AUTODESK **UNIVERSITY** 2015

GEN11255

More than a Pretty Picture: Photorealistic Rendering Techniques in AutoCAD

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4D Technologies

Learning Objectives

- Learn how to add lights and model actual light fixtures
- Learn how to attach and modify materials and create custom materials
- Learn how to control the rendering environment to simulate natural lighting and atmospheric effects
- Learn how to render on your computer or in the cloud

Description

AutoCAD 2016 software introduces an entirely new rendering engine. Do you want to create professional-looking renderings? Learn how to convert your 3D AutoCAD software models into finished, photorealistic renderings using tools already built into AutoCAD software. In this class you will learn how to use AutoCAD software's lighting, material, and rendering tools to place and control lights, add and adjust materials and textures, and control the surrounding model environment to produce eye-catching images. We will also see how to take real-world objects and quickly create custom materials and produce reusable models of light fixtures that behave like real-world lights. You will also learn how to capitalize on Autodesk 360 software's cloud-based rendering service to create beautiful renderings quickly and easily, and even produce rendered animations entirely inside AutoCAD software.

Your AU Experts

David Cohn is the technical publishing manager at 4D Technologies, where he develops the CADLearning courses and eBooks for AutoCAD software and other Autodesk, Inc., products. He has more than 30 years of hands-on experience with AutoCAD and 14 years with Revit software as a user, developer, author, and consultant. He is both an AutoCAD and Revit Certified Professional. A contributing editor to Desktop Engineering magazine, David is also the former senior editor of CADalyst magazine and the author of more than a dozen books about AutoCAD software. 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 has taught college-level AutoCAD courses and has consistently been a top-rated speaker at Autodesk University.

Introduction

Rendering creates a 2D image based on a 3D scene. It shades the scene's geometry using the lighting you have set up, the materials you have applied to the geometry, and the render environment and exposure settings you have selected.

Rendering can be a very time-consuming aspect of a project. Because of the subtleties involved, you can spend a great deal of time adjusting camera positions, lighting, and materials. Happily, the tools in AutoCAD can help you shorten this process, because you can preview many aspects of your final image, such as the appearance of realistic materials and shadows, before you actually create a rendering. You can also produce test renderings at low-quality settings, or render just a portion of the final image to test your changes, before creating a final high-resolution rendering.

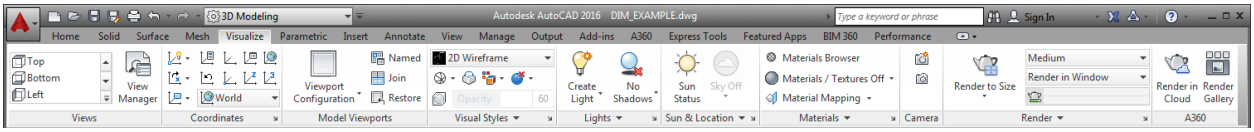
The process of creating a computerized rendering involves four steps:

- Create the actual model
- Place lights
- Attach materials to objects in the model
- Render the image

Other than creating the model, these procedures are conceptual, rather than discrete sequential steps, and often are performed in an iterative process. For example, you may place some lights and create a test rendering. Then, after viewing the results of your test, you may change some of the lights and render the image again.

Although the rendering engine in AutoCAD 2016 is new, the process of creating a rendering is not very different from previous releases. And the tools provided by the new rendering engine actually simplify and speed up that process.

The rendering tools are all located on the **Visualize** ribbon. This ribbon is available when working in the **3D Modeling** and **3D Basics** workspaces. This ribbon includes tools for placing lights and controlling solar illumination, adding materials, and rendering the image. It also provides tools for saving and switching views, changing the visual style, placing cameras, and creating animations.



You can create and save views to compose the scenes that you want to render. One method you can use to accomplish this is to place virtual cameras into the model.

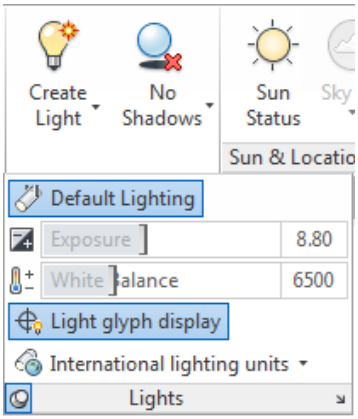
To help you to see how each change you make to the lighting and materials will appear in the finished rendering, you can display the model using the **Realistic** visual style.

You can include background images and environments to make your renderings even more realistic.

When you are ready to produce a rendering, you can render on your local computer or in the cloud.

Adding Lights

Placing lights in your model quickly adds a new level of realism. The combination of carefully placed lights and realistic materials turns a flat, shaded image into a close approximation of reality.



