Best Practice in Environmental and Sustainable Architecture

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1. Introduction

Sustainability as a concept has been around for centuries. Writing by Vitruvius over two millennia ago emphasised the need to harmonise architecture with nature. (Vitruvius 1914) Throughout the ancient world – in Africa the Americas, Asia and Europe – it was possible to find evidence of human adaptations to the influence of the sun. In New Mexico we find cave dwellings - hillside shelters utilising the constant ground temperatures to maintain a satisfactory level of thermal comfort, while in the humid tropics of Indonesia, breeze houses are the norm. In Africa we see variations, from the thick walled huts of Southern Africa - a response to the cool temperate climates of the higher latitudes - to the more breezy huts of central Uganda, while the Bedouin of the Arabian Desert use the simplest of elements - a sheet of cloth - to keep cool or warm in the dessert. These responses enabled our ancestors to survive in climates that were in some cases anything but hospitable.

The use of the term 'Sustainability' in connection with the built environment is more recent; first arising in a publication entitled "World Conservation Strategy", published in 1980 by the International Union for the Conservation of Nature (Steele, 2005). It was however not till the publication of a publication "Our Common Future" by the World Commission on Environment and Development in 1987 that the concept of sustainable development truly came to the forefront. Central to the findings of the Commission was the concept of Sustainability, defined as being development "…that meets the needs of the present without compromising the ability of future generations to meet their own needs." (World Commission on Environment & Development, 1987, p8)

Since the publication of "Our Common Future" report, there had been a concerted effort to engage built environment professionals, policy makers and the public in debate to get sustainability and environmentally responsible principles on the table as a worthy discourse. While for the most part the basis for legislation has been put in place - in Uganda the existence of the National Environment Management Authority (NEMA) is testament to this effort - there are still fundamental problems that prevent the implementation of environmental sustainable principles on the ground. Most important is a general lack of awareness of the pertinent issues, and even more significant is the lack of readily available contextual information. Further, with all the institutional instruments in place – at least on paper, the degree of implementation is and will continue to be extremely low. This is partly because of the fact that it is easy to set down rules governing professional activity, but it is an entirely different matter, making people aware of the issues, and in establishing standards of excellence, put simply codes do not motivate people to act. (Collier, 2005)

The purpose of this paper is twofold:

- Firstly to shed light on the basic concepts of passive solar architecture, environmental design and sustainability in the context of Uganda. This will be taken from the point of view of ethical, sociocultural, professional and technological issues which highlight the complexities of sustainable architecture, but more importantly putting it in the context of the Ugandan situation;

- Secondly to showcase examples from Uganda where these practices have or are being implemented with existing technology and resources;
- Thirdly, it will highlight some pertinent issues that need to be addressed in order to increase the awareness of passive solar architecture and sustainable design in Uganda.

2. Solar Architecture

To many, Solar Architecture for tropical regions appears to be somewhat of a misnomer. On the surface, Solar Architecture seems to refer to the heating of buildings, while in tropical regions, cooling of living spaces is the primary objective in design. So what exactly does Solar Architecture mean for tropical locations? Passive and low energy design, or solar architecture, takes "… advantage of the climate when it is advantageous, and protects the building from the climate when it is not." (Rosenlund, 2000, p10) Passive Solar Architecture for the tropics can therefore be described as "… architecture which minimises – nor negates – the impact of climate … " (Misra, 1999, p14) Specific design techniques employed in passive solar architecture utilise what the earth has to offer; reducing or slowing down the adverse impact on the environment, which would have happened otherwise. For the tropics, this implies passive systems for cooling through the use of natural heat sinks. These include the sky and outer spaces, temperature variations and vegetation. (Misra, 1999) Understanding of the climatic influence on buildings and the thermal comfort of their occupants thus play a vital role in selecting sustainable technologies. (Zain-Ahmed et al. 1998)

It is often the case that modern buildings in the tropics are often designed without taking sufficient account of the climate and factors such as the surroundings, site characteristics, orientation and materials in the design process. More and more buildings are being designed to use air-conditioning, ignore the basic principles of climatic design, as more people seek to achieve a 'Northern' standard of living. (Kumar, 1999) Furthermore, architecture is often viewed in its utilitarian ethic, in which the environment is seen more as a resource, generally hostile to humans and therefore should be controlled and dominated in a 'heroic mode' of development. (Schaefer, 1994 and Williamson and Radford, 2000)

One of the main reasons for this situation has been a lack of access to knowledge among Architects, Engineers and Planners about environmentally sustainable design practices and how to interpret them (Olweny, 1996). Environmental data, such as temperature, relative humidity, wind speed and direction, precipitation, topography, solar radiation and sky conditions, etc - important considerations in the design of built environments – are generally not available, and even if they are, interpretation of this data is time consuming and tedious.

