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VIRTUAL ARCHITECTURE IN FUTA: A CASE STUDY OF THE NEW SCHOOL OF ENVIRONMENTAL TECHNOLOGY (SET) BUILDING.

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Abstract

Virtual Reality (VR) is a technology that can make a significant impact on how construction project stakeholders can perceive and successfully complete their projects. It can enhance the efficiency and effectiveness of all stages of a project, from initial conceptual design through detailed design, planning and preparation, to construction completion. The builder/client can review the design and rehearse the construction of the facility in a 3D interactive and immersive environment. This can increase the understanding of the design intent, improve the constructability of the project, and minimize changes and abortive work that can be detected prior to the start of construction. Real time virtual walkthroughs of the structure can be performed to allow for experiencing, in near-reality sense, what to expect when construction is complete. Various efforts in the industry and academia are underway to explore these possible benefits of VR in construction. This paper provides an overview of recent example of successful adoption of VR technology as applications in construction. The paper also provides an overview of what Virtual Reality (VR) is, and present a work jointly carried out at the Departments of Computer Science and Architecture of the Federal University of Technology, Akure, FUTA.

Keywords: Virtual reality, construction, architecture, concepts, planning, CAD software.

1.0 Introduction

The Virtual Building model is useful for all professionals connected to the building industry - architects and residential designers, interior designers, real estate agents, facility managers and marketing staff. Working from the same Virtual Building as the architect, the real estate agent can easily obtain exact room dimensions and area calculations, present perspective views from any vantage and even invite prospects on a virtual tour of the building. Interior designers can begin working during the planning phase on the same Virtual Building model. After construction is complete, building managers are able to use the comprehensive materials list and integrated 3D partition plan to track building assets and modify spaces.

2.0 Virtual Reality Technology

2.1 A Taxonomy of Virtual Reality (VR)

The term Virtual Reality (VR) is used by many different people with many meanings. There are some people to whom VR is a specific collection of technologies that is a Head Mounted Display, Glove Input Device and Audio. Some other people stretch the term to include conventional books, movies or pure fantasy and imagination. The NSF taxonomy mentioned in the introduction can cover these as well. However, for the purposes of this paper, we restrict VR to computer mediated systems. "Virtual Reality is a way for humans to visualize, manipulate and interact with computers and extremely complex data".

The visualization part refers to the computer generating visual, auditory or other sensual outputs to the user of a world within the computer. This world may be a CAD model, a scientific simulation, or a view into a database. The user can interact with the world and directly manipulate objects within the world. Some worlds are animated by other processes, perhaps physical simulations, or simple animation scripts. Interaction with the virtual world, at least with near real time control of the viewpoint is a critical test for a 'virtual reality'. Some people object to the term "Virtual Reality", saying it is an oxymoron. Other terms that have been used are Synthetic Environments, Cyberspace, Artificial Reality and Simulator Technology. VR is the most common which has caught the attention of the media.

2.2 Historical Background of VR

Its origin is attributed to flight simulators developed about fifty years ago by the United States Army. The beginning of VR is attributed to Ivan Sutherland, with the introduction in 1965 of the first three-dimensional immersion helmet, which was later divulged to the peripheral device industry with the designation, head mounted display. A precursor, Nicholas Negroponte (and collaborators), in the 70's, produced a virtual map of guided walks using a model of the city of Aspen, Colorado. In 1989, Jaron Lanier, an important driving force behind this emerging technology, designated it *Virtual Reality* (Vince, 1998).

In the 90s, with the upsurge of the Internet, a specific programming language was defined, the Virtual Reality Modeling Language (VRML). It is a three-dimensional interactive language devised for the purpose of modeling and visually representing objects, situations and virtual worlds on the Internet, which makes use of mathematical co-ordinates to create objects in space (Burdea and Coiffet, 2003). This constitutes a new means of communication that allows the construction of, and experimentation with, new computer-modeled realities.

