TRENDS IN SUSTAINABLE DESIGN IN ARCHITECTURE

Auwalu Umaru[2], Bello Muhammed Murtala[1] and Orewere Emmamoge[3]

[1]Department of Architecture, Faculty of Environmental Technology, Abubakar Tafawa Balewa University, Bauchi
[2]Department of Architecture, Faculty of Environmental Science, University of Jos
[3]Federal College of Forestry, Jos
E-mail: ayola3@gmail.com

ABSTRACT

The concept of Sustainable design also called environmental design, environmentally sustainable design, environmentally conscious design, etc. is the philosophy of designing physical objects, the built environment, and services to comply with the principles of social, economic, and ecological sustainability. This research embraced quantitative data collection method by looking at sustainable architectural designs around the world with an aim to highlight practices which promote sustainable design that is about creating a better quality of life now, for future generations in architecture and construction industry in Nigeria. The main objectives of sustainable design are to reduce, or completely avoid, depletion of critical resources like energy, water, and raw materials; prevent environmental degradation caused by facilities and infrastructure throughout their life cycle; and create built environments that are liveable, comfortable, safe, and productive. Principles and methods of sustainable design are discussed in this write-up. The paper recommends working with nature as the most efficient way to sustainable development through architecture in Nigeria.

Keywords: Sustainable Design, Sustainable Materials, Sustainable Construction, Architecture and Sustainable Development

INTRODUCTION

We all want to improve the quality of life in Nigeria and this guidance highlights the important contribution which can be made to improve the design of new developments. It is important to create developments that are more cost effective to run, more secure, and that minimise their environmental impact and provide healthy living conditions, while respecting the area's rich heritage and distinctiveness. This paper is intended to sensitize architects and contractors when undertaking new development. Careful consideration of design and specification at an early stage can provide significant savings compared with an ad-hoc approach and proposers of development will benefit at the planning stage if they understand the principles of sustainable design prior commencing the design work. The intention of sustainable design is to "eliminate negative environmental impact completely through skillful, sensitive design". McLennan (2004), the Philosophy of Sustainable Design Manifestations of sustainable design require no non-renewable resources, impact the environment minimally, and connect people with the natural environment. Beyond

the "elimination of negative environmental impact", sustainable design must create projects that are meaningful innovations that can shift behaviour. A dynamic balance between economy and society, intended to generate long-term relationships between user and object/service and finally to be respectful and mindful of the environmental and social differences. The negative impacts of poor sustainable designs leads to poor construction industrial activities on the environment include destruction of natural habitats, demand for materials which leads to mining activities and consequently land destruction, air emissions/pollutants, health and safety harm, among others.

Design Process

The exact point in time when design professions' embrace of green principles changed from a desirable commodity to a fully integrated design expectation is probably lost in history. The difference between both designer and client expectations now versus the 1990s is striking. Green design transcends mere descriptions of the techniques that may be employed in shaping a more sustainable existence on Earth. It must also incorporate the principles, processes, and cycles of nature in a way that leads to a deeper understanding of what makes a design successful. Ideally, a book in the first decade of the third millennium that addresses green design should form the foundation for exploration and discovery of new and innovative ways to minimize ecological footprints. Now, and from now on, designers must strive for an end product that mutually benefits the client, the public, and the environment. It is only through creating a better understanding of the natural world that new strategies can emerge to replace the entrenched design mind-sets that have relied on traditional schemes steeped in an exploitation of nature. Designs of much of the past four centuries have assumed an almost inexhaustible supply of resources. Almost everything we do in some way affects the health of the planet, from showering and brushing our teeth in the morning to well after we are finally tucked in at the end of the day, and the small clock on our nightstand continues to demand energy from the grid. One of the great misconceptions of scientists and non-scientists alike is that environmental consciousness is not dictated by sound science. To the contrary, everything that we do to the environment can be completely explained scientifically. The good news is that by applying the laws of science, we can shape our environment and provide the products demanded by society both predictably and sustainably. That is, strategic use of the principles of physical science informs our designs and engineering decisions.

