

Peter Eisenman's House X, Scheme G: 3D Game Engine for Portable Virtual Representation of Architecture

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Recently introduced 3D games, game editors, along with gaming software offer great potential for delivering three-dimensional, collaborative virtual environments for on-line audiences. These capabilities have significant potential in architectural visualization. The University of Missouri-Columbia's Emerging Technology Group developed the Virtual Campus Project introducing the university campus to prospective students through the Internet. Fascinating quality, seamless real time rendering, and smooth navigation are enough to impress visitors. However, the developers had to use eye measures and guesses based on photos rather than architectural drawings for initial 3D computer models. The absence of a precise scaling system as well as not being able to recognize a standard 3D architectural drawing format in a virtual environment were the prime generators of this paper.

One important goal for this paper is to suggest architects the potentials of using universal or exchangeable formats of 3D models with accurate structure data to build virtual models. A second goal is to provide better understanding of potentials in 3D game engines for virtual representation of architecture.

Keywords: *Game engines, 3D Model, virtual reality.*

Introduction

Creation of 3D modeling and Virtual Reality Models are not new, but the use of game engines to power real-time interactivity with multiple users for architecture is very recent. There is very little doubt that Virtual Reality promises significant advances in architecture and virtual 3D representation. It is an area that needs to be explored further by architects and designers. Recent expansion of virtual reality technology has been possible due to game engines. In architecture, the game engine can serve a much important role than visualization, which includes

understanding the language of architecture itself.

Proponents of Virtual Reality believe that user performance such as collaboration or learning can be improved via immersion or giving an enhanced sense of "being there". That is what distinguishes Virtual Reality from preceding 3D technologies: the sense of immediacy and control created by interaction and continuously changing visual display. When the subject comes to architecture, the advantage is more obvious. It's difficult for people to read architectural structure, but if they can "walk" around in a virtual environment they get a much better idea. For the designer and architect, the virtual environment

that 3D game engines can provide enhances the understanding of design components as well as on-line collaboration.

The House X, an early un-built work by Peter Eisenman, is purposefully chosen to experience its spatial quality, materiality contrast, and spatial composition. Compared to his series of earlier houses, House X represents more a point of departure than a contradiction. It is rather a strategy for design; a move away from rationalism and formalism. The process in House X is no longer about the manipulation of a preferred set of linear and planar elements and a sequential progression found in his earlier houses. It is rather a notion called by the architect 'Decomposition', or search for unknown order. This unknown order, organization of primary volumes in four quadrants, and use of contrast materiality, makes the house interesting to explore in a virtual interactive world.

Virtual Reality and Game Engines

Although Virtual Reality (VR) has great potentials, it is commonly dependent on expensive, specialized computer hardware. In terms of its utility and aesthetics, the basic categories of VR can be divided into following categories:

VRML (Virtual Reality Modeling Language), a PC based relatively low-cost solution, sounded promising in theory but had never reached a stage where designers can be excited about due to its drawbacks. First of all, it only allows low frame rates and a low sense of realism since the VRML models are strictly limited in size and detail. The navigation in a VRML browser does not help a sense of realism or involvement of the user. Systems for large and more detailed models are very expensive. Therefore they are often not an option for most users.

QuickTime VR for architecture representation is also relatively inexpensive VR technology while the rendering quality is incomparable to VRML. Stitching several photographs or renderings to give the feeling that the user is inside the environment can cre-

ate a 360-degree panorama of a building. Despite the fact that it gives quality rendering based on real photos, the limited freedom of navigation and the lack of interaction remain as the most recognized disadvantages. As a means to visualize a building design, this method is often lost considering the balance between the limited interaction and demand of a lot of time for actual modeling and rendering tasks ahead.

3D Walkthrough Animations are rendered along a pre-defined path through a model. It can provide the most sophisticated model and quality rendering while the user experiences a low sense of immersion because of its one-directional presentation with lack of possibilities to explore and understand the model. Besides, the time and energy spent on modeling and rendering for just a few seconds of animation may not help the designer to simulate different ideas for feedbacks.

