

Lecture Notes

Working with Revit Architecture Designs in Autodesk 3ds Max

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Preface

This document comprises a series of units (lecture notes with associated exercises in Autodesk® 3ds Max® software) that teach principles of texturing, animating, and rendering 3D scenes in 3ds Max. It is divided in six units that cover the tools that would commonly be used in a Revit® Architecture/3ds Max architectural visualization project.

The six units can be covered in a week or spread over an entire semester. Not all of them are equal in length or importance. The following table indicates how long each one might take to teach.

Sem	Day	Theory	Autodesk 3ds Max
1	1	Data Transfer UI Overview	Exporting from Revit Architecture, Linking a DWG™ File Basic Interface, Layers, Viewport Manipulation
1	2	Additional Modeling	Creating a Standard Primitive, Noise Modifier, Paint Deformation, Foliage
1	3	Materials	Setting Map Scale, Applying mental ray® Architectural and Design Materials
1	4	Lighting	Creating and Animating a Daylight System Using Omni Lights
1	5	Rendering	Creating and Animating a Camera, Rendering Still Images and Animation

Organization

Each unit is broken down into the following parts:

- Theory
- Autodesk 3ds Max
 - The Connection
 - Features to Learn
 - Notes
 - Hands-on Topics
 - Questions

At the end of each unit is a list of topics for hands-on technical training. In some cases these reference the companion Student Workbook. In other cases these are just areas of functionality the instructor may use to illustrate the concepts and theory discussed in the lecture notes.

You can use these units to supplement an existing curriculum, such as the Revit Architecture curriculum, or as the seed for a new one. Thinking of them as lecture notes is helpful. What the lectures consists of is up to you.

Introduction

3ds Max is a comprehensive visualization tool for creating high-quality still images and animations. The 3ds Max workflow commonly includes modeling, material design and application, lighting, camera creation, animation, and rendering.

When 3ds Max is used for architectural design visualization, the geometry typically comes from another application, in this case Revit Architecture.

The 3ds Max file linking feature enables the capture of Revit data with the powerful advantage of being able to update that data as changes are made in Revit. Once the data is in 3ds Max, the software's powerful modeling tools come into play. Their strength is in free-form organic modeling, such as the creation of terrain, rocks, or foliage.

Materials are a key feature of 3ds Max. They define how light interacts with the model surfaces, and hence determine how realistic the rendered images appear. The 3ds Max Material Editor contains a comprehensive set of tools that enable you to represent a wide variety of physical materials. Materials that were applied in Revit Architecture are retained with minor exceptions, so changes may have to be made only on select objects.

3ds Max provides physical and non-physically based lights that are designed to work with several renderers. One important example is the daylight system, which incorporates two lights and an environment map for rapid and highly effective rendering of outdoor scenes.

3ds Max supports keyframe animation, where virtually every aspect of a scene can be changed over time. The most pertinent applications for working with Revit Architecture are camera and light animation.

Rendering concludes the design visualization workflow. It is the process where the scene model and its applied materials, lighting, and choreographed animation come together to create still images or video sequences.

This document provides the theory and exercises designed to take students through an architectural design visualization workflow using Revit Architecture and 3ds Max software.



Unit 1: Data Transfer

This unit covers transferring design models from Revit Architecture to 3ds Max. The procedure involves exporting from Revit Architecture to a DWG file format, and then linking that file into 3ds Max. This unit also covers setting the 3ds Max default user interface and display units, as well as binding the DWG file.

Theory: Data Transfer

Data transfer between Revit Architecture and 3ds Max is accomplished via the DWG file format. A DWG file containing 3D building geometry is exported from Revit Architecture. This file is then brought into 3ds Max using the File Link Manager tool. This unit looks at the steps involved in this data transfer process.

Exporting from Revit Architecture in DWG Format

Revit Architecture has several representations for model elements. For example a door object has a

- 2D plan view representation
- 2D elevation view representation
- 3D view representation

Generally, 3ds Max requires the 3D representation. By default, exporting generates data associated with the active view, so a Revit Architecture 3D view should be set before exporting.

Revit Architecture supports exporting either to Polymesh or ACIS® solid objects. Both work well with 3ds Max. However, Polymesh treats Revit Architecture objects as multiple components, making it easier to edit the materials that make the inside and outside of a wall, for example. ACIS solids have the advantage of treating objects as volumes, so that you can ultimately use Boolean operations in 3ds Max to create intersections, unions, or subtractions between objects. However, this makes material manipulation a bit more complex because you must work at a subobject level if you need to apply different materials to the same object.

Setting 3ds Max Default UI

Default user interface (UI) settings tailor 3ds Max to different applications. The DesignVIZ.mentalray default is appropriate for photorealistic rendering of architectural models. Selecting this default makes changes that include the following:

- Activating mental ray extensions
- Providing extra parameters for cameras, lights, and shadows
- Populating the Material Editor with architectural and design materials
- Setting real-world scale texture coordinates

A complete listing of the DesignVIZ.mentalray settings is provided in the information panel of the defaults switcher, which can be accessed through the Customize menu (Customize > Custom UI and Defaults Switcher). After the defaults switcher is set, you need to exit and restart 3ds Max for the changes to take effect.

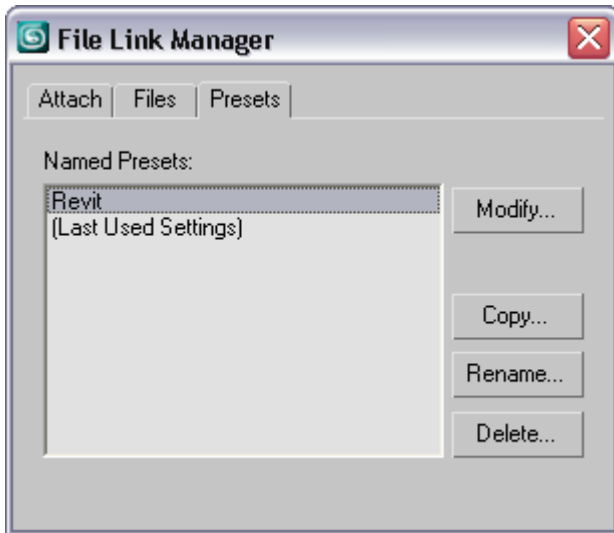
Setting 3ds Max Display Units

In addition to its System Unit setup, which describes model geometry in the database, 3ds Max maintains a display unit. The display unit controls how values are presented in the user interface. 3ds Max automatically converts values from the system units to display units and vice versa.

Linking a DWG File

3ds Max provides a File Link Manager that controls links to one or more DWG files. The key feature of file linking is that it maintains a connection to the source file. If the file in Revit Architecture is changed and re-exported to the same DWG file, you have the option of updating the data in 3ds Max.

The File Link Manager provides several options to control the linking process. A set of link options suitable for Revit Architecture files is available in the Revit preset and can be selected in the File Link Manager dialog box. When a file is linked, you can specify which layers in the source file to include.



Binding a DWG File

Use the Bind option to sever the link to the DWG file. Subsequent changes to the DWG file cannot be updated in 3ds Max.

3ds Max: Data Transfer

The Connection

The Data Transfer unit of the Student Workbook illustrates the process of taking data from Revit Architecture to 3ds Max.

Features and Concepts to Learn

Exporting from Revit Architecture in DWG Format

- [Setting a 3D View in Revit Architecture](#)

- [Selecting ACIS or Polymesh Output](#)

- [Exporting the DWG File](#)

Setting 3ds Max Default UI

- [Activating the DesignVIZ.mentalray UI](#)

Setting 3ds Max Display Units

- [Accessing the Display Unit Dialog Box](#)

- [Specifying the Display Units](#)

Linking a DWG File

- [Accessing the File Link Manager](#)

- [Choosing a Preset](#)

Rescaling Units
Attaching the File
Binding a DWG File
Binding a Linked DWG File

Notes

Exporting from Revit Architecture in DWG Format

Before exporting from Revit Architecture, set a 3D view active. The data can be exported as a Polymesh or ACIS solid.

Setting 3ds Max Default UI

The DesignVIZ.mentalray setting for UI defaults takes advantage of the mental ray rendering engine in 3ds Max. One example is the daylight system, which automatically uses the mental ray Sun and Sky, that is, mrSun and mrSky. The UI default setting has to be made only once. It remains in the new state until explicitly changed.

Setting 3ds Max Display Units

3ds Max maintains a system unit and a display unit. The system unit controls how model data is stored, and the display unit controls how the units are presented. The software automatically handles conversion between the system and display units.

Linking a DWG File

File linking maintains a connection to the source DWG file. Changes to that file can be updated in 3ds Max. The File Link Manager is the interface for working with linked DWG files. Layers to link can be specified, and the incoming data can be rescaled.

Binding a DWG File

Binding a linked file breaks the link to the source file and eliminates the option of updating any changes to that file.

Hands-on Topics

- Open the Units Setup dialog box and examine the different choices offered for display units.
- Set a few different display units, and investigate the difference when you create geometry—a sphere, for example.
- Open the File Link Manager and link a DWG file into 3ds Max.
- Bind the DWG file that was linked in the previous step.

