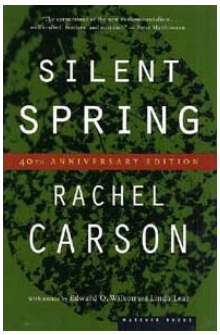
Moving towards green…from the ugly duckling to the beautiful swan…

A brief history of sustainable design in commercial and institutional buildings

Real *change* does not just "happen". It requires either a catalyst or a series of events to effect evolution. Lasting change requires both success and commitment. Sustainable design has been no different. The directed evolution of green building, from its inception in the mid 1960s to its current state in the year 2004, has been the result of a series of publications, key events and significant buildings. Commercial and institutional building has been slow on the uptake, but progress is beginning to be evident.

the egg

It wasn't always called "green building". And it wasn't always even about building. It started in the 60's with the publication of Rachel Carson's book "Silent Spring". Carson brought the issue of the toxicity of pesticide use to the environmental forefront and managed to eventually effect a remarkable improvement in the way that crops were managed, without DDT. From the vantage of 2004, it seems a little obvious that pesticides sprayed on crops will eventually make their way into the food chain, be consumed by humans and cause illness. Sewage issues in major European cities during the early 1800s were really no different. Dump waste into the river. Draw drinking from the same river. People die. In 2004 we are grappling with the fact that the construction of "everything" is having a negative and irreversible effect on our environment. Buildings are among the worst offenders.

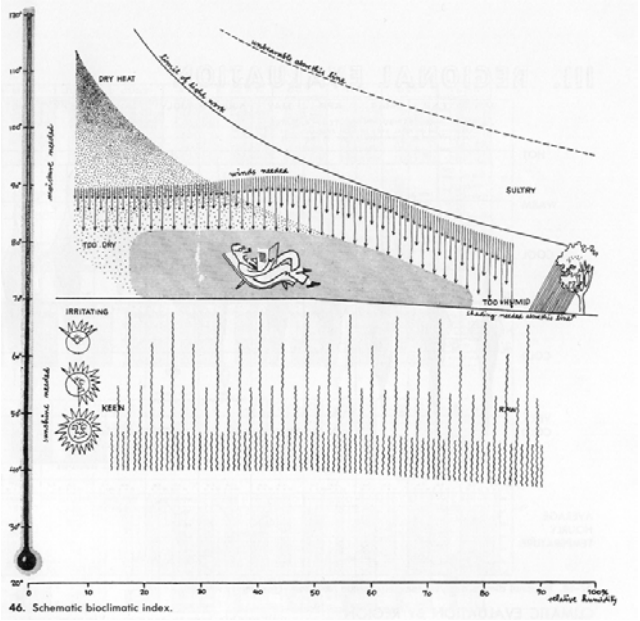


Silent Spring. Rachel Carson. 1963

Carson's book was followed very closely by two important works that brought environmental concerns to the field of architecture: "Design with Climate" by Victor Olgyay, published in 1963, and "Design with Nature" by Ian McHarg, published in 1969. Olgyay's book initiated a different approach to thinking about building. It's premise, that buildings should be designed to accommodate regional climatic differences, based on vernacular models for building, ran completely counter to the ideas behind Modern Movement architecture. The "International Style" of architecture supported building the same project in any location, and relied on mechanical heating and air conditioning to compensate for climatic differences and make the interiors "livable".

Victor Olgyay. Design with Climate. 1963

In 1963, energy was still cheap, so was not the motivating factor in pushing for a climate based design theory. *Comfort was*. The notion of "thermal comfort" of which Olgyay wrote, provided the climate based seedbed for the "solar movement" that grew out of the fuel crisis in the mid 1970's and saw the first iteration of climate based building.



