



## Design Visualization Techniques in AutoCAD® 3D

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### AU208-2

Learn how to control the appearance of three-dimensional models in AutoCAD. In this class, you'll learn how to use visual styles to adjust the look of your drawing as you work and use 3D tools to navigate through your model. You will also learn how to place cameras, create views, render to the screen, save renderings to a file, redisplay rendered images, and include those rendered images in printed drawings. We'll also learn how to create animations. You'll be amazed at all the visualization techniques available entirely inside AutoCAD.

### About the Speaker:

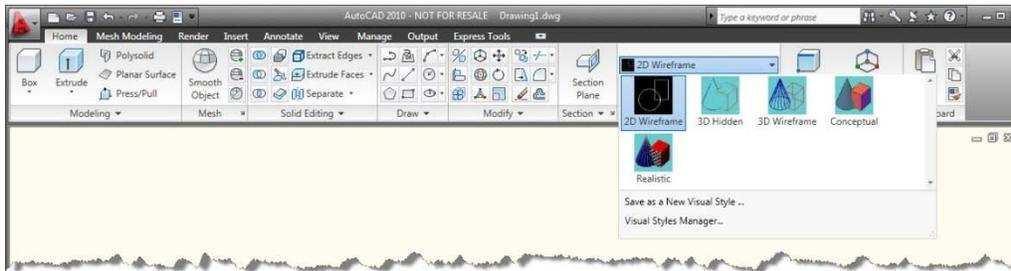
David has more than 25 years of hands-on experience with AutoCAD® as a user, developer, author, and consultant. He is an independent CAD consultant, a contributing editor to *Desktop Engineering* magazine, the former publisher and editor-in-chief of *CADCAMNet* and *Engineering Automation Report*, the former senior editor of *CADalyst* magazine, and the author of more than a dozen books about AutoCAD. A licensed architect, David was also one of the earliest AutoCAD third-party software developers, creating numerous AutoCAD add-on programs. As an industry consultant, David has worked with many companies including Autodesk. He teaches college-level AutoCAD courses and is always a popular presenter at both Autodesk University and AUGI® CAD Camps.

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As you work on a 3D model in AutoCAD—particularly a 3D model that you intend to show to a client in some sort of presentation form—you will want to adjust the appearance of that model, both to improve your work process, and to prepare the model for presentation. There are a number of tools you can use.

## Visual Styles

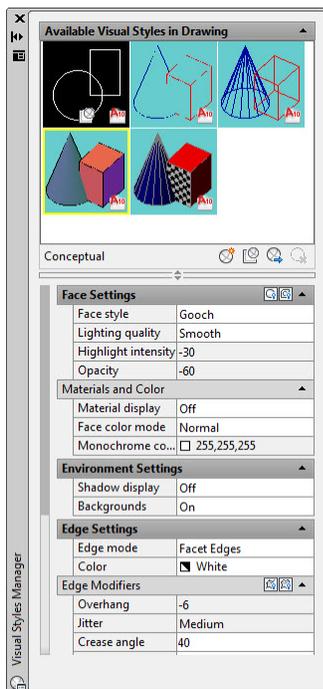
A visual style is a collection of settings that control the display of edges and shading in the viewport. Instead of using commands and setting system variables, you can quickly change the appearance of a view by applying a visual style. As soon as you apply a visual style or change one of its settings, you can see the effect in the viewport.



You can quickly change visual styles from the Visual Style drop-down on the Home ribbon tab (3D Modeling workspace). AutoCAD comes with five predefined visual styles and you can define and save your own custom styles. You can select a visual style and change its settings at any time. Visual styles are controlled from the Visual Style Manager palette.

### Using the Visual Style Manager Palette

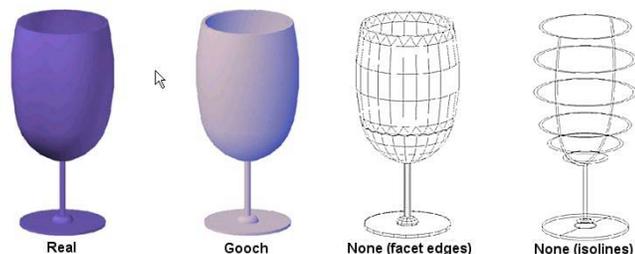
The Visual Style Manager palette contains the controls for adjusting visual styles.



The palette is separated into several sections. The top section shows the available visual styles, both the five predefined styles and any styles you've created. The current style is indicated by a yellow border and its name and settings are displayed in the panel below the sample images. Any changes you make to those settings will be saved with that style.

Buttons directly below the sample images enable you to create a new visual style, apply the selected style to the current viewport, export the current visual style to the Tool palette, and delete the selected visual style. You cannot delete any of the predefined visual styles. These are identified with an AutoCAD icon.

In the Face Settings area, you can control the shading and color effects applied to faces of the model. AutoCAD provides three face styles: Real, Gooch, and None. Note that when this is set to None, only edges are displayed and the selected Edge Mode will affect the results. You can also control the lighting quality, highlight intensity and opacity.



Note that in a shaded visual style, faces are lighted by two distant light sources that follow the viewpoint as you move around the model. This default lighting is designed to illuminate all faces in the model so that they can be seen. The default lighting is only available when other lights, including the sun, are off. As you move from modeling to rendering, you may need to toggle back to the default lighting in order to turn off the effect of other lights.

In the Material and Color area, you can choose to turn the display of materials and textures on or off. Both are turned on when using the Realistic visual style. The Face Color Mode setting can be set to Normal (do not apply a modifier), Monochrome (display the model in shades of a selected color), Tint (change the hue and saturation values of face colors), or Desaturate (soften the color by reducing its saturation component by 30 percent).

In the Environment Settings area, you can control the display of shadows and backgrounds. A background can be a color, a gradient fill, an image, or the sun and sky. To use a background, you must first create a named view and then select the desired background. The background setting associated with the visual style simply turns that background on or off. We'll look at backgrounds later in this class.

