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HOLLOGRAM AND BIM APPLICATIONS FOR POSITIVE DEVELOPMENT IN THE NIGERIAN CONSTRUCTION INDUSTRY

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Abstract

Uncommon development in the context of architecture could best be described by the recent trend in the design of buildings, which is to design and construct buildings that are sustainable to their host environment. A major breakthrough in the design of green/sustainable buildings is the use of hologram and Building Information Modelling BIM to not only visualise the proposed design in 3D but to also layer the design with additional project information, where there are 4th and 5th dimensions of time and cost. In addition to all these, an emerging schema in BIM is Building energy simulation, which is the use of software to predict the energy use of a building. The hologram and Building Information Modelling Software has positively impacted on the quality of [redacted] *designs produced by building industry professionals internationally. This paper therefore seeks to review current trends in the use of hologram and BIM with a view to educating built environment professionals in the Nigerian environmental disciplines and practices.*

KEYWORDS: *Building, Environment, Sustainability, Hollogram, Professionals*

Introduction

Currently, there is a lot of concern on the impact of man on the environment. The building and construction sectors have been identified as one of the major contributors to global environmental impacts due to their high energy consumption (embodied and operational), high usage of materials, and development space. Sustainable Architecture therefore seeks to minimise the negative environmental impact of buildings by efficiency and moderation in the use of materials, energy, and development space (Wikipedia 2014).

Giant strides have been made by architects globally in the field of designing buildings that are green and subservient to the environment. The most recent development in BIM is Building energy simulation where it is used to predict the energy use of a building. Using this tool, the architect for example can simulate how wind flow around and through a building and how ventilation and wind velocity might change if a building shape or surface material was changed (Inhabitat 2011).

A typical energy model will have inputs for climate; envelope; internal gains from lighting, equipment, and occupants; heating, cooling, and ventilation systems; schedules of occupants, equipment, and lighting Energy models will output building energy use predictions in typical end-use categories: heating, cooling, lighting, fan, plug, process. In addition to energy units, most software includes utility rates input, and can predict energy costs (Wikipedia 2014).

In Nigeria, BIM has not been widely adopted in both the private and public sectors and amongst different building professionals (Architects, Quantity Surveyors, Civil Engineers etc). Architects have adopted but mainly for enhancing the visual quality of their presentation. This is unfortunate because of its enormous potentials to enhance efficiency, reduce disputes, save costs and curb corruption (Alufohai 2012). Generally understanding of BIM in Nigeria is limited to 3D visualisations, component details and specifications, whereas it encompasses so much more with hologram as a three-dimensional image formed by the interference of light beams from a laser or other coherent light source with a photograph of an interference pattern which, when suitably illuminated, produces a three-dimensional image

The purpose of this research was to highlight the important role BIM plays in the design of sustainable buildings which to a large extent can be termed as uncommon within the context of Nigerian Architecture. A case study of the Miami Science Museum in the United States was undertaken to showcase how BIM works at design stage of buildings to achieve sustainability.

METHODOLOGY

The Research methodology was through primary source of data using case study approach analysed by a Qualitative means.

BRIEF HISTORICAL BACKGROUND OF BUILDING INFORMATION MODELLING AND HOLLOGRAM

The concept of BIM has existed since the 1970s. The term Building Information Model first appeared in 1992. However, the terms Building Information Model and Building Information Modelling (including the acronym "BIM") had not been popularly used until 10 years later when Autodesk released the white paper entitled "Building Information Modelling". Jerry Laiserin helped popularize and standardize the term as a common name for the digital representation of the building process as then offered under differing terminology by Graphisoft as "Virtual Building", Bentley Systems as "Integrated Project Models", and by Autodesk or Vectorworks as "Building Information Modelling" to facilitate exchange and interoperability of information in digital format.

According to Laiserin and others, the first implementation of BIM was under the **Virtual Building** concept by Graphisoft's ArchiCAD, in its debut in 1987.Today, BIM allows multi-disciplinary information to be superimposed within one model, creating an opportunity for sustainable measures and performance analysis to be performed throughout the design process (Azhar 2010).