The tools used to add lights to a model are located in the **Lights** panel. This panel includes tools to add four types of lights:

- Point lights
- Spot lights
- Distant lights
- Weblights

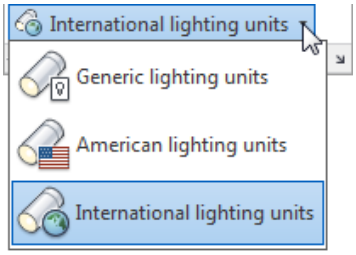
You can also toggle between default and modeled lighting, adjust the exposure and white balance, toggle the display of light glyphs, control the lighting units used within the drawing, and control whether the visual style displays shadows.

Default Lighting

When you work in a viewport with a 3D shaded view, the default lighting comes from two distant light sources that follow the viewpoint as you move around the model. All of the faces of the model are illuminated so that they can be seen. You can adjust the exposure of the rendered image, but you do not need to create or place lights when using default lighting.

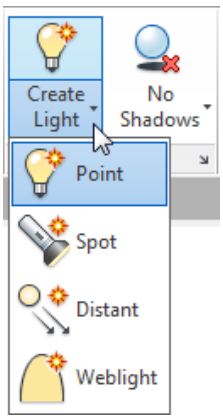
When you place a user-defined light or enable sunlight, you can disable default lighting (and the program will prompt you to do so) so that the scene is lit by more realistic photometric lighting. Default lighting is controlled on a per viewport basis.

Photometric Lighting



When you add user-defined lights to a model or enable sunlight, you will use photometric lighting, which uses light energy values that enable you to define lights more accurately, as they would be in the real world. You can create lights with various distribution and color characteristics, or import specific photometric files available from lighting manufacturers. When using photometric lighting, the light energy values can be measured using American lighting units (foot-candles) or International lighting units (lux).

Adding User-Defined Lights



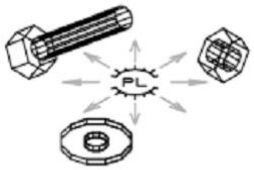
When you add user-defined lights to a model, you can choose the type of light by selecting from the **Create Light** split button. You can use this tool to create point lights, spot lights, distant lights, and web lights. Whichever type you used last floats to the top of this split button.

When placing user-defined lights, options enable you to control parameters such as its name, intensity, status, photometry, shadow, attenuation, and color. In AutoCAD 2016, shadows are always rendered regardless of the Shadow option. It is often easier to accept the defaults and change these later using the **Properties** palette.

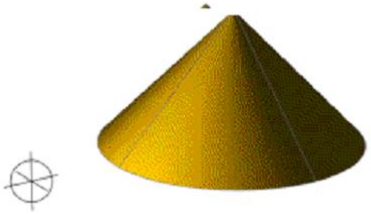
When placing lights, it is useful to have Dynamic Input enabled so that you can position the light in the XY-plane and then specify its Z-coordinate.

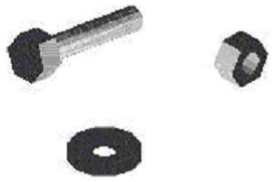
Point Lights

A *point light* radiates light in all directions from its location and illuminates everything around it. Point lights can be used for general lighting effects and to simulate light sources such as candles and light bulbs.



point light





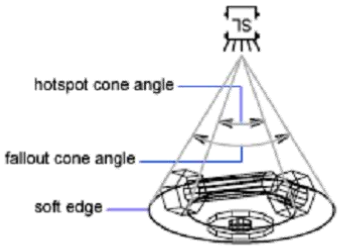
rendering with point light

A standard point light does not target an object. A target point light has additional properties so that it can be directed to an object. You can use the **Properties** palette to control whether a point light is targeted or not. You can also control whether light intensity from a point light diminishes with respect to distance or not and how that attenuation is calculated. By default, attenuation is set to none.

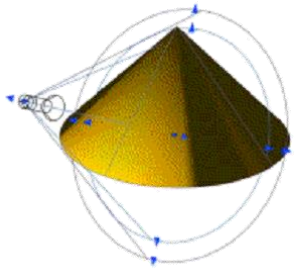
Note that point lights appear in the model as glyphs that can be selected and modified as you would any other AutoCAD object.

Spot Lights

A *spot light* emits a directional cone of light. It cases a focused beam of light like a flashlight, a follow spot in a theater, or a headlight. The light in the central portion of the cone is typically brighter than the light around the edges of the cone. You can control the direction of the light and also adjust the angle that defines the size of the central portion of the cone, or *hotspot*, as well as the angle that defines the outer extents of the cone, or *falloff*. The greater the difference between the hotspot and falloff angles, the softer the edge of the light beam. If both values are nearly equal, the edge of the beam is sharp. Values can range from 0 to 160 degrees. Spotlights are useful for highlighting specific features in areas of your model.



spotlight



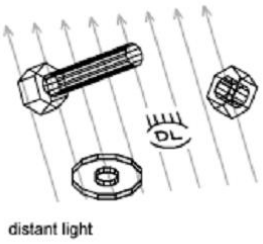
rendering with spotlight

A standard spotlight targets an object, so you must specify both the light location and the target. You can create a non-targeted spotlight (a freespot) that points directly down, however. You can use the **Properties** palette to control whether a spot light is targeted or not.