Research on environmentally responsible housing in the tropics, despite its significance, has for the most part produced somewhat generic information that is not particularly useful in specific situations. This is due to the different contextual experiences of the various locations they are purported to be relevant to. Research by Suite (1990) and Boodhoo (1990/91) questioned the application of such generic information, based on a realisation that there is no single 'environmentally friendly design' that can be duplicated for all applications. (Williamson and Radford, 2000) It is therefore acknowledged that context relevance is important in the application of environmentally responsible design information.

In the implementation of passive solar and sustainable designs, it is important to be aware of what has been termed 'greenwashing': claims that by using certain materials, incorporating certain features or installing high-tech gadgets can make a building sustainable or environmentally friendly. However, as is pointed out by Williamson, et. al. (2003), by simply installing solar panels, or using locally sourced materials, is not an indication of a sustainable building. For a building to be regarded as environmentally responsible, it is necessary to actually demonstrate an actual environmental benefit. (Williamson, et. al. 2003)

3. The Issues

The main purpose of a building is to give shelter – for privacy and thermal comfort. To achieve this, a physical envelope is created to transform a space and the prevailing environmental conditions to suite the needs of the occupants. Ancient building solutions offer clues to how indigenous people resolved some of these contextual issues, resulted in satisfactory solutions for their particular circumstances and technological context. For the tropics, this often meant a roof to keep the sun and rain out, and few walls to allow cross ventilations. Modifications to this theme can be found – with the threat from wild animals and human enemies way the strengthening of fortifications either on or around the buildings. These simple solutions were quite effective; however the lessons they gave us have been neglected in the quest to modernise. (Steele, 2005)

I would certainly not advocate a return to the old traditional buildings, as an environmental responsible solution as they fall short of offering solutions to contemporary problems, and assume continuity with old living patters and lifestyles, which is certainly not the case. Indeed, this pastiche approach or what has been coined "cultural clamps" (Williamson et. al. 2003, p.11) tend to freeze indigenous architecture in the distant past, purportedly portraying vernacular architecture as the correct approach to sustainable design. Our knowledge of environmental conditions and advances in technology would suggest that this approach is probably inappropriate given the changed circumstances. Nevertheless, it is essential that we acknowledge the value of the traditional approaches, and combining this understanding with current technologies and knowledge as a basis for appropriate responses to the environment we live in today and into the future.

It is often argued that environmentally friendly building should not be a priority of developing countries, after all a more pressing concern is the provision of basic shelter. Such an approach however ignores decades of data from around the world that show that this is a recipe for disaster. By ignoring environmental issues in provision of shelter, we are only postponing the inevitable, making the problem more and more difficult to solve in the future. That is not to mention the fact that this subjects the most vulnerable sections of society to uncomfortable conditions, and greatly increases their life time living costs, negating any initial savings in the production of the dwelling through modifications the inhabitants have to undertake in order to make the spaces more comfortable. Certainly this is more of an issue in cooler climates, but nevertheless it is an issue in Uganda, as work by Olweny (1996) revealed; the energy crisis is as much a problem in low income households as it is in high income households.

An integrative approach to architecture is therefore desirable looking not only at the individual components, but as they relate to the whole. Such an approach of followed by Malaysian architect Ken Yeang, who has used passive low-energy techniques: incorporating building configuration, shading, placement of components, selection of materials, solar and wind related orientation, natural ventilation and landscaping, in his quest to discover an environmental approach to tropical architecture. (Steel, 2005)

4. Best Practice Examples

The examples of good practice in relation to the Solar Architecture in Uganda as presented here as discussions of components of the buildings. Examples are drawn form the central districts of Kampala, Mpigi and Wakiso, the three districts that account for over 80% of building construction in Uganda. These will be used to showcase what can be achieved in the local context.

4.1 Site and Environment

The site and its location are important factors in relation to environmental design strategies. Thus the importance of site studies, which should including topography, surrounding buildings, existing vegetation etc. The surroundings of a building have a significant impact on the indoor conditions of a building. At the same time, the built environment modifies the urban climate – a cyclic process that creates the urban heat island effect. (de Schiller and Evans, 1996) Knowledge of the physical surroundings as well as the macro and microclimates is therefore useful in formulating passive energy design solutions. Many times however; these issues are ignored in the design of buildings in Uganda, it is argued that a lack of data is often to blame, however a number of site-specific factors can be used to reduce the environmental impact of a building.