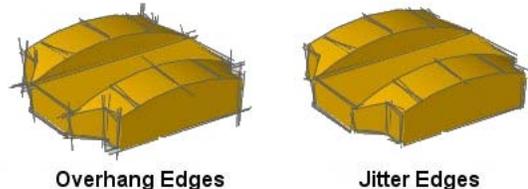
Shaded objects in a viewport can display shadows. Your choices are off, ground shadows, or full shadows. Ground shadows are shadows that objects cast on the ground. Full shadows are shadows cast by objects onto other objects. Note that displaying shadows can slow performance. You can turn shadows off in the current visual style while you work and then turn them back on when you need them. You can also use the Properties palette to control how individual objects react to shadows.

In the various edge settings areas, you can control how edges of different types are displayed and adjust special effects such as jitter and overhang.

**Edge Mode** can be set to Facet Edges, Isolines, or None.

**Color** enables you to set the color for edges.

Edge modifiers control settings applied to all edge modes except None.

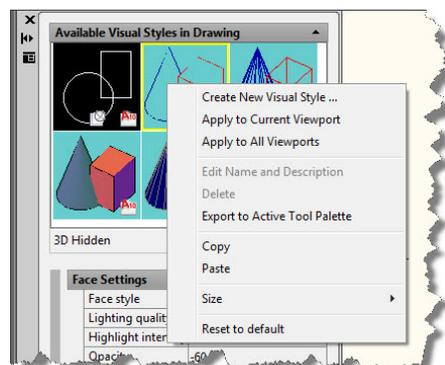


**Overhang:** Makes lines extend beyond their intersection, for a hand-drawn effect.

**Jitter:** Makes lines appear sketched. Settings are Low, Medium, High, and Off.

**Halo Gap %:** Specifies the size of a gap displayed where an object is hidden by another object. (Only available when using a visual style based on Conceptual or 3D Hidden Line.)

Other settings are only available when the Edge Mode is set to Facet Edges. The Crease Angle determines the angle at which facet edges are not shown, producing a smooth effect. Fast Silhouette Edges settings let you adjust silhouette edges by controlling their width. And the Obscured Edges and Intersection Edges settings let you control their color, and their linetype.

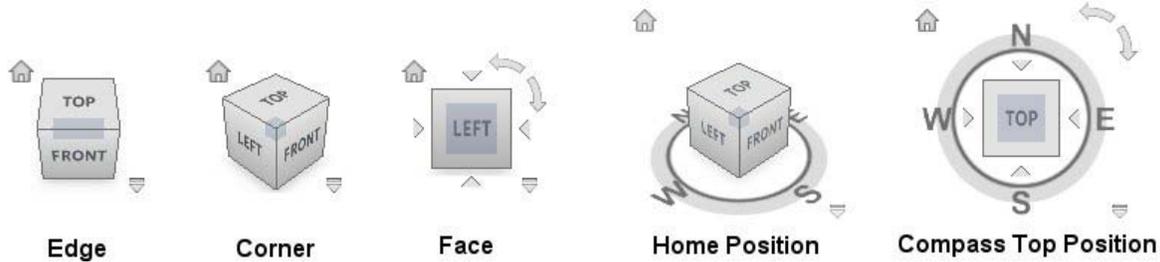


You can easily create new visual styles or copy and paste an existing style to use it as the starting point for creating a new visual style. You can also right-click on any visual style in the sample images area and then select actions from the shortcut menu

## Navigating in 3D

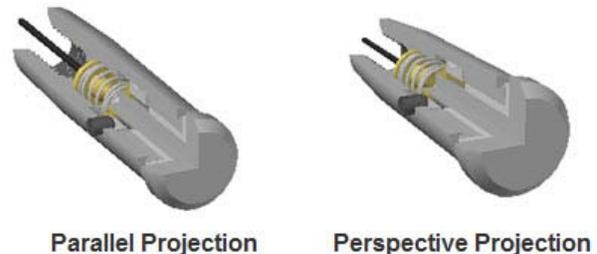
New tools added to AutoCAD make it extremely easy to navigate in 3D. In addition to the Orbit, Dview, Pan, and Zoom tools that have always been available, you can also use the ViewCube and SteeringWheels that have been added to more recent versions of AutoCAD.

The ViewCube, which is available when the current visual style is set to anything other than 2D Wireframe, provides visual feedback of the current orientation of the model. By default, the ViewCube displays in the upper-right corner of the viewport, although you can control its location, size, and other settings using the ViewCube Settings dialog.



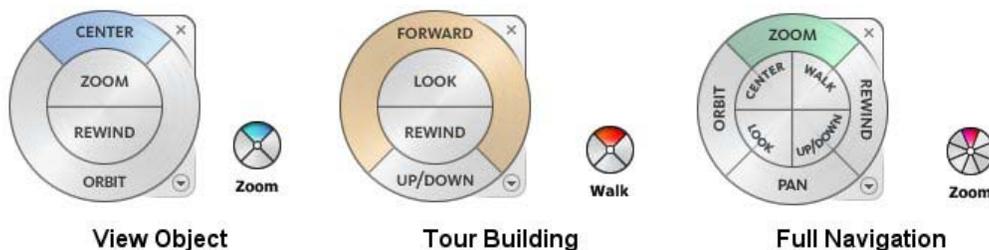
As you use various tools to adjust the orientation of your model, the ViewCube orientation also reorients to reflect those changes. You can also adjust the orientation of the model by manipulating the ViewCube. For example, you can click on edges, corners, or faces of the ViewCube to reorient the model. You can also click on a cardinal direction on the compass to reorient the model or click and drag on the compass to rotate the model around the current center of the view.

If you click on Home, the model is restored to its home orientation, which by default is a south-west isometric. But you can change this default home orientation. You can also use ViewCube controls to change the display to a parallel or perspective view, or even a perspective view with orthographic faces.