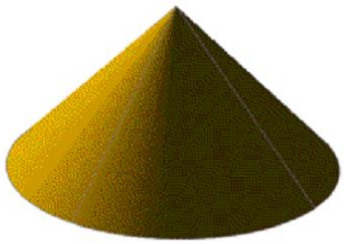
Note that spot lights appear in the model as glyphs that can be selected and modified as you would any other AutoCAD object.

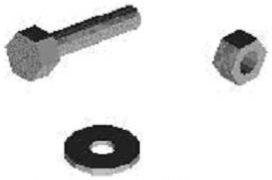
Distant Light

A distant light emits light that travels in parallel rays in one direction and does not diminish over distance; it is as bright on each face it strikes as it is at the source. You must specify the From point and the To point. Distant lights can be useful for applying uniform lighting to a scene, but they can make a scene appear washed out or too light. For that reason, when you insert a distant light, the program displays a warning, and you must specifically allow distant lights.



distant light



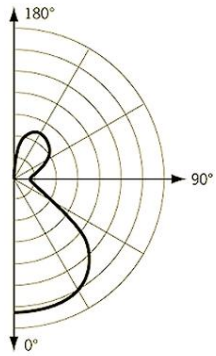


rendering with distant light

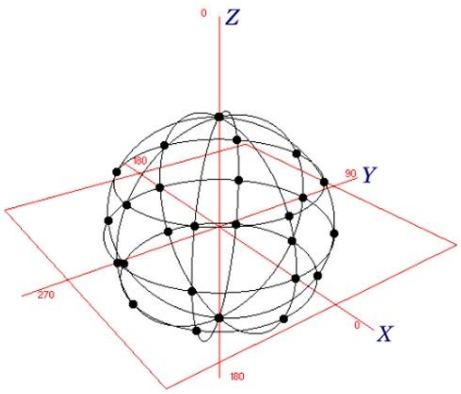
Note that distant lights do not have an associated light glyph, so you cannot select a distant light in the model. Instead, you can display the **Lights in Model** palette, select the distant light, and then adjust its properties.

Weblight

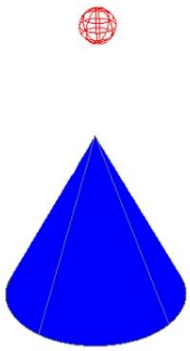
A weblight is a 3D representation of the light intensity distribution of a light source. Weblights can be used to represent non-uniform (anisotropic) light distributions derived from data provided by manufacturers of real-world lights. This gives a far more precise representation of the rendered light than either a spotlight or point light is capable of producing.



Photometric data depicted using a goniometric diagram



3D representation of light distribution



A typical web light

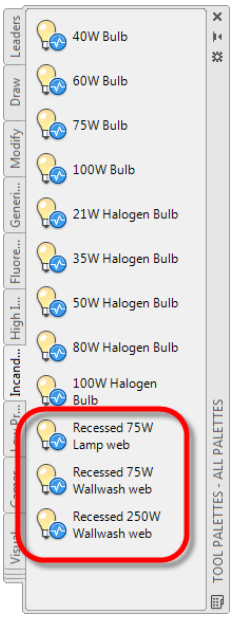
This directional light distribution information is stored in a photometric data file in the IES format using the IES LM-63-1991 standard file format for photometric data. The photometric data is often depicted using a goniometric diagram that shows how the luminous intensity of the source varies with the vertical angle, but the horizontal angle is fixed, so if the light distribution is not symmetrical, more than one goniometric diagram may be needed to describe the complete distribution. The photometric web is a three-dimensional representation of the light

distribution that extends the goniometric diagram to three dimensions so that both the vertical and horizontal angles can be examined simultaneously.