"The Comfort Zone". Olgyay. 1963

the ugly duckling

Olgyay's famous map of the bioclimatic "comfort zone" initiated a way of thinking that favored solar control and natural ventilation in buildings. This trend in thinking, of course, went counter to the creation of the hermetically sealed glass boxes that were springing up all over Europe and North America during the post-war building boom. And of course, needless to say, this *revolutionary idea* of using architectural devices (operable windows, shading devices, building orientation, planting) to modify the interior environment, rather than handing over the job to one's mechanical engineer, proved to be very unpopular with the majority of big-name architects. The new "solar" buildings looked so remarkably different from mainstream modern architecture, resulting in by-and-large rejection as a viable means of designing commercial and institutional buildings. Most of the "environmentally designed" buildings that were developed during this period were houses or smaller community type projects. These unique clients were interested in working with the innovative ideas and building systems presented by environmentally designed buildings.

Patoka Lake Interpretive Center.
Fuller Moore Architect and Environmental Professor, 1983

Although the Patoka Lake Interpretive Center might not have been a largely influential building in the environmental movement, its author simultaneously authored a text, "Environmental Control Systems", published in 1993, which, both following and replacing Olgyay for a new generation, served widely as the base text for many environmental courses and subsequent educational publications.

The 1970s saw the growth of a limited solar building movement that was directed at reducing the energy consumption in buildings as a result of rising fuel costs. In Canada, which is a heating dominated climate, winter conditions governed design choices. Window strategies were developed to maximize penetration for free heating. Insulation levels were increased and buildings were tightly sealed to cut down on leakage. When people began to suffer the ill effects of too tightly sealed buildings, fresh air requirements were examined and standards modified to include indoor air quality as a consideration. Indoor air quality concerns nudged open windows again – operable windows began to come back into "vogue", but in limited application on commercial and institutional buildings.

In 1974 the American Solar Energy Society held its first passive design conference. The conference provided a venue for researchers, educators, practitioners and members of industry to share ideas and advanced passive design strategies. The group expanded in the 1980s to include active technologies, and has been both the sounding and publication ground for significant research in the area of solar as well as sustainable design.

In 1984 a World Health Organization report suggested that up to 30% of new and remodeled buildings worldwide had such inferior indoor air quality as to be detrimental to the health of their occupants. Indoor air quality morphed into studies into "sick building syndrome" – effecting ventilation strategy changes in commercial and institutional buildings that began to include operable windows.

Still throughout the 1970s and 1980s such concerns remained "residential" in their influence. Larger buildings continued to follow traditional modern principles of design. Frankly, many of the early solar buildings were either quite unattractive, or downright strange looking. "**D**"esign has never been about willfully creating ugly buildings. Commercial buildings need tenants to be viable. Tenants want smart looking buildings. Institutional buildings must answer to the public. The public also wants "accountable" appearing architecture. The 1980s experienced numerous stylistic changes in architectural design: post-modernism, neo-rationalism, deconstructivism. Environmentalism was not included. It was not fun. It required scientific calculations to make it credible. It did not look good. Only the hardcore environmentalists were committed. Mainstream superstars shunned the idea.

So what happened to change the attitude of commercial and institutional development?

The World Commission on Environment and Development, Our Common Future, 1987:

Sustainable development is development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs.

The boundary conditions had changed from concern about the mere consumption of increasingly expensive fossil fuels, to global issues of environmental stability. Statistics regarding dwindling supplies of natural resources, that are needed to create and maintain our lifestyle, caught the attention of many. It was becoming increasingly obvious to architectural educators as well as a wider body of practicing architects that the problems posed by the sustainable design question were not about to go away. Architectural curricula began to both develop and expand courses in "environmental building design". The new definition of sustainable design was increasingly holistic in its approach to building, expanding the initial of "energy efficient" architecture to include: energy and atmosphere, materials and resources, indoor environmental quality, site design and water efficiency.

the transformation

In 1992 the German corporation of Commerzbank announced a competition for a radically innovative skyscraper. It was to be the first and tallest ecological building. The programmatic requirements included: reduction in energy use, a specialized skin that would allow natural ventilation (unheard of in high rise construction), high levels of daylighting for occupant comfort, skygardens, recycled greywater systems as well as care at ground level to integrate the building into the community surroundings. The winner of this limited competition was Sir Norman Foster and Associates – a superstar! *The sustainable building game had just changed*.