2.3 Application Areas of VR

The applications being developed for VR run as a wide spectrum, from games to architectural and business planning. Many applications are worlds that are very similar to our own, like CAD or architectural modeling. Some applications provide ways of viewing from an advantageous perspective not possible with the real world, like scientific simulators and telepresense systems, air traffic control systems. One of the areas in which the incorporation of VR technology as a means of geometric modeling and visual presentation of three-dimensional animated models is most often applied is Architecture and Engineering. The range of potential applications extends from buildings on a small scale to the development of town plans. However, VR technology does not merely constitute a good interface but presents applications that provide the possibility of finding solutions to real problems in such diverse fields as Engineering, Architecture, Estate Management, Medicine or Psychology.

2.3.1 Virtual Architecture

Proponents of virtual reality (VR) have paid a great amount of lip service to the idea that architecture is one of the many professions that can benefit and grow with the development of virtual reality technologies. However, in its current state, VR technology is in its infancy. The interfaces are clumsy, the concepts are immature, and many of the promises that proponents of VR make are, as yet, just promises. But research and development in VR indicates that it is not just the latest technological innovation, hyped by the media, and destined for failure as the masses realize that they have been fooled by confusion of science fiction and fact. Rather, VR may be at least as significant as modern inventions like the telephone, television, and automobile (and its freeway system) in its potential to alter human society and interaction.

As the technology develops, the interfaces will become less clumsy, and virtual reality will achieve its goal: to become a transparent medium of communication which will provide total immersion of the senses into an alternate "reality." As this is realized over the next several years, the technology may become more widespread in society than communication media like the telephone and television. Twenty-first century society may come to depend on VR as much as twentieth-century society has evolved to depend on the automobile to survive.

2.3.2 Virtual Building concept

The Virtual Building embraces the entire building industry and manages the entire information life cycle of buildings. Unlike a simple 3D model on a computer, the Virtual Building contains a great deal more information about the building's materials and characteristics. It is a 3D digital database that tracks all elements that make up a building. This information can include surface area and volume; thermal properties; room descriptions; price; specific product information; window, door and finish schedules; and more.

A definition is here introduced, (Christiansson, 1993), a Virtual Building as "a formalized digital description of an existing or planned building which can be used to fully simulate and communicate the behavior of the real building in its expected contexts". IT tools can in this connection be used to design, build and use the virtual building, interact with the digital building model from idea to demolition. It can also be used to simulate the behavior of the final building during erection, use and demolition. It can act as a vital tool to check the performance against requirements on the final building. Lastly, it can support various *building processes* from idea or conceptual stage to completion.

3.0 The Virtual Model

As a case study, in the building construction field, the new School of Environmental Technology was selected. The developed virtual model allows the builder/client to visualize and experience the building even before a block of the actual building is laid, thereby permitting real time modification and interaction with the model. The construction component focuses on different aspect of the construction process: the structural part, the vertical panels and the opening elements. The 3D geometric model of the building was defined using the Vizx3D Virtual reality modeler and then export as VRML format so that it could be viewed by any VRML browser like Cosmo Player, Octaga, and others.

3.1 Creating the 3D geometric model

All building elements of the wall were identified and defined as 3D objects. Structural elements, vertical panels of the wall and standard opening elements were modeled. In order to provide the virtual simulation of the geometric evolution of a building under construction, the 3D model was defined as a set of individual objects, each one representing a component.

3.1.1 Structural elements of the building

Foundations, columns and beams, were considered as structural elements. The concrete blocks were defined as *box* graphic elements (available within the Vizx3D system). FIG. 1 shows some details of these components.

