Production of Intelligent and Active Architectural Drawings: Synergy of Autodesk Architectural Desktop 2005 with 3D Studio Max Version 7.

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Abstract

The increasing prevalence of Computer Aided Design (CAD) in the training and practice of architecture has encouraged rapid improvement in the quality of CAD software. Issues of compatibility and convergence are now being seriously addressed. The new generation of software has a more intuitive user interface and is more reliable. These developments coupled with low prices have brought tremendous design power to the desktop of even students of architecture. The possibilities are exemplified by a synergy between Autodesk Architectural Desktop (ADT) 2005 and 3D Studio Max Version 7. ADT 2005 is based on AutoCAD 2005 but it uses AEC objects to turn erstwhile complex 3D modelling into child's play. Building components such as walls, floors, roofs, doors, windows and stairs can be quickly designed using templates, tool palettes and drag-and-drop. Even complex modifications can be accomplished using grip editing. These AEC objects contain attributes that make ADT drawings intelligent. Architects can now concentrate on building 3D models while construction documents such as plans, elevations, sections and details are easily extracted from the model using multi-view blocks, styles and variable object display. Drawings are organized into projects to ease coordination and team work. The property set definitions embedded into AEC objects automate the production of schedules and cost data. 3D Studio Max (3DS) uses materials, lights and animation to produce photorealistic renderings and video footage of 3D models. The improvement of file-linking between ADT 2005 and 3D Studio Max makes model data directly available to the rendering software. Thus most technical documentation can be accomplished using ADT while visualizations are done in 3DS. The tight integration of the two software packages is an encouraging move towards convergence.

Introduction

The integration of Computer Aided Design (CAD) into the curriculum of architecture students has been identified as essential for the production of CAD proficient architecture graduates (Ogunsote and Prucnal-Ogunsote, 2004). While such integration has been achieved in developed countries, developing countries are still battling with lack of a standard curriculum for CAD, non-availability of funds for equipment, unreliable power and communication infrastructure, and scarcity of trained personnel. But even in developed countries the proliferation of CAD and presentation software has led to the development of numerous incompatible file formats. The difficulties experienced in transferring model data between popular CAD software packages have however encouraged the current trend towards compatibility and convergence.

CAD Software

CAD software proliferation over the last few decades was encouraged by the massive shift from the drawing board to computer aided design and dramatic drops in the cost of computer hardware. There are 3 categories of CAD software: 2D and 3D modelling software, rendering software and animation software (Table 1). While current CAD software may have capabilities found in all 3 categories, the emphasis is usually on one category.

Table 1: CAD software categories

Category	Examples of software
2D and 3D modelling	AutoCAD, Autodesk Architectural Desktop, ArchiCAD
Rendering software	Accurender, ArchiCAD, AutoCAD, Autodesk 3D Studio Max, Autodesk 3D Studio Viz, Autodesk Architectural Desktop, Viz Render
Animation software	Autodesk 3D Studio Max, Autodesk 3D Studio Viz, Viz Render

Source: Researchers' software tests.

ADT 2005

Autodesk Architectural Desktop 2005 is a powerful AutoCAD-based software package for CAD specifically designed for architects.

ADT and AutoCAD

ADT 2005 is based on the AutoCAD 2005 engine. The user interface is practically identical, and all the functionality of AutoCAD 2005 can be found in ADT 2005. Some of the improved features include enhanced drawing management, details and drafting tools.

AEC Objects

The design objects in ADT include doors, openings, railings, roofs, slabs, stairs, structural members, walls and windows. These design objects use multi-view blocks, tool palettes and styles to simplify the creation and modification of building model components. Multi-view blocks are used for variable object display, since the blocks may contain views of the object from various directions and at different scales.

ADT Projects

A project is made up of two parts: the building model and the reports generated from the model. The building model is composed of constructs, which in turn are created from elements. The reports consist of views and plotting sheets. In a project, elements are referenced into constructs, constructs are referenced into views, and views are referenced into plotting sheets (Figure 1). Project capability is a major enhancement of ADT over AutoCAD. The advantages of using projects include:

- A sophisticated external reference mechanism allowing extensive distribution of source files. This makes team work involving hundreds of files over large distances possible.
- Elements and constructs that simplify the creation of models from existing resources.
- Plans, elevations, sections, schedules and details can be easily generated as views and plotting sheets from the building model. When an element or construct is modified, the change is reflected in the views and plotting sheets.
- Drawing management is enhanced through the use of levels, divisions, categories, and global cut planes.