LITERATURE REVIEW

Building information modelling (BIM) is one of the most promising recent developments in the architecture, engineering, and construction (AEC) industry. With BIM technology, an accurate virtual model of a building is digitally constructed. This model, known as a building information model, can be used for planning, design, construction, and operation of the facility. It helps architects, engineers, and constructors visualize what is to be built in a simulated environment to identify any potential design, construction, or operational issues (Azhar 2011).

According to Azhar et al, Building Information Modelling (BIM) represents the process of development and use of a computer generated model to simulate the planning, design, construction and operation of a facility as shown in Figure 1. The resulting model, a Building Information Model, is a data-rich, object-oriented, intelligent and parametric digital representation of the facility, from which views and data appropriate to various users' needs can be extracted and analyzed to generate information that can be used to make decisions and to improve the process of delivering the facility.

Fig 1a showing 3d architectural model sourced from http://bim.messer.com/construction/trade_coordination

Fig 1b 1b showing Integrated Structural and MEP Model sourced from pcs-structural.com

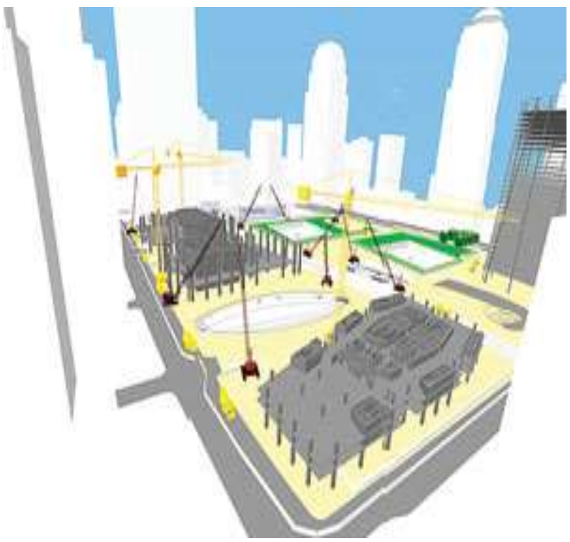

Fig 1c showing a site logistic planning model sourced from newyork.construction.com

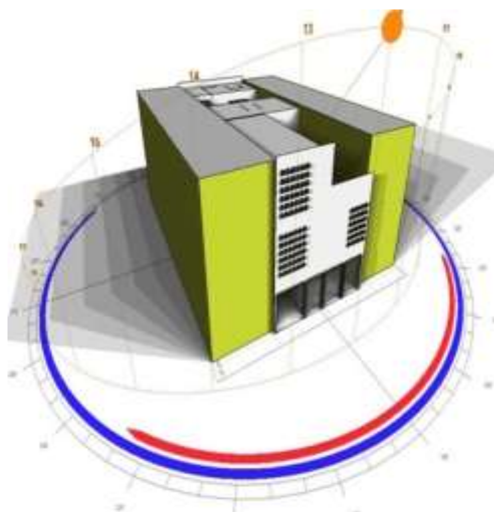

Fig 1 d showing an energy simulation model sourced from www. Youngcities.org

Alufohai further defined, BIM as an approach to construction that supports the continuous and immediate availability of project design scope, schedule, and cost information that is of high quality, reliable, integrated. According to Sacks et al, BIM is a generic term used to describe advanced 3D Computer Aided Design (CAD) technology for modelling and managing buildings and information related to them but which are differentiated from traditional CAD systems in that the software objects in a BIM model are intelligible to computer programs as representations of real-world building components, unlike the graphic objects in a two-dimensional CAD file". The American Institute of Architects (AIA) defines BIM as "a model-based technology linked with a database of project information". BIM covers geometry, spatial relationships, geographic information, quantities and properties of building components.