Questions

- Does the default UI have to be set each time 3ds Max is started?
- Can the 3ds Max display unit be different from its system unit?
- If a DWG file is bound to 3ds Max, can changes to the source be updated?

Unit 2: User Interface Overview

This unit provides a look at the 3ds Max tools for selecting and organizing objects and manipulating the display.

Theory: User Interface Overview

When 3ds Max is used with Revit Architecture, the goal typically is to render still images, an animation sequence, or both. The workflow includes modeling, the application of materials, lighting, and defining camera motion. The process requires repeated selection of objects and manipulation of the scene viewports. This unit describes the tools for achieving that.

Object Selection

Arguably the most intuitive method for selecting specific objects is to simply click them in the viewports. This technique is fast and works fine in most cases. However, when working with complex scenes or when the location of an object is unknown, users must find alternative methods. 3ds Max provides many alternatives that enable users to select objects quickly and efficiently.

An important aspect of 3ds Max is that every object in the scene has a name. The object names are apparent in several areas of the user interface. These include tooltips that appear when the cursor is held over an object, the Name and Color rollout in the Command panels, the Select by Name dialog box, and the Layer Manager. The Select by Name dialog box and Layer Manager list all scene objects, and through these tools, you can select one or more specific objects by their name, regardless of where they are located in the scene or whether they are visible in the viewports.

Layer Manager

Layers in 3ds Max are analogous to those found in AutoCAD® or Revit Architecture software. Layers provide a method for organizing objects and adjusting their characteristics based on their layer associations. The Layer Manager dialog box lists all the layers within a scene. Furthermore, objects contained within each layer can be displayed directly in the Layer Manager.

The Layer Manager can be used to select objects within the scene. It may also be used to set the display or render characteristics of a layer. For example, a particular layer can be set to a frozen state. Objects on a frozen layer can be seen, but they cannot be selected. This capability is helpful to prevent objects on a layer from being inadvertently moved or modified.

A layer can also be set to a hidden state. Objects on a hidden layer remain in the file but are removed from viewport display. This capability can be useful to simplify the viewports and concentrate on other objects.

Objects contained on each layer appear when the layer hierarchy is opened. An object's visibility, freeze, and render states can be set individually or by layer.

Select Objects by Name Dialog Box

The Select Objects by Name dialog box in 3ds Max lists all scene objects, independently of their layers. The listing may be filtered by object types such as geometry, lights, cameras, and a few other categories. The order in which objects are listed varies alphabetically, by object type, color, or size. The usefulness of the dialog box depends to some extent on the adopted naming convention, that is, how well a name associates with the object it represents. Objects coming from Revit Architecture are often duplicated or too generic to be of much use. Therefore, Revit Architecture users might find that selecting objects using layer tools is more convenient. Still, it is important to understand the Select by Name dialog box as it is normally a key tool for working with 3ds Max scenes.

Adjusting Viewport Sizes

The 3ds Max display area can contain single or multiple viewports. When multiple viewports are displayed, the relative sizes can be altered by dragging their interior borders. The layout can be restored by right-clicking a border and then clicking Reset Layout. Only one viewport is active at any given time. A viewport is made active with a simple right-click within its boundaries. The active viewport can be toggled full screen using the ALT+W key combination.

Zoom, Pan, and Arc Rotate

A common requirement of 3D graphics applications is the ability to manipulate the viewports so that the scene or 3D world can be seen from different vantage points. 3ds Max viewport navigation tools are located in the lower-right corner of the interface. The most commonly used tools are Zoom, Pan, and Arc Rotate. Zoom adjusts the display to show a larger or smaller view of the scene. The Pan tool controls the portion of the scene displayed in a viewport while keeping the same zoom setting. Finally, Arc Rotate enables the viewing point to be set to any point in 3D space so that you can view objects from any direction.

Note that the Zoom, Pan, and Arc Rotate tools alter only the *display* of scene objects. None of these tools actually modifies an object's size or position in 3D space.

The viewport navigation tools vary slightly for different viewports. For example, the controls for an orthographic viewport (such as top, front, or left) are different from that of a perspective or camera viewport.

If a mouse with a wheel is used, you can zoom and pan using the wheel, eliminating the need to find and click a specific tool. Rolling the middle mouse wheel changes the zoom. Pressing and holding the middle mouse wheel while dragging pans the view. Arc rotate is achieved by holding the ALT key while clicking and dragging the left mouse button.

There are three Arc Rotate modes: gray, white, and yellow. They are accessed from the arc rotate flyout, which appears when the tool is clicked and held.



The gray mode is the basic Arc Rotate tool. It rotates the view about the current view center. The white mode is Arc Rotate Selected. It rotates about the geometric center of the selected object or objects. The yellow mode is Arc Rotate Sub-Object. It rotates the view about the geometric center of a selected subobject, such as a face or vertex. The name of each Arc Rotate mode appears in the status bar as you move the cursor over each button in the flyout.

Changing Views

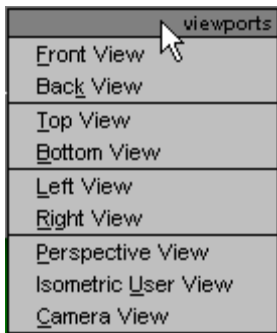
3ds Max supports several viewport types. One such type is orthographic, also called a “flat” or “straight-on” view. This includes the top, front, and left viewports. These represent the scene using parallel projection and are useful for creating new objects on the three construction planes of the world coordinate system, or comparing object positions along the X, Y, or Z axes.

Another viewport type is perspective, which more closely matches the natural human visual system. Finally, any viewport can be set to a camera view. This provides an interactive display of the scene that updates as changes are made to the position of the camera or its parameters.

The active view can be saved on the View menu. This option is especially useful for a perspective view. The saved view can be recalled at any time during the editing session.

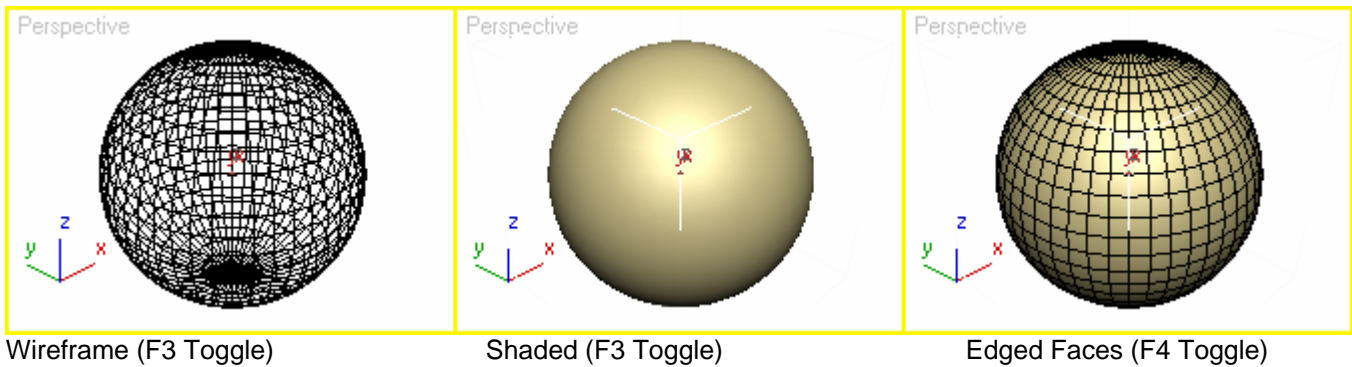
Viewports can display any type of view. Each view can be selected from within the viewport label shortcut menu. Keyboard shortcuts are provided for several of the common views, such as T for top, F for front, and P for perspective.

In addition to the viewport label shortcut menu, 3ds Max provides a Viewports menu accessible by pressing the V shortcut key.



The menu lets you quickly switch to any orthographic, perspective, or camera view and is especially useful if a view has not been assigned a shortcut.

In Viewport Shading mode, you can switch between Shaded, Wireframe, and Edged Faces using function keys. The F3 function key toggles between Shaded and Wireframe modes, and the F4 function key toggles Edged Faces mode on or off. Edged Faces mode highlights the underlying geometry when objects are shaded.