Commerzbank, Frankfurt, Germany
Sir Norman Foster and Associates, 1992

Now that a high profile international firm had tossed their hat into the ring, a larger number of architects began to give serious consideration towards including sustainable design into their portfolio. This was likely both good and bad for the movement. Projects such as Commerzbank, that used a high-tech approach to sustainable design, resulting in very sexy buildings, also had extremely large budgets. Sustainable design was classified by many as beyond the budget and scope of most projects. Commerzbank, and the subsequent line of double skin façade buildings, resulted in heated debate in the architectural and engineering community. Debate that is ongoing some 12 years later. Such buildings may generate energy savings (which to be credible requires monitoring and published documentation), but also use higher quantities of natural resources in the mere fabrication of their elaborate skin systems. (author aside, for more information on double skinned buildings, take a look at my website: http://www.fes.uwaterloo.ca/architecture/faculty_projects/terri/ds/title.html

Where such approaches to both towers as well as mid to low rise commercial and institutional buildings began to take hold in Germany and other parts of Europe, North America lagged behind. Why? *The German building regulatory system mandates daylighting and access to natural ventilation in office type buildings*. Occupants must be no more than 7 metres from the outside wall of the building! No similar regulations exist in either Canada or the United States. However, numerous studies were done in the U.S during this period to try to establish a scientific connection between daylighting and occupant health. *(Big windows were found by architects to have more design potential than insulation…)* Also included in these studies were connections between daylighting and increased worker performance as well as reductions in employee absenteeism. *(Commercial clients found that interesting…)* 1995 sees the publication of key articles regarding the health benefits of daylight in schools as well as daylight and productivity in commercial buildings.

Ecology of Commerce. Paul Hawken, 1993.

It is likely no coincidence that such studies followed the publication of Paul Hawken's influential book, "The Ecology of Commerce: A Declaration of Sustainability" in 1993, where he unequivocally states that "Business people must either dedicate themselves to transforming commerce to a restorative undertaking, or march society to the undertaker…Quite simply, our business practices are destroying life on earth."

The 1995 publications include research into daylit schools that generated data that not only included energy savings with respect to reduced electric lighting requirements, but also statistics regarding the health of students. Such published statistics documented a reduction in dental problems in students studying in daylit schools, as well as better academic scores and lower rates of absenteeism of both students and teachers. Studies were also published that year regarding the economic success of the Lougheed 157 building constructed in Sunnyvale, California in 1983. The Lougheed building was designed with a sophisticated wall and atrium system that included floor to ceiling windows, and light shelves, combined with "shaped ceilings" to bounce light further to the interior. Where savings were documented in electric lighting costs, these paled in comparison to statistics that demonstrated a 15% reduction in employee absenteeism. It was calculated that the combined savings of these two factors resulted in a saving of $500,000 per year for the company.

Lockheed Atrium (have to find better image…)

the swan emerges…

Where earlier forays into environmental design had netted some not-so-interesting architecture with perhaps questionable absolute green value, there are few who will argue with daylighting and its connected benefits, as a focus for architectural design. Daylighting – AKA windows – also brings to the table important issues regarding envelope design and performance. However, the increased use of windows can effectively *decrease* the overall performance of the building envelope where insulation levels are a primary concern, such as in cold climates. Design involved a balancing act between amounts and locations of glazing, combined with the thermal performance of the building envelope, and the overall effect on heating, cooling and electricity loads. Luckily, advances in spectrally selective glazing, and overall window and curtain wall design, have assisted in answering some of these more scientific aspects.