Since the industrial revolution of the nineteenth century, architects and engineers have been key players (culprits?) in the war against nature. Single-minded exploitation and subjugation of nature was the norm during much of the twentieth century and persists as a mainstay of design. Technology has hastened the process. Notably, "man-made weather" (i.e., air conditioning) is now a universal expectation of building design in the West, following the invention of an "Apparatus for treating air" patented by Willis Carrier in 1906. It is also entrenched in the desire for conformation of the International Style of Architecture, which spanned much of the twentieth century. Many of us follow the remnants of this style, still seeking one universal building, regardless of climate and place. Actually, green thinking is not

new at all. In fact, our new way of thinking resembles an understanding of and respect for nature found in antiquity, as evidenced by the designs of cliff-dwelling native peoples. Re-establishing the link between built form and the environment will require a more complete understanding of the science that underpins successful sustainable design strategies, and incorporating this knowledge as architects and engineers engaged in shaping our world along with the construction community charged with realizing a new vision. The *law of unintended consequences* is ever ready to raise its ugly head in design. There are numerous examples of building design solutions touted as sustainable that fail to recognize and respond to the specifics of local climate. A building project that has applied sustainable principles with the mind-set that these principles are "universal" solutions will produce less than optimal results, if not total failure. For example, a wind system is renewable but is not necessarily efficient. Incorporating wind turbines without first understanding local climate and the physics of wind-generated energy could lead to poor design solutions by placing turbines in an area that does not generate sufficient wind speeds throughout the year. The idea of a more "holistic" approach is required to arrive at complete, sustainable design strategies. The notion of life cycle in the design and construction community has too often been confined to a cost–benefit economic model of demonstrating the return on investment that can be expected over the life of a building.

STATEMENT OF THE PROBLEM

The specific problem of creating sustainable design in sustainable human habitats is visible in both rural and urban centres of developing countries. Olotuah (2009) averred that incremental design and construction has pervaded most urban centres in Nigeria. Many of such buildings are inhabited with the barest facilities in place. Although sustainability is fast assuming a global trend, the position of architecture in actualizing the sustainable design goals in developing countries is not encouraging. The concept of the necessity to protect the environment through architecture is not well understood by many intending developers or house-owners. Quacks, who claim to be architects most times, use corrupt means of getting architectural works done. Consequently, the environment is left unsafe and unsustainable for habitation. Furthermore, poverty seems to have clouded reasonable thoughts of what a habitable and sustainable house should be, and consequently, people find shanty and uncompleted dwellings habitable. It is obvious that the role of architecture in its theory, education and practice, in sustainable development cannot be over-emphasized.

Sustainable Design

Peakstoprairie (2005) describe a sustainable design as "the systematic consideration of a project's life cycle impact on environmental and energy resources". One of the key features is the need to minimise material and resource consumption and some strategies for achieving this, and consequently sustainable construction, include:

- Ensuring land is safe for development
- Ensuring access to and protection of the natural environment
- Reducing negative impact on the local environment
- Conserving natural resources and reducing carbon emissions

- Conserving economic and social well-being

The Push for Sustainable Design

There are now many factors encouraging designers and developers to adopt more sustainable design practices:

- Growing awareness from shareholders, investors and the public has led to increased public reporting on social and environmental issues, with some developers now producing annual environmental, social or sustainability reports
- Socially responsible investment has placed pressure on government to integrate social and environmental considerations into their working practices, and to adopt environmental management systems, creating greater pressure from clients for buildings with reduced running costs and more attractive and healthy working environments for their staff
- Planning authorities around the world are setting increasingly high standards for sustainability, adopting a strong sustainability strategy for all developments will save time and money when sustainability is required on individual developments.
- The UK Government in conjunction with BRE released the Code for Sustainable Homes rating scheme in April 2007, it is expected that this will become a mandatory requirement in a few years and Code Level 3 is already stipulated by the Housing Corporation and English Partnerships for developments built on their land

Sustainable Architecture

Sustainable architecture is the design of sustainable buildings. Sustainable architecture attempts to reduce the collective environmental impacts during the production of building components, during the construction process, as well as during the lifecycle of the building (heating, electricity use, carpet cleaning etc.) This design practice emphasizes efficiency of heating and cooling systems; alternative energy sources such as solar hot water, appropriate building siting, reused or recycled building materials; on-site power generation - solar technology, ground source heat pumps, wind power; rainwater harvesting for gardening, washing and aquifer recharge; and on-site waste management such as green roofs that filter and control storm water runoff. This requires close cooperation of the design team, the architects, the engineers, and the client at all project stages, from site selection, scheme formation, material selection and procurement, to project implementation. Ji *et al* (2006). Sustainable architects design with sustainable living in mind. Holm (2006) Sustainable vs green design is the challenge that designs not only reflect healthy processes and uses but are powered by renewable energies and site specific resources. A test for sustainable design is — can the design function for its intended use without fossil fuel — unplugged. This challenge suggests architects and planners design solutions that can function without pollution rather than just reducing pollution. As technology progresses in architecture and design theories and as examples are built and tested, architects will soon be able to create not only passive, null-emission buildings, but rather be able to integrate the entire power system into the building design.