The central region of Uganda is extremely hilly, and we do take pride in associating ourselves with this aspect. Unfortunately, building design has for the most part ignored this aspect. Most buildings appear to ignore the slope, with many building designs taking the sites as flat – even though relatively few places in the area are flat. This approach to building design has caused significant damage to the natural environment, not to mention the fact that this approach is extremely costly. A look at the new developments on Naguru Hill, and most new areas of Kampala reveal the extent of the problem. Extensive cut and fills and retaining walls dominate the hill.

***Figure 1**: Housing on Naguru Hill, Kampala.*
Source: (Olweny, 2005)

The slope of a site can be a valuable asset in the design of a building, and making use of the slope can add significant value to the project. Two housing units being built on the Uganda Martyrs University campus illustrate this. The site itself is prominent, located at the entrance of the university. The site slopes from west to east, with a slope of 1:5. This in addition to the environmental factors of solar access, views, and ventilation were key factors in the design of the dwelling. With magnificent views to the southeast, an opportunity to exploit this view could not be missed. This resulted in a design that would be contrary to many design manuals for the tropics, however this was done to maximise the opportunities of the site, and mitigation measures have been factors into the design to reduce possible effects of solar gains. It is often stated that buildings in the topics should have the long axis in the east-west direction to prevent solar gains from the east and the west. Theoretically this is an appropriate solution – for an imaginary flat site - but like all rules of thumb it does not take into account the local context.

The building is designed for the site, taking the slope into consideration, resulting in a split-level design. In this was no excavation of the site was necessary, and material excavated from the foundation trenches was used in the back fill for the upper section of the building. The three levels created demarcate the three functional zones of the dwellings: A recreation zone (incorporating the living room and the study), a sleeping zone (incorporating the bedrooms) and a living zone (incorporating the dining room and kitchen). These zones are occupied at different times of the day and thus have different comfort requirements. The recreation space is rarely used in the morning hours, thus it can be placed due east, and at the higher level to give the occupants a talking point while they enjoy the cool evening in this area. This space can also take advantage of the views to the southwest, as well as any cooling breezes that would aid in keeping the area cool. A veranda also aids in reducing the impact of solar gains in the morning. The living zone, located to the west is protected by mature trees, and existing buildings again mitigating any solar gains, while the sleeping areas are located on the lower level was to ensure the sleeping spaces, which require the most comfortable conditions, can benefit from the insulation given by both the ground and the spaces above. In addition, this responds to a customary practice in Uganda, where windows and doors are shut at night, regardless of indoor conditions, resulting in often unbearable indoor conditions. The cooler conditions of the spaces close to the ground coupled with natural heat movements would ensure that night comfort is easy to maintain. The importance of identifying the occupancy patterns of the users is vital in order to optimise the design. Further, internal finishes are designed to reduce heat gains. A raked ceiling allows heat to escape through a series of vents at a high level at a high level preventing heat build up, while adequate openings allow cross ventilation through the building.

Figure 2*: Classroom Block.*
Source: (FBTA, 2006)

Figure 3*: Classroom Block.*
Source: (FBTA, 2006)

Certainly compromise is always a necessity as not all conditions will be ideal. However this also results in innovative solutions to prevailing conditions, as can be seen on the recently completed British High commission building in Kamwokya, a suburb of Kampala. With its long axis in the North-south direction, the building was fully exposed to the morning as evening sun. To solve this problem, novel features were added to the building – on which the designers had tried to make use of locally sourced materials. To mitigate the problem, the designers made extensive use of solar shading, using a specially made fired clay louver sunscreens, as well as extensive landscaping around the building.

***Figure 4**: Student project exploring space.*
Source: (Adrian Hobbs, Architects Journal, 2006)

For security reasons, it was deemed necessary for the building to have anti-blast windows, this much of the building is air-conditioned as many windows cannot be opened. Nevertheless, measures to reduce the potential energy load have been taken. Solar shading is provided on windows, a double roof construction with clay tiles, and steel.

***Figure 5**: Breezeway - British High Commission, Kampala.*
Source: (Adrian Hobbs, Architects Journal, May 11, 2006)

Attempts to resolve solar heating in the tropics can often result in compromises where lighting is concerned, leading to rather dark interiors. Lighting along with acoustics are probably the least understood aspects of environmental design, and in both cases it is generally the case that little attempt is made to optimise indoor lighting for comfort or energy use.