Kyoto, 1997, focused the discussion of sustainable design on the production of greenhouses gases (mainly CO_2). The developed notion of sustainable building design expanded the area of concern in building design to not only include greenhouse gas emissions as a result of the burning of fuels associated with heating and cooling buildings, but also from the production of building materials, in terms of their embodied energy, transportation costs, as well as resource depletion with respect to deforestation. Canada has ratified this agreement which seeks to reduce greenhouse gas emissions from 1990 levels by 7% from the period 2008 to 2012. *Both the United States and Russia have still not signed the agreement.*

During the mid 1990s the US Green Building Council is formed. A means to evaluate the relative "greenness" of buildings is sought. The British counterpart, BREEAM, had been developed, but did not suit American standards and codes. The LEED assessment tool, launched in 1998, post Kyoto, was developed to: establish a common standard of measurement for green buildings; promote integrated, whole building design processes, stimulate environmental building and competition; make consumers more aware of the benefits; and, transform the building market. By awarding buildings bronze, silver, gold and platinum medals, based on their sustainable design qualifications, the tool was designed to respond to commercial marketing strategies. The oldest certified building was the Kandalama Hotel, in Sri Lanka, constructed in 1994, followed by the Energy Resource Center in Downey, California in 1995. Only a handful of buildings were certified in the first few years, but numbers of projects both registered as intending to apply for certification, and those actually certified, are rapidly growing. It would seem that the idea of LEED is catching on. Numerous cities and government organizations have begun to adopt LEED minimum qualifications standards for all new buildings. As of March 2004 there were 1,118 LEED registered projects in the United States, 93 certified.

from the swan to the Canada goose?
So what does this mean for the state of Canadian sustainable design when it comes to commercial and institutional buildings? Well, if you live in and around Vancouver, quite a bit. The green building movement gained significant strength in British Columbia through the creation of LEED BC. The Canadian Green Building Council was formed in April 2002 to act as a national agency whose interest is to create and market a Canadian version of LEED, which is largely based on LEED BC. In Canada there are 66 LEED registered projects of which, 35 are in British Columbia. All 3 certified projects are also in British Columbia. This West Coast trend is also apparent in the United States, with California, Oregon and Washington State carrying 25% of the LEED buildings.

key projects:
This is not to say that all good sustainable buildings are LEED driven. A number of highly successful Canadian examples have been motivated by the same principles that ground LEED, but do not go the certification route (which does cost money…). The ideals include a responsible attitude towards energy and resource use, natural ventilation strategies, sustainable site design as well as the benefits of daylighting as it connects to both indoor environmental quality as well as reduction in electrical consumption. The buildings herein will show some of the main strategies that are now being used in commercial and institutional construction, as well as highlight the creation of articulate mainstream architectural projects. The ugly duckling is no more… in fact, I think we have a few peacocks among the lot!

The palette of sustainable moves that are being routinely applied to commercial and institutional buildings is becoming both more standardized as well as more widely applied on a wide range of types and sizes of projects. The major *green moves* that can be now be found on most projects would include:

Increasingly common strategies used to implement sustainable design:

Resources:	• Use of local materials • More environmentally friendly products: recycled materials or content, low embodied energy, avoidance of endangered resources • Increased use of flyash concrete to reduce CO_2 emissions • Cellulose insulation
Water:	• Use of low flush toilets and waterless urinals • Grey water cleansing systems • Control of storm water runoff on site • Green roofs
Indoor Air Quality:	• Natural ventilation • Access to daylight • Low VOC materials • More user control for heating, cooling and shading systems.
Energy:	• Differentiated façade design to achieve solar control, shading and free solar gain • High levels of insulation • Energy efficient windows and selective glazing systems • Sensors to control artificial lighting levels • Occupancy sensors
Siting:	• Concern about orientation • Minimize site disturbance • Access to public transit • Brownfield development favoured over green sites

The Green Building Challenge, an international gathering and competition for quality sustainable buildings, has provided a key opportunity to both show off, as well as learn, about varying strategies and solutions to sustainable building issues from around the globe. The Challenge started in 1998, and runs every two years. Some of the buildings highlighted in this article were those selected to represent Canada as our national entries.