An essential element of Sustainable Building Design is indoor environmental quality including air quality, illumination, thermal conditions, and acoustics. The integrated design of the indoor environment is essential and must be part of the integrated design of the entire structure.

Principles of Sustainable Design

While the practical application varies among disciplines, some common principles are as follows:

- Low-impact materials: choose non-toxic, sustainably produced or recycled materials which require little energy to process
- Energy efficiency: use manufacturing processes and produce products which require less energy
- Emotionally durable design: reducing consumption and waste of resources by increasing the durability of relationships between people and products, through design
- Design for reuse and recycling: "Products, processes, and systems should be designed for performance in a commercial 'afterlife'. Anastas & Zimmerman (2003).
- Design impact measures for total carbon footprint and life-cycle assessment for any resource used are increasingly required and available. Vallero & Brasier (2008), Sustainable Design.
- Sustainable design standards and project design guides are also increasingly available and are vigorously being developed by a wide array of private organizations and individuals. There is also a large body of new methods emerging from the rapid development of what has become known as 'sustainability science' promoted by a wide variety of educational and governmental institutions.
- Biomimicry: "redesigning industrial systems on biological lines ... enabling the constant reuse of materials in continuous closed cycles... Hawken, Lovins, & Hunter Lovins (1999). Natural Capitalism
- Renewability: materials should come from nearby (local or bioregional), sustainably managed renewable sources that can be composted when their usefulness has been exhausted.
- Robust eco-design: robust design principles are applied to the design of a pollution sources. Ben-Gal, Katz and Bukchin (2007)

Sustainable Planning

Urban planners that are interested in achieving sustainable development or sustainable cities use various design principles and techniques when designing cities and their infrastructure. These include Smart Growth theory, Transit-oriented development, sustainable urban infrastructure and New Urbanism. Smart Growth is an urban planning and transportation theory that concentrates growth in infill sites within the existing infrastructure of a city or town to avoid urban sprawl; and advocates compact, transit-oriented development, walkable, bicycle-friendly land use, including mixed-use development with a range of housing choices..

Sustainable Landscape and Garden Design

Sustainable landscape architecture is a category of sustainable design and energy-efficient landscaping concerned with the planning and design of outdoor space. Plants and materials may be bought from local growers to reduce energy used in transportation. Design techniques include planting trees to shade buildings from the sun or protect them from wind, using local materials, and on-site composting and chipping not only to reduce green waste hauling but to increase organic matter and therefore carbon in the soil.

Samples of Sustainable Designs

The term sustainable is thrown about quite a bit these days, but there's more to it than adding some solar panels to the roof of an inefficient building and calling it a day. True sustainability is made up of many facets, from building materials to the use of renewable energy sources to design that strives for efficiency and harmony with the surrounding environment. We think the following selections meet many of these criteria.

Waste

The Waste House is a sustainable construction project installed at the UK's University of Brighton. As its name suggests, the prototype home is built *almost* exclusively from discarded waste. Around 90 percent of the materials that went into making the Waste House derive from household and construction waste, including 20,000 toothbrushes, 4,000 DVD cases, 2,000 floppy discs, and 2,000 used carpet tiles, used to clad the home's facade. While nobody actually lives in it at present, the building is a remarkable achievement and proves the organizer's mantra that "there is no such thing as waste, just stuff in the wrong place."

S House

Vietnam's Vo Trong Nghia Architects has been tinkering away at the issue of providing practical, sustainable, and most importantly, cheap, homes. The result is the S House, a US$4,000 dwelling part-built using local, easily-obtained materials, including Palm leaf thatching and bamboo.