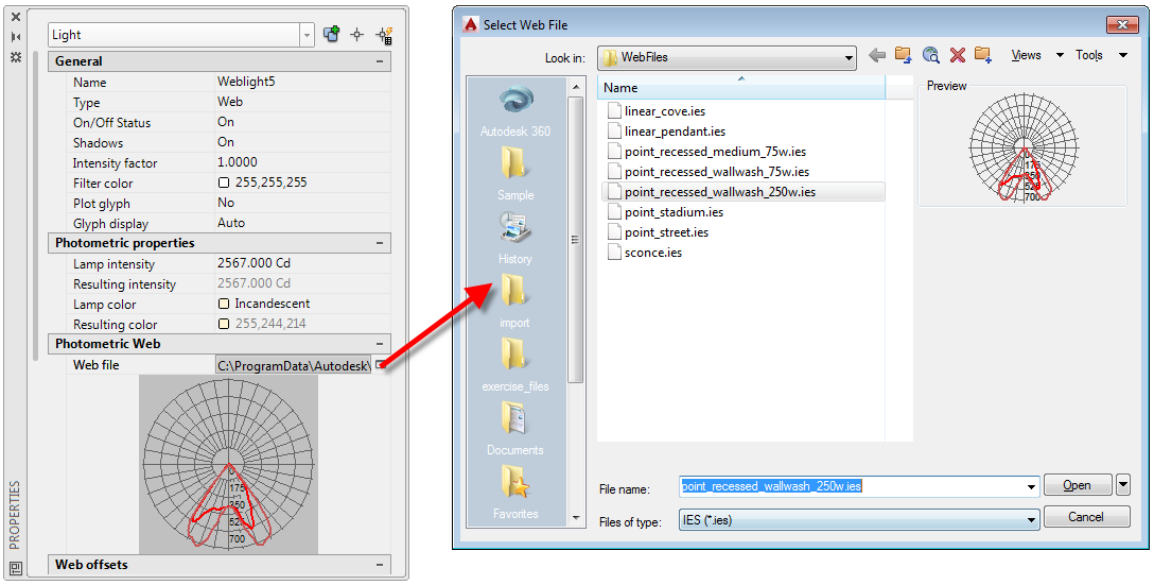
Note that the web distribution is only used in rendered images. The light from weblights is approximated as a point light within the model viewport. Weblights appear in the model viewport as glyphs that can be selected and modified as you would any other AutoCAD object. When an IES file is associated with a weblight, the glyph takes on the appearance of the 3D representation of the light distribution.

A standard weblight targets an object, so you must specify both the light location and the target. You can create a non-targeted spotlight (a freeweb) that points directly down, however. You can use the **Properties** palette to control whether a weblight is targeted or not.

AutoCAD comes with several weblights that have IES files already attached. These can be found in the **Tool Palette** on the **Incandescent** tab and include the word “web” in their name.



You can also place a weblight into the model and then attach an IES file using tools in the **Properties** palette. To do this, after inserting the weblight, select it and then display its properties in the **Properties** palette. Under **Photometric Web**, the **Web file** field will be blank. When you click in this field, a button becomes available. Click the button to open a **Select Web File** dialog. You can then locate the IES file you want to attach to the light. When you do, you see a preview of its light distribution diagram (the goniometric diagram).

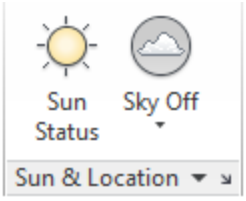


Once you attach an IES file to the weblight, its glyph changes to take on the appearance of the 3D light distribution.

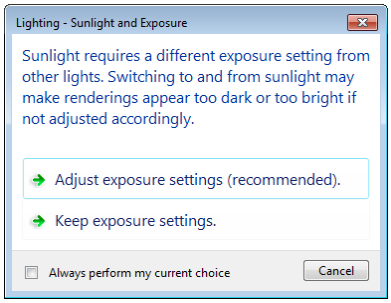
Working with Sunlight

You can enable sunlight to light your model using a special light that simulates light from the sun. Sunlight can also be used in conjunction with sky simulation to provide a dramatic background and show how the shadows cast by a structure affect the surrounding area.

Sunlight is rendered using an accurate sunlight model. For example, the color of sunlight is computed based on the time, position in the sky, date, and location specified in the drawing. The rays of the simulated sunlight are parallel and have the same intensity at any distance. The angle of light from the sun is controlled by the geographic location you specify for your model and by the date and time of day. Whereas the rays of the sun are parallel and of a yellowish hue, the light cast from the atmosphere comes from all directions and is distinctly bluish in color. All settings for the sun except geographic location are saved per viewport, not per drawing. Geographic location is saved per drawing.



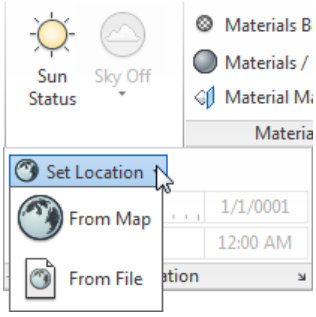
To enable sunlight, on the **Visualize** ribbon, in the **Sun & Location** panel, click **Sun Status** to toggle it on. When you do, the program may warn you that sunlight requires a different exposure setting and that switching to and from sunlight may make renderings appear too dark or too bright if not adjusted accordingly. You should click **Adjust exposure settings (recommended)** to avoid this problem.



Once you enable sunlight, the model will likely appear very dark, and if you were to render the scene, the resulting rendering would likely be entirely black. That is because you have not yet established the location of the model. Since sunlight is computed based on the date, time, and geographic location of the model, you must use the geolocation tools to set the geographic location of the model.