Lighting of course falls into two categories; daylight and artificial light. Daylight indoors is affected by the size, shape, position, orientation and number of openings as well as the framing installed. In Uganda, window openings appear to be determined by historical precedents, rather than practical lighting needs. The size of the openings is often relatively small, a result of two factors – a lack of windows on indigenous buildings, as well as the high expense and poor availability of glass during the 1970s and 1980s. The increased threat of theft of personal property, and danger to the lives of inhabitants resulted in the additional need for burglar bars on windows and doors. The result has been a significant decrease in the area of the. Consequently many buildings have relatively dark interiors during the day, forcing inhabitants to rely on artificial lighting, when there is an abundance of free light outside. While achieving a balance between adequate natural day light and increased air-to-air gains is difficult without proper training, it is nevertheless important in the quest to achieve more energy efficient and sustainable buildings. One building that has tried to resolve this conflict is the Ndere Centre in Kampala. While it acknowledges the need for natural lighting in one of its display areas, it does also acknowledge the thermal factors that result form this. It therefore incorporated in its design, a significant amount of mass as well as ventilation to help reduce heat retention indoors.

***Figure 6**: Ndere Cultural Centre, Kampala.*
Source: (Olweny, 2004)

4.2 Urban Issues

As part of the reconstruction of the Uganda Martyrs University Entrance, it was evident that a key problem had to be solved. Over the years, storm water drains had been built across the university, with an increasing number of hard surfaces. This helped alleviate some of the water problems on the university campus but no one was tacking the consequential issue, where did the water go, and what did it do along the way. Those two questions were easily answered by the eroded roadways at the entrance to the university, where the water was discharged onto the roadway. As more and more land is covered by buildings, roadways and other hard surfaces, there is less natural grassed surface for storm water to soak into the ground; even more of a problem when city governments seek to cover every last piece of green space with buildings. Without a functioning storm water drainage systems, roads in built up areas become torrential rivers after heavy downpours, often with tragic results, as reported in the *Sunday Vision*, August 6, 2006 – "Kampala floods kill three".

A solution to this problem – 'Soakaway pits' – are a simple and cost effective means of resolving this problem, can be implemented on public land immediately. Soakaway pits have been used for decades as a means of disposing domestic wastewater, but their use for the disposal of storm water has not been high. The benefit of this system are immense, with an instant reduction of storm water runoff, and an added benefit of an aquifer recharge system. The benefits of this system, which has been used in some rural villages in the United Kingdom, are only just being seen in urban areas, where I might add they were illegal – in Australia, the council bylaws stated until recently that "storm water must be discharged onto the street". The importance of these systems are just now being recognised in urban areas, with the British Research establishment (BRE) releasing a computer based design package "BRESOAK" in 2006 to allow the design of a storm water soakaway system.

Two soakaway pits have been constructed on the Uganda Martyrs University campus, and have been very effective in reducing storm water runoff. Certainly by taking care of storm water close to the source, it is easier to deal with, and will result in less damage to property further down the hill slopes.

***Figure 7**: Completed Soakaway Pit.*
Source: (FBTA, 2006)

***Figure 8**: Soakaway Pit With Hardcore.*
Source: (FBTA, 2006)

5. The Future

There is no doubt that there is an urgent need to improve energy utilisation and the environmental performance of buildings in Uganda, particularly in light of the crippling energy shortages the country is experiencing, but also for the benefit of future generations. The question is “HOW?” A major limiting factor has been the lack of context relevant information. In addition to the lack of local research studies, this lack of information is a consequence of the multi-layered nature of the building design practice itself, where different fields of influence such as political, economic, planning, engineering, and building practice are found. (Moosmayer, 1998) This is further complicated by the fact that achieving an environmentally responsible building depends not only on the skills of the building designer, but also on the awareness stakeholders[1] have of environmental issues.

The ability to design passive solar buildings depends on the skills and ability of the architect to identify variations of climatic parameters within a site, develop awareness of possible future modifications produced by introduction of new built form and use this potential during the design process at different scales of application. (de Schiller and Evans 1996) Design tools thus become an important factor in the architects’ arsenal in the design environmentally responsible buildings. Design tools for building simulation[2] are less complicated than they were in the pasts. Modern computer based simulation packages such as ECOTECT™ (Marsh 1996-2005) help make the assessment of the environmental performance of buildings, particularly during the initial design phases a lot less stressful.