By default, when you reorient the model using the ViewCube, the model pivots around a point at the center of the current viewport. But if you select one or more objects in the model, the model will then pivot around those objects.

When displayed, the SteeringWheels follow the movement of the cursor and can be used to reorient the model. There are three different SteeringWheels that can be used when working in 3D, in both full and mini-versions.



In addition to the various tools in the SteeringWheels, you can use ShowMotion to record and play back transitions between views that you create when reorienting the model.

## Using the Render Panel

The Render panel provides access to most of AutoCAD's rendering commands.

### Using the Advanced Render Settings Palette

The Advanced Render Setting palette contains the main controls for the renderer. The palette is separated into several sections ranging from basic to advanced settings. The General sections contain settings that affect how your model gets rendered, how materials and shadows are handled, and how anti-aliasing (the smoothing of the stair-step effect at the edge of curved lines or edges) is performed. The Raytracing section controls how shading occurs. The Indirect Illumination section controls lighting properties, how your scene is illuminated, and if global illumination and final gather are processed. There are also diagnostic controls that can be useful in helping you understand why an image isn't getting rendered as expected.

### Setting the Render Destination

Rendered images appear in either a viewport or in the Render window. This render destination is set in the Advanced Render Settings palette in the Render Context section. The default setting is Window. When the render destination is set to Window, the renderer automatically opens the Render window and the image is processed. Upon completion, the image is displayed in this window and a history entry is created. As more renderings are created, they are added to the render history so you can quickly look at previous images and compare to see which have the desired results. Images that you want to keep can be saved from the Render window.

If you set the render destination to Viewport, the image is rendered and displayed in the active AutoCAD viewport. This is a one-time rendering because there is no render history entry that you can compare later. If you want to keep the image that you rendered to the viewport, use the SAVEIMG command.

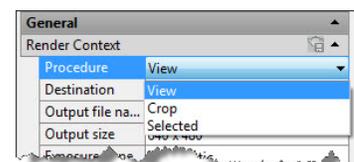
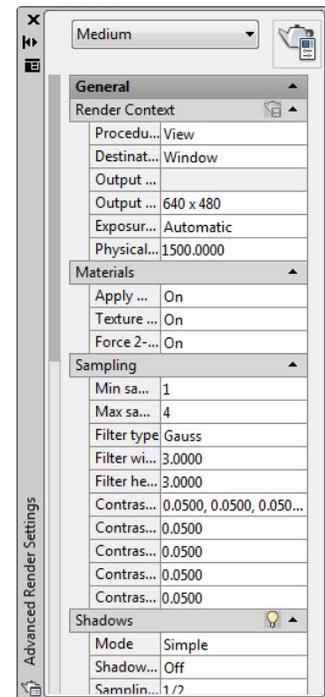
When rendering to the Render window, you can also specify that AutoCAD save the rendering to a file. When rendering to a Viewport, this option is not available.

### Rendering Views, Selected Objects, or Cropped Content

You can render an entire view, a set of selected objects, or a portion of what you see in the viewport. By default, AutoCAD renders all of the objects in the current view. To render a named view or camera view, first restore that view, which you can easily do from the drop-down in the Views panel of the View ribbon tab.

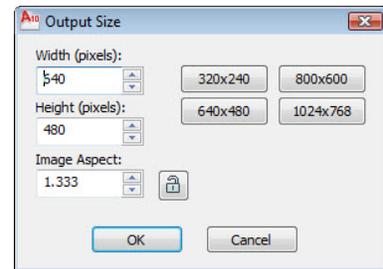
If you only want to render specific objects, first change the rendering procedure to Selected in the Advanced Render Settings palette. AutoCAD will then prompt you to pick the objects that you want rendered.

You can also choose to render only a portion of what's displayed in the viewport, by either setting the rendering procedure to Crop or by selecting the Render Region tool in the Render panel. AutoCAD will then prompt you to select the opposite corners of a window. Any objects within that region are rendered; everything outside the region is ignored. When rendering a region, the rendering only displays in the viewport, not the Render window.



## Setting Output Resolution

You can set the resolution of the rendered image by specifying the width and height of the image, in pixels. The default output resolution is 640x480, and can be set as high as 4,096x4,096. Higher resolution settings result in finer detail, but take longer to render. You can select from several predefined output sizes using the drop-down list in the Render panel. For complete control over the output resolution, use the controls in the Output Size dialog box.



Here you can also control the aspect ratio of the image, which determines the size of the image as a multiplier based on the ratio of its width to its height (for example, 4:3 would be expressed as 1.333). After setting this multiplier, if you lock the aspect ratio, the height and width are tied together, so that changing one value will automatically update the other to maintain the desired aspect ratio.

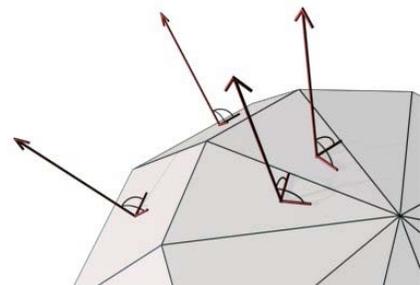
## Preparing a Model for Rendering

The way a model is built plays an important role in optimizing rendering performance and image quality.

### Understanding Face Normals and Hidden Surfaces

In order to minimize the time it takes to render a model, it is common to remove hidden surfaces or hide objects that are positioned off camera. Ensuring that all face normals orient in the same direction can also speed up the rendering process.

Every surface that you model is made up of faces. The direction in which a face is pointing is defined by a vector called a normal. The direction of the normal indicates the front, or outer surface of the face. When normals point in the same outward direction, the renderer processes each face and renders the model. If any normals are flipped (facing inward), the renderer skips them and leaves a hole in the rendered image. If you see a hole in a rendered image, either the normal is flipped and the Force 2-Sided setting is turned off in the Advanced Render Settings palette, or the face is physically missing from the model. If the face is missing, you'll need to reconstruct it. But if the normal is simply facing in the wrong direction, you can turn on the Force 2-Sided option in the Advanced Render Settings palette. You may also want to leave this setting on if the viewing angle of your rendering allows you to see inside your model (so that you are viewing the back sides of some faces) or if portions of the object you're rendering are transparent. While discarding the back faces of objects can speed rendering, AutoCAD's performance is only marginally affected when the Force 2-Sided option is active.