Setting the Geographic Location

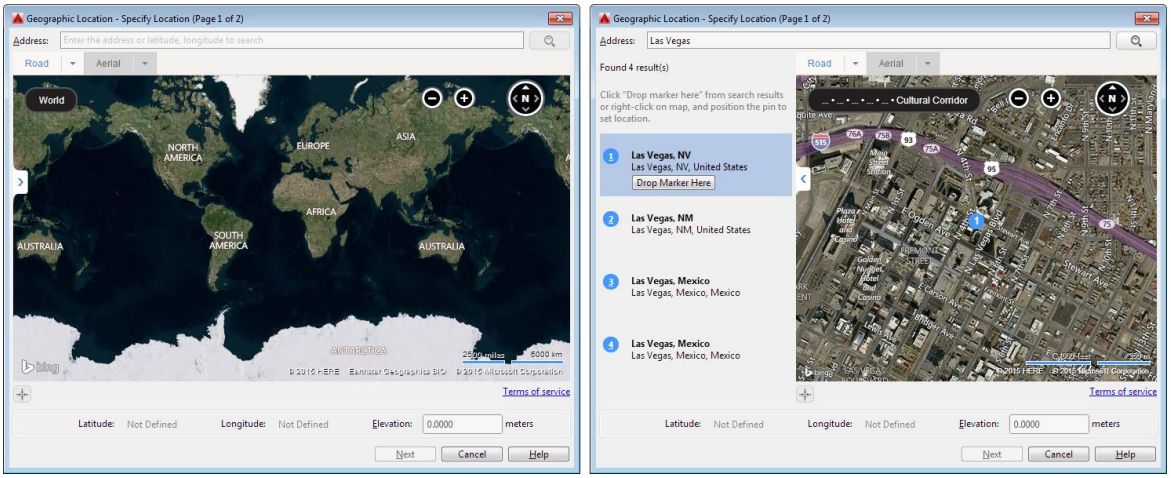
To establish the geographic location, on the **Visualize** ribbon, expand the **Sun & Location** panel and expand the **Set Location** tool. You can choose **From Map** to assign the geographic location using maps from an online web service, or **From File** to assign the geographic location by importing coordinates from a GIS file saved in the .kml or .kmz format.



Click **From Map**.

AutoCAD displays a dialog asking if you want to use online map data. Since you must use online map data to assign the geographic location using maps, click **Yes**.

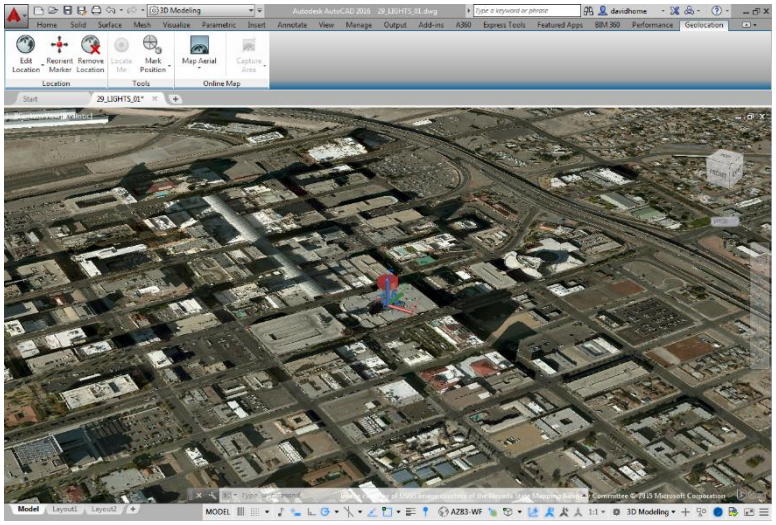
If you are not yet signed into your A360 account, the program will display a sign-in dialog. Enter your Autodesk ID and password, and then click **Sign In**. Once you have signed into your A360 account, the program displays the **Geographic Location** dialog. Initially, this dialog shows the entire world. While you can click to specify a location on the map, it is much easier to search for an address or a latitude and longitude. The map zeroes in on the location you specify. When you have found the correct location, click **Drop Marker Here.** A pin is placed on the map and the corresponding latitude and longitude are automatically applied.



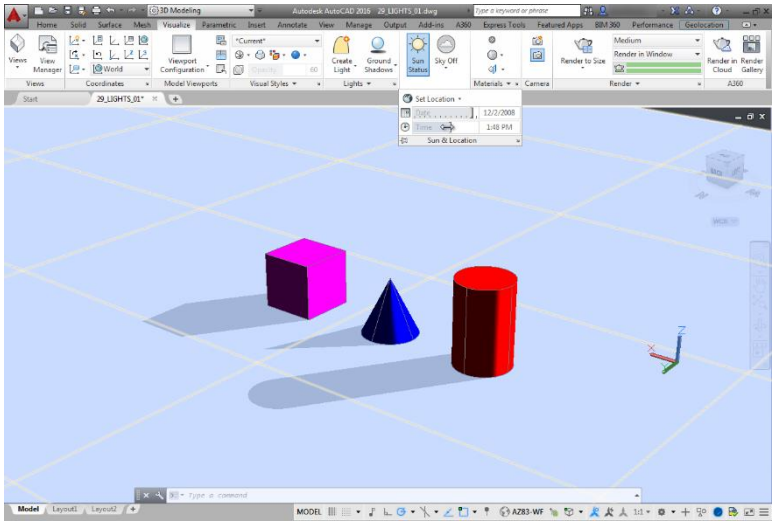
Note that the Elevation is shown as 0 meters. If you knew the elevation, you could click in the Elevation field and type that value. Click **Next** to proceed.