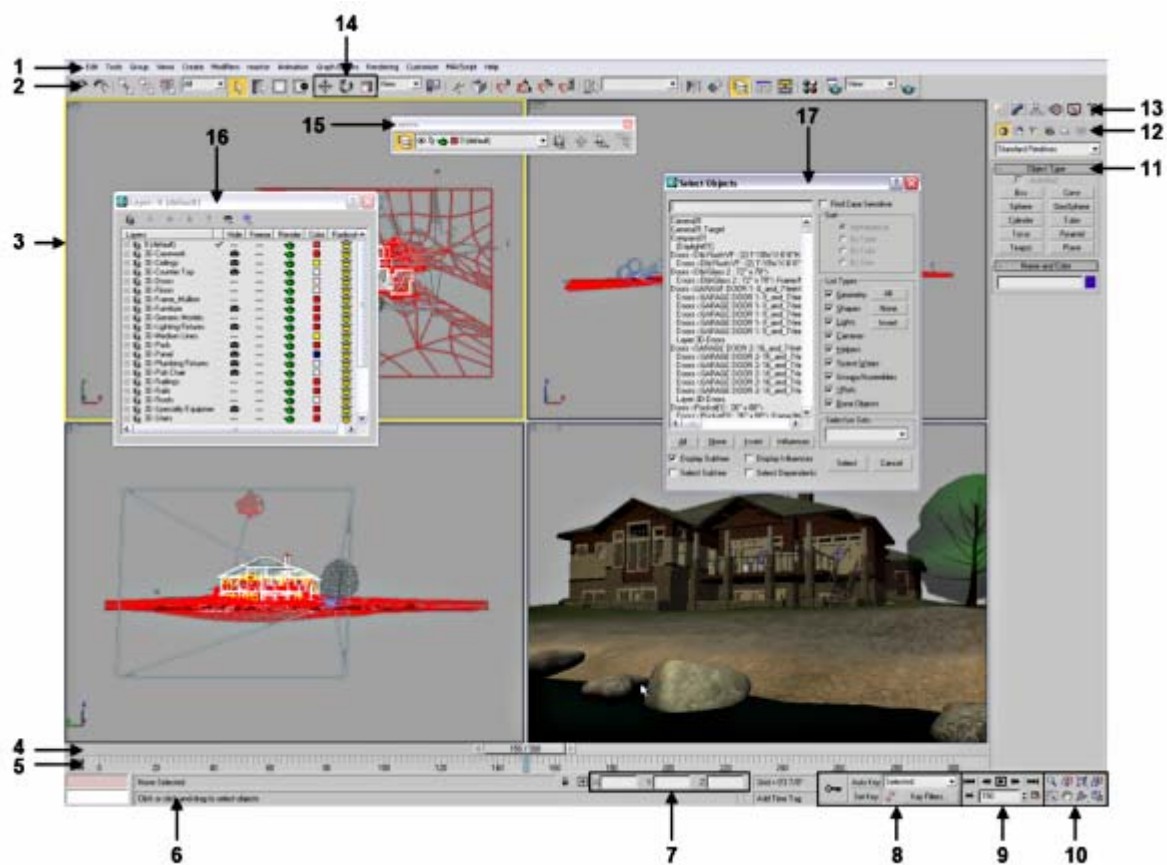
3ds Max: User Interface Overview

The Connection

The User Interface Overview section of the Student Workbook presents the layer and view control tools in 3ds Max.

Features and Concepts to Learn

[Basic Interface](#)



1. Menu bar
2. Main toolbar
3. Active viewport
4. Time slider
5. Track bar
6. Status bar
7. Coordinate display and type-ins
8. Animation keying controls
9. Animation playback controls
10. Viewport navigation controls
11. Rollout
12. Object categories
13. Command panels
14. Transform tools (Move, Rotate, Scale)
15. Floating toolbars (Layers toolbar shown)
16. Modeless dialog boxes (Layer Manager shown)
17. Modal dialog boxes (Select Objects shown)

Layers

- Enabling the Layers Toolbar
- Hiding Layers
- Make a Layer Current Based on an Object Selection
- Using the Layer Manager
- Selecting All Objects on a Layer
- Selecting Individual Objects in the Layer Manager

Select Objects by Name Dialog box

- Displaying Subtrees
- Selecting Parent Objects

Viewport Manipulation

[Resizing and Resetting Viewports](#)
[Maximizing and Minimizing an Active View](#)

Navigation Tools

[Using Zoom, Pan, and Arc Rotate](#)

Viewport Display

[Saving and Restoring an Active View](#)

[Changing Views](#)

[Viewport Labels](#)

[Shading Modes](#)

Notes

Layers

Layers are handy for scene management. Using them, you can easily hide objects from view or freeze them to prevent their selection. You can use the Layer toolbar to that effect or the Layer Manager, which provides some additional functionality. You can also use layer tools to quickly select scene objects, globally or individually. Both the Layers toolbar and the Layer Manager are modeless, which means you can leave them on screen as you work in your scene.

Select by Name Dialog Box

You can open the Select by Name dialog box in two ways: using the icon on the main toolbar or by pressing the H key. Names can be changed at will. With logical object naming, the Select by Name dialog box becomes a useful tool. Objects can be listed by type—geometry, cameras, and so forth.

Resizing Viewports

The relative sizes of multiple viewport layouts can be modified. The original layout can be restored by right-clicking over a border and then clicking Reset Layout. Only one viewport is active at any given time. A viewport is made active by right-clicking in it. Right-clicking preserves the current object selection. Left-clicking in an open area clears the selection. An active viewport can be toggled full screen by pressing the Maximize Viewport Toggle icon in the bottom-right corner of the screen, or by pressing ALT+W. If the toggle is used again, the previous multiview layout is restored.

Zoom, Pan, and Arc Rotate

Zoom, Pan, and Arc Rotate are the most common viewport navigation tools. Access them in the bottom-right corner of the screen or using the mouse wheel. Rolling the wheel enables an incremental zoom. Pressing the wheel down and dragging enables a pan. Holding CTRL+ALT while pressing the wheel down and dragging enables a real-time zoom. Holding ALT while pressing the wheel down and dragging enables Arc Rotate.

Changing Views

Views can be switched in several ways: using shortcuts, the viewport label, or the V key, which lists all available options in a shortcut menu. Views can be set to different shading modes, including Wireframe and Shaded modes (using the F3 toggle) and Edged Faces mode (F4), which displays both shaded surfaces and the underlying geometry. You can save a perspective view angle for later use.

Hands-on Topics

- Open a 3ds Max file and use the Layer Manager to investigate the organization of objects. Try selecting a few of them and locating them within the viewports.
- Use the viewport control tools to manipulate the scene. Look at it from different directions, and use the view shortcuts to switch between the perspective and orthographic views.

Questions

- What is the shortcut key for switching between a shaded or wireframe display?
- What is so useful about Edged Faces mode?
- How can zoom and pan be accomplished with a wheel mouse?
- What are the shortcut keys for the perspective, top, front, and camera viewports?
- How do you reset viewports after changing their size?
- What shortcut key do you use to open the Select by Name dialog box?

Unit 3: Additional Modeling

This unit covers several 3ds Max modeling tools applicable to architectural applications.

Theory: Additional Modeling

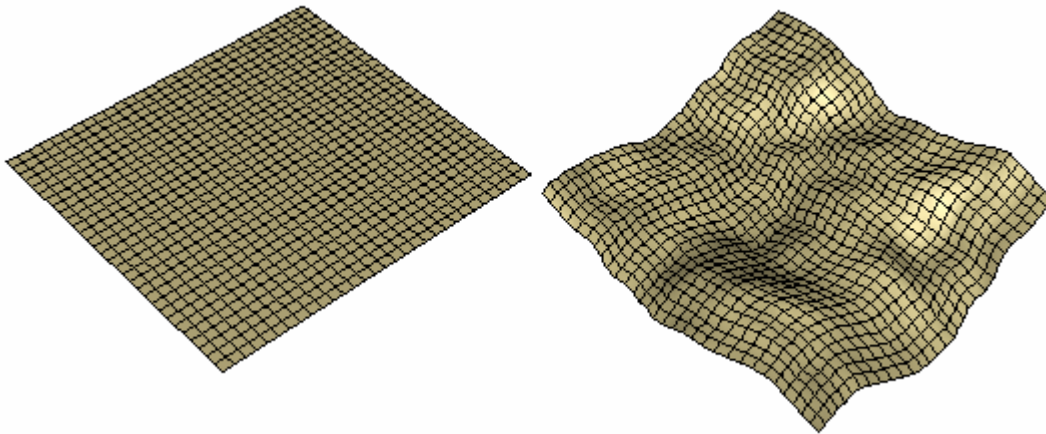
When 3ds Max and Revit Architecture are used together in an architectural design workflow, most of the modeling is performed in Revit Architecture. However, several modeling tools in 3ds Max are well suited for creating organic geometry and other elements that can enrich the scene and rendered images. This unit describes several of these 3ds Max tools.

Modifiers

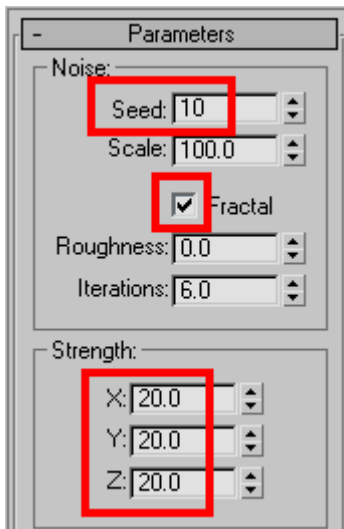
Modifiers in 3ds Max can be applied to objects to change their shape or characteristics beyond that allowed by the objects' parameters. Modifiers are selected from the Modifier list in the Modifier panel. There are many to choose from, with widely varying results. Many modifiers can be applied to a single object. A window termed the *modifier stack* shows the base object and all applied modifiers, which act as filters on the base object. 3ds Max evaluates an object's final form, starting with the base object and progressively evaluating each modifier in the stack. There are two types of modifiers to choose from: OSM modifiers (Object-Space modifiers), which act locally on an object, and WSM (World-Space Modifiers), which take into account the relation of the object with the 3D space surrounding it.

