

AC 2008-325: AN ARCHITECTURAL WALKTHROUGH USING 3D GAME ENGINE

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An Architectural Walkthrough using 3D Game Engine

Abstract

Today's 3D game engines have long been used by game developers to create dazzling worlds with the finest details—allowing users to immerse themselves in the alternate worlds provided. With the availability of the “Unreal Engine” these same 3D engines can now provide a similar experience for those working in the field of architecture. The rapid rendering quality and multi-user interactivity of these engines have given architects an edge over the past traditional 3D pre-rendered and non-interactive visualization tools. This paper describes an approach for developing realistic 3D architectural walkthroughs using the “Unreal Engine 2”. The Engine based walkthrough allows users to navigate virtual environments from an ultra-realistic first person vantage point, creating the illusion of actually seeing the environment from the character's point of view. For architecture students the added realism of these models can enhance understanding of their own design in relation to time, space, environment, and scale. Add interactive elements like lighting, sound, triggered events, animations, and artificial intelligence and the realism of the 3D model can be enhanced even further. Walkthrough visualizations using 3D Game Engines provide better and broader understanding of architectural planning and conceptual design, interior and exterior feel, and the aesthetic appeal of construction compared to the typical “paper based models” currently used by most architectural students.

Introduction and Background

“Animation/visualization techniques provide virtual experiential learning when combined with interactive design animation and virtual design navigation. These activities are self-directed, experiential, and personalized for the autonomous self-directed distance learner. Web based teaching and learning has potential advantages compared to traditional education since it is less expensive, easy-to-access, easy-to-update and platform independent. Although multimedia is generally considered as an individual pursuit, authors' study suggests that its use in classes with a large audience can be accommodated, provided that it is linked directly to the achievement of a specific group of learning objectives.”¹

Recent developments in the field of graphic processing units and the availability of breath taking rendering capabilities on computers systems form gaming companies provides a ready made solution and keeps us from reinventing the wheel.²

With the rapid development and implementing of new visualization by the Gaming industry many previous versions of game engine and game related libraries are available for free or almost no cost. Game engines can be used to give our clients a tour of the project rather than making them mere spectators of a predetermined view.³

Harrison⁴ states that a game engine is normally designed for a particular game such as first personal shooters, real-time strategy and vehicle simulations. One advantage of a game engine is that it can be reused to the development of many different kinds of games, in an automated way,

saving a lot of programming time. Since the time computer graphics has been introduced, the demands for visualization techniques have grown continuously. Today, the visualization of three-dimensional worlds seems to be a demanding task requested by many geo related disciplines. Due to the increasing interest in the consumer market, tremendous progress can be observed in the hardware and software. Game engines are powerful software packages that efficiently use rendering pipelines, special data-structures and speed-up techniques to visualize texture mapped 3D objects, scenes and 3D worlds in real-time⁴. The rendering performance and quality continuously increases as the game industry develops and implements new visualization technologies. And many of the last generation engines or game-related libraries are now available for little or even no cost in the form of open-source software.

Presenting a large commercial structure in 3D, such as an office building or bank, normally requires several weeks of painstaking design to create a realistic model and have a walkthrough of it rendered, frame-by-frame. Due to the time and cost typically involved, architectural design firms primarily use 3D visualizations only at the behest of clients, and usually for marketing purposes.³ Even though the benefits of using virtual reality all the way from the design through the presentation stage have been documented, shortcomings in the technologies -- long rendering times, lack of real-time visualization, etc. -- have made using them impractical, and the lack of immediacy in the medium decreases the usefulness during the initial conceptualization process.³

Specifically, the latest offering from Epic Games, Inc., and the most advanced commercially released 3D game engine available today: the Unreal engine. It offers features and capabilities for architectural design, visualization and advanced presentations unmatched by any other product or system, and the Unreal concept has the potential to jump-start the use of virtual reality technology in architecture and real estate, from concept to presentation and beyond.⁵ Campbell and Wells³ found that "the delay between the conception and visualization of design ideas did not provide direct or immediate feedback in the design process," making virtual reality useless in that aspect. Conceptual visualization of the design was relegated to sketches and pre-rendered walkthroughs of the design.³

The UnrealEngine2 Runtime software is the state of the art in cross-platform, real-time 3D rendering solutions for the desktop. It is optimized for both indoor and out door environments and is a versatile engine.⁶