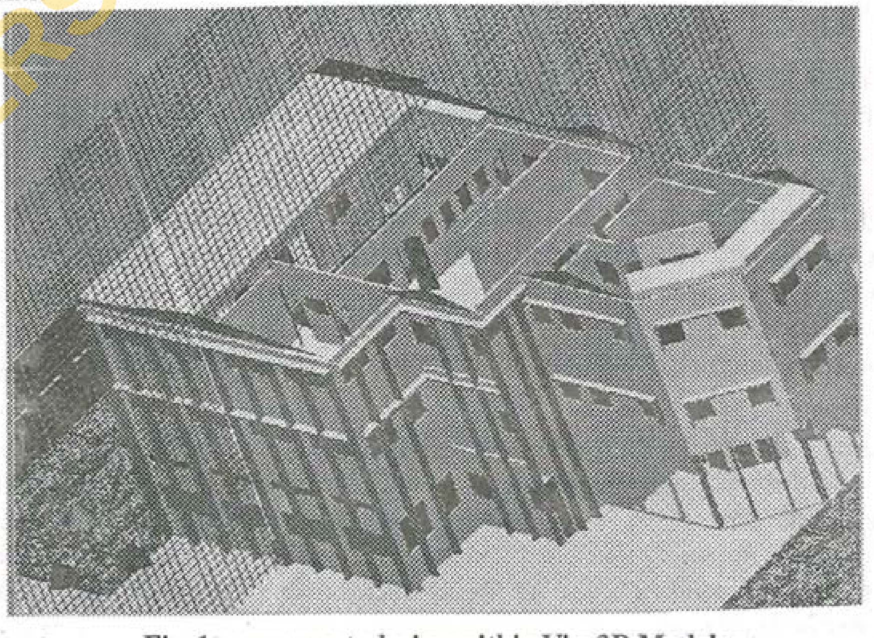

Fig. 1 components design within Vizx3D Modeler

3.2 Application of Virtual Reality capacities

One by one every part of each element considered as a building component was modeled. FIG. 2 shows the complete model. Next, the 3D model was exported as a VRML file. The VR system should allow the manipulation of the elements of the model according to the plane prescribed for carrying out the construction. Supporting that, a range of nodes or functions is available in the system to build up convenient virtual animations.

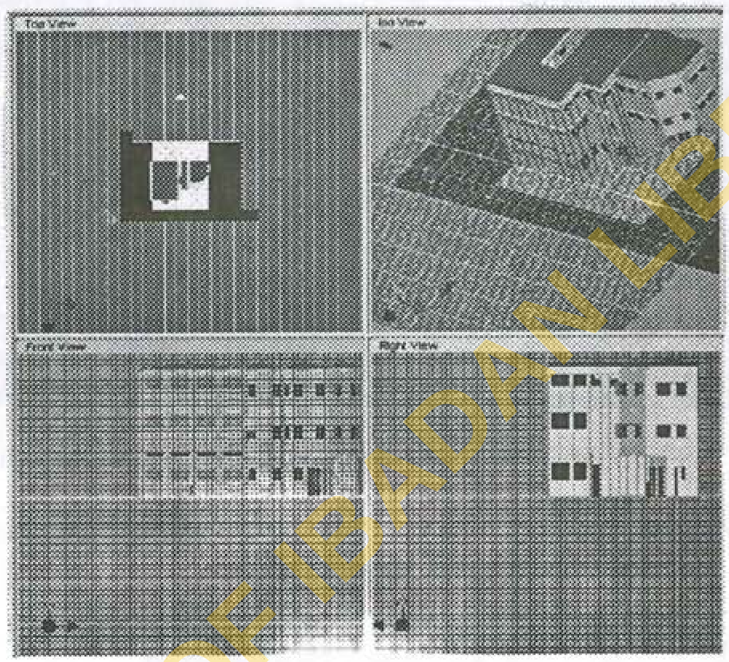

Fig. 2 Displaying the complete model within Vizx3D

The steel reinforcements were modeled as *cylinder* and *torus* graphic elements. In FIG. 3, it is possible to observe how to accommodate the steel reinforcements inside the structural elements. This is a real problem that
is solved for each case in the work place.

