects use a mass construction technique in one instance and a delicate frame in the other. The mass house in Baha introduces a focus on rainwater collection via its dramatic butterfly roof. Not only does this roof collect rain water and direct it to a cistern but it serves as the cooling system by accelerating breezes through its hollow form and shading the walls below.

DESIGNER HOUSES FOR THE POOR (ALABAMA)
A third expression is found in the work of the students of Auburn College of Architecture, Design and Construction. Once again the roof serves to shelter, collect breeze and water and define an uplifting living space, this time on an extremely tight budget. The design is a collaboration involving numerous students, educators, the residents, the municipality and the materials on hand.

ARIZONA ENVIRONMENTAL SHOWCASE HOME (JONES STUDIO)
At the other end of the visual spectrum is a demonstration project evolving from the partnership of a number of agencies and institutions expressing a common desire to develop a teaching home. The home displays a number of energy conserving approaches with a sophisticated language, this time with the intent of not only explaining and raising awareness of the principles involved but housing educational activities as well.

HOUSE IN BREISCH GERMANY (THOMAS SPEIGELHALTER)
The technological (and somewhat whimsical) expression dominates a house that in reality is a living organism relying on solar energy and rainwater for survival. It is also organized to embrace the arts in the form of small concerts and exhibitions while tracking the sun.

EARTH SHELTERED HOME IN NORTHERN CONNECTICUT (ALFREDO DE VIDO)
A completely different yet sophisticated vocabulary evolves when a home prioritizes energy con-
servasion instead of energy production, this time with earth sheltering. The client, a weaver, finds room for self expression in the ceiling finish.

ECO-VILLAGE IN ITHACA NEW YORK
This thirty home cluster is the first phase of a 500 person community in New York State. It is the result of an intense one year collaboration between architects, residents, engineers, landscape architects, agriculturists and the municipality. The homes are sited and moulded to maximize solar gain, minimize energy use by sharing heat sources and protecting one another and to establish a stronger and safer sense of community focusing on the communal building. The vocabulary is once again made richer by the recognition and integration of natural determinants, community concerns and mechanical considerations and once again site specific.

THE BOYNE RIVER ECOLOGY CENTRE
This project was originally conceived of as an upgraded cabin which would incorporate a few extra energy efficient add-ons to be specified by an engineer. When the team was structured to include myself as the architect, the engineer, a biologist, the educators, the maintenance staff, the students and various suppliers the project evolved exponentially into a didactic built environment which has made its tiny voice heard around the world.

THE KITCHENER YMCA BY CHARLES SIMON
A project based on a very similar building program and ideology in the identical climate expresses itself in a different manner with equivalent results.

LESLIE SCIENCE CENTRE, MICHIGAN
A building with an almost identical program on a different site took on a radically different form. This form evolved from dialogue with the staff and users, as a response to site and climatic conditions and the water treatment system. Its circulation was organized to replicate a trip to the headwaters of a stream which in turn purifies, cools, humidifies and delights the users of the building as they pass through.

ENVIRONMENTAL EDUCATION CENTRE, WIARTON ONTARIO
Adding representation of aboriginal and settlement heritage changes the expression and the experience but leaves the principles intact.

THE NMB BANK IN AMSTERDAM
This 500,000 sq. ft. office building resulted from the collaboration of architects, landscape architects, engineers, artists, building physicists, management and staff. No one person was totally responsible for the design. Its form is derived from the natural determinants of maximum daylight penetration and access to fresh air. Its interior integrates water, light, delight and art. It is famous not only for its three month energy payback but for its vastly improved employee production and reduced health problems. Apparently no one ever wants to go home.

THE MENARA MESINIANG TOWER IN MALAYSIA (T.R. HAMZAH & YEANG)
This 15 storey tower uses a three storey earth berm at the base, massages its facade in response to solar positions throughout the day, and employs brise-soleils to reduce its energy consumption.

