Sustainable Design in the Caribbean Context

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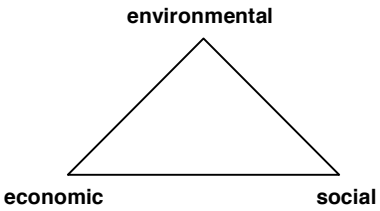
Sustainable design is particularly sensitive in Caribbean island developing states due to the nature of our economies. Sustainable design tends to be overlooked under the greater socio-economic pressures of social housing for example. With inadequate access to housing, infrastructure and basic commodities, the question of sustainable design becomes a moral one for governments. How can one begin to speak of sustainability in a context where other social needs are not being met? The answer lies in integration. Referred to as the *triple bottom line*, a meaningful approach to sustainable design begins with the integration of environmental, economic and social factors. Each aspect is equal, each informs the other, and each depends on the other for its success.



According to the US Green Building Council (USGBC), some of the environmental benefits of sustainable design include enhancing and protecting ecosystems and biodiversity; improving air and water quality; reducing solid waste; and, conserving natural resources. Some of the economic benefits include reducing operating [and maintenance] costs; enhancing asset value and profits; and, optimizing life cycle economic performance i.e. the building costs less to operate over time; the return on investment (ROI) is positive. Some of the social benefits include improving occupant comfort and health; minimizing strain on local infrastructure i.e. less utility demand, less waste; and, improving overall quality of life.

Prescriptive or Performance Based Goals

Sustainable design involves *prescriptive* or *performance based* goal-setting. Prescriptive refers to the inclusion of specific technologies. Performance based refers to the use of an environmental metric such as a target of energy use in kWh per year or a target of maximum carbon emissions in tonnes per year. Setting a performance indicator allows one to measure the efficiency of the building in terms of its actual consumption of energy or its carbon footprint – how much carbon am I releasing into the atmosphere by operating this building or running this household?

The matter is particularly important within the Caribbean because developing countries will become one of the next major contributors to carbon emissions over the next twenty five years; mainly due to our dependence on oil. To put the matter in perspective, one can refer to the carbon emissions index. This measures the carbon emissions per capita of two hundred and seven countries worldwide.

Examples are Singapore which emits 9 tonnes of carbon per capita; The United States at 5 tonnes per capita; and, the Cayman Islands at 1.96 tonnes per capita. At its last measurement (2005), there were global emissions of 7,596 million tonnes of carbon in one year. Refer to the Earth Policy Institute (www.earth-policy.org)

Trinidad and Tobago is not on the carbon emissions index. However, countries with cheap energy tend to have high emissions. Such is the case with Qatar, the highest emitter per capita (14 tonnes) due to its natural gas industry and the distribution of free electricity to households.

Trinidad and Tobago's electricity rate is US$ 6 cents per kWh (compare to Barbados at US$ 12 cents per kWh, for example). As a result our electricity consumption is high because energy is cheap. Therefore the motivation to reduce energy consumption or adopt energy efficient strategies is lacking. Within the Trinidad and Tobago context this forms an indelible part of our triple bottom line. Our journey towards sustainability must consider the fact that energy is relatively inexpensive. Due to the absence of real economic benefit, the green imperative on the client's side is understandably less.

As a consequence, designers will have to be particularly creative at adopting and implementing sustainable design strategies. At the end of the day it should not cost the client more to be green; unless the client desires to do so.

Passive or Active

Creative sustainable design strategies lie in the approach, whether *active* or *passive*. Active design refers to the use of technology and devices to (1) generate energy, such as, photovoltaic (PV) panels or wind turbines; and, (2) reduce resource consumption such as energy-efficient lighting, low water use / waterless plumbing fixtures.

There are also strategies that can be adopted to reduce the demand on resources such as rainwater harnessing, groundwater mining, green roofs, sewer mining, air conditioning condensate recovery and grid connected PV's.

Sewer mining refers to the practice of tapping into the sewer main to recuperate grey water for recycling and reuse. This is done in Australia.

Air conditioning condensate recovery is the practice of recovering the drip water from air conditioning condenser units. The volume of drip in a day, week, month, year is not insignificant and the quality of water retrieved is that of distilled water. This is done in Trinidad.

Grid connected PV's refers to the practice of feeding excess energy generated from PV's back to the municipal grid. This is done in Jamaica. Feeding PV energy back into the grid as it is generated removes the logistics of having to store the energy. The batteries for storage are costly and the physical space required is extensive. As

the energy is generated (during the daytime) the excess is exported to the grid; at night (when there is no energy generation) energy is imported from the grid. The utility company then offers a credit from the daytime PV energy export against the nighttime grid energy import.

In the case of PV panels it is important to note that the return on investment (ROI) is negative in Trinidad and Tobago because of our low energy costs. The use of PV technology has to be client-driven because PV panels attract a higher capital cost or *first cost*. The selling point for PV use in Trinidad and Tobago is that it is a renewable source of energy that will generate a significantly greater amount of energy than that used to produce it (i.e. embodied energy).

When considering the use of active strategies it is important to factor in the *embodied energy* of the product. Embodied energy is the amount of energy it takes to manufacture a product, from extraction of the raw material, to transportation, manufacture and installation. It also includes the energy it takes for the product to decompose.