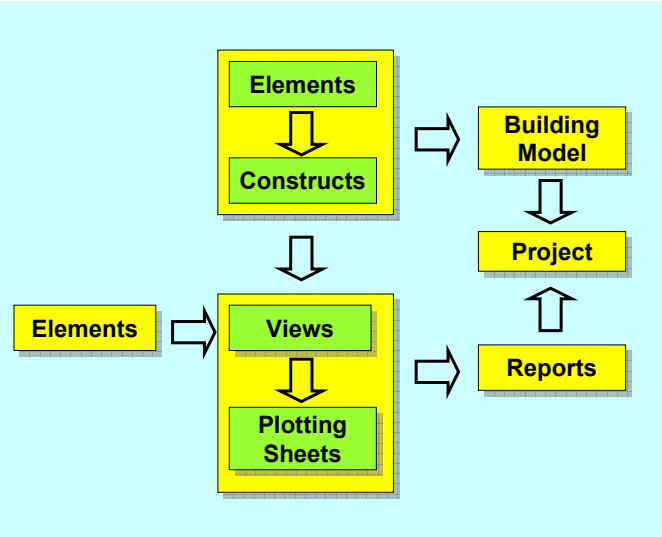

Figure 1: Building project structure.

Templates and Tool Palettes

A drawing template contains conventions and default settings such as units, blocks, layers, limits, styles and linetypes. Tool palettes contain a complete inventory of ADT design object tools such as walls, doors and windows in a consistent, highly visual user interface. Complex building models can be speedily built by starting from a previously saved or standard template and by dragging design objects such as walls, windows and roofs from tool palettes into the drawing. This is called drag-and-drop while grip editing is the use of a pointing device to stretch, move, rotate, scale, or mirror objects quickly using grips that are displayed at strategic points on objects.

Materials, Cameras and Lights

The ability to apply specific structural finish materials, to visualize models and to create lighting is found in AutoCAD 2005 and by extension in ADT 2005. Photorealistic renderings can thus be produced while videos can be created by animating cameras.

Intelligent objects

Many of the design objects in ADT are intelligent objects. This intelligence is partly derived from the application of styles and property set definitions. Styles are sets of parameters that determine the

appearance or function of objects. For example, a wall in ADT is defined not only by its location in the drawing and its dimensions, but also by its style. The wall style may determine it width, material, display and components. A property set definition specifies the characteristics of a group of properties that can be tracked with an object. A property set contains a user-definable group of related object properties. The property set can be attached either to a style or an object. Each property has a name, description, data type, data format, and default value. For example, a property set to be attached to a door style may contain the properties weight, colour, supplier and unit cost. The most common use of property set definitions is the generation of schedules and cost data.

Viz Render

Viz Render 2005 is an advanced visualization tool that is integrated with ADT. Although it is a standalone application, it is automatically installed when ADT is installed. Viz Render is derived from Autodesk Viz 4, which in turn is a scaled-down version of 3D Studio Max. Viz Render can be started directly from within ADT, or using other Windows methods.

Viz Render cannot create geometry, instead it uses design objects created in ADT. It can however create lights, cameras, and helpers and merge scene files. Geometry linked to Viz Render can be modified using modifiers, but there are only 9 modifiers available, and these are used for minor changes to geometry. The File Link Manager maintains a live link in Viz Render to ADT, thus allowing experimentation with different lighting conditions, textures, material effects and animations. Viz Render can animate not only cameras, but also components of the design itself, such as cars, doors and lifts (elevators). Viz Render creates DRF (Discreet Render Format) files, which can be opened by 3DS.

3D Studio Max Version 7

3D Studio Max is a very powerful software package for the creation of professional quality 3D models, photorealistic still images and film-quality videos and animations.

3D Modelling

3DS has powerful tools for creating design objects in 7 categories: geometry, shapes, lights, cameras, helpers, space warps and systems. There are a large number of geometric primitives built in and these can be modified to create complex shapes.

Materials and Lights

3DS has a very powerful Material Editor for the creation, modification and application of materials. These materials describe how an object reflects or transmits light and they can contain maps to simulate textures, applied designs, reflections, refractions and other effects.

Rendering

3DS produces photorealistic still images called renderings by shading the model using lighting setup, applied materials and environment settings such as background and atmosphere. The 3 renderers provided with 3DS are the default scanline renderer, the mental ray renderer and the VUE file renderer. The default scanline renderer uses global illumination including light tracing and radiosity. It is used for ActiveShade rendering which are preview renderings that interactively update as the scene changes.

Animation

Unlike most CAD software that can only animate cameras, almost anything can be animated in a 3DS max scene. You can animate the position, rotation and scale of objects, and almost any parameter setting that affects an object's shape and surface. You can animate object-space modifier parameters such as mirror centre, slice plane or taper amount, and material parameters such as colour or transparency of an object.