Some types of geometry create special rendering problems. When objects intersect, creating intersecting faces, the resulting edge may be rendered with a rippled effect. Creating a Boolean union between the objects will usually eliminate this.

Similarly, faces that overlap in the same plane can cause ambiguous results, particularly if different materials are applied to the two faces. Moving the objects slightly so that they are no longer coplanar will fix this situation.

The mesh density also affects the smoothness of surfaces. Smoothing happens automatically, and while you cannot control this process, you can control the display accuracy of curved objects by using the VIEWRES command and the FACETRES system variable. VIEWRES controls the display accuracy of 2D line work such as circles and arcs in the current viewport. The higher the VIEWRES setting, the smoother arcs and circles display, but they take longer to regenerate.

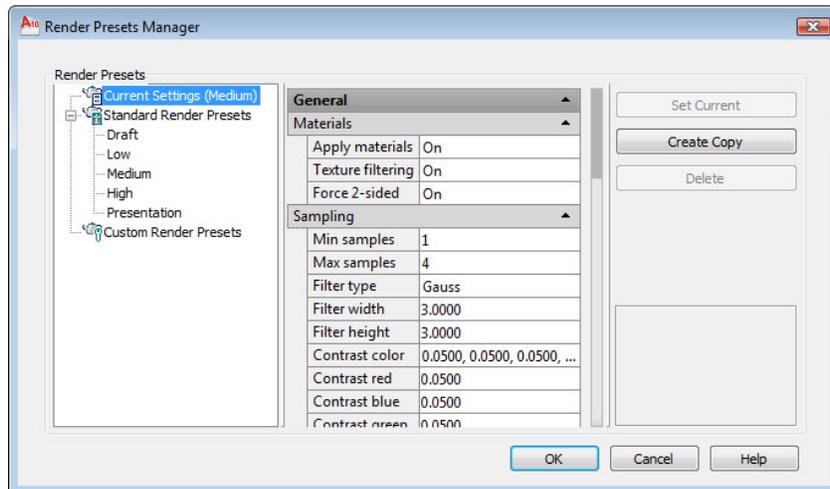
FACETRES controls the mesh density and smoothness of shaded and rendered curved solids. Solids will appear faceted if the FACETRES value is too low. When FACETRES is set to 1, there is a one-to-one correlation between the viewing resolution of circles and arcs and the tessellation (the subdividing of faces) of solid objects. When FACETRES is set to 2, the tessellation will be twice the tessellation set by VIEWRES.

## Adjusting Rendering Settings

AutoCAD comes with five predefined rendering settings—draft, low, medium, high, and presentation—which can be selected from the Rendering panel. Each preset uses predetermined rendering settings, and you can easily create beautiful renderings without ever adjusting any of these settings. But you can also modify the settings used by any of these rendering presets, or create and save your own custom render presets, by using the controls in the Advanced Render Setting palette.

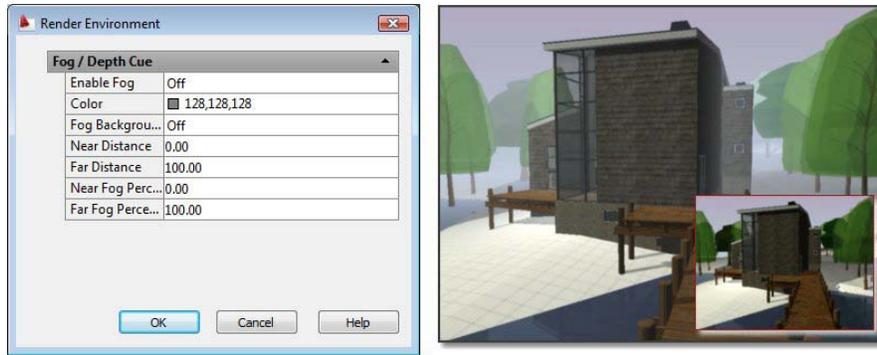
### Creating Render Presets

You can also adjust render settings using the Render Presets Manager. The Render Presets Manager shows all of AutoCAD's render presets. You can use the controls in this dialog box to change parameters of standard or custom render presets, create or update render presets, and select a render preset to be used by AutoCAD's renderer. You can also delete render presets, but only custom presets can be deleted. If you select a standard preset, the Delete button is inactive.



