Multi-functional Sustainability: Off-Grid City Living

2004 Ecohouse Competition

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Precedent and Initiative in Architectural Design:

"The works of the past always influence us, whether or not we care to admit it, or to structure an understanding of how that influence occurs. The past is not just that which we know, it is that which we use, in a variety of ways, in the making of new work…. The typology argument today asserts that despite the diversity of our culture there are still roots of this kind which allow us to speak of the idea of a library, a museum, a city hall or a house. The continuity of these ideas of type, such as they are, and the esteemed examples which have established their identity and assured their continued cultural resonance, constitute an established line of inquiry in which new work may be effectively grounded." [i]

- John E. Hancock

ECO-HAVEN

General Climate and info about the Toronto Climate:

Latitude	43°
Longitude	79°
Average Temperature as low as	-7.3° winter
Average Temperature as high as	26.5° summer

Sun angle summer 72°
Sun angle winter 23°

In a location where its climate has such extremities, it would be challenging and rewarding to design a successful sustainable project in Toronto. To minimize the footprint of the building itself, it was decided between me and my design partner that the site should be in downtown Toronto, where buildings are tight up against each other and the integration with pedestrian must be considered. To create a close-knit environment for the family of four, Eco-Haven would be a mixed use building that facilitates the family business of a floral shop at ground level and a residence for the two adult and two children above. In addition, a small rooftop garden has been integrated into the design to not only provide a retreat and play area for the family in the otherwise busy city, but it will also contributes of the thermal massing strategy for the sustainable design.

One important goal of the ecohouse design, as with any other sustainable project, is to minimize energy and resource consumption while providing a high level of comfort and architectural aesthetics for occupants. This is achieved by design strategies that respond to specific climates by following LEED's general guideline and standards. A 3-tier approach is used for the design of Eco-Haven:

1. Basic building design is based on conservation of energy and resources.
2. Maximize use of natural and renewable energy such as passive heating, cooling and lighting.
3. Loads not handled by 1st and 2nd tier is satisfied by energy efficient mechanical equipment and systems with minimal use of non-renewable energy source

As sustainability is climbing its way to a secure and prominent spot in the world of architectural design, it illustrates a transformation of a certain typology throughout the years based on demands and the change of pace in life and essence of lifestyle. We try in many occasions to trace transformations of things back to its origin. We achieve this by looking and reflecting upon the past, which is what John E. Hancock reiterates with "*The past is not just that which we know, it is that which we use, in a variety of ways, in the making of new work….*" [i]

When thinking about the essence of the climate of Toronto, I think about the hot scorching summers and blistering snow storms of the winter. In this vast fluctuation of temperature and climate, it can compare to the unique multi-cultural aspect of our city. If Toronto can embrace people of different ethnicity and culture, then embracing our extreme climate is also essential. The fundamental idea behind Eco-Haven is its ability to adapt to different situations and climate and even times of day. Located in the heart of downtown Toronto, it adapts to the site by obtaining a slim rectangular section, building vertically upwards instead of widening the lot to minimize the footprint of the building therefore lessening the disruption to the site. However deep the floor plate of the ecohouse maybe in relation to its width, skylights cut in crucial places and having large double glazed low-e coated windows strategically positioned towards the North-East and South-West, to make maximize use of solar gain and minimize heat loss in winter. Similar techniques are used in the CMHC Healthy House in Toronto, which is a 1,700 square foot semi-detached house on a vacant infill lot in an older part of the city known as Riverdale.

"House design, landscaping and technology are all used to help heat and cool the house and reduce dependence on the earth's resources." iii

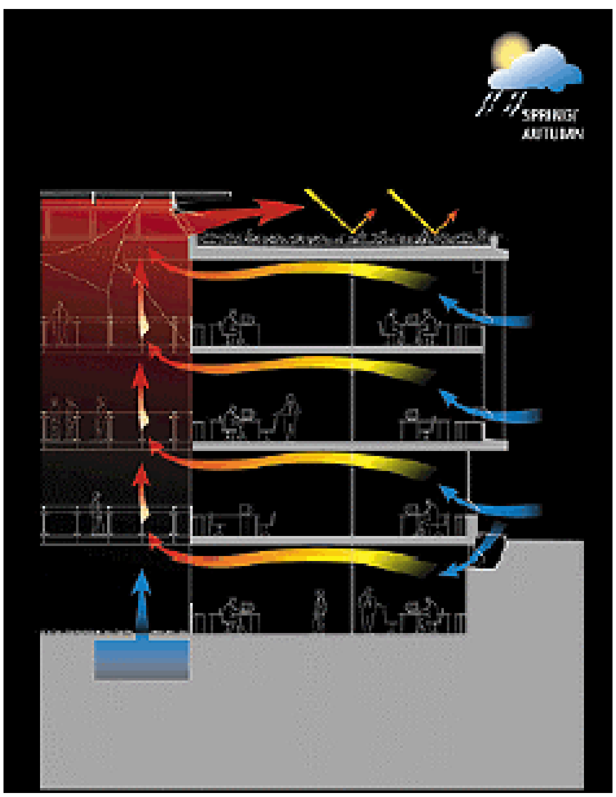
ii. *CMHC's Healthy House in Toronto, Ontario*