On the second page, you can specify the coordinate system. Based on the marker location, the program lists only relevant coordinate systems. You should typically select the coordinate system with an origin close to your location, and the list is ordered by closest origin to the set location. Once you select the coordinate system, the program fills in the correct time zone and drawing units. Click **Next** to proceed.

The dialog disappears and the program prompts you to **Select a point for the location**. After specifying the point, the program prompts you to specify the north direction, or you could specify the angle. As soon as you do, the command ends. A geolocation marker is displayed in the drawing at the point you specified and a map is applied to the drawing. You can use the tools on the **Geolocation** ribbon to change the display of this map or toggle it off.



Back on the **Visualize** ribbon, in the **Lights** panel, you can expand the **Shadows** split button and choose **Ground Shadows**. Now you can see distinct shadows on the ground cast by the objects in the model. When you expand the **Sun & Location** panel, you can adjust the date and time of day by moving the sliders. As you move the time slider, you can see the shadows change.

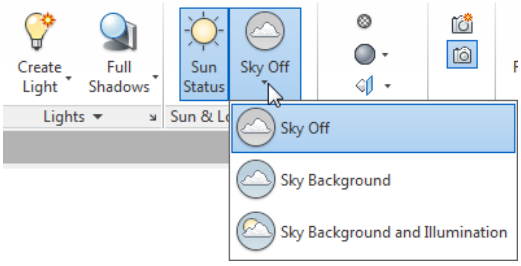


Also note that once you have established the geographic location, you can sign out of your A360 account. The drawing remembers the geographic location.

Controlling the Sky Background and Illumination

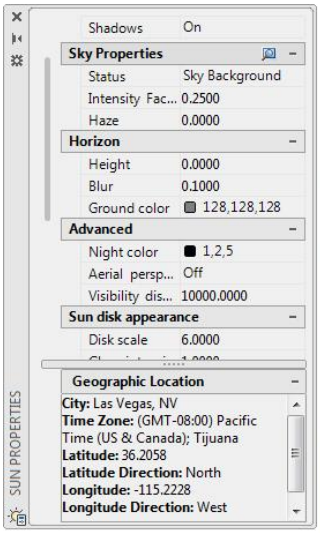
The sun and sky are the primary sources of natural illumination in AutoCAD. While the rays of the sun are parallel and of a yellowish hue, the light cast from the atmosphere comes from all directions and is distinctly bluish in color. When using photometric lighting, you can adjust the sky background and other sun properties.

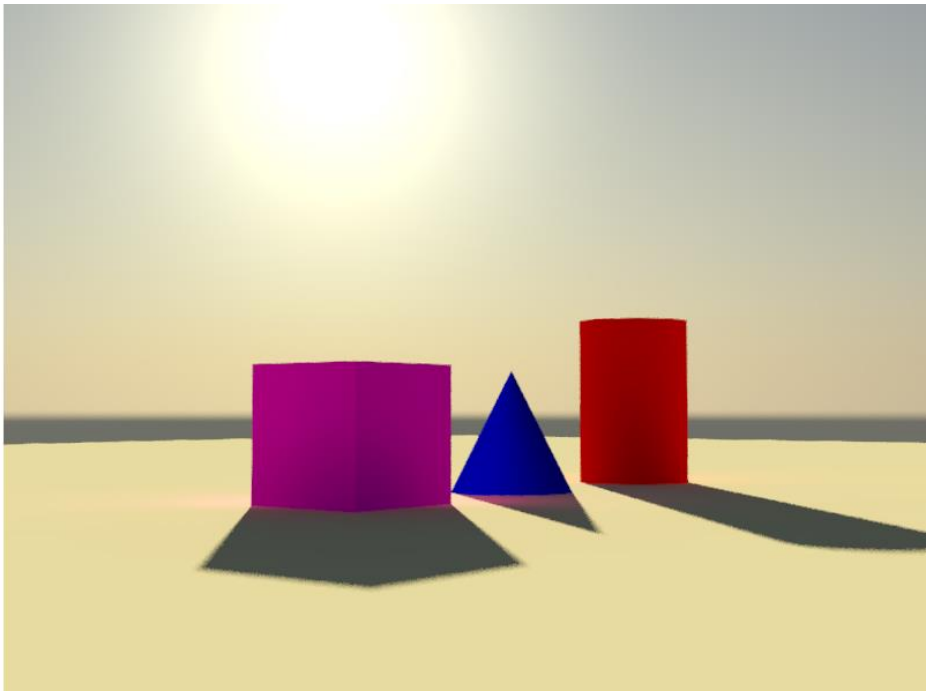
If you render the scene with sky illumination turned off, the shadows cast by the objects are unrealistically harsh and the background is black, because the drawing would be lit only by the yellow light of the sun. However, when you expand the **Sky** split button and choose either **Sky Background** or **Sky Background and Illumination**, the sky illumination will be computed when you render the scene. The sky is no longer black, the shadows are no longer harsh, and if you look carefully, you can see that some of the color of the objects themselves has been reflected onto the ground, just as it would in the real world. Although this may seem like a minor detail, if it is missing from a final rendered image, the image tends to look fake, even though it may be difficult to point out exactly why.