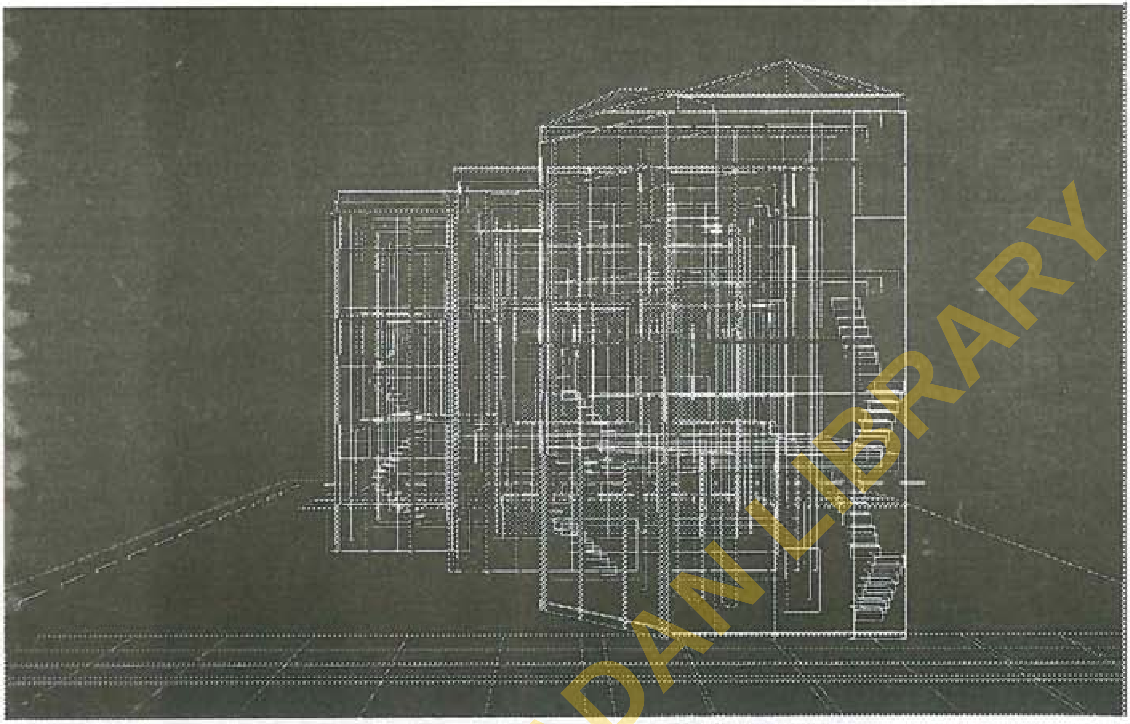

Fig. 3 Observing steel reinforcements inside the structural elements

Figures 4 – 7 show samples of different real time walkthrough a builder/client could make through the modeled structure.