Modifiers

Modifiers are tools for reshaping an object. However, modifiers do not change the underlying creation parameters of an object, though they determine the final appearance of the object. There are 3 categories of modifiers: selection modifiers, world-space modifiers and object-space modifiers. For example, object-space modifiers directly affect an object's geometry in local object

space. There are several dozen available, including bend, bevel, extrude, fillet, melt, mirror, skew, skin, slice, taper, twist and UVW map modifiers. Multiple modifiers can be applied to the same object. When a modifier is applied to an object, the modifier is placed in a modifier stack in a position relative to other modifiers applied to the same object. The original object is at the bottom of the stack, while the 'most recently applied' modifier is at the top. Changing the relative position of modifiers in the stack determines which modifications are applied first.

The use of modifiers in 3DS is a significant departure from the logic and engine of most CAD software. For example, to create a skewed pyramid from a cube, traditional CAD software will slice off parts of the cube. The resulting skewed pyramid has no sense of history, and it does not remember that it was once a cube. In 3DS however, the cube can be told to taper and skew to look like a skewed pyramid. The skewed pyramid in this second case is actually still a cube, only disguised as a skewed pyramid. The garb or disguise can be gradually and selectively removed, with the object eventually reverting back to its cube shape.

Synergy between ADT 2005, Viz Render and 3DS Max

File Linking

The ability to maintain a single design database while working in various software environments including 3DS, AutoCAD and ADT is provided by the File Link Manager. When DWG or DXF drawings are linked into a 3DS scene, changes made to the drawing file are optionally reflected in the scene. Thus the same design database can be used to produce project documentation in ADT and up-to-date renderings/animations in 3DS.

Sharing of Materials, Lights and Cameras

When a drawing is linked into a 3DS scene, you are given the option to include lights and cameras (views) in the link. When the link is refreshed, changes made to lights and cameras using ADT can optionally be reflected in the scene. Material assignments in ADT are imported together with geometry into 3DS scenes when a file link is established. Thus changes to materials in the drawing are reflected in the scene when the link is refreshed.

Others

ADT is compatible with other Autodesk applications such as Land Desktop, MapGuide and DWF Viewer.

Intelligent and Active Drawings

Intelligent Drawings

Intelligence in living beings is the ability to acquire and apply knowledge and skills. An intelligent drawing may be described a drawing that can acquire knowledge from its components and other drawings, and apply this knowledge to generate new drawings. While truly intelligent drawings may be futuristic, the intelligent objects found in ADT are an indication that self-consciousness and intelligence will become commonplace in design objects.

Active Drawings

Active drawings may be described as drawings that have the ability to respond to stimuli and to change over time. The design objects found in 3DS can incorporate a large number of modifiers, making it possible to change the appearance of the objects over time. Since these objects are in a 3D drawing, such drawings are actually 4D drawings, with a fourth dimension of time.

The Importance of Convergence

This refers to the extension of the capabilities of the software to provide the functionality previously found in separate software packages. For example, CAD software now commonly includes 3D modelling, rendering and animation capabilities (Table 2).

Table 2: Primary and secondary functionality of popular CAD software.

Software	Primary functionality	Secondary functionality		
		2D and 3D modelling	Rendering capability	Animation capability
3D Studio Max	Rendering and animation	Very strong	Very strong	Very strong
3D Studio Viz	Rendering	Strong	Very strong	Strong
Accurender	Rendering	Strong	Very strong	Good
ArchiCAD	2D and 3D modelling	Very strong	Strong	Good
AutoCAD	2D and 3D modelling	Very strong	Strong	Good
Autodesk Architectural Desktop	2D and 3D modelling	Very strong	Strong	Good
Viz Render	Rendering and animation	Nil	Very strong	Strong

Source: Researchers' software tests.

Ogunsote and Prucnal-Ogunsote (2002) have identified the advantages of convergence as lowered learning curve, lower cost of software and higher efficiency. The disadvantages are increased software complexity leading to lower reliability, software monopoly and the stifling of creativity and enterprise. Also, a software package that can do everything is unlikely to be the best in all it does.

The convergence and compatibility found in 3DS is an encouraging sign of things to come. To enhance this trend, it is proposed that CAD and presentation software should have the following characteristics.

- Universal drawing file format. A single universal format should be developed for 2D and 3D drawings. The format should integrate 2D and 3D at the level that ArchiCAD does. A drawing in this format can then be edited by practically any drawing software.
- Smart linking of rendering software to drawing files similar to links to 3DS from ADT.
- Smart linking to bitmap files. Photo editors should be smartly linked to bitmap files so that modifications to the bitmap are retained even after the bitmap is regenerated. This is similar to the use of layers found in Adobe Photoshop.

Conclusion

The use of intelligent objects in ADT and modifiers in 3DS has brought the glimpses of intelligence and activeness to architectural drawings. The synergy of ADT and 3DS makes it possible to produce architectural drawings that are both intelligent and active. The convergence found in 3DS is encouraging, but there is need for greater compatibility and integration. Areas for improvement include removing the need to bind external reference files when linking and smart linking of bitmap files.

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