3D game engine is modular simulation code that builds a 3D Virtual environment. Thanks to rapidly grown mass market for PC games (even larger than the movie industry), the popularity has led game engines to be written for a specific game. However, it is general enough to be used for a family of similar games or to be repurposed for portable architectural representation. The graphic details of 3D games are amazing while the game engines have low-cost hardware requirements because consumers play games at home on their desktop PCs. In a highly interactive and up-tempo environment as components for games, they are very smooth to navigate and explore.

The extensive interactive feature with sound, animated object as well as Artificial Intelligent characters called 'Avatar' can enhance a sense of being there for the environment even more.

In the next segment of the paper discussions will follow on selected video game engines and will highlight a specific game engine that is used for the featured House X.

3D Game Engines for Architectural Representation

Although, the trend is changing, most architects still consider 3D technology as a complimentary activity to their design presentation. One reason for this is the high production cost of 3D presentation and more labor time. For architects and designers, the 3D technology has remained limited to rendered walk-throughs. Real estate agencies have started to use 360-degree panoramas (from photographs) to create virtual tours for marketing. But the potential strength of virtual 3D interactive environment has remained unexplored by architects and interior designers. The video game engines discussed in this paper show promising futures for architectural adaptation.

The 1993 release of Doom, a computer game by id Software, led to a new era of game design and play that presents an immersive first-person perspective, though it is not the first one since 3-Demon (1987) and Wolfenstein3D (1992). Doom achieved a sense of realism, on PCs of that time and today. It also offered the most sophisticated and responsive interactive simulations. Quake III Arena (1999), Unreal Tournament (1999), and Max Payne (2001) are truly the descendants of Doom. They also provide the most developed, flexible and usable engines for research purposes. Discussions in this paper will take account of these three video game engines.

Features of Quake III, Unreal Tournament, and Max Payne Environments

The graphic detail of 3D games has made tremendous progression since Doom. A sense of realism on PCs is achieved by assiduous use of texture maps, programming tricks for special effects, interactive and animating objects and simultaneous/interactive sounds.

For example, two significant features introduced by Doom are multiplayer play over network and

user/third-party programmability. Multi-player features over network add a great dimension to distance communication with low costs. At present, a 3D game package often includes its own game level editor that allows users to build their own gaming environments to boost excitement through the users' involvement. Sometimes programmers have introduced third-party programmable tools, called 'level-editor' for one or more game engines. Since 3D game level-editors were not developed for designers or programmers in particular, but for general game users, interfaces are simple and very easy to model and render compared to 3D computer aided design software. The Unreal Tournament game package comes with level editor. Quake or Max Payne has level editors available to download from the Web.

When using 3D game level editor, architectural representation using 3D computer graphics is no longer expensive for creating the model and rendering it. Presenting a structure in 3D normally requires several weeks of painstaking design to create a realistic model with a walk through or fly through along pre-determined path. Level editors have their interfaces designed to show 3D rendered scenes while constructing the model. It makes it easy to modify an object since changes can be viewed in 3D rendering simultaneously.

Surface textures in 3D game engines are not just static covers. They appear animated and function to handle special circumstances, like liquids, flowing sky and special effects in a game world with simple scripting. Objects can also be animated or programmed to be triggers for actions and/or sounds.

Among the most sophisticated 3D game engines Quake III, Unreal Tournament, and Max Payne are noteworthy to mention. The most recent one, Max Payne, a third person shooting game, offers surprisingly realistic graphical details. It is a story driven game focused on the main character. For super realistic rendering and compromising interactivity, Max Payne was not considered as the

primary choice for this paper.