There are a growing number of products being manufactured under cradle to cradle initiatives. The cradle to cradle initiative takes the embodied energy into account so that the product has a cradle to cradle (regenerative) existence rather than a cradle to grave (disposable) existence.

Passive Design

Passive design speaks to a harmony in design with the natural patterns of our environment. It goes back to first principles, those seen in indigenous dwellings. It refers to orientation to the sun to capture heat in temperate climates; or, deep overhangs to provide shade in tropical climates, for example.

In the Caribbean context, passive sustainable design involves orientation of the building to minimize heat gain while optimizing natural light. This translates into an east-west orientation of buildings possibly with a shallow floor-plate, or a series of small spaces to allow natural light in.

Our heat gain is greatest on the east and the west, so minimizing façade exposure on these extremities minimizes heat gain. Our sun altitude is mostly in the south but for four months out of the year it is in the north. Shading in the north is therefore relevant. Heat gain on the south elevation is not insignificant and is often overlooked. Fenestrations on the south require vertical fins for shading as well as overhangs. The overhangs on the south may not need to be as deep as those on the east and west because the south has high angle sun, while the east and west have low angle sun. It is therefore important to look at each façade independently; it might lead to a new archetype and is a creative way of exploring economic efficiency to the client's benefit.

It is becoming increasingly important to use the tools available to do the analysis. Most CAD software have a solar study component. It automates the process of analyzing the incident sun. If studies are done for the extremes the building can be made to function like a machine, optimized to shade itself and give the client best value for money.

There are other strategies that can be adopted to mitigate the effects of the sun. The integration of landscaping can lower ambient temperature. Arbors can provide shading while being a meaningful introduction of permaculture. More sophisticated greening can be green roofs or green walls (vertical gardens). Xeriscaping is the practice of using drought-resistant vegetation that will be self-sufficient; reducing the need for maintenance and demanding less irrigation.

Atrium and courtyard spaces promote convective cooling and provide natural light deep into the plan. When proposing a naturally ventilated atrium, be guided by the stack effect. Ensure there is a portal for air to enter at ground level and exit at clerestory level. Entrance canopies act like verandahs to modulate external sun temperature before entering indoor air conditioned temperatures. So the impact of hot to cold is gradated on the body. This not only increases a sense of well being, but also reduces the mechanical load of the building.

In the case of natural ventilation, orienting the building to the prevailing wind patterns is another strategy. In the Caribbean, our daytime prevailing wind is from the north-east; and, nighttime from the south-east. Micro-climate will vary per site, so it is essential to do the necessary reconnaissance. The wind velocity through a space can be increased by providing larger openings on the windward facades and smaller openings on the leeward, or vice versa.

Our mechanical ventilation strategies require more research. We continue to be cloaked in winter wear in our office buildings. Occupant comfort is compromised and electricity consumption is greater than it needs to be.

Our humidity is considerably high so water features, though cooling, exacerbate saturation of the air. Particularly in the case of mechanically air conditioned spaces; the load on an air conditioning unit is significantly greater because of the additional moisture introduced by a pond or water fountain.

It is also important to work within the context. Specify local materials and be sensitive to the limitations of the local craftsmanship within reason. One should aspire to build buildings that last; that can accommodate the technology of the next revolution. Buildings consume a high amount of energy to build. It is therefore imperative to make them timeless. They should be flexible enough to accommodate change without demolition. A case in point is the

Salvatore Building in Port of Spain. The building was designed before current VAC technology. The floor-to-floor heights cannot accommodate present day VAC requirements. It was therefore difficult to retrofit the building to function in our times. Demolition began and it now stands as a ruin in the city.

When designing, keep in mind the site works. The impact of construction on the environment is critical. How much energy is required to transport the materials to the site? How much impact will the excavation have on the surrounding rivers? What about the storm water run off during construction; and the dust emission? Is there a less hydrophilic cement that can be specified? How will the building be cleaned after it is built? Will it require millions of gallons of water in power washing? Can a more permeable hard surfacing be specified for parking; instead of a large expanse of asphalt? Is it necessary to have so many parking spaces? Green design promotes a reduction in the number of car parking spaces to reduce the motivation to arrive by car. Is it necessary to use unitized double glazing? This attracts a high cost and carries a high amount of embodied energy. If the glass is shaded, the need for double glazing is removed and the shading strategy may lead to a creative design solution. These are some of the questions that one can begin to ask. Designers ought to be no less than revolutionary in each project. Each project should aspire to push the green envelope a bit further each time.

The final point to make to our local industry is that it is essential to become aware of the trends outside of the region. It should be done in the context of reinterpretation and not replication. There are several bodies pioneering the sustainability cause. There are also rating systems that offer valid guidance, LEED, USA; BREEAM, UK and Green Star, Australia to name a few. They are guides, not rules; and require a rigorous understanding before application in our local context.

This document represents a working paper, feedback is welcome.
For more information go to www.aclaworks.com
For further reading see, Hyde, R., Watson, S., Cheshire, W. Thomson, M. *The Environmental Brief*, Taylor & Francis, 2007