Fall House

San Francisco's Fougeron Architecture recently designed and built a particularly beautiful luxury house that's guaranteed to make the neighbours see green. Located on California's Big Sur coastline, the Fall House sports a copper facade that will weather and patina over time, as it comes into contact with the sea air. The copper is also designed to offer a degree of fire-protection. In addition to its enviable looks and views, the two-story Fall House features energy-efficient windows and its open design naturally encourages stack ventilation, automatically opening windows help reduce the need for air-conditioning. A grey water recycling system is also installed.

ZEB Pilot House

The ZEB Pilot House, by international architecture outfit Snøhetta is a remarkable experimental home that makes an even more remarkable claim: thanks to incredible

efficiency and ample solar panels, it's said to generate almost three times the amount of electricity it requires.

Pop-Up House

Whatever kind of home you live in, the chances are it took longer to build than the Pop-Up House, by French architecture firm Multipod, which was erected by a team of builders in just four days with no more tools than a screwdriver. The firm likens the construction process to building with Lego.

Tight house

Said to be the first certified Passive House in New York City, Tighthouse represents an impressive energy-efficient renovation of an existing row house that's over a hundred years old. Architectural design firm Fabrica718 added a new rear facade, an additional story, a roof terrace, and an art studio to the house. Sustainable technology installed includes two solar thermal panels for hot water needs, and solar PV panels, which reduce grid-based electricity requirements. As the home is almost air-tight, a highly-efficient heat recovery ventilation system (HRV) is always running to provide plenty of fresh air.

Blooming Bamboo

Like Vo Trong Nghia Architects, Vietnamese firm H&P Architects has also produced a prototype home that will eventually be mass-sold to Vietnamese people on a low income. However, this particular home is also flood-proof. The Blooming Bamboo house is placed on stilts and designed to withstand floods of up to 1.5 m (5 ft) in depth, though H&P Architects hopes to increase this to 3 m (10 ft).

Illawarra Flame

Students from Australia's University of Wollongong took a typical Australian "fibro house," and retrofitted it with enough sustainable technology to make the notoriously energy-hungry style of home into a net-zero houses. The Illawarra Flame house project involved a lengthy renovation process, including transforming a bedroom into a living space, and the installation of prefabricated pods which contain amenities including laundry room and bathroom.

Z6 House

The Z6 House in California is all about innovative and convenient sustainable design. In fact, the name itself is based on the philosophy of achieving zero levels across key areas: waste, energy, carbon emissions, water and ignorance. Essentially, the Z6 house is a combination of every sustainable method of construction, and the result is not only a zero waste home, but a stylish looking one too. The building makes heavy use of solar power and this is responsible for around 70% of its energy use. Through other luxuries such as solar powered water heaters and heated floorboards, the Z6 house makes the best of natural resources.

Z6 House
Source: www.aiatopten.org

The Change Initiative

Located in Dubai, TCI is officially the most sustainable commercial building in the world to date. The building itself is a shop that provides sustainable solutions, so we certainly know that it practices what it preaches. While most of the materials used to create TCI is recyclable (including the water they use), the roof is equipped with solar panels and heat-reflective paint which provides 40% of the building's energy, and the outer structure has three times the insulation of your average building. The building's logo is a clever play on the 'on switch,' reinforcing the circuitous nature of sustainable living.

The Change Initiative
Source: www.bigprojectme.com

Pixel

Pixel was the most sustainable commercial building in the world before TCI knocked it from the top spot, so it's certainly worthy of note. Built in Australia, it was the first building to ever be granted a perfect Green Star score and set precedence for sustainable architecture in the country. Pixel itself is a small office building that makes use of several innovations for sustainability, including a sun shade system that lets natural light into the office whilst reducing glare and heat. The building even generates its own electricity through the use of wind turbines. It's also fair to say that the design is pretty striking; certainly one to be remembered.

The Change Initiative
Source: www.greenbiz.com

The Experience of Building Research Establishment (BRE) Innovation Park, Watford, United Kingdom

Created in 2005, The Building Research Establishment (BRE) Innovation Park has some of the world's most sustainable buildings, landscape designs and many innovative low carbon products, materials and technology. It is an independent research-based consultancy, testing, certification and training organisation, offering expertise in every aspect of the built environment.