First person shooting game players often compare Unreal Tournament with Quake III. Like Coke and Pepsi, these two game engines have their fans. As the older game, obviously the Quake III engine has more resources for questions and assistance. Many believe it is the fastest-running game engine over all polygonal architecture. The newer engine, the Unreal engine, benefits from existing technology. Like the Java scripting language, Unreal Script, is easy to use and well documented. While the Quake engine offers true curves and direct access to graphics functions such as deformation shading, the Unreal engine allows a broader range of sophisticated graphics such as bump maps. As the Quake engine is the fastest engine, the Unreal engine is relatively slower and known as an easier environment for inexperienced game programmer. Being also fast in rendering and having more available sources for assistances makes Quake suitable for architectural work.

House X and Virtual Representation

As mentioned earlier, House X is an early un-built work by Peter Eisenman purposefully chosen to be constructed and placed in a video game environment. The architect himself mentioned once that the disassociation of man, object and nature was implicit from the very beginning of this project. He mentions that, "Because there were no transformational process in House X, the diagrams for it were only heuristic approximations – that is a non-reality". This makes the house unique enough to be explored in a non-real digital environment.

House X is strongly colored by metaphoric ideas of ruin, decay, and falling to pieces. The house attempts to use these ideas from a viewpoint of modern society rather than borrowing elements from history as a notion of post-modern style. In house X, there are four quadrants initially seen as similar elements in similar positions. As they changed size and volume, they become dissimilar elements in similar positions. They also represent variation in use of

material and texture. Eventually, the center becomes a residue of juxtaposition of four volumes. It becomes both conceptually and literally a void.

In terms of geometric configuration House X can be constructed with a series of rectangular and cubic 3D forms. This is a very useful feature since Quake III allows low polygon rectilinear forms to be simulated much faster than curvilinear forms in real-time 3D environment.

House X is not a simple building to be read and represented easily through two-dimensional drawings. The complexity of the house becomes more evident when four quadrants superimpose both in plan, elevation, and section. The ability to view both the interior and exterior at the same time while constructing the 3D environment gives Quake Virtual Reality software the unique edge over other architectural software. It also provides interactivity in real time to understand complex interiors.

Placing Universal Format 3D Models into Gaming Scenes: Problems Identified and Solutions Found in Quake III for House X

One of the primary concerns of this paper was to bring universal format (DXF, DWG, 3DS, etc.) 3D models into a Quake III interface. We found two specific limitations in Quake III that needed to be resolved: the issue of compatibility and the issue of Accuracy.

Compatibility: As every 3D graphics application has its own polygon building mechanisms, game level editor has an even more distinctive one due to its unique output format. It causes difficulties to bring 3D models in universal formats into gaming scenes through level editors. Even with relatively simple interface and easy operation, architects and designers do not always feel encouraged to learn new software. On the other hand, a model done in one format needs to be interchangeable in order to avoid redundant jobs in different interface. The modeling environment in Quake III only allows low polygon objects

to simulate smoothly in real-time and not able to import universal DXF or DWG format 3D models.

Accuracy: The level editor for Quake III, GTKRadiant is not designed for professional architects or designers but general game players to play with customized environments. Therefore accurate unit system is not required unlike other 3D graphic tools that architects and designers are familiar with. It does not give users options for unit setup for metric or US standard. Sometimes game developers made the characters very tall and heroic on purpose. Then eye level also goes up much higher. With these dissimilar conditions, it is hard to build and bring a structure to Quake III in a specific scale.

In this paper, we are suggesting the most approachable way to import universal format into

gaming scenes for architects and designers without having computer programmers involved. The following are working procedures for placing universal format models in Quake III scene.

First, a three dimensional model is built in either FormZ or 3D Studio Max based on architecture drawings (Figure 1). AutoCAD format seems unstable while converting to 'Brush' that is primitive geometry unit in the Quake engine. Compound objects created with Boolean or Enclosure tools in FormZ or 3D Studio Max cannot be converted into Brushes. Everything needs to consist of standard primitive object type box to ensure it from collapse when converting.