Noise Modifier

The Noise modifier is used to randomly displace vertices on the mesh it's applied to. The modifier displaces vertices in each of the X, Y, and Z coordinate directions according to the specified Strength parameters.



The two planes shown are identical, but the one on the right has a Noise modifier applied.



The Fractal parameter adds a degree of roughness or chaos to the displaced mesh.

The Noise modifier includes a Seed parameter. Changing the seed value ensures that two otherwise identical objects aren't the same after noise is applied. The random noise varies when a different seed value is used.

In this unit, a Noise modifier is applied to a standard 3ds Max object, the geosphere.

Note that the Noise modifier is more effective if it has a large number of vertices to work on. When applying it to standard primitives, increase the segments parameter(s) to increase the resolution of the mesh.

Scaling Geometry

Scaling is one of the transform tools provided in 3ds Max. There are three scaling tools:

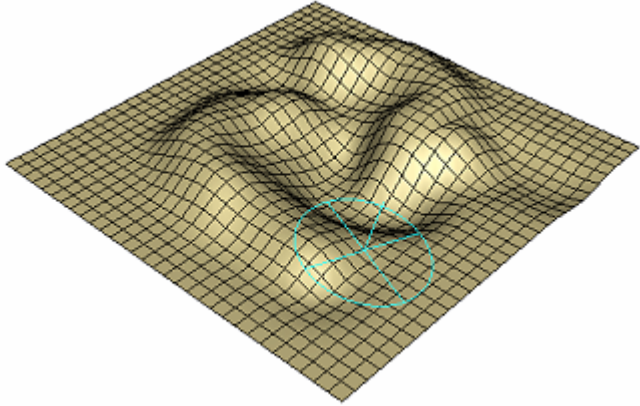
- **Uniform Scale Tool:** As the name implies this tool scales geometry equally in each coordinate direction.
- **Nonuniform Scale Tool:** This tool scales an object by different amounts in each coordinate direction.
- **Squash:** Squash performs several scaling operations simultaneously, for example, scaling an object down in one direction while scaling it up in the other two. The effect, as its name implies, is to squash the object while maintaining its volume.



Like the Move and Rotate transform tools, Scale uses a special gizmo to indicate which axis or axes the action applies to. For example, clicking the Z axis of the gizmo and dragging causes the scaling to be applied to the Z axis only. An axis turns yellow when you hover your cursor over it.

Paint Deformation

Paint deformation works with Editable Poly objects and enables the pulling or pushing of vertices by dragging the cursor over a surface, as if you were painting. It acts by moving vertices along their normal direction. It is useful for shaping terrain or landscaping.



Using Paint Deformation over the mesh displaces the vertices.

Merging a 3ds Max File

Objects from one 3ds Max file can be brought into another 3ds Max file. This process is termed *merging*. When you merge a file into another, you can select which objects within the source file are brought into the current scene. Materials associated with the merged objects also become part of the current 3ds Max file.

Cloning

Cloning is a term used to describe the process of making a duplicate of an object. In 3ds Max three types of clones are possible:

- **Copy:** This makes one or more copies of the original object that are independent of one another. They are all defined separately in the database; therefore modifications made to one object do not affect any of the others.
- **Instance:** With the Instance option all objects are derived from a single definition in the database. As a result, modifying one of the objects causes the rest to update as well.
- **Reference:** Reference has some similarity to both the Copy and Instance options. With Reference, a modification made to the original object affects the others. However, modifications made to any of the duplicates do not influence either the original or the other duplicates.

You can access the Clone tool in two ways:

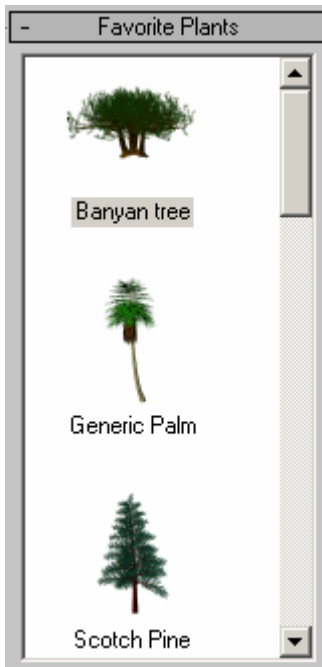
- Clicking Edit menu > Clone
- Pressing SHIFT with the Transform tools (Move, Rotate, or Scale)

Using the latter approach has the advantage of separating the cloned objects so that they are easier to distinguish and select. Using the Edit menu places the clones on top of one another.

Cloning applies sequential names to the objects. For example, if the first object is sphere01, the duplicates are named sphere02, sphere03, and so forth.

Foliage

The Foliage category provides a selection of 3D trees and shrubs. Foliage objects have parameters that control their height, density, pruning, and display of components. They are accessible via the AEC Extended category of the Create panel. Foliage objects have many faces, and although this contributes to their realism, it can slow rendering performance, especially if several are included in a scene.



3ds Max: Additional Modeling

The Connection

The Additional Modeling portion of the student workbook leads students through several modeling exercises.

Features and Concepts to Learn

Creating a Primitive

- Setting Object Parameters

The Noise Modifier

- Setting the Fractal Parameter
- Setting the Strength Parameter

The Scale Tool

- Uniform Scaling
- Nonuniform Scaling
- Squash

Paint Deformation

- Setting Parameters
- Using the Push/Pull Tool
- Using the Relax Tool

Merging a 3ds Max File

- Merging a 3ds Max File
- Selecting Objects to Merge

Cloning

- Copying an Object
- Instancing an Object
- Referencing an Object

Foliage

- Creating a Foliage Object

Notes

Noise Modifier

The Noise modifier is useful for giving geometry objects a random, natural appearance. It does so by displacing mesh vertices. The noise strength can be set for each of the X, Y, and Z axis directions. The Fractal parameter gives the mesh a rougher appearance, and the Seed parameter makes the noise application distinct.

Scale Tool

Use the Scale tool to enlarge or reduce an object. When scaling is done with the Uniform Scale tool, each axis is influenced by the same amount. When done with the Nonuniform Scale tool, each axis can be scaled independently, and with the Squash tool one axis is scaled up while the other two are scaled down, or vice versa. The Squash tool maintains object volume.

Paint Deformation

The Paint Deformation tool operates on Editable Poly objects, or objects with an applied Edit Poly modifier. The tool causes the mesh vertices to be displaced along their normal direction while you paint over the surface. Use the ALT key to reverse the displacement direction.

Merging a 3ds Max File

One 3ds Max file can be merged into another. You can specify which objects in the source file to merge. Merging does not maintain a link to the source file.

Cloning

Cloning duplicates an object. There are three types of clones: Copy, Instance, and Reference. Copy creates an independent duplicate. Instance bases each duplicate on a single database definition where changes to one affect all the others. Reference creates a duplicate where changes to the original are applied to all others, but changes to duplicates are applied independently.

Foliage

Foliage is a tool to create 3D trees and shrubs. The created objects offer a high degree of realism, and you can alter density and pruning parameters, among others.

Hands-on Topics

- Create a plane object with 50 segments in both the Length and Width directions, and apply a Noise modifier. Experiment with the Fractal and Strength parameters.
- Create three geospheres and try each of the scaling tools on them: Uniform Scale, Nonuniform Scale, and Squash.
- Create a plane object with 50 segments in both the length and width directions. Apply an Edit Poly modifier to the plane, and experiment with the Paint Deformation tool. Try both the Push/Pull and Relax brushes. Use ALT to reverse the direction of the deformation.
- Create a standard 3ds Max primitive, a teapot, for example, and use the clone tool to make a copy. Make a change to the radius of the teapot. Notice that only the one you adjust changes. Now clone an instance of the original and make a change to the radius. Notice that both update. Create a reference duplicate of the original, and apply a noise modifier to the reference. Change the noise parameters and notice that only the reference updates. The original remains unchanged.

- Create several foliage objects. Select each one in turn and adjust their size, density, and pruning values to view the effects.

Questions

- Which Command panel is used to apply a Noise modifier?
- When cloning an object, what is the distinction between Copy and Instance?
- Which tool is used to scale an object in one axis direction only?
- When merging a 3ds Max file, do the materials merge along with the geometry?
- Which category of objects are foliage objects contained in?

Unit 4: Materials

This unit examines materials and the Material Editor.