COMMERCEBANK IN FRANKFURT (FOSTER AND PARTNERS)
This 42 storey tower embodies a number of interior gardens arranged in a similar rotation for similar reasons. One of these three storey spaces in every twelve floor "village" provides convective air loops through stack effect, daylight, air cleaning (all occupants have 100% fresh air) and pleasure for the occupants. A full height atrium brings daylight into the interior offices.
IDEAS CHALLENGE
The original intention was to design an energy efficient high rise. By constructing the design team to include wall system suppliers and the builder as well as the engineers and architects and designing in full team sessions the scope quickly and easily expanded to establish a building that not only delivers 100% fresh air to every room but also processes its own waste biologically, receives green garbage to process in its methane digester for fuel for the its co-gen system which in turn exports power. The formation of the facade, building form and internal layout comes directly from examination of a number of wind, water and sun determinants and blends with considerations for requirements of energy efficiency and an improved quality of life and community. My personal opinion is that the result is much enriched but then as the architect I have a certain bias.

MANHATTAN GREEN GIANT (FOX AND FOWLE)
This 48 storey, 1.6 M sq. ft. office project employs fuel cell and photovoltaic technology to top up its energy efficient systems and to produce power for the mandatory signage requirements of Times Square. It was designed by the developers, construction managers, future tenants, engineers, specialized consultants on air quality, the National Resources Defense Council and the Rocky Mountain Institute. The design was also modified to involve future tenants in the initial thinking. This empowerment of the tenants saved time, contradiction and stress during the design phase, ensured the proper operation of the building and essentially established the feasibility of introducing and operating leading edge technology in the market.

DESIGN FOR A TRANSEPT ADDITION TO ST. JOHN THE DIVINE CATHEDRAL, NEW YORK CITY
This design for a new transept for the largest cathedral in the world came from an intensive charrette process with numerous religious and community members and other consultants including biologists from two think tanks. The result is that the inspirational work of Santiago Calatrava is lifted to an even higher plane with the integration of a greenhouse as the apex of the transept and into the attic of the existing nave. This greenhouse cleans and cools the air and water and filters the light and serves as an inspirational representation of the leafy canopy of the forest.

Summation
While the reader will draw their own conclusions as to the aesthetic values of the examples offered it should seem clear to all that when numerous disciplines form an interdependent and interlocking design methodology the opportunities for expression are greatly expanded. It is also readily apparent that the vocabulary of expression is as varied as the site and the participants. Stick shelters, schools, apartments, office towers and cathedrals can all look to the sun, wind, air and water currents, biological systems and the like to generate a design direction and yet each can find a personal and singular expression.

The joy of these design directions is that they are more relevant and more (pardon the phrase) sustainable than those which overlook the input of certain professions. The benefit of these directions is that they eliminate the necessity of arguing whether or not the planet can or should be rescued via the built environment and of rationalizing “green design” through demonstrations of improved employee performance, improved health, lower energy costs etc. and re-introduce enrichment as a motivation and catalyst.

The freedom found by stepping around these arguments empowers the design team to utilize delight, comfort, pleasure and inspiration to be found in a holistic design philosophy as the rationale for design. Pleasures of the flesh have historically been one of the easiest sells. The market for them is the size of the planet and the planet needs the product. This sounds like opportunity to me.

Doug graduated from U of T in 1968 and have practiced architecture in Toronto since, primarily in his own practices. He focuses on projects which demonstrate an intelligent use of land, resources and finances and which can permit user participation in the design process.
Ontario Association of Architects

The Ontario Association of Architects is the licensing body and professional association representing the 2500 architects, and over 1100 Intern Architects and associates. Architecture is a self-governing profession under the Architects Act in Ontario. The Association has a mandate to regulate the practice of architecture in order that the public interest may be served and protected, as well as to promote public appreciation of architecture and the role of architects and to set standards of knowledge and practice for the profession.

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MISSION STATEMENT
To lead and co-ordinate the profession’s involvement in environmental and energy related issues and to promote the role of the architect in preserving and protecting our planet from environmental damage.

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