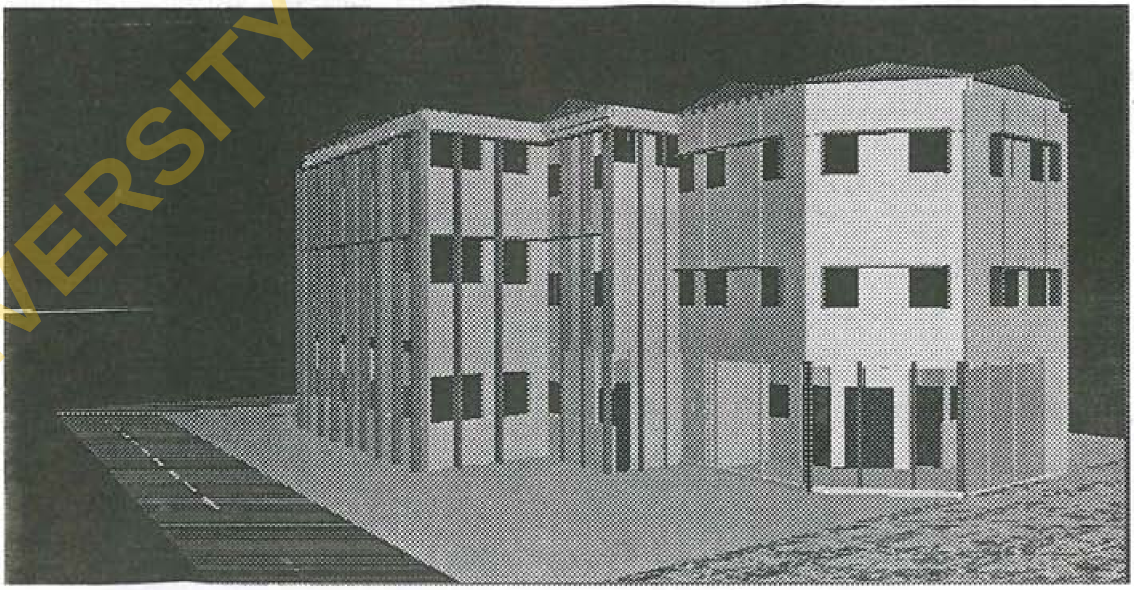

Fig. 4 The Side View of the model viewed within Octaga – a VRML browser

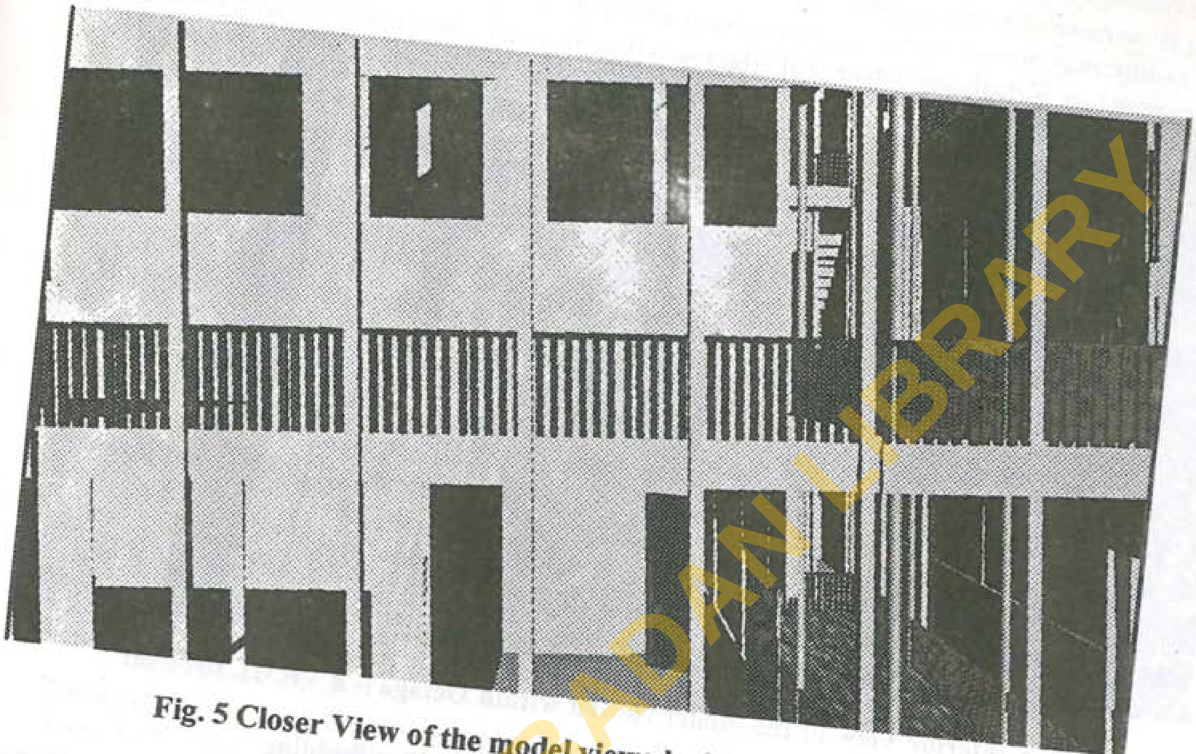

Fig. 5 Closer View of the model viewed within Octaga – a VRML browser

Fig. 6 A View of the model viewed within Octaga – a VRML browser

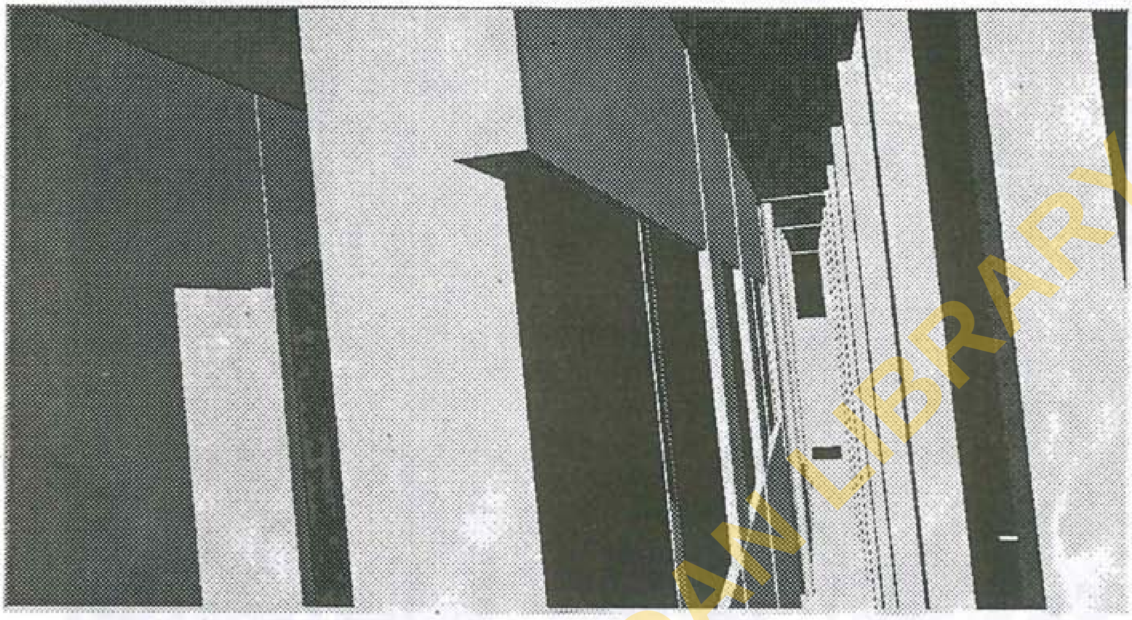

Fig. 7 Interior View of the model viewed within Octaga – a VRML browser

4.0 Future Research Direction of Vrand Virtual Architecture/Building

The introduction and widespread integration of VR into society may lead to consequences greater than what is generally predicted. With the existence of a complex and chaotic society today, how can it withstand the introduction of a technology which can only provide a simulation of reality? Social relationships and interactions will be dramatically altered as the transfer of information and images comes to substitute the movement of mass. VR technology is now being integrated with broad-band global networks (like the internet), and soon people may come to communicate with others around the world with a medium so realistic that its users cannot differentiate between what is real and what is simulation. The main enabling information technologies are efficient *access* tools to physical computer networks, standards/protocols for *services* on the Internet. Utilization of emerging *object oriented* distributed global operating systems and appropriate *multimedia* (this includes virtual reality) interfaces in networked environments. Consideration for the use of mixed and extended *knowledge representations* in networked environments where necessary. The reliable, cost effective and high capacity *information storage devices* must also be well planned.

5.0 Conclusions and Recommendations

The VR technology applied to construction field made possible to represent a three-dimensional space realistically. The visual simulation of the construction evolution of a common case was achieved. The user can interact with the virtual model of the structure and impose any sequence time in the construction process, select from the building's model any component or parts of element and manipulate the camera as desire in order to observe conveniently any detail of the components configuration. While the technology is yet to be fully embraced for building construction in Africa, it is predicted that the technology has a bright future in the construction industry in Nigeria.

Information technology will have a great impact on how to design, construct and the use of new and existing buildings in the near future. The enabling technologies have made great progress in several fields which is evolving, though it is still at the infancy stage in Nigeria. Application and technology transfer in this direction, will effect desirable changes in several building related or relevant areas. It will reduce the case of non-redundant models, but encourages overlapping representations of building products and processes. The use of multimedia interfaces with realistic access to underlying models and efficient utilization of personal competencies through *computer supported team collaboration.* It provides the platform for the efficient interactive building documentation and increased possibilities for project experience capture and re-use. These all will eventually help in the introduction and increase of *intelligent and responsive buildings* in practice

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