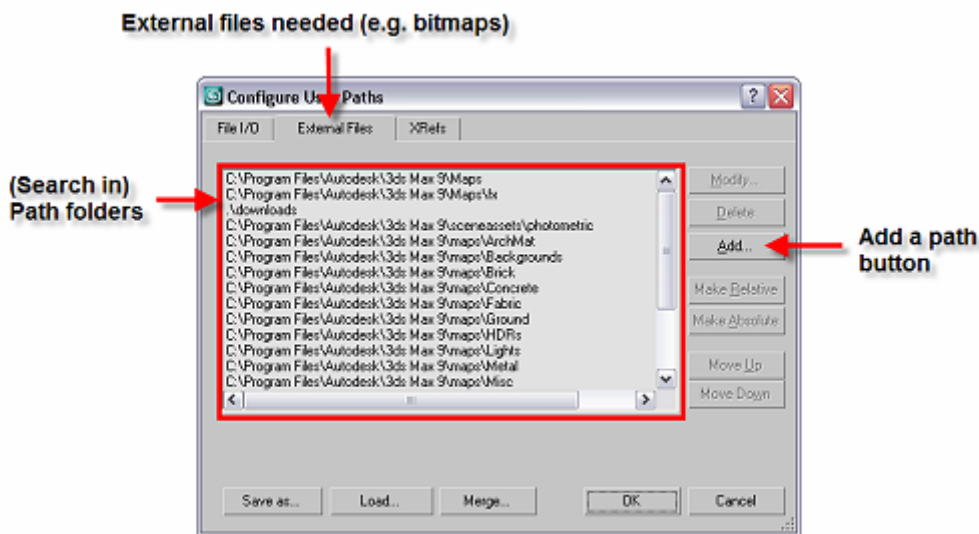
Theory: Materials

Materials define the way light interacts with model surfaces and are of primary importance in achieving a desirable rendered image. Materials are designed in the Material Editor interface and then applied to scene objects. This unit introduces the basic concepts of materials, including setting the path for maps, determining an existing material name and type, setting the real-world map scale, adjusting the mapping coordinates, and applying a mental ray architectural and design material.

Setting the Map Path

When you link a DWG file into 3ds Max, it may include references to material bitmaps applied in the source application such as Revit Architecture. For those maps to display and render correctly, 3ds Max must be able to locate them. By setting the map path, you provide a location for 3ds Max to search for these bitmaps.

The path controls are found on the Customize menu, under Customize > Configure User Paths. The resulting dialog box provides tools to add or modify search locations.

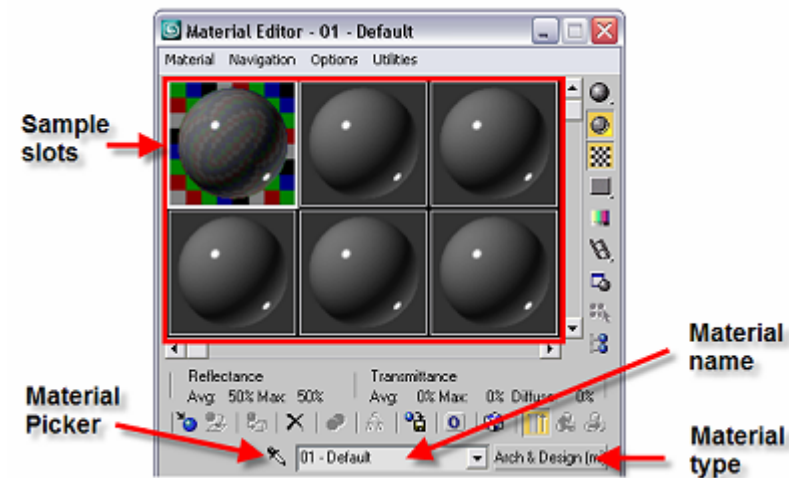


Students doing the exercises in the Student Workbook should not encounter any problems with map paths as all scene files and bitmaps are contained in the same working folder. However, the information is provided here to prepare the user for that eventuality.

Determining Material Type

An object's material name is listed in the Object Properties dialog box. You can access the dialog box by right-clicking over an object and then clicking Quad menu > Object Properties.

You can see full details of an object's material by loading it into a sample slot in the Material Editor. The Material Editor provides tools to determine the name and type of material applied to an object. The Pick Material from Object (eyedropper) tool enables you to bring an object's material from the scene into a sample slot. Once loaded in the sample slot, all details of that material are displayed within the Material Editor rollouts. This information includes the type of material and any bitmaps it references.



Transferred from Revit Architecture, materials based on bitmaps (scanned images) require little user input, because they are already set with the proper image and scale. However, Revit Architecture materials based on procedural (mathematical) calculations are not accounted for in 3ds Max and require a bit more work.

Setting Real-World Map Scale

When bitmaps are applied to objects, they are often replicated over the surface. This replication is termed *tiling*, and the tiling parameter specifies how many times a bitmap is replicated. Examples of bitmaps that require tiling are bricks or ceramic floor layouts. Traditionally, the value of the tiling parameter could be found by dividing the overall length of an object by the length of the geometry represented by the bitmap. With the Real-World Map Scale option, you can avoid this calculation. When Real-World Map Scale is set, you enter the horizontal and vertical sizes of the bitmap image in real-world units. If the image shows two bricks across, then you enter a width value of 16" or 400mm depending on your unit setup. Once the size values have been entered, 3ds Max performs the tiling calculations and replicates the image appropriately across the surface.

Real-World Map Scale is not active by default in 3ds Max, unless you use the DesignVIZ.mentalray custom UI, which you loaded in Unit 1.

The MapScaler modifier is applied in this section. The primary purpose of the modifier is to maintain map scale when an object is scaled. Its use here, however, is for its Wrap Texture option. This is used to correctly wrap the shingles over the roof of the lake house.

Revit Architecture Procedural Maps

When DWG files are exported from Revit Architecture and linked into 3ds Max, the materials are normally included. One exception is procedurally mapped materials. A procedural map is one that's generated programmatically, rather than being based on a fixed-size bitmap. When a Revit Architecture material includes a procedural map, it comes into 3ds Max as an Architectural Material type without the map, using only its diffuse color (the color under direct lighting) on the surface.

To remedy this situation you need to locate a suitable map and apply it in 3ds Max to replace the diffuse color information.

Applying mental ray Architectural and Design Materials

When the default UI is set to DesignVIZ.mentalray, each sample slot in the Material Editor contains Arch and Design materials. If the DesignVIZ.mentalray UI is not active, you can access the Arch and Design material from the Material Map Browser.

The mental ray Arch and Design material is a material designed to support most materials used in architectural and product-design renderings. It supports most hard-surface materials such as metal, wood, and glass. It is especially tuned for fast, glossy reflections and refractions and high-quality glass. It is based on templates, which makes it easy to use. It is also physically accurate and enables you to achieve some advanced functionality, such as defining reflectivity based on the viewing angle, among others.

To apply a material, either drag it from the sample slot and drop it on the object, or select the object and use the Assign Material to Selection tool. The latter approach may be easier when the scene contains many objects and there's a higher likelihood of dragging and dropping onto an incorrect object.

3ds Max: Materials

The Connection

The Materials unit of the Student Workbook presents the fundamentals of working with materials.

Features and Concepts to Learn

Determining Material Type

- [Accessing the Object Properties Dialog Box](#)

- [Opening the Material Editor](#)

- [Using the Material Picker Tool](#)

Setting Real-World Map Scale

- [Setting the Show Map in Viewport Option](#)

- [Accessing the Bitmap Parameters Rollout](#)

- [Setting the Real-World Scale Option and Entering Map Size](#)

- [Applying a MapScaler Modifier](#)

Revit Architecture Procedural Maps

- [Applying a Map to the Diffuse Color Channel](#)

- [Opening the Material Map Browser](#)

Applying Mental Ray Architectural and Design Material

- [Using the Go to Parent Tool to Navigate the Material Hierarchy](#)

- [Applying an Architectural and Design Material](#)

- [Applying a Material Template](#)

Notes

Determining Material Type

An object's material name is listed in the Object Properties dialog box. Detailed material information is available by loading a material into a Material Editor's sample slot. You can use the Pick Material tool to load any scene material to the active sample slot.

Setting Real-World Scale

The Use Real-World Scale option helps you correctly tile a bitmap over geometry. It has to be set in the Material Editor and the UVW map modifier. When the default UI is set to DesignVIZ.mentalray, Real-World Map Scale is active by default. You can use the MapScaler modifier to help correctly orient a bitmap over an object's surface.

Revit Architecture Procedural Maps

A Revit Architecture material imports as an Architectural Material type. Procedural maps don't import and must be replaced by another map in 3ds Max.

Applying mental ray Arch and Design Material

Arch and Design materials populate the Material Editor by default when the DesignVIZ.mentalray UI is set. Alternatively, you can access the Arch and Design material from the Material Map Browser. To apply a material, either drag it onto the scene object, or pre-select the object and use Assign Material to Selection.

Hands-on Topics

- Create a geosphere and apply a material to it. Set the material name to Sphere and set its diffuse color to blue.
- Open the Object Properties dialog box for the geosphere and confirm its material name.
- Create a 50 x 50 unit plane and apply an Arch and Design material to it. Set the material template to Glazed Ceramic Tile. Verify Real-World Map Scale is set in both the planes parameters and the bitmap Coordinates rollout. Set the size to 20 x 20.

Questions

- How can the Object Properties dialog box be accessed?
- What is the purpose of the Real-World Map Scale option?
- What is a procedural map?
- What is the Material Editor's eyedropper used for?
- What material type do Revit Architecture materials appear as once you link the DWG file to 3ds Max?