One of the Unreal engine's greatest strength as a design tool is its integration with the UnrealEd level editor. UnrealEd is a real-time level design tool, optimized for building real-time 3D environments. It is fully integrated with Unreal's rendering engine, offering a camera view, and immediate display of all lighting, texture placement and geometry operations. UnrealEd also offers single-click playability: even in the midst of the design process, the designer can launch the Unreal viewer and walk around their building in real-time.⁷

The aim of the research was to develop a realistic 3D architectural walkthrough using the "Unreal Engine 2" that would allow the architecture/construction science students to navigate virtual building from an ultra-realistic first person vantage point. Relying on the powerful capacities of present graphics engines, the first person vantage point creates the illusion of actually seeing through the eyes of the character taking the walkthrough. The game engine

driven models can enhance understanding of their own design in relation to time, space, environment, and scale. In addition, interactive elements, such as lighting, sound, triggered events, animations, and the realism of the 3D model can be enhanced even further.

Model Development Methodology

The steps involved in making the interior and exterior of the building model using the game engine are explained in the following steps with the flowchart (Fig.1):

- First step was to design a residential building.
- The next step was to develop a 2D architectural drawing that includes floor plan (Fig. 1), elevation and furniture lay out using AutoCAD 2006.
- After the development of 2D drawings a basic 3D model was developed in unreal editor by subtracting the world space and then adding as few large blocks which were then carried out to form rooms, doors, windows, and others.
- Generate a terrain in the Unreal Ed.
- Textures were resized or created in Photoshop 7, and then saved in .dds, .bmp and .tga formats.
- Textures imported in to the unreal texture browser, and applied to the geometry created in unreal. Creating the static mesh in 3ds Max like the door, windows and furniture to populate the basic structure that was developed in unreal.
- UV mapping and or unwrapping in 3ds Max or any third party software's like Deep UV and texturing the Model in 3ds Max.
- Exporting the 3ds models as .ASE and textures as .DDS or .BMP or .TGA.
- Importing the static mesh in Unreal Ed and applying material in the static mesh browser.
- Subtract space away from the level for skybox and add textured static mesh planes to act as clouds. Also add static mesh rings that act as cloud rings.
- Add different lights and sunlight and adjust them
- Use triggers for message display and lighting controls
- Use movers to make auto-opening doors.
- Optimize and save the Map. Add screen shots; customize the runtime interface and test run the map.

The Methodology of creating a world in Unreal and adding static mesh is explained using screen-prints (Figs. 2, 3, 4, and 5), which were taken during the development of the model. Level editors cannot create 3D content, such as static meshes and player models. For this reason 3D modeling software's like 3ds Max or Maya was used to create things not available in the Unreal runtime engine. The advantage of using static mesh in multiples times is that it runs very fast as if only a single copy of the static mesh in the level.