Taking note of this successful strategy, it was decided that we should implement it to our design as well. Facilities and resources are shared between the floral shop and the family's residence. The area of the site is pedestrian friendly which promotes the use of public means of transportation such as walking and biking. Limited parking (required for delivery van), bike racks and protected walkways enhance this pedestrian friendly character of the area.

Since the flower shop requires high volume of water usage, a storm water collection and grey water filtration system is implemented in an attempt to conserve potable water usage. Storm water is collected with an extensive drainage system that is integrated into the building design. High efficiency fixtures are installed to reduce waste water volumes. Similarly, the Healthy House had implemented a water self-relying system. Grey water is collected from the roof and is stored in an underground cistern and purified without the use of chemicals. Such water can then be used for drinking, washing and recycled again for use in the showers, washing machine or toilets.

Located on the north end is a vegetated roof garden retreat for the family. This is excellent for relaxation and also as a tool to reduce heat islands to minimize impact, human and wildlife habitat. Aside from aesthetic purposes, landscaping is implemented for microclimate purposes. Using the salvaged bricks from the original building not only lowers the cost of building, but also make use of reusable resources and ease of obtaining such materials, hence making the how construction period as short as possible. As with the Healthy House in Toronto, one of the more obvious strategies that were used is installed on the rooftop. Solar panels are used to store heat during the day which is then transformed into a usable energy source for the whole house.

Since not all spaces within the building are occupied throughout the day, even if they are, they would require different levels of heating / cooling depending on its location and orientation. For example, spaces facing south require less heat in the winter compared to the north. To reduce energy usage, the building is divided in zones where temperatures are controlled separately for individual thermal comfort and needs. This technique can be compared to the York University Computer Science Building also located in Toronto. This sustainable building is designed by Busby + Associates in conjunction with van Nostrand Dicastri Architects. As Architects Alliance puts it: "solar gain and heat absorption structure make it highly



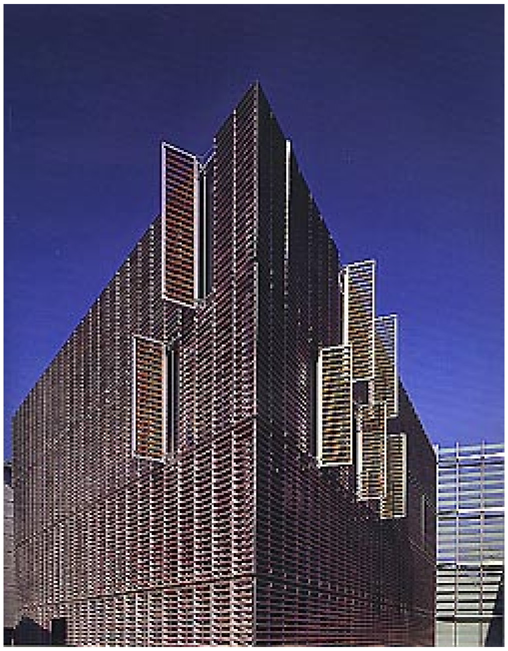
iv. *Ventilation Diagram of interior conditions* insulated for the cold climate…" and a "naturally ventilated tropical structure at other times." The designers understood this concept and all classrooms dedicated to computers are all oriented towards the North, avoiding direct sunlight and only receiving the less harsh incidental lights, which helps reduce heat gain in the summer. Likewise, in our design avoiding heat is the first tier for cooling done mostly by shading and avoiding solar gain. The north roof garden is nicely shaded by the building through the summer, creating a cool microclimate for users. Comparably, the York building had their landscaped roof clad in various types of wildflowers and greenery which help retain the rainwater collected, and in the process, helps moderate the temperature of the building in the interior. It is also successful in the fact that the eight-inch layer of soil covering the Computer Science Building's concrete rooftop along with the exposed concrete walls helps store heat attained in the afternoon, and later slowly disperse it into the building as it cools. Meanwhile, to avoid extensive solar gain, louvers and overhang on the south of Eco-Haven are closed during the summer to block out undesired solar energy. Spaces that require less heat and day lighting (eg. mechanical and storage) are located on the north end as well. Since the machineries in the mechanical room actually generate heat, the room is insulated which reduces heat loss in the shop. Spaces on the north take advantage of the sun for heat and light. Orienting and placing rooms appropriately to take advantage of "free energy" reduces hydro energy consumption significantly.