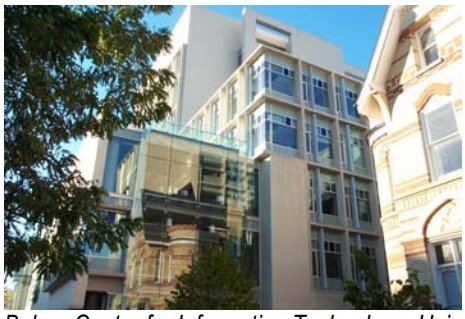
Liu Centre UBC. 2000
Architectura with Arthur Erickson
The Lui Centre was the second building on the UBC Campus to go green. It is situated next to the C.K.Choi Centre for Asian Studies (Choi important as one of the earliest ventured into institutional sustainable design in 1994). Liu is quietly nestled into the densely treed landscape, so site disturbance during construction had to be minimized. There is extensive glazing for complete daylighting of spaces, as well as operable windows. The plan organizes itself around two courtyards, again to give all users both daylight and views. The site microclimate helps to keep things cool. Many recycled materials were used. Flyash concrete was employed. This new variety of concrete uses slag from the steel industry to replace part of the cement required in the concrete. Cement production creates high quantities of CO_2, so use of the flyash material helps with greenhouse gas emission reduction.

Terasen Gas. Surrey, BC (formerly BC Gas) 2000
Musson Cattell Mackey Partnership
Terasen Gas also makes use of flyash concrete for its main concrete structure. The building uses differentiated façade shading strategies on the 4 cardinal elevations, combined with central atria in each of the 4 building pods, to assist with daylight control, as well as natural ventilation. Extensive rainwater collection pond systems are used on site to manage site water and provide a stunning natural water system that supports diverse wetland life.

York University Computer Science Building. 2001
Busby + Associates with Architects Alliance.

Canadian Green Building Challenge Submission 2000
The York University Computer Science Building replaced another Computer Science facility that had outgrown its academic usefulness in only 10 years! For that reason, the planning of the building focused on flexibility and ease of changing the interior partitions, so the same fate would not befall the new facility. Differentiated façade treatment strategies for both daylight and natural ventilation are used. Important to this facility was the use of an "integrated team approach" to the design and planning of the building. The corridor and courtyard spaces are allowed to be slightly less than optimized for comfort to save energy. The computer labs, which generate heat, are situated beside cooler spaces, so that the systems in the building can assist in self balancing. Flyash concrete was used here as well, for CO_2 emissions reduction.

Jackson Triggs Estate Winery. 2001
KPMB Architects
Canadian Green Building Challenge Submission 2002.
This very high profile winery in the Niagara region boasts a brightly daylit interior which helps to cut down on electrical consumption for lighting. Also cooling the building are the oversized overhangs from the large planar roof that extends well beyond the walls of the building. The footprint of the building was kept compact to both minimize site disturbance as well as optimize the land remaining for vine production. The 5:1 ratio of the floor plate size results in an elongated south building face to increase solar gain potential in the winter months. Stormwater collection systems were used on the site as well, discharging collected water to "soak away pits" for controlled re-entry to the groundwater system.



Bahen Centre for Information Technology. University of Toronto. 2001
Diamond and Schmitt Architects
The Bahen Centre is one of the largest buildings on the UofT campus. It is a complex infill project that has made good use of spatial adjacencies to balance heating loads in the building, as well as atrium spaces and floorplate size to provide good daylighting of the interior spaces. The large heat intensive computer labs are located on the north side of the building, while the lounges and offices face south and east. Differentiated façades were used for sun control, with shading devices, selective glazing, and operable windows. Site water is well managed and accommodated in a series of courtyards around the complex shape of this infill project. The project densifies the city, replacing a series of asphalt paved parking lots that once occupied the site.