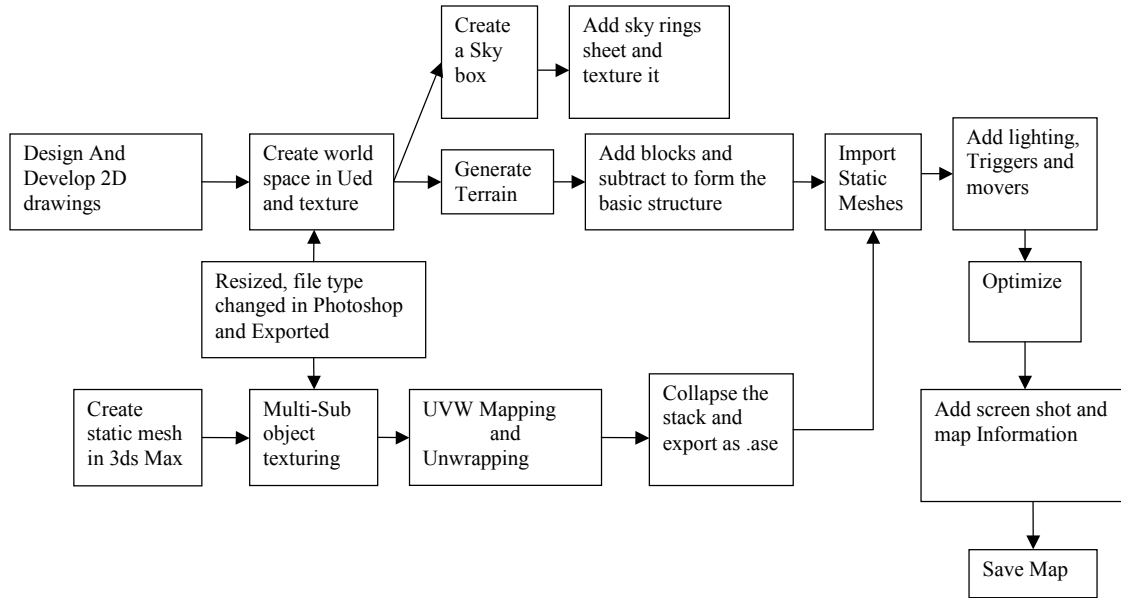


Figure 1: Research Methodology Flow Chart

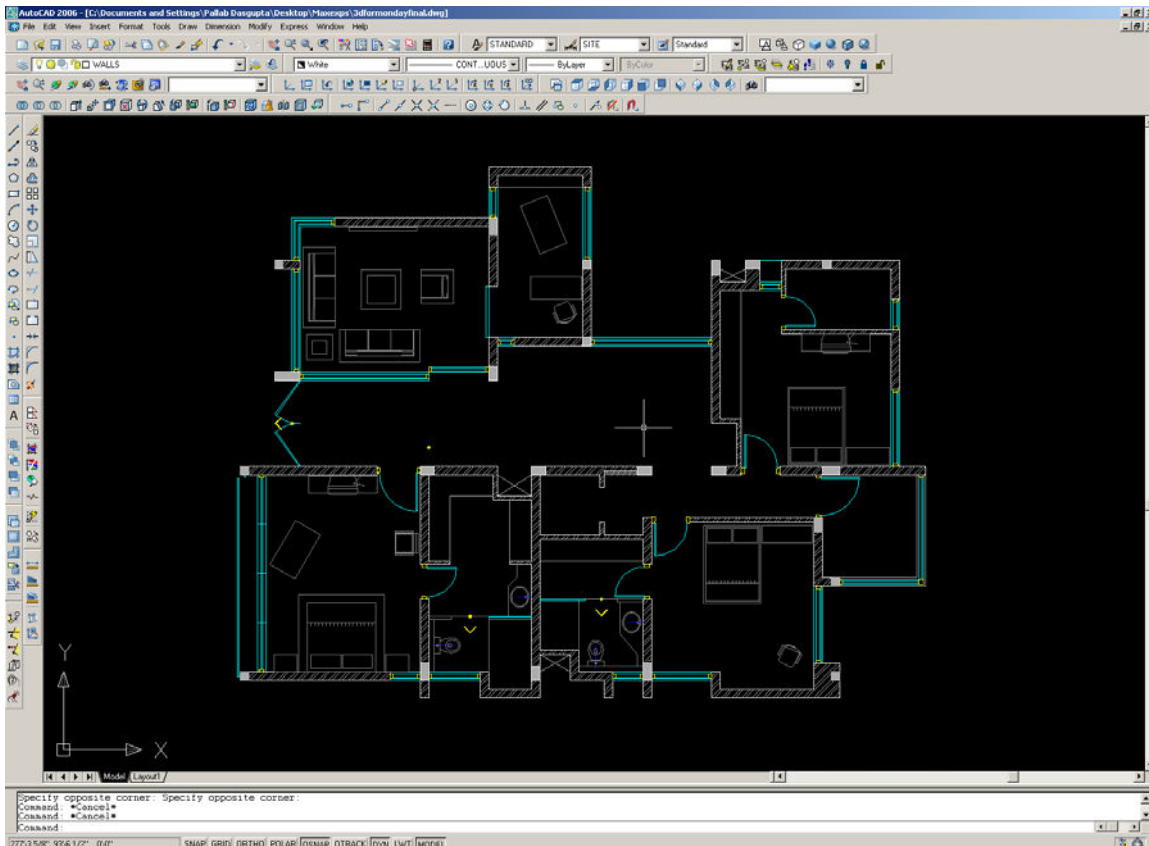


Figure 2: 2d Architectural Drawings in AutoCAD - Building Plan

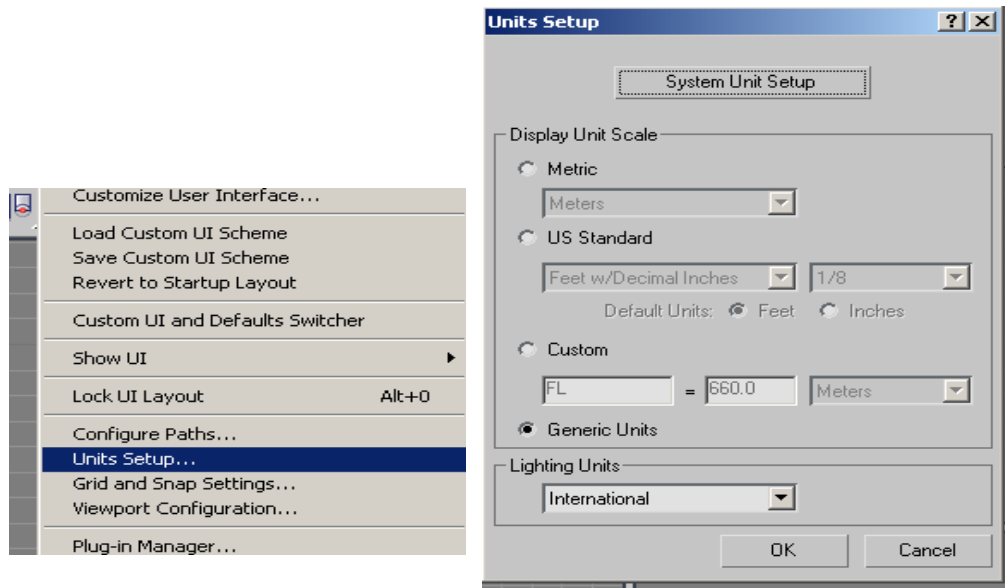


Figure 3: Setting up units in 3ds max

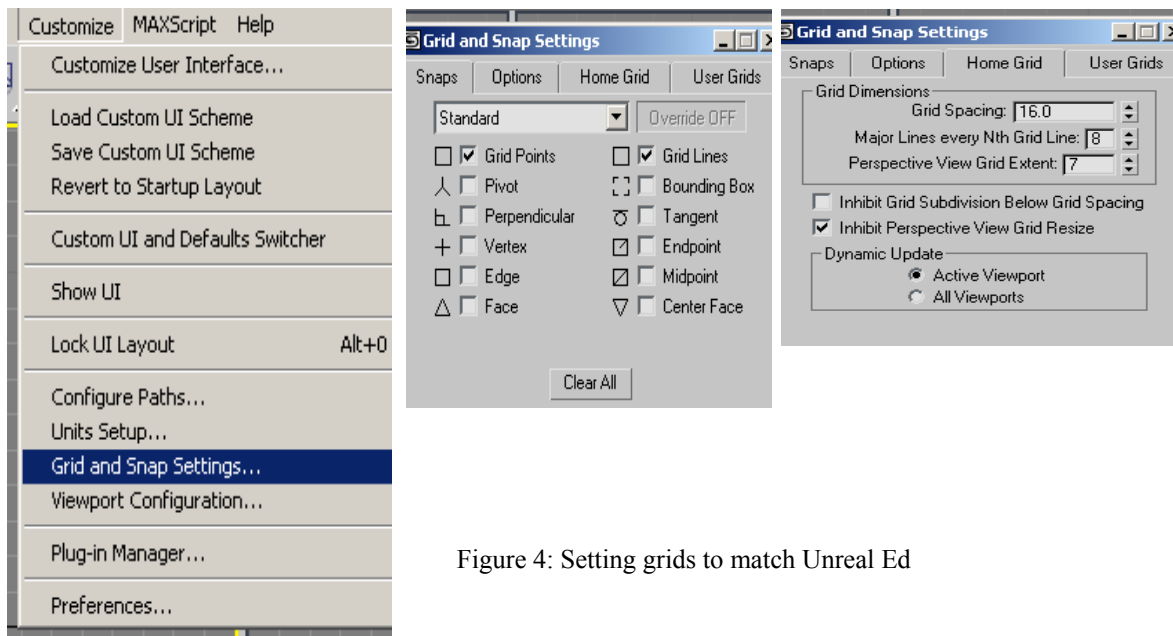


Figure 4: Setting grids to match Unreal Ed

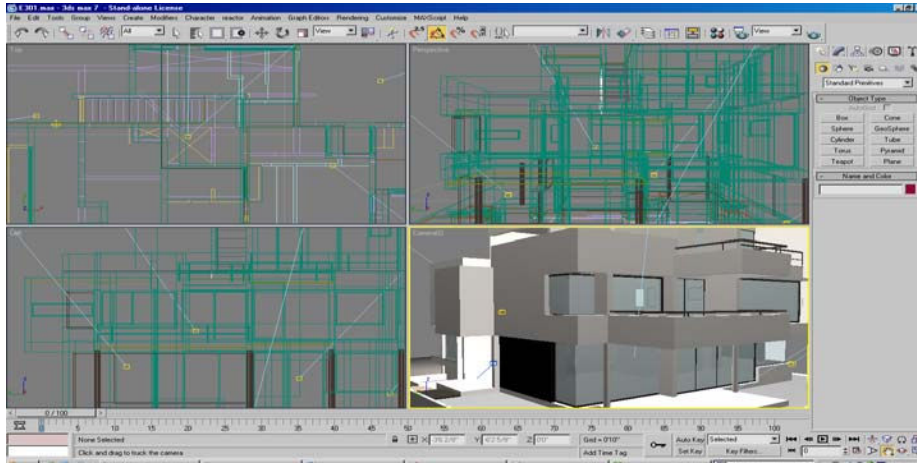


Figure 5: Create the polygonal model

Overview of the Model

The entire model was based on the plan (Fig 1), and developed mostly using UnrealEd2, 3ds Max and Photoshop. With the help of mouse and/or arrow buttons, users can walkthrough the interior and exterior of the building with full degree of freedom. The user can open the doors and enter into the building, roam around living rooms, bed rooms, bathrooms, hallway, and other, and switch on/off lights, and so on. Some of the pictures that have taken during the walkthrough are shown in Figs. 6, 7 and 8.



Figure 6: The front entrance of the building



Figure 7: Building interior walkthrough using the game engine



Figure 8: Bedroom walkthrough using the game engine

Significance of the Research

Game engine driven 3D environment can help the user to understand architecture through exploring it in a surreal environment where one can walk around in the 3D environment. The availability of interactive elements like lighting, sound, triggered events and animations, sprites and artificial intelligence makes it possible to simulate near realistic virtual environment. It can greatly aid students of interior designer to quickly change lay out, color of