Unit 5: Lighting

This unit describes the creation and control of several light types, including the daylight system, which is particularly useful when lighting exterior scenes.

Theory: Lighting

The daylight system provides illumination and shadows that are appropriate for a specified time, date, and geographic location. The system consists of three components: sunlight, skylight, and an environment map. The feature is especially useful for evaluating exterior lighting and shadows for a specific time or range of times.

An omni light is a general-purpose light that cast rays in all directions. It is often used to simulate an incandescent bulb, mostly to provide interior lighting for night scenes. A light can be simulated to switch on or off by animating its multiplier parameter.

Creating a Daylight System

When the default UI is set to DesignVIZ.mentalray, the daylight system consists of the following:

- **A mental ray sunlight (mrSun):** This provides a direct light source that simulates the light from the sun.
- **A mental ray skylight (mrSky):** This simulates the atmospheric lighting effects provided by the scattering of sunlight through the earth's atmosphere.
- **Optionally, a mental ray Physical Sky environment map (mr Physical Sky):** This provides the sky color in the background in the form of a gradient that changes based on the time of day and a representation of the sun disk when it is visible to the camera, either directly or via reflection.

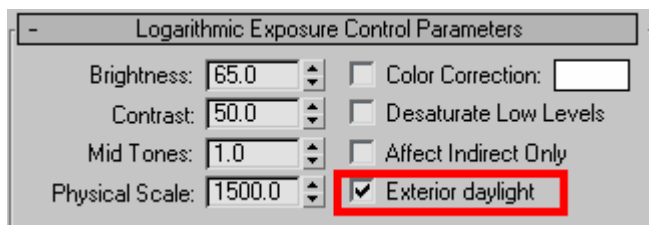
MrSun is a direct light, meaning it casts parallel light rays, in contrast to a spotlight, which casts diverging light rays. The sun effectively casts parallel light rays on the earth, and the mrSun parallel light rays are important for achieving correct shadow shapes.

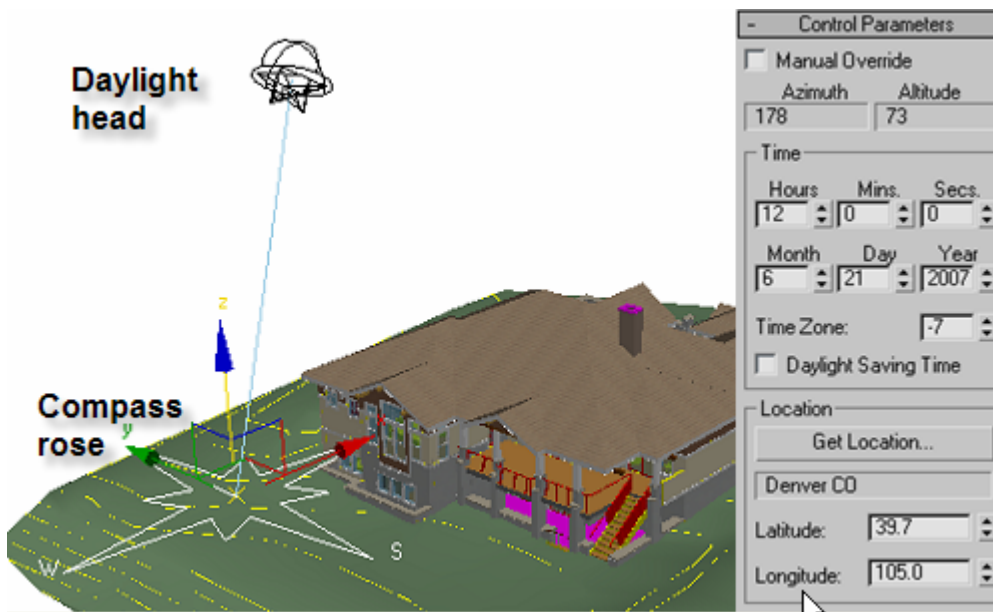
The mr Physical Sky environment map is accessible through the Rendering menu (Rendering menu > Environment).

The daylight system is accessible through the Systems category of the Create panel. It consists of a compass and a Daylight head. The compass is used to indicate true north. Initially, north is coincident with the world Y axis direction; however, you can adjust the North Direction parameter to any angle.

The controls for location, time, and date are available in the Create panel when the daylight system is initially created. Later, you can edit these controls in the Motion panel. Other parameters can be changed in the Modify panel, although the default values should work fine for most situations.

With the daylight system, the energy from the mrSun light is physically accurate and therefore extremely powerful. It can cause the scene to be washed out at rendering time. You can compensate by setting the exposure control (in the Environment dialog box) to account for the sun's energy.

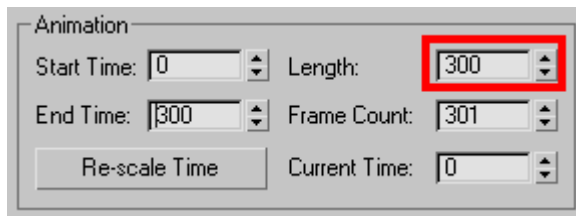




Animating Time of Day

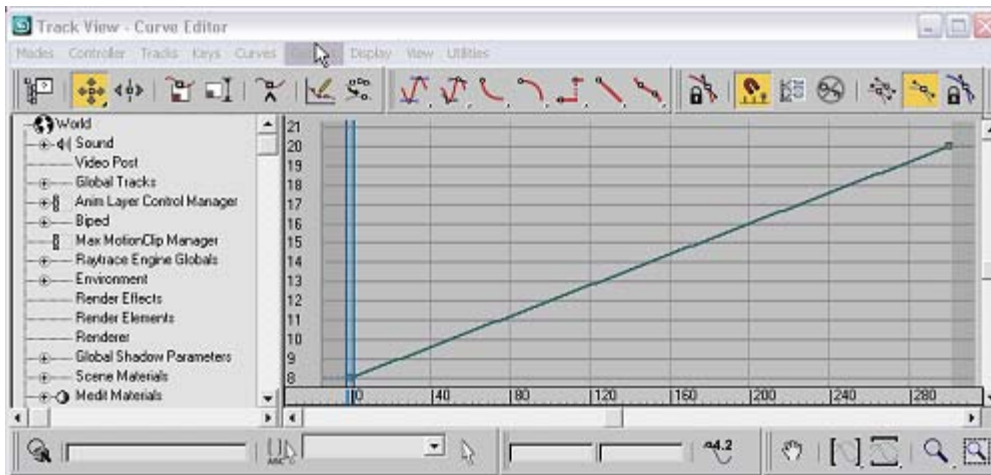
The daylight system can be animated so that its sun component passes appropriately over the scene geometry. This requires setting animation keys for the Time parameter in the Motion panel. In the Student Workbook the daylight system is animated between 8 a.m. and 8 p.m. over the course of 300 frames to create a shadow study.

The default animation range for a new 3ds Max file is 100 frames. At 30 frames per second this corresponds to just over three seconds. The animation range can be changed within the Time Configuration dialog box by changing the Length parameter.



A parameter can be animated by first enabling the Auto Key button, moving the time slider to a nonzero frame, and making a change. If it is the first time you've animated the object or parameter, 3ds Max creates a keyframe recording the state of the object at both frame 0 and the current frame. After an object has been animated, it is good practice to turn off Auto Key to avoid accidentally animating another object or parameter. When the animation is played back, 3ds Max interpolates the animated parameter value between keyframes.

A graphical display of the animated value is available in the Curve Editor (Graph Editors > TrackView-Curve Editor). This interface has many tools to control animation, such as moving, copying, and creating keys.



Creating Interior Omni Lights

The daylight system provides the high illumination level of the sun for exterior daytime scenes. You can create interior scenes by placing omni lights to simulate incandescent bulbs. Omni lights emit light in all directions. MR Omni lights are recognized by the mental ray renderer and can emit light from a cylindrical or spherical volume.

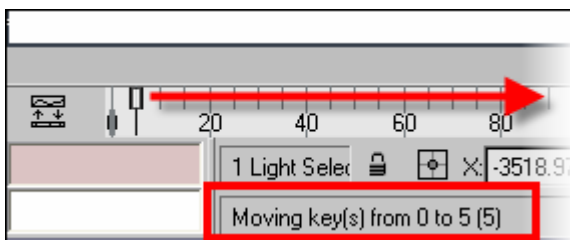
When the daylight system is used, it is recommended to set the Exterior daylight option (within the Exposure controls) to reduce washout from the intense light emanating from the sun. As a result, omni lights used in the same scene have little effect. For that reason, the intensity of the omni lights must be set to a high value to have any noticeable effect.

In this exercise, two omni lights are created. They are meant to have the same physical specifications, so one is made as an instanced clone of the other. That way, a change to either one affects both.

Animating Omni Lights

The omni lights used for the interior lighting can be animated so that they switch on at a specific time, in this case around 6 p.m. as the sun goes down. The omni light multiplier value is increased from 0 to 60 at the frame corresponding to 6 p.m.