When you turn on the sky background and illumination, AutoCAD also calculates the appearance of the sky and the sun, and the sun can even be included in the rendered image. You can adjust the sky and sun settings to fine-tune the appearance. In the **Sun & Location** panel, click the dialog box launcher to open the **Sun Properties** palette. The tools in this palette enable you to adjust the sky and sun settings. For example, you can adjust the atmospheric haze, the appearance and location of the ground plane, the intensity factor, and even the size of the solar disk. You can also precisely set the date and time.

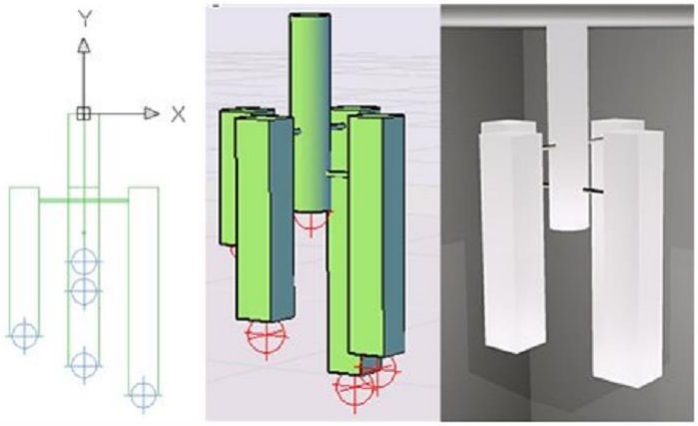
After making changes, when you render the view again, you should be able to see the solar disk.





Using Luminaire Objects

You can embed lights inside blocks that also contain geometry, thus creating light fixtures that model both the physical and photometric properties of actual light fixtures. To do this, you first model the light fixture in 3D, then place lights in the proper location within the light fixture model, and finally create a block containing both the 3D model and the lights. You can then place this block into other models.



When you render a view containing one of these luminaire objects, you can see that the light appears to actually be coming from the light fixture and that both the properties of the lights and the shape of the light fixture model affect the appearance of the light.

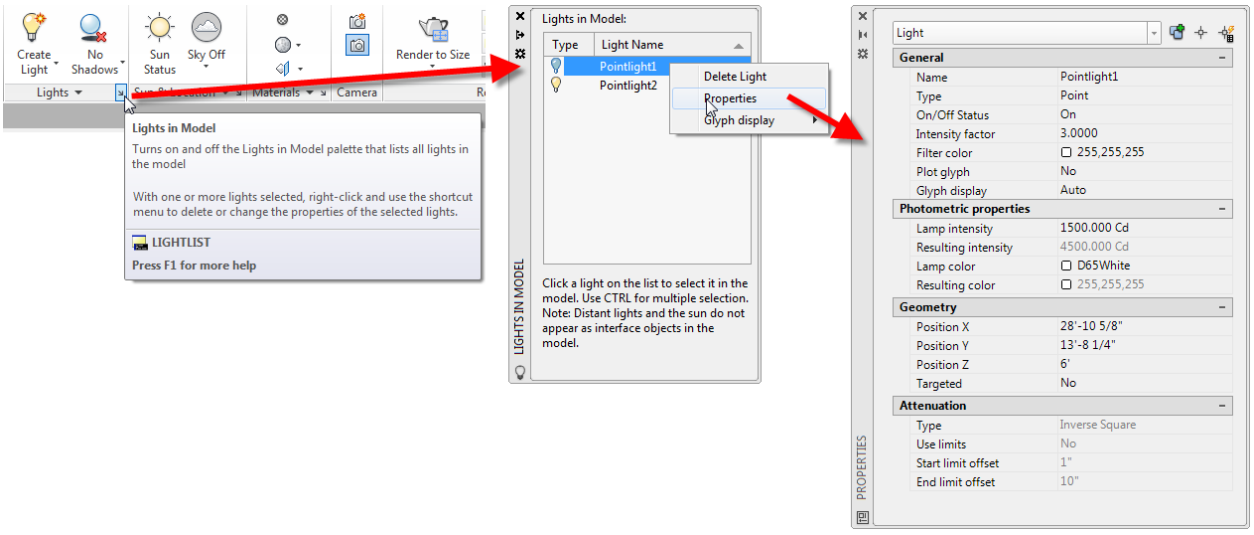
By placing each light fixture on its own layer, you can use layer controls to try out different light fixtures. You can also save layer states with various views to quickly see what an image would look like with different light fixtures.