### Controlling the Rendering Environment

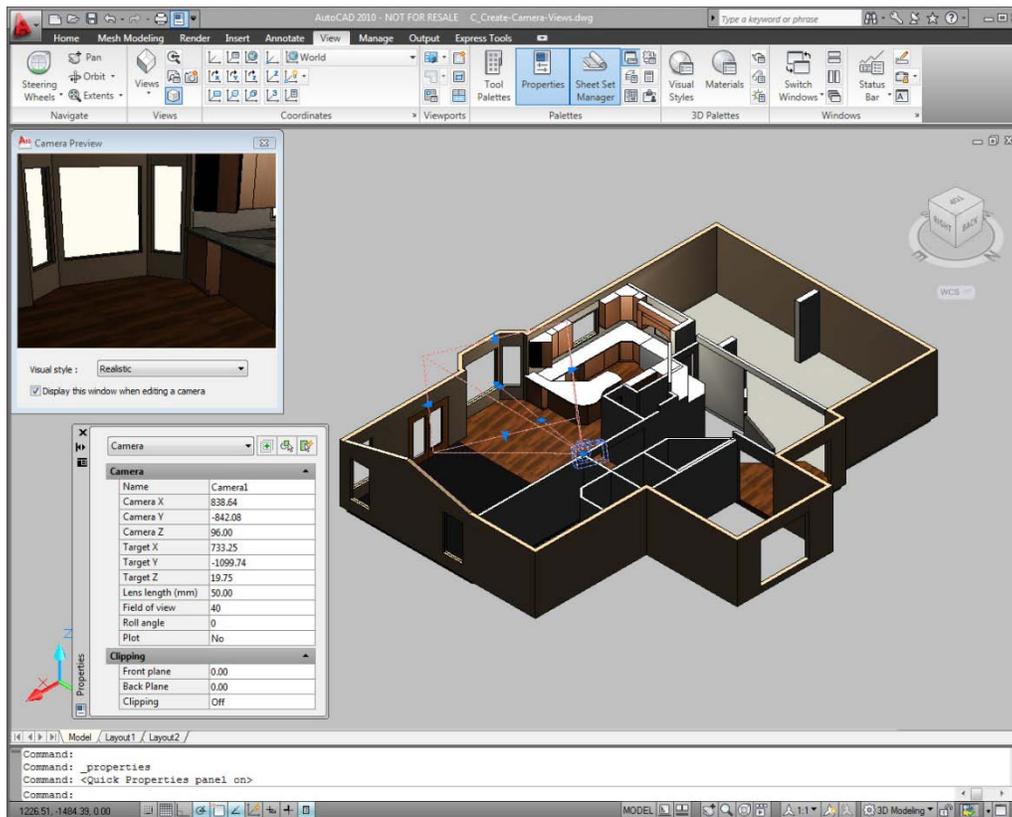
You can use environmental features to set up atmospheric effects or background images. You control fog and depth cue effects using the Render Environment dialog box. This dialog box lets you turn fog on and off, control the color of the fog, apply the fog to the background as well as the geometry, set the distance from the camera at which the fog begins and ends, and specify the opacity of the fog at the near and far distances.



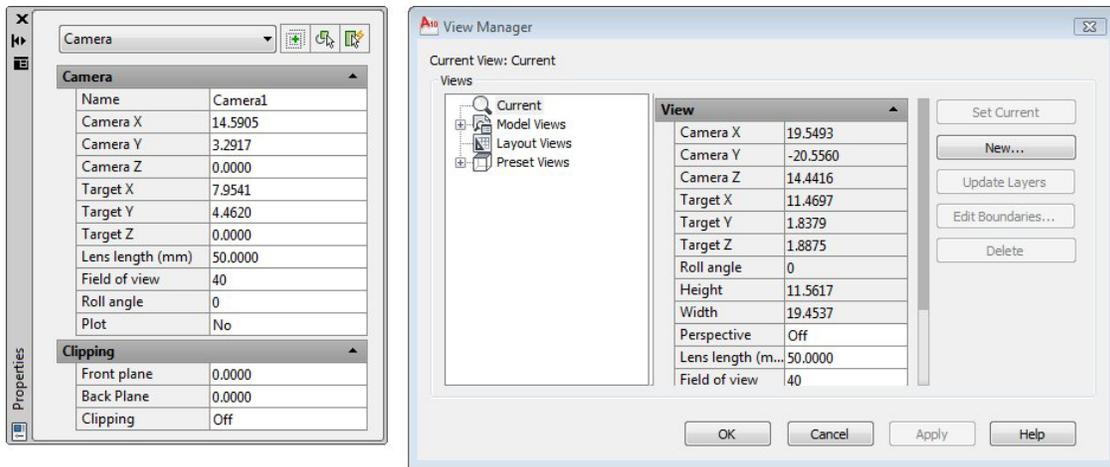
## Placing Cameras and Creating Views

In previous versions of AutoCAD, you could render a scene consisting of a named view and a list of associated lights. That capability is no longer available, but the ability to place cameras to create views is now easier than ever before. The CAMERA command (located in the Views panel of the View ribbon bar) lets you set a camera and target location and save a 3D perspective view of objects in your model. When you place a camera, AutoCAD automatically creates a named view matching the name of the camera.

Glyphs associated with each camera-based view appear in the drawing. When you select a camera glyph, AutoCAD displays a Camera Preview window showing the view seen by that camera, and you can adjust the visual style used to display the camera view.



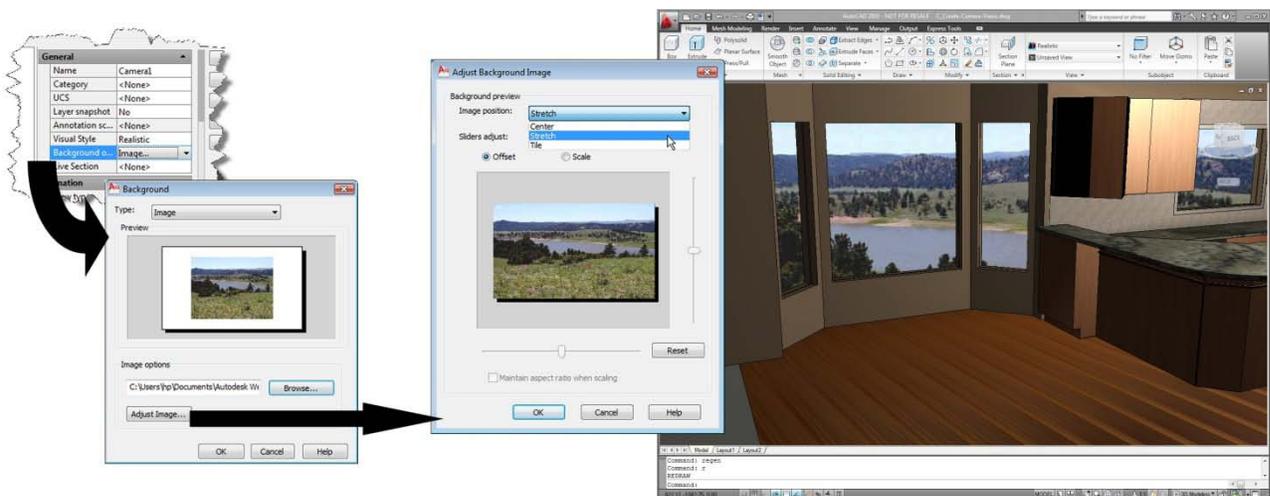
You can control the view name and other properties associated with the view using the Properties palette or the View Manager dialog box.