To animate the lights, a keyframe for the multiplier is created at frame 251, which corresponds to 6 p.m. The value of the multiplier at that keyframe is 60. At this point the value varies linearly from 0 at time 0 to 60 at frame 251. To create a more sudden change, the two keyframes need to be much closer together, so that the intensity change is almost instantaneous (1 frame long). You can easily achieve this effect by dragging the keyframes in the track bar so that the change happens between frames 250 and 251.



3ds Max: Lighting

The Connection

The Lighting unit in the Student Workbook provides an exercise in creating a daylight system and animating omni lights.

Features and Concepts to Learn

Daylight System

- Creating a Daylight System
- Setting the Compass North Direction

Animating Daylight System

- Setting Time, Date, and Location Parameters
- Setting Scene Animation Length
- Opening the Curve Editor

Creating Interior Lighting

- Creating Omni Lights
- Positioning Lights
- Setting Light Color
- Setting Light Intensity
- Setting Light Decay

Animating an Omni Light

- Moving an Animation Key in the Track Bar

Notes

Creating a Daylight System

The Daylight System Creation tool is located in the Systems category of the Create panel. The mrSun component of the daylight system provides parallel light rays representing the sun. The North direction parameter is used to align the daylight system to true north. When the default UI is set to DesignViz.mentalray, the mr Physical Sky environment map is created automatically. The mr Physical Sky environment map appears in the Environment dialog box. It is used to simulate the gradient colors of the sky dome based on the time of day.

Animating Time of Day

The daylight system appears as an assembly in the Select by Name dialog box, rather than as a light, because it is made of different components. The Time, Date, and Location controls for the daylight system are located in the Motion panel. mrSun and mrSky parameters are located in the Modify panel. The scene animation length is set within the Time Configuration dialog box. A curve representing the change of an animated value over time can be seen in the Curve Editor.

Creating Interior Omni Lights

Omni lights placed in the house interior can yield effective nighttime scenes. If the Exposure control is set to Exterior Daylight the intensity (multiplier) of the omni lights must be set to a high value. Setting their color to a warm yellow gives pleasing results.

Animating Omni Lights

Animating a light's multiplier value from zero to a higher value over a single frame simulates the light switching on. Animation keys can be copied or moved in the track bar much like geometry in the scene.

Hands-on Topics

- Create a daylight system in the perspective viewport. Change the North Direction parameter to view its effect. Experiment with various values for Hours, Month, and Day.
- Create an omni light and animate its Multiplier value, changing from 0 to 1 over 100 frames. Open the Curve Editor to view the changes in value over time.
- Slide the omni light's animation key at frame 0 to frame 50. Open the Curve Editor to see the effect of the change.

Questions

- Where is the creation tool for the daylight system located?
- What is the daylight system North direction parameter used for?
- Which command panel contains the controls for Time, Date, and Location of the daylight system?
- Which interface contains a curve of value versus time for an animated parameter?
- Which light parameter can be animated to simulate the light switching on or off?

Unit 6: Rendering

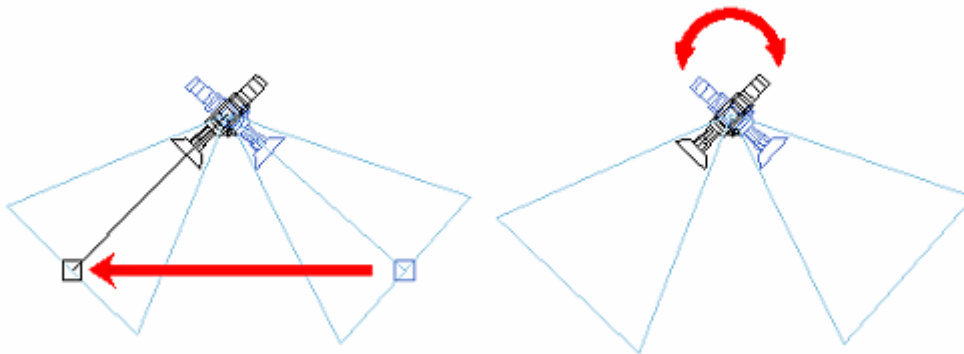
This unit covers camera creation and positioning, camera animation, as well as the steps required to render an animation to a video format file.

Theory: Rendering

Preparing 3ds Max for rendering involves several steps. In general, you create and position a camera so that it displays the scene geometry correctly. The Render dialog box contains many controls, but the basic ones specify which frame or frames to render, the output size (resolution) of the image, and the location and type of file to produce. This unit describes each of these items.

Creating and Positioning a Camera

Cameras are accessible in the Cameras category of the Create panel. There are two types: target cameras and free cameras. The controls and behavior are the same for both. The difference lies in positioning. A target camera has a target object that the camera is always directed at. When the target is moved, the camera automatically redirects itself. Target cameras offer a bit more flexibility for positioning. Both the camera and target can be adjusted with the Move tool. The pointing of a free camera has to be adjusted with the Rotate tool.



Target Camera

Free Camera

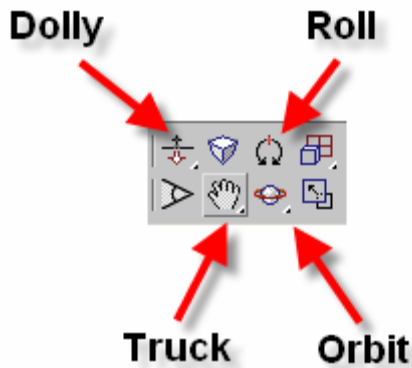
In addition to its positioning in 3D space, a camera has a set of controls that appear in the Modify panel when it's selected. One of the most important is its lens size. This determines the camera field of view and how much of the scene is covered in the shot.

Once a camera is placed in the scene, you can set any viewport to display that camera's view by pressing C. Any subsequent adjustments to the camera's controls or position are immediately updated in the camera viewport.

Camera Viewport Controls

When a camera viewport is active, the viewport navigation tools in the lower-right portion of the screen change to a set of camera-specific controls. These controls include Orbit, Pan, Truck, and Dolly:

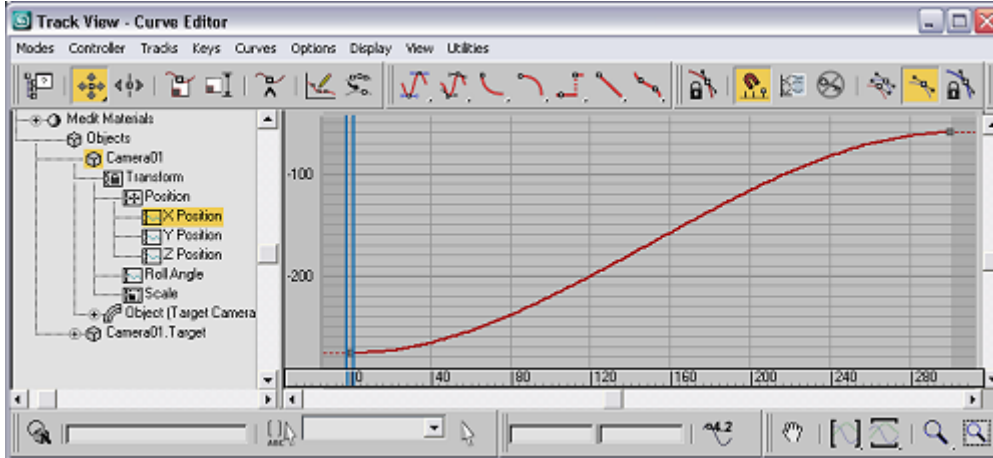
- The Orbit tool moves the camera around its target.
- The Truck tool moves both the camera and target perpendicular to the line of sight.
- The Roll tool rotates the camera around its line of sight.
- The Dolly tool moves the camera toward or away from its target.



Animating a Camera

A camera can be animated in many ways. In this unit, you use the Dolly tool to make the camera move toward its target, and therefore toward the house. When the Dolly tool is used, only the camera position changes. Other parameters, such as lens and field of view, remain the same.

The animation is performed by creating keyframes. Keyframes record the state of an object in time, in this case recording the position of the camera at the beginning and end of the animation. Creating keyframes is done by moving the time slider bar to a specific moment in time. Then, with Auto Key enabled, you can change the state of that object. In this case, you use the Dolly tool to record a new camera position at the end of the animation. The result is a camera that animates from the initial Dolly setting at frame 0 to the final Dolly setting at frame 300. The intermediate frames are automatically generated with a smooth transition between keyframe values. A representative graph of smooth camera motion shows how the camera motion changes gradually as it leaves and enters keyframes, creating what is commonly called an ease in/ease out effect.