light, wall paper alternatives and show the changes in their work within minutes once the basic model is created. It also gives them a sense of scale and ambience that paper models and traditional 3D models cannot match. In addition, 3D game engine has the capability to adjust different parameters of virtual environment like weather conditions or day and night.

The significant difference between game engine driven and non-game engine based walkthrough is its user interactivity. Non-game engine based visualizations, such as 3D Max based walkthroughs are pre-rendered movie files. In order to see a new walkthrough, user needs to re-render and re-create a new movie file. This significantly limits the users freedom in the walkthrough as they are forced to observe only the visuals predetermined by the creator of the movie file. On the otherhand, in game engine driven walkthrough, the users can walkthrough with a full-degree of freedom with the help of mouse and/or arrow buttons. Users can enter into the building through any exterior door and walk around in side the building without any predefined path. They have the opportunity to fully engage their environment by moving objects, opening doors, turning on lights, and more; giving them the sense of realism required to understand the intricacies of the architecture model. The model presented in this paper has full-degree of freedom in walkthrough.

In addition, the engine driven models have rapid rendering quality and multi-users interactivity. Several players, such as interior designers, architects, students can work interactively within the same model. By allowing the design students to enter the virtual space at full scale, it is possible to add more pragmatism to their design experiences.

Evaluation of the Model

In order to determine the effectiveness of the model as an instructional tool was conducted in a small sample (graduate students). Initial feedback of the evaluation of the model was very encouraging. Evaluation of the model using a large sample of population (undergraduate students) will be conducted in future. This instruction model will be tested on a Likert scale of 1 to 5 to see whether the model achieves its aim or not.

Concluding Remarks

This paper describes an architectural model development methodology using the “Unreal Engine 2”. The Engine based walkthrough allows the students to navigate with full degree of freedom within the virtual environments. For architecture students the added realism of these models can enhance understanding of their own design in relation to time, space, environment, and scale.

The interactive elements of the game engine like lighting, sound, triggered events and animations, were studied in detail to increase the level of interest of the users, and to create a near realistic space. The preliminary evaluation of the developed walkthrough visualization model using 3D Game Engines showed that it would provide better and broader understanding of planning and conceptual design, interior and exterior feel, and the aesthetic appeal of construction compared to the typical “paper based” or “movie based” models currently used by most architectural students.

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