You can also associate a background with a named view. A background is basically a backdrop that displays behind your model. Backgrounds can be a single color, a multi-color gradient, or a bitmap image. Backgrounds work best when you are rendering still images, or animations in which the view doesn't change very much. Backgrounds are controlled using the View Manager dialog box, and once set, the background is associated with the named view or camera and saved with the drawing.

For example, to create a view in which you can see the image visible through the window of a room you have modeled, you could take a digital photograph of what would be visible through the window, and then associate that image with the view. To do this:

1. Select the named view in the View Manager.
2. Under General properties for the view, select Background Override and then select Image from the drop-down list.
3. In the Background dialog box, click Browse, locate the digital photo, and click OK.
4. After loading the image into the Background dialog box, click Adjust Image.
5. In the Adjust Background Image dialog box, select Stretch from the Image Position drop-down list, and then click OK to close all of the dialog boxes.



When you restore the named View, it displays with the associated image. When you render that view, the image appears as the background.

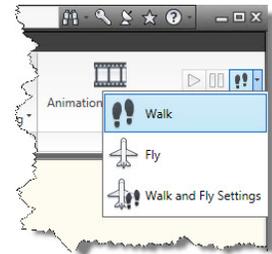
## Saving and Redisplaying Rendered Images

You can save a rendering and then redisplay it later. Redisplaying is much faster than rendering again. Rendered images can be saved as BMP, PCX, TGA, TIF, JPG, or PNG files.

- **Rendering Directly to a File** No matter how your display is configured, you can bypass the screen and render directly to a file. When you render to a file, you can use resolutions higher than your current display configuration permits. You set the file location and file name by setting the Image Target in the Advanced Render Settings.
- **Saving a Viewport Rendering** If you render to a viewport, you can save the image to a file by using the SAVEIMG command.
- **Saving a Rendering from the Render Window** If you render to the Render window, you can save the image or a copy of the image to a file by selecting the image from the history list, right-clicking, and choosing either Save or Save As.

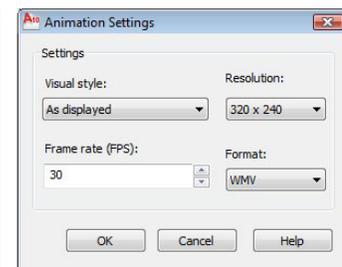
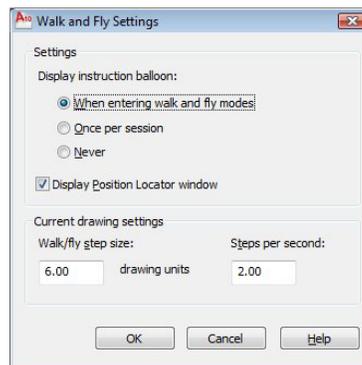
## Creating Walkthroughs and Flythroughs

AutoCAD 2007 also introduced new commands that let you navigate through your model using the arrow keys, the W, A, S, and D keys, or the mouse. 3DWALK keeps the camera at a consistent height whereas 3DFLY enables you to change the camera height as you navigate through the model. These commands appear in the Animations panel on the Render ribbon bar. If this panel is not displayed, right-click the Render tab and choose Panels>Animations.