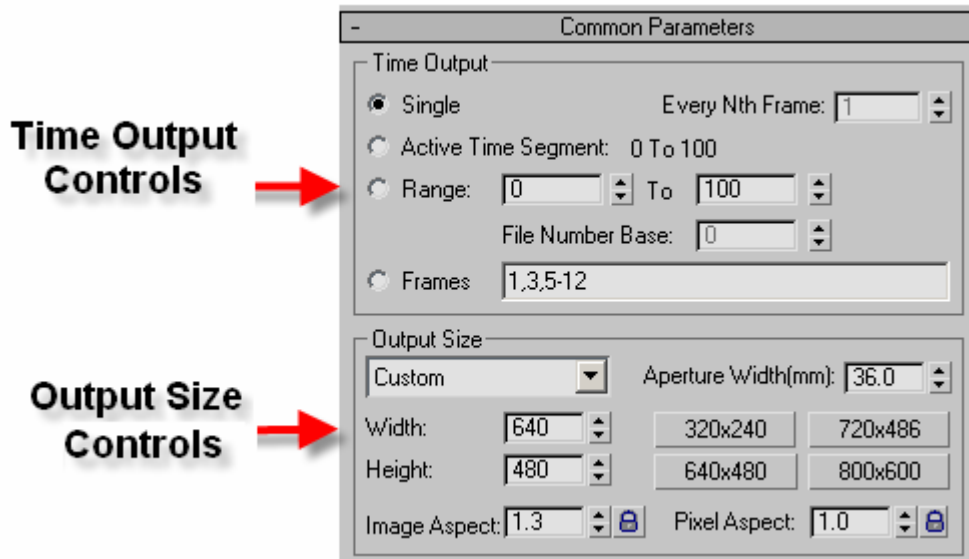
A smooth transition is generally desirable for camera movements.

Render Dialog Box

You can access the Render dialog box by selecting its Main toolbar button or by pressing the F10 function key. The dialog box provides controls for many aspects of the rendering process. The fundamental settings are time output, output size, and where to direct the render output.

Time output controls what frame or range of frames is rendered. When set to Single, the current frame is rendered, which is the frame the time slider is currently positioned at.

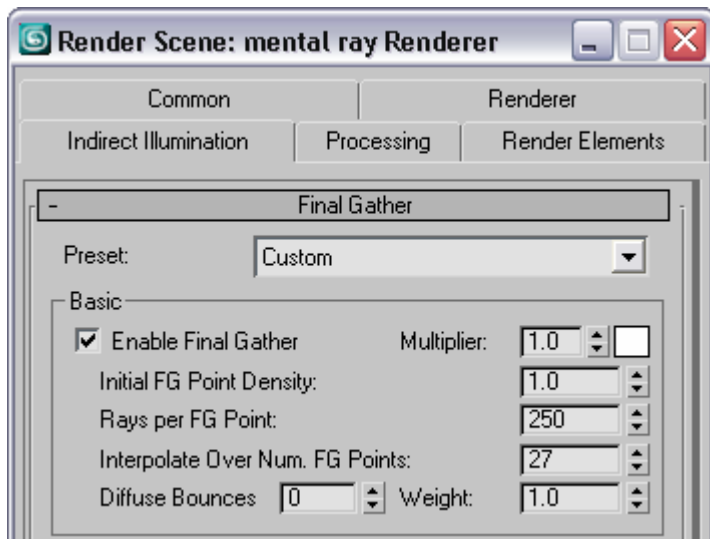
The output size determines the number of pixels rendered in the horizontal and vertical directions. Note that the region of the scene displayed during rendering does not change when output size is adjusted. Instead, that region defined by the current camera or viewport settings is divided into the specified number of pixels.



Setting Final Gather

Rendering calculates the color of each pixel representing the scene based on the interaction of light and surface materials. By default, the effects of light reflections are not taken into account. Instead, the light travels to all surfaces it can "see" and is completely absorbed. While not ideal, this result is acceptable for a quick evaluation of the scene. Without light reflection, though, surfaces in the shadows are rendered completely black.

In the real-world physical environment, much of what we perceive is based on light reflected between surfaces. This is termed *indirect illumination*. The mental ray renderer can simulate indirect illumination in a variety of ways, including a process called Final Gather. Final Gather calculates the distribution of light between surfaces in the scene. The settings for Final Gather are on the Indirect Illumination tab of the Render dialog box.



Final Gather works by casting vectors into the scene from each pixel to see what light and color information will be collected at that point. Its parameters include settings for the number of points sampled, the number of bounces sampling vectors make, and how the resulting information is averaged through the scene. Typically,

though, you seldom have to manually adjust these parameters. There are presets that make the setup much easier. Start with the Draft preset and work your way up for better quality. Surprisingly, you will find the Draft preset to be quite satisfactory most of the time. Final Gather can make a significant improvement in the rendered scene with a small increase in rendering time.



With Final Gather, areas in the shadows receive indirect illumination.

Saving a Rendered Image from the Framebuffer Window

A rendered image can be sent to a Framebuffer window, a file on disk, or both. When setting up a scene, it is common to render only to the framebuffer. Once the rendering is complete, you have the option of saving this result to disk with the Save to Disk tool. The Save to Disk tool is located in the top-left corner of the Framebuffer window.

Saving Directly from the Render Dialog Box

You can send the rendered output directly to disk by specifying a file name, type, and location within the Render dialog box. The file type specifies the format of the file. Examples include JPG, TIF, and PNG.

The render output and framebuffer are not mutually exclusive. You can have the Framebuffer window display at the same time 3ds Max is rendering to disk.

Rendering an Animation

When rendering an animation, the time output specifies the range of frames to be rendered. The entire animation range can be rendered, or any portion of it.

While an animation can be rendered to the Framebuffer window, it should be saved directly to disk. If it is sent only to the Framebuffer window, each frame overwrites the one before it. The resulting animation cannot be played back.

Animations can be rendered to disk as a sequence of individual frames or as a video format file such as AVI or MOV. Sequences of individual frames are common when rendering using multiple machines on a network. Rendering to an image sequence has the additional requirement of assembling the frames to a video file format before they can be viewed. In this section the animation output is sent to an AVI format video file.

As with single-frame rendering, the file name and path of the video file must be specified. An additional requirement is choosing a codec. Codec is short for compressor-decompressor. Because of their file size, video

files are commonly compressed for storage and transport. A codec handles the initial compression as well as the decompression during playback. The codec has to be present on the computer that renders the file, as well as any computer that plays the file.

Codecs commonly have a compression or quality option. Reduced file size involves some tradeoff with video quality.



3ds Max: Rendering

The Connection

The Rendering unit of the Student Workbook describes the still image and animation rendering process.

Features and Concepts to Learn

Creating and Positioning a Camera

- Creating a Target Camera
- Setting the Lens Size
- Activating a Camera Viewport

Camera Viewport Controls

- Using the Orbit Tool
- Using the Roll Tool
- Using the Dolly Tool
- Using the Truck Tool

Animating a Camera

- Setting Keyframes

Setting Final Gather

- Activating Final Gather
- Using Presets

Saving a Rendered Image from the Framebuffer Window

- Using the Save to Disk Tool

Saving Directly from the Render Dialog Box

- Specifying a File Format
- Setting an Output Path

Rendering an Animation

- Specifying an Animation File Format
- Specifying a Codec
- Specifying an Output Location

Notes

Creating and Positioning a Camera

The target and free camera creation tools are found in the Cameras category of the Create panel. Their parameters are the same, but the target camera offers more flexibility for positioning. A camera viewport can be made active by pressing C.

Camera Viewport Controls

When a camera viewport is active, the view controls become camera specific. Orbit rotates the camera about its target, while Truck moves the camera and target in a plane perpendicular to the view direction. Dolly moves the camera closer to its target.

Animating a Camera

Animation is done with the help of keyframes. Keyframes record the state of an object in time. As you create keyframes, 3ds Max automatically calculates the transition between one and the next. This is called *interpolation*. When a camera motion is animated, it results in a smooth interpolation between keyframes.

Render Dialog Box

The Render dialog box can be opened with the F10 function key. Setting the Time Output to Single causes the current frame to be rendered. The Output size determines the number of pixels in the horizontal and vertical direction. The output file type and location are specified in the render output group of the dialog box.

Setting Final Gather

Final Gather simulates indirect illumination in the scene. After rendering with Final Gather, areas in the shadows no longer appear black. Final Gather can improve realism with a relatively small increase in rendering time.

Saving a Rendered Image from the Framebuffer Window

Rendering to a Framebuffer window is useful for test renders. It does, however, give you the option of saving the rendered image using the Save to Disk tool.

Saving Directly from the Render Dialog Box

Rendering to disk requires specifying a file name, type, and location in the Render dialog box. The output can be concurrently sent to the Framebuffer window.

Rendering an Animation

When rendering an animation, the range of frames to render must be specified in the Time Output group. If an animation sequence is being rendered to a video file format, a codec must be selected. The selected video codec must be installed on any given computer that needs to play the file.

Hands-on Topics

- Create a target camera in the perspective viewport. Press C to activate the camera viewport. Then experiment with the Camera viewport controls. While adjusting the camera, observe how it moves in the other viewports.
- Create a camera and use Auto Key and the Move tool to animate it moving through the scene.
- Open the final version of the lake house file and experiment moving the camera and rendering other points of view.

Questions

- What are the two available camera types?
- Which keyboard shortcut activates a camera viewport?
- List three camera viewport controls.

- Which function key opens the Render dialog box?
- When the Time Output is set to Single in the Render dialog box, which frame is rendered?
- Can an image in the Framebuffer be saved to disk?

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