Secondly, models saved in 3DS format can be converted into editable Brushes in Gmax Tempest, a

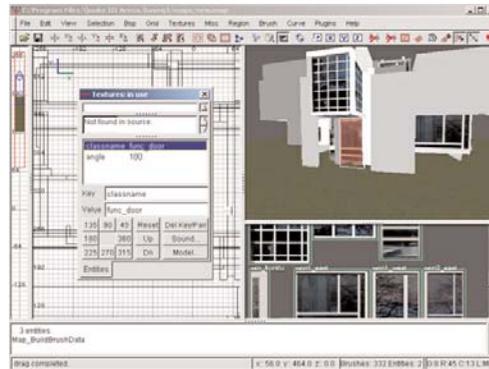
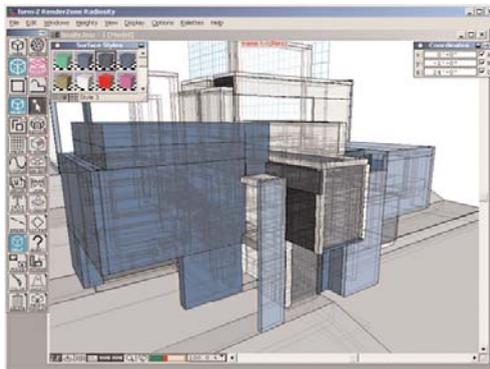


Figure 1. Initial modeling in FormZ

Figure 2. Gmax Tempest interface

Figure 3. Editing properties in GTKRadiant

Figure 4. House X in Quake III Arena



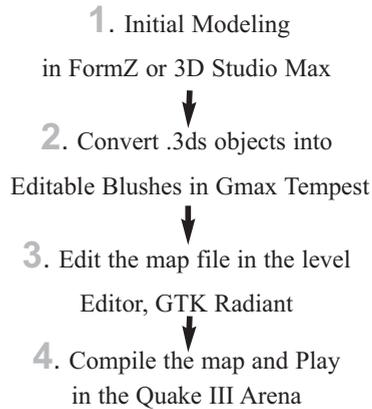


Table 1. Working Procedure

shareware released in 2001 by Discreet. Tempest is a plug-in for Quake III. in Gmax (Figure 2).

Then, in GtkRadiant, level editor for Quake III, textures, lighting and object trigger properties for interactive functions as well as sound effects (Figure 3) were added. 'Shaders' are short text scripts that define the properties of a surface as it appears and functions in a game world. Realistic liquids, sky and special effects can be programmed along with textures using shaders. Since lighting and texture mapping coordinate system in Quake III take different mechanism from other 3D software, users need to experiment to get used to it.

Gmax Tempest and GtkRadiant interchange files only in map format. As the last step to turn the map file from editor code into game code, after a map is finished it must be processed or 'compiled'. In the Quake gaming mode, the compiled map can be found to activate the walk through (Figure 4) mode.

Conclusion

Although weaknesses of modeling features in most game applications are obvious when compared with AutoCAD, 3D StudioMax, and Form-Z, the strength of game engines nonetheless lies in their interactivity and rendering in real time. Game engine based 3D interface offers better interaction to understand a

physical environment.

The problem of importing universal formats of 3D scale model can be resolved by using available conversion software. Once the 3D model is imported successfully, manipulation of color, texture, lighting, and surrounding environment can be edited to create appropriate interactivity.

We appreciate the 3D game engines as valuable rapid prototyping tool for fast exploration of design ideas. What we found out is low cost virtual reality can be accomplished more successfully than ever with game engines. While House X was designed but was never built, a simulation of built architecture can provide possibilities to understand how the user perceives the environment made from bits in VR compared to the real one.

This written paper is an integral segment of the manual demonstration and cannot be separated from the total presentation. While this paper highlights backgrounds and theoretical procedures, the demonstration focuses on a working solution and experience in quality for interactivity.

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