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TYPES OF BIM SOFTWARE PACKAGES

Over the years, software developers have come up with different types of BIM packages. These BIM packages each have their strengths and weaknesses. A few prominent ones are discussed below:

1. **Autodesk REVIT**- With Revit, it is possible to coordinate every building element in one database, so users can immediately see the results of any design revisions made in the model, and reflect them in the associated views (drawings), as well as detect any coordination issues.
2. **Graphisoft's ArchiCAD** application creates a virtual building model which has many applications in a building's model rather than being the central clearing point that a single model is.
3. **Autodesk Architectural Desktop** (ADT) ADT creates its building model as a loosely-coupled collection of drawings, each representing a portion of the complete BIM which are aggregated through various mechanisms to generate additional views of the building, reports, and schedules as though there was a single BIM at the center. Errors occur when the user manipulates the individual files outside the drawing management capabilities provided in ADT.
4. **Autodesk Ecotect Analysis** is a comprehensive concept-to-detail sustainable building design tool. Ecotect Analysis offers a wide range of simulation and building energy analysis functionality that can improve performance of existing buildings and new building designs. Online energy, water, and carbon-emission analysis capabilities integrate with tools that enable you to visualize and simulate a building's performance within the context of its environment.
5. **Nemetschek's AllPlan design** allows third party design and analysis applications to interface with the building objects in the model. Its main market is German-speaking countries in Europe.

HOLLOGRAM, BIM AND SUSTAINABLE DESIGNS

Buildings have been identified to consume 40% of global energy and with the rising cost of energy and growing environmental concerns; the demand for sustainable building facilities with minimal environmental impact is increasing.

The most effective decisions regarding sustainability in a building facility are made in the early design and preconstruction stages. In this context, BIM can aid in performing complex building performance analyses to ensure an optimized sustainable building design. Some of the BIM packages used for this type of analyses are Ecotect, Green Building Studio (GBS) and Virtual Environment. As a result of this, Dowsett (2013) suggested that BIM can assist in the following areas of sustainable design: Building orientation (selecting a good orientation can reduce energy costs), Building massing (to analyse building form and optimize the building envelope), Day-lighting analysis, Water harvesting (reducing water needs in a building), Energy modelling (reducing energy needs and analysing renewable energy options can contribute to low energy costs), Sustainable materials (reducing material needs and using recycled materials), Site and logistics management (to reduce waste and carbon footprints).

Design options for sustainability can be tracked and studied in a model along with spatial data to geographically locate and import building site information to place it within context and to contribute to an understanding of issues relating to climate, surrounding systems and resources. The building can then be adjusted and engineered using real coordinates to reduce the impact on and utilise sustainably the surrounding environment to reduce energy requirements, for example solar orientation.

ADVANTAGES OF HOLLOGRAM AND BIM

Nagalingam (2013) mentioned that benefits and key advantages that BIM confers include:

- Increased speed of delivery (time saved) and Better coordination (fewer errors)
- Decreased costs (money saved) and Greater productivity
- Design visualization and Reduction of Errors
- Collision Detection and Quantity Take Off
- 4D Constructability and 5D Cost Estimating
- Asset/Equipment Inventory, Facility Operations and Space assignment
- Maintenance/Repair and Emergency response, cost effective, flexibility, etc.
- Higher-quality work
- New revenue and business opportunities

CHALLENGES OF HOLLOGRAM AND BIM

Some problems associated with BIM as highlighted include:

1. BIM systems create big and complex files hence the scalability and manageability of a fully loaded central BIM project database becomes a major challenge.
2. Sharing Hollogram and BIM information as drawing files rather than sharing intelligent objects from the model.
3. The need for increasingly sophisticated data management at the building object level..
4. A contradiction in work process when using a single detailed Hollogram and BIM to try to represent a number of the alternative design schemes under consideration.
5. Every company on the project team cannot adopt one BIM system.