Mayo Replacement School. Yukon. 2001
Kobayashi + Zedda Architects
Canadian Green Building Challenge Submission 2002
The Mayo school is a multi-purpose facility designed to accommodate the many needs of a small community. Co-existing in the facility for this town of 500 are a K-12 program, recreation center, community library, Yukon College and a First Nations education centre. Extensive daylighting is used, via clerestory windows, to minimize electricity consumption during those times of the year where daylight is plentiful in the north. Recognizing the severity of the climate, and the high price of fuel in the north, the building is constructed to C-2000 standards, with high insulation levels throughout. Materials are sourced as locally as possible as shipping into the extreme north presents difficulty as well as high cost implications.

Caisse de Depots et Placements. Montreal. 2003
Gauthier, Daoust Lestage Inc./Faucher Aubertin Brodeur Gauthier/Les architectes Lemay et associés, in joint venture.
The CDP is perhaps one of the largest, most "high-tech" and most expensive of the recently constructed green projects. Its signature is an "intelligent façade system" that uses a partial double skin to buffer the cold Montreal climate. The façade incorporates user controlled shading devices as well as operable windows for ventilation. Daylighting has been an important part of the design – which in addition to the special façade, includes a series of centralized atria along the length of the building. The building itself is constructed over top of the Autoroute Ville Marie, and uses long span steel trusses to support the building as it sits on top of the expressway, creating a more sustainable urban density.

Moving Towards Green:

> "With lifespans of decades or even centuries, buildings are among the most lasting objects we produce. They account for more than one-third of national energy use and over sixty percent of national electricity consumption. Buildings in the United States alone account for almost 10% of global energy use. They also serve as models for much of the new construction in the developing world. A quick sketch or clay model made by an architect in the earliest stages of design can affect building energy consumption well into the future. A thoughtless decision about building orientation may create a cooling load that lasts as much as a century. Decisions about the extent and type of glazing in a commercial or institutional building will affect power use for thousands of business days." *Vital Signs Project Brief.* http://www.arch.ced.berkeley.edu/vitalsigns/brief/vsl.html

Green building is coming to be seen as an important and scientifically backed international initiative that is starting to profoundly change the way architects *must* design and build. *It is not a passing trend.* Buildings, and the way that we as occupants live and work in these places, just plays too big a part in global issues of sustainability, that change must occur. Increasing numbers of cities and government organizations and universities are a creating a trend-setting example by mandating construction to meet or exceed LEED benchmarks. Schools of Architecture in the United States and Canada, for 10 years now, have been proactively changing their curricula to widen sustainable design teaching. In June 2004 I attended the second Canadian meeting of "Greening the Curricula". Faculty representatives and students from all 11 schools of architecture in Canada brainstormed and shared ideas for two days as to the best means to transform courses, students and faculty to a more sustainable mentality. Students, whose green education is even now, significantly beyond that of their professional elders, will undoubtedly have a great impact on the profession in years soon to come! A remarkable number of Sustainable Design motivated professional courses are being offered to Architects who must satisfy continuing education credits on an ongoing basis in order to upgrade their skills. The Green courses (Sustainable Design, Marketing Green Design, Building Integrated Photovoltaics, for example) are some of the best subscribed offerings.

Eventually, sustainable design criteria will become an integral part of all commercial and institutional design processes and requirements. Green building practices will come to be seen as good building practices and slowly form part of everyday design. Someday, it will become so commonplace that our students will wonder what all the fuss was about… And it can't happen soon enough. It is sincerely hoped that this escalating trend in design will result in an increasingly substantial body of simply "good" architectural work, and that sustainable design strategies and building choices will someday have become so mainstream as to be unworthy of a highlighted separation when discussing building.

"Treat the Earth well. It was not given to you by your parents. It was loaned to you by your children."
--- Kenyan Proverb