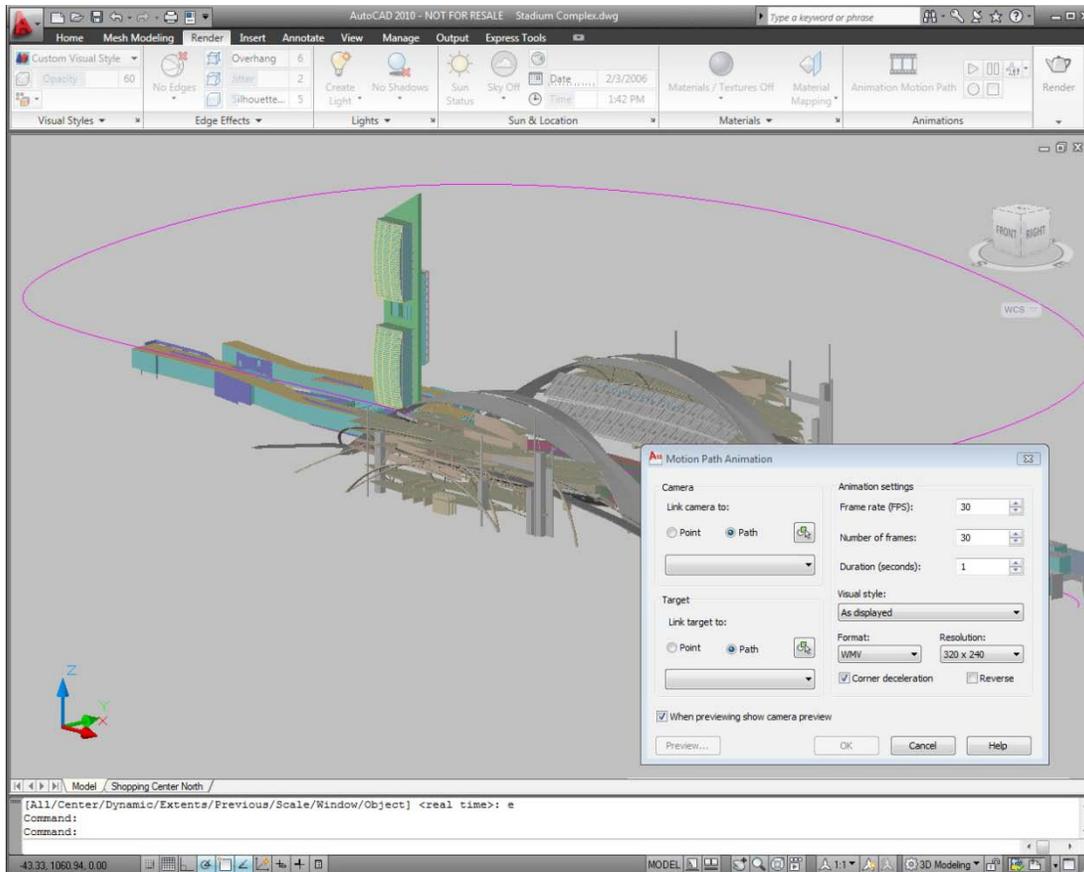


You can select the Walk or Fly tools from the flyout. You can also select Walk and Fly settings to adjust the default walk and fly settings, such as step size and steps per second, using the Walk and Fly Settings dialog box.

As you walk or fly through your model, you can record your movements using the animation control buttons. When finished, you can save the walkthrough or flythrough to a file. The Animation Settings dialog box lets you control the resulting animation file. AutoCAD can save the animation as an AVI, MPG, or MOV file. Each frame of the resulting animation can be rendered using a predefined visual style or rendering preset.



You can also create a flythrough using the Animation Motion Path tool (the ANIPATH command), which displays a Motion Path Animation dialog box. The controls in this dialog box let you specify a point or path for the camera and target, as well as the frame rate, number of frames, duration, file format, and resolution. You can also select the desired visual style or rendering preset from the Visual Style drop-down list. Click the Preview button to quickly preview the resulting animation. When you click OK, AutoCAD saves the animation to the specified file. If you select a rendering preset, each frame of the resulting animation is rendered using the rendering settings associated with the selected preset.



## Advanced Render Settings

Although in most cases, you can simply use the existing render presets to achieve excellent renderings, there are a host of other settings available in the Advanced Render Settings palette that you can adjust as needed to fine tune your renderings.

### Adjusting Materials

You can use controls in the Materials section of the palette to turn materials off, causing all objects in the model to be rendered using the characteristics of the GLOBAL material.

When texture filtering is turned on, the renderer uses a pyramidal filtering method, which applies anti-aliasing to texture maps but requires additional memory.

As already discussed, enabling 2-sided rendering causes AutoCAD to render both sides of faces.

### Adjusting Sampling

Although increasing resolution has the biggest impact on the quality of a rendering, you can also control sampling to adjust anti-aliasing. Sampling provides a “best guess” color for each rendered pixel. The renderer first samples the scene color at locations within the pixel or along the pixel’s edge, and then uses a filter to combine the samples into a single pixel color. You can adjust the minimum and maximum sample rate and also the filter type used to combine samples into a single pixel value. Increasing the minimum and maximum sample ranges greatly improves

the quality of a rendering. The filter types—Box, Triangle, Gauss, Mitchell, and Lanczos—can be selected from the drop-down list, and increase in complexity and time required to calculate.

You can also adjust the width and height of the filtered area. Increasing these values can soften the image but will also increase rendering time.

The Contrast Color setting lets you specify the RGB threshold values, while the contrast red, blue, and green settings let you specify the threshold values for the red, blue and green components of samples. You can also specify the threshold value for the alpha component of samples.

## Adjusting Shadows

With shadows, you can create rendered images that have greater depth and realism. The renderer can generate shadows by shadow mapping or ray tracing. Shadow mapped shadows rely on a bitmap that the renderer generates during a pre-rendering pass of the scene. Shadow mapping provides softer edges and can require less calculation time than ray traced shadows, but shadows are less accurate. Ray tracing traces the path of rays sampled from the light source. Shadows appear where rays have been blocked by objects. Ray traced shadows have more accurate, hard edges, but require more calculation time.

Shadow maps are off by default, and you should not use shadow maps when you have light shining through a transparent surface, such as a window with glass and mullions, since you'd have to remove the glass in order for the mullions to cast shadows. When shadow maps are off, the renderer uses ray-traced shadows.

You can also select one of three shadow mode settings. Simple, the default mode, causes the renderer to call shadow shaders in a random order.

In order for shadows to be cast in a model, lighting must be established. A light source must be added and you must specify that the light source will cast shadows.

## Ray Traced Reflections and Refractions

Ray tracing traces the path of rays sampled from the light source. Reflections and refractions generated this way are physically accurate. To reduce the time required to generate reflections and refractions, you can limit the number of times a ray can be reflected, refracted, or both. Trace depth controls the number of times a light ray can be reflected or refracted. Tracing stops when the total number of reflections and refractions reaches the maximum depth. Max Reflections specifies the number of times a ray can be reflected while Max Refractions specifies the number of times a ray can be refracted. As these numbers increase, you also increase the amount of processing time required by the renderer.

## Global Illumination and Final Gathering

Indirect illumination techniques, such as global illumination and final gathering, enhance the realism of a scene by simulating radiosity, or the interreflection of light in a scene. Global illumination allows for effects such as color bleeding. For example, if a red countertop is next to a white wall, the wall gets a slightly pink tint. Without this transference of color, the image would look fake.

To calculate global illumination, the renderer uses photon maps, but this technique can result in rendering artifacts such as dark corners. But these artifacts can be eliminated by turning on final gathering, which increases the number of rays used to calculate global illumination.

The accuracy and intensity of global illumination is controlled by the number of photons generated, the sampling radius, and its trace depth. Increasing the number of photons used makes global illumination less noisy but also more blurry, while decreasing the value makes global illumination more noisy but less blurry. The larger the value, the longer the rendering time.