CASE STUDY

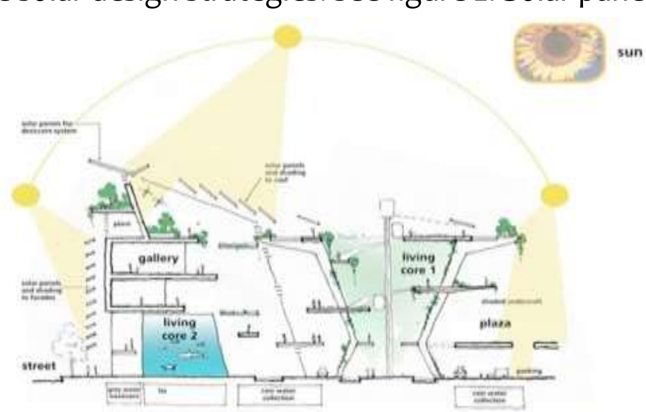
PROJECT: Miami Science Museum ARCHITECTS: Grimshaw Architects

LOCATION: water front, Miami USA COMPLETION DATE: 2016

DESCRIPTION: The museum is designed to have a partly open-air structure that will be home to science galleries, a history gallery, a planetarium and a 'living core' aquarium and wildlife centre that contains a microcosm of South Florida's animal, fish and plant species. The core design concept is "building as exhibit". Grimshaw's design is a "living building" - physically and visibly changing in response to environment, events and the mood of the city. A vegetated roof will be accompanied by a constructed wetland adjacent to the building for control of storm water runoff and to enhance site biodiversity. . Issues observed in the case study are solar, water strategies, airflow and ventilation strategies as explained below.

SOLAR STRATEGIES

The Museum carefully integrates the direction and location of the sun into its design in both passive and active solar design strategies. see figure 2. Solar panels cover areas at museum's roof and facade. Passive solar strategies are well-integrated into the design, and provide a mode for both heating and cooling. In fact, in many instances the PV



panels offer direct shading for the building and the interior.

Figure 2 showing solar analysis source from http://inhabitat.com

WATER STRATEGIES

The museum will act as virtual sponge when it comes to water catchment. A belvedere water feature is designed at the roof of the building which uses the natural bio-filtration of rainwater through mangroves and other elements within the opening. The museum's green roof and interior green wall provide further bio-filtration as well as a temporary means of rainwater retention for later irrigation, see figure 3. Rainwater harvesting and storage is incorporated. Toilets are to utilize treated grey-water captured from basins, showers and building systems.