One of the most effective ways of removing heat passively is by ventilation. During the summer, the Eco-Haven store front opens up completely, inducing ventilation into the building. Stack effect created by the atrium and cross ventilation are two effective strategies for removing heat though the top clerestory windows. These strategies also ensure constant supply of fresh cool air, maintaining a high level of indoor air quality within the building. This is also applied to the Computer Science Building at York. Instead of conventional forced air blowers to promote air circulation in buildings, this green structure is dependent on a passive ventilation system consisting of two large ventilation stacks, one being the atrium acting as a chimney for hot air to vent out of. The "stack effect" is the heart of the system as it functions by drawing warm stale air outside, and substitutes it with the cool fresh air that was collected.

As important as ventilation of the house, the design for Eco-Haven strives to maximize the use of natural lighting. Spaces that can take advantage of day lighting, such as common gathering area and shop are located on the south end of the house. Diffuse lighting strategies are integrated into the building design for maximizing use of solar light yet avoiding solar gain. Light colored and reflective surfaces are used for "brightening" spaces. A light atrium at the stairway with clerestory window allow for light penetration into the core of the house. While light is lured inside the Computer Science Building by thermal chimneys, our simpler version of clerestory windows work in similar fashion.

All windows of Eco-Haven have vertical wooden slats installed onto it. Aside from acting as vertical shades, these louvers are also effective for controlling desired lighting and privacy level. This idea was inspired by the Finnish Embassy in Berlin. The building shape is due to its designated site and its sculptural form is emphasized by its wooden exterior. Larch battens form the grid-like skin which protects the glazing and acts as sun screens. "During the day, the facade comes to life as the uniform appearance becomes fragmented. At night the building withdraws back to its shell, and the lights inside twinkle through the battens."[vi] This was a very metaphorical illusion that became a theme for the ecohouse. During the day and summer, Eco-Haven's vertical louvers open wide and the slats adjusted accordingly for shade.


v. *Night shot of Finnish Embassy exterior*



vi. *Day shot of wood batten exterior*

On the other hand, as winter approaches and the sun angle lowers and the air turns cold, the louvers are closed as if the ecohouse is in hibernation. This transformation and adaptation, is crucial to our design. With Eco-Haven's building footprint being that of density and compactness, the lightness of the wooden louvers and the transparent and luminous quality in which the nightscape of the building offers sets up an interesting contrast.

All this concentration and dedication to create an energy-efficient building not only benefits economically and environmentally, but in the process creates a place that has a dialogue with its surroundings and its users. In salvaging materials from the original buildings wherever possible, the project managed to minimize the disruption of the site and work with local materials to achieve the same harmonized building with its intimate scale and functionality. All the various sustainable elements merges together to create a structure with the well-being of its occupants and surrounding as top priority, resulting in a warm environment that is inviting as part of the commercial sector of the city, as well as providing an assuring dwelling for the owner and his family of four.

Credits

i. The Harvard Architectural Review. Volume 5. 1986. "Precedent and Invention. Between History and Tradition: Notes Toward a Theory of Precedent." John E. Hancock.

ii. CMHC's Healthy House in Toronto. http://www.cmhc-schl.gc.ca/popup/hhtoronto/

iii. Priesnitz, Wendy. Living Off-Grid in the City, Copyright © 2004 Life Media http://life.ca/nl/56/house.html

iv. Ventilation diagram of the York University Computer Science Faculty: Busby & Associates Architects. http://www.busby.ca/projects.htm

v. Night shot of the Finnish Embassy exterior. http://www.arcspace.com/architects/viiva/

vi. Day shot of the wood batten exterior of the Finnish Embassy exterior. Finnish Architecture Review. http://www.ark.fi/ark6_99/suomensuureng.html

vii. http://www.materia.it/materia/panoramaScheda?id=0022448310

viii. Built with Care, by: correspondent Dan O'Reilly http://www.cs.yorku.ca/general/building/article1.html

ix. Cool and Green, by: Albert Warson http://www.architectureweek.com

x. York University Computer Science Faculty, Toronto, Ontario http://www.busby.ca/projects.htm

xi. York University: Unique Green Technology, by: Don Proctor http://www.cs.yorku.ca/general/building/article2.htm