When Use Radius is off, each photon is calculated to be 1/10 of the radius of the full scene. When this setting is on, the Radius value specifies the area within which photons will be used when illuminance is computed. Ideally, photons should overlap, which increases smoothing and creates more natural-looking illumination.

The Max Depth, Max Reflections, and Max Refractions settings under global illumination work much the same as they do for ray tracing, except they determine the number times a photon can be reflected or refracted.

Final gathering is an optional extra step that can be used to improve global illumination. Rays determines how many rays are used to compute indirect illumination in a final gather. Increasing this value makes global illumination less noisy, but also increases rendering time. Radius determines the radius mode for final gather processing. Max Radius sets the maximum radius within which final gathering is processed. Reducing this value can improve quality but increases rendering time. Use Min controls whether the Min Radius setting is used during final gathering. When on, the Min Radius value sets the minimum radius within which final gathering is processed. Increasing this value can improve quality but increases rendering time.

The Light Properties settings affect how lights behave when calculating indirect illumination. Photons/Light sets the number of photons emitted by each light for use in global illumination. Increasing this value increases the accuracy of global illumination but also increases the amount of memory used and the length of render time. The Energy Multiplier multiplies the global illumination, indirect light, and intensity of the rendered image.

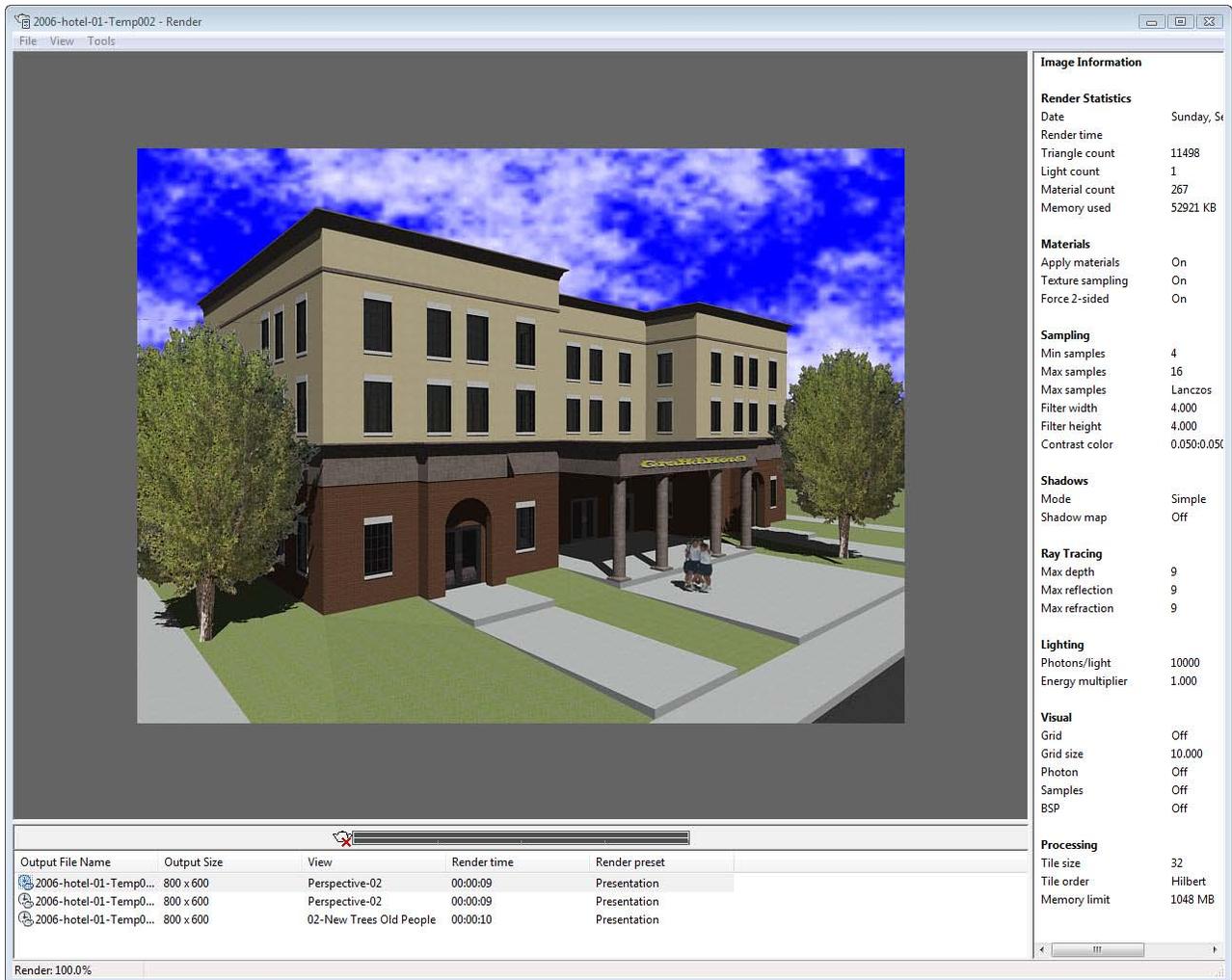
## Diagnostic Settings

The remaining controls and settings can be used to help you understand why the renderer is behaving in a certain way and also lets you control the tile size for rendering, the tile order, and how much memory to allocate for rendering.

## Rendered Image Histories

The render history in the Render window maintains a list of recently rendered images generated from the currently loaded model. Each image that is rendered to a file or the Render Window is recorded as a history entry.

Each history entry contains information about the images that have been recently rendered, including the data and time of the rendering task and other statistics, the current view or name of the stored view, the active render preset name, active render settings such as output resolution, and the size of a cropped region (if crop was used for the render task).



You can use the render history to redisplay a rendered image or save the image to a file.

Note that if you render to a viewport, you can save the image using the SAVEIMG command.

## Conclusion

Although there are far more rendering tools available in 3ds max that you can use to further enhance the quality of your models and create more sophisticated renderings and animations, AutoCAD truly does have all of the basic tools for creating professional, photorealistic images.