RECOMMENDATION

The adoption of urban design principles can contribute significantly to a safer environment. Development schemes could incorporate measures in their design, layout, siting and landscaping to minimise the risk of crime and maximise security. Blank walls and parts of buildings such as loading bays, that cannot contribute to passive surveillance, should not face onto public space but should be placed at the backs of blocks. The adoption of the 'perimeter block' layout can support these measures, comprising frontages where the public realm is readily overlooked from adjacent properties and the rear gardens are private

Secure areas which are difficult for third parties to access. The following issues should be considered when designing a safe development:

- Opportunities to incorporate passive surveillance of streets, spaces, parking and servicing areas
- Strong demarcation between public and private space
- Public areas are well lit and landscaping does not obscure views into and out of the space
- Developments are constructed of vandal resistant materials, and that maintenance arrangements are in place
- Installation of sprinkler systems and hard wire smoke alarms where feasible
- All Designs to be developed must have satisfied the principles of sustainable designs before been approved for development by the various approval bodies in the country
- More discuss on sustainable design, sustainable living, sustainable materials, sustainable construction etc. should be carried out in architecture schools,

NIA/ARCON organised events; this will create more awareness on sustainable living in the built environment within country.

- Nigerian architectural education should be a conscious process which entails effort towards development of skills, knowledge, attitudes and information for the improvement of our architecture within our cultural realm.

CONCLUSION

For any progress to be made in entrenching sustainable Design through design and constructing buildings that are sustainable, we in turn are allowing the building's inhabitants to lead more sustainable lives. Building occupiers will experience lower fuel and water bills, healthier living conditions and draw comfort from the fact that they are helping to protect the environment. While responsible development can ensure that resources are protected and carbon emissions reduced over the lifetime of the building, occupiers can deliver further environmental benefits by choosing to live sustainable lifestyles. However, without the provision of appropriate facilities or information, these options can be restricted or even withdrawn altogether. We need buildings that can breathe naturally, not sick buildings. Let us now design with nature, an architecture deeply rooted in our culture and traditions. That is the architecture of our time.

REFERENCES

Anastas, P. L. and Zimmerman, J. B. (2003). "Through the 12 Principles of Green Engineering". *Environmental Science and Technology*. Wikipedia

ASHRAE Guideline (2011): Interactions Affecting the Achievement of Acceptable Indoor Environments "www.buildings.com

Ben-Gal I., Katz R. and Bukchin J. (2007), "Robust Eco-Design: A New Application for Quality Engineering", IIE Transactions, Vol. 40 (10), p. 907 - 918. Available at: http://www.eng.tau.ac.il/~bengal/Eco_Design.pd

Buzz Holling 1973 Resilience and Stability of Ecological Systems. Wikipedia

Congress for the New Urbanism (2011) "Charter of the New Urbanism". Internet

Elizabeth Hons (2013) "Waste and recycling DEFRA", published by *Department for Environment, Food & Rural Affairs, Environment Agency*

Holm, Ivar (2006). "*Ideas and Beliefs in Architecture and Industrial design: How attitudes, orientations, and underlying assumptions shape the built environment*". Published by Oslo School of Architecture and Design. ISBN 82-547-0174-1.

J.A Tainter (1988) "The Collapse of Complex Societies" Published by Cambridge Univ. Press

Ji Yan and Plainiotis Stellios (2006) "Design for Sustainability. Beijing: China Architecture and Building Press". ISBN 7-112-08390-7

Local Authority Building Control (2006) "Architects Guide to Sustainable Design and Construction" Published by Local Authority Building Control

McLennan, J. F. (2004), "The Philosophy of Sustainable Design" Wikipedia

Office for National Statistics, UK (2012). "Household waste" Wikipedia

Olotuah A.O. (2009) "The Built & Human Environment Review" *Journal of Architecture*

Paul Hawken, Amory B. Lovins, and L. Hunter Lovins (1999). "Natural Capitalism: Creating the Next Industrial Revolution" Published by Little, Brown.

Rodrigo Bautista & Zoë Olivia John (2011) "Sustainable Design Research". Wikipedia

Rolf Disch Solararchitektur (2003). Wikipedia

Traditional Architecture Group (2014) "Beauty, Humanism, Continuity between Past and Future". Published by Traditional Architecture Group

Uzuegbunam F.O. (2013). "Reflections on Nigerian Architecture and Culture for a Sustainable Development of the Hot Humid Tropical Environment". *Journal of Environmental Management and Safety.*

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