A number of design aids require a lot of data input, and require a lot of interpretation of the output data to make them useful. As is pointed out by de Schiller and Evans (1996), it is more useful if data have to be clearly presented, preferably in graphic form with enough information to enable a response. Design aids of course do not have to be complicated computer based packages, as has been shown with the developed of “Windows and Energy” by Williamson et. al. (1992). This booklet produced for the three climate zones for Australia - Warm Humid, Hot Arid and Temperate - gave a quick indication of the likely effect of vertical

[1] Stakeholders include clients, building user, and city authorities

[2] Building simulation, in the broader context, refers to the whole range of simulation tools that can be applied in the case of design, construction and maintenance of buildings. As most of the building simulation programmes are designed for environmental performance evaluations of buildings, the terms - building simulation and building energy simulation are used synonymously. 3 Building Energy Software

and horizontal shading devices for windows could have on indoor condition. The rationale for this particular document was that built environment professionals are often unable and in some cases unwilling to go into too much detail. A similar approach was used by Olweny (1996), who formulated a set of design data sheets that that could be used by architects to determine the potential energy that could be saved by making changes to a design. This study, and another by Sufianto (1995) highlighted the importance of contextualising the data sets, a vital step in making design information more relevant to the end users. They do however caution the use of these 'rule-of-thumb' data sets as the final and only answer. (Olweny, Williamson and Sufianto, 1999)

The importance of the assessment of the impact developments will have on the environment must be reiterated. We have all heard of, and are aware of the value of Environmental Impact Assessments (EIA) as one methodology, but are probably not familiar with other assessment techniques, such as Life Cycle Assessment (LCA) or Life Cycle Costing (LCC). Each of these of course has its merits, however, none offers a comprehensive analysis on its own. (Williamson et.al., 2003) a solution that is sound according to an EIA, may fail to make the grade when subjected to assessment using an LCC analysis. Nevertheless, the importance of these assessments, puts many familiar practices to task, as they are clearly unsustainable.

In addition, "every architect bears responsibility for how human beings are to exist in a shared world, for all buildings, even the most simple structure, not only presupposes and makes visible an already established way of life; it inevitably helps to preserve, reinforce or challenge it, and thus helps shape the future." (Harries, 2001, p6) It is the duty of professionals to help make this possible by being proactive in bringing sustainability and environmental awareness to the forefront of architectural discourse, not only through talk, or publications, but through visual dialogue – built works. Professionals are not passive observers, but active participants with a collective responsibility for the future "… not simply about the consequences of today's choices, it is also about the way in which we envision the future, because this will shape tomorrow's choices. As humans we simultaneously live in the present and in a mythic Other Place, a better world" (Collier, 2005, p94)

6. Conclusion

Built Environment professionals have most certainly entered a new era and have a choice to make as to which way we are to proceed. According to Collier,

> … the progress of globalisation and the awareness of the social, economic, political and environmental costs of an apparently unstoppable expansion of global consumption present a radical challenge to the boundaries and the ethical frameworks within which we have existed so comfortably. We cannot simply continue 'business as usual' in business, in politics, in the professions. We cannot continue to ignore the systematic dysfunctions of our 'world system' and the unsustainability of its present trajectory. (Collier, 2005, p100)

The fundamental basis of environmentally sustainable architecture will require a fundamental change in our approach to human habitation problems. Existing PRESCRIPTIVE regulations offer no scope for development of innovative ideas. This focus on rules and regulations tends to exclude other possibly legitimate and creative solutions. (Bennetts, 1998) The danger of this approach are also seen in the current practice in Uganda, where seemingly once practical, but now outdated regulations are still enforced even though they are clearly inappropriate.[3]

[3] As is the case in Uganda, where the Public Health Act (1964) is still used by the City Councils to assess the suitability of building designs.

Although there is no single best way to improve both living conditions and the performance in buildings, incorporating passive solar and environmentally responsible technologies into the design and construction process will contribute to overall environmentally responsible goals (Misra, 1999). In order to achieve this, there is a need for some form of DESCRIPTIVE (as opposed to prescriptive) design information, that address the issues of concern such as reducing embodied energy and operational energy use, as well as a concerted effort to make designs respond to sites, rather than the other way around. The development of standards suiting the local context, and incorporating these into model codes for buildings, and encouraging building designers to adopt these will go a long way in developing an environmentally responsible and sustainable strategy for the built environment.

Certainly there is no such thing as Sustainable Architecture, Sustainable Architecture **IS** Architecture!

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