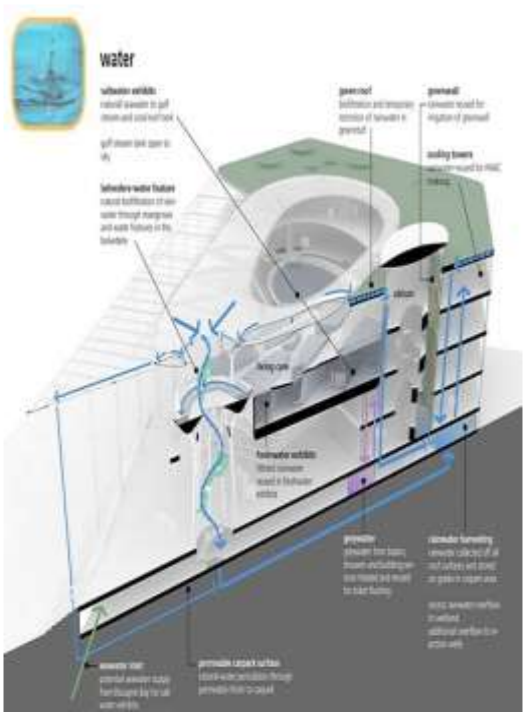


Figure 3 showing water strategies http://inhabitat.com

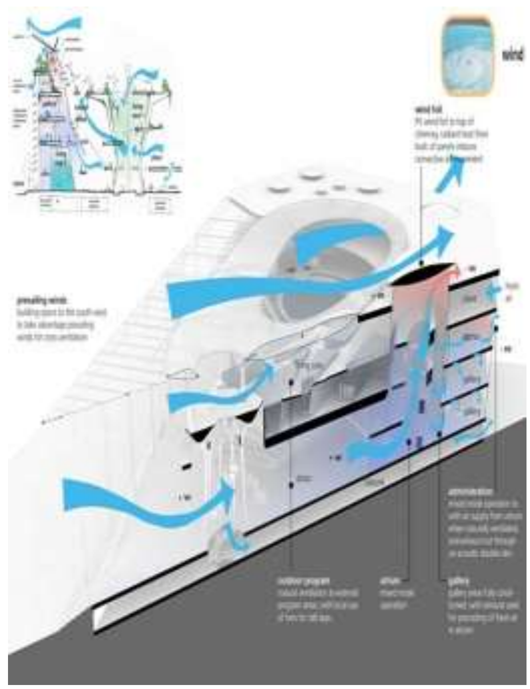


Figure 4 showing wind strategy.

MODELING AIR FLOW AND VENTILATION

The shape of the building is not accidental. It was designed to take advantage of pattern of wind flow on the site. The building was designed as a solid block on the north and west boundaries of the site. The southwest orientation was chosen to take advantage of the prevailing winds. A canyon was created at the roof to improve air balance for comfort.

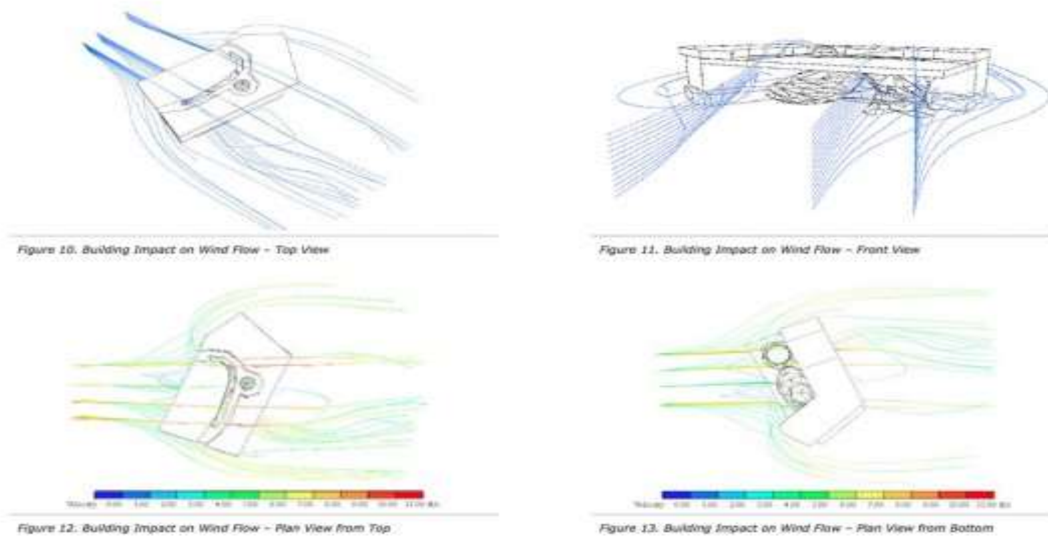
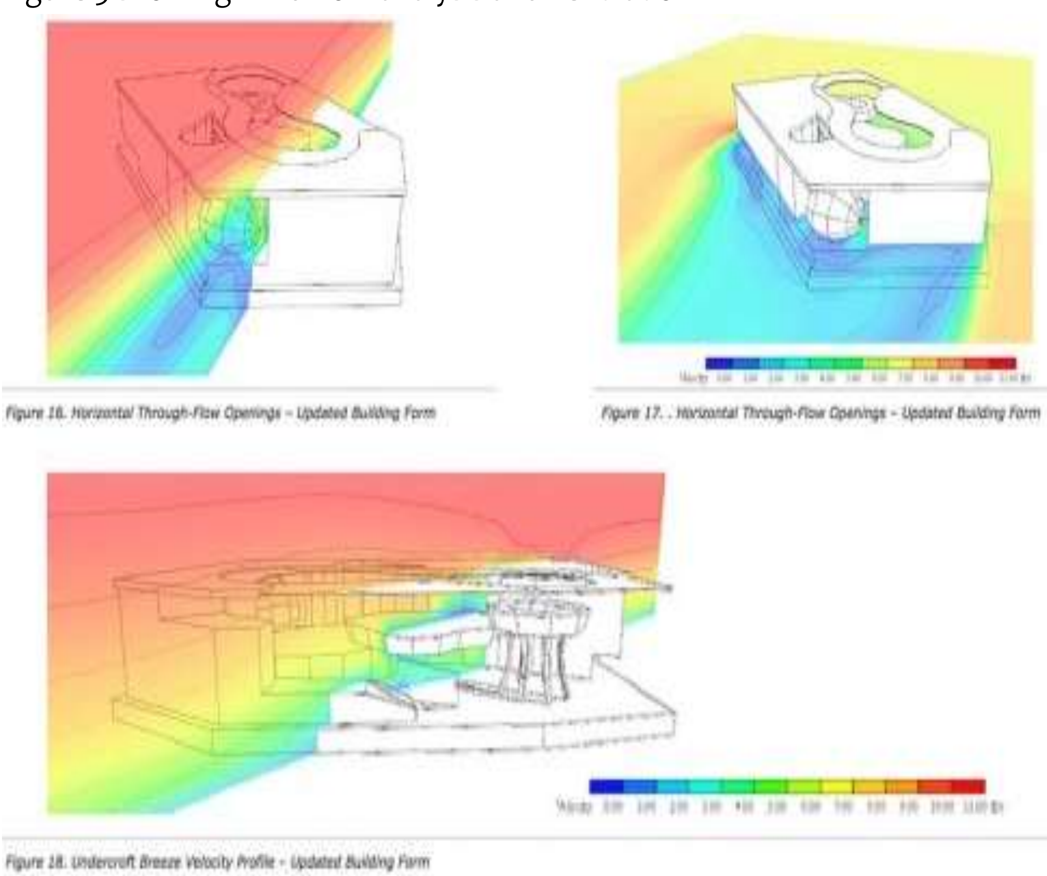


Figure 5 showing wind flow analysis and ventilation



Figures 6 showing wind flow analysis and ventilation at design stage

Opening to the southwest, the museum takes advantage of the site's prevailing winds for optimal cross-ventilation and comfort within the total space, as well as the parking lot below. Stacked administration and gallery spaces sit on the eastern end of the museum, and air exchange within these spaces is maximized through an adjacent atrium. While gallery areas are fully conditioned mechanically, the air that is exhausted into these spaces is recycled to pre-cool the fresh air of the atrium, which then flows to cool the administrative floor eventually being exhausted through an acoustic double skin.

FINDINGS

From the case study above, it was discovered that Hollogram and BIM has been successfully utilized to design sustainable buildings. However in Nigeria the adoption of Hollogram and BIM in the AEC is still marginalised.

CONCLUSION

Sustainable building design hinges on the ability to gain insight into a building's performance through analysis and optimization of the design. From the case study carried-out it would be seen that the project studied has to a large extent met the goals of sustainable architecture by the deliberate minimisation of the building impact on the environment.

With the glaring capabilities of Hollogram and BIM in the area aiding architects to carry-out building analyses with a view to designing sustainable buildings, its adoption in Nigeria beyond visualisation is non-existent. With exponential increase in population and attendant pressure on our limited natural resources this paper therefore highlights the need for urgent action by all stakeholders in ensuring we are not left behind.

Finally, to create buildings that are unique and uncommon, we must respect our environment and ensure compliance with global best practices as it relates to Sustainable Architecture.

RECOMMENDATIONS

- There is a need to increase awareness so as to promote adoption by our institutions and professionals first step in promoting adoption.
- Professional institutions should to organize training for their members and clients, including or perhaps especially public sector institutions.
- Hollogram and BIM should be included in tertiary institution curriculum.

- Government should enact policies to encourage the adoption of Hollogram and BIM and sustainable design approaches.

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