Note that when you create light fixture blocks like this, you can no longer turn individual lights on and off. To switch an individual light on and off or change its properties, you would need to go into the block editor in order to control the lights within the light fixture block.

Also note that when rendering a scene that contains a block reference with one or more lights, set the LIGHTSINBLOCKS system variable to 1. If LIGHTSINBLOCKS is set to 0, the lights contained in the block references inserted into a drawing are ignored during rendering.

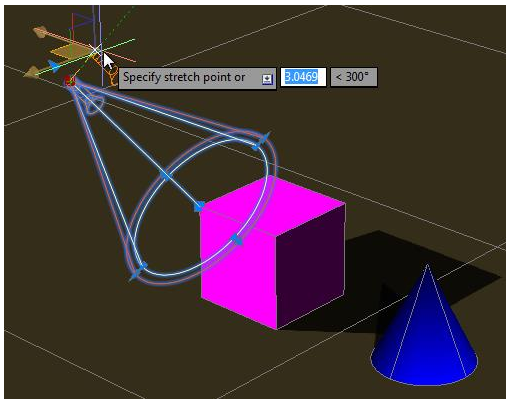
Controlling the Location and Properties of Lights

With the exception of the sun and lights in blocks, each light you add to the drawing is listed by name and type in the **Lights in Model** palette. You can easily modify lights similar to the way you would modify any other objects in a drawing.



When you select a light in the **Lights in Model** palette, that light is also selected in the model. When you select a light in the model, that light is also selected in the **Lights in Model** palette. With a light selected, in the **Properties** palette, you can control any of its properties. For example, under **General**, you can change the name of the light or even change its type. You can also change the status of the light, which turns the light on and off.

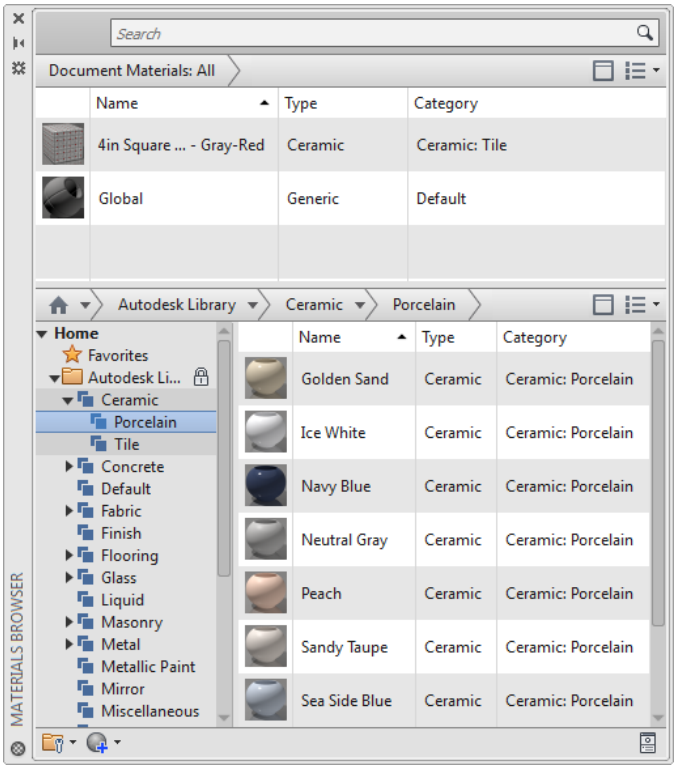
For lights that appear in the drawing as glyphs (point lights, spot lights, and web lights), when you select a light, AutoCAD displays grips. You can then use those grips to modify the light. For example, you can use the **Move** gizmo to change the location of the light. For targeted lights, you can use the **Target** grip to change where the light is shining. And for spotlights, you can use the **Falloff** and **Hotspot** grips to change the appearance of the light.



Working with Materials

Attaching realistic materials to objects in your model truly brings those objects to life. By attaching materials, you make the flat surfaces appear to be made out of real brick and mortar.

On the **Visualize** ribbon, in the **Materials** panel, you will find tools for adding realistic materials to your model. AutoCAD comes with a library of hundreds of predefined materials and textures. That library is shared by all Autodesk programs that support materials.



You can access all of the materials using the **Materials Browser**. This palette is divided into two main areas. The **Document Materials** area at the top shows the materials already loaded in the current drawing. This area will always include a **Global** material, which is the default material for all objects that have not yet been assigned a material. You can use filters to change the way the document materials are displayed. For example, you can display only those materials that are already applied to objects in the drawing or those that have not yet been applied. You can also change the way materials are displayed, such as in a list or thumbnail view; change how materials are sorted; and change the thumbnail size.

The **Library** in the lower portion of the palette shows the material libraries. By default, it includes the **Autodesk Library** and a **Favorites** library. You can also create and save your own custom material libraries. Libraries are organized into a hierarchical

structure based on categories, making it easy to drill down to find materials. You can also use the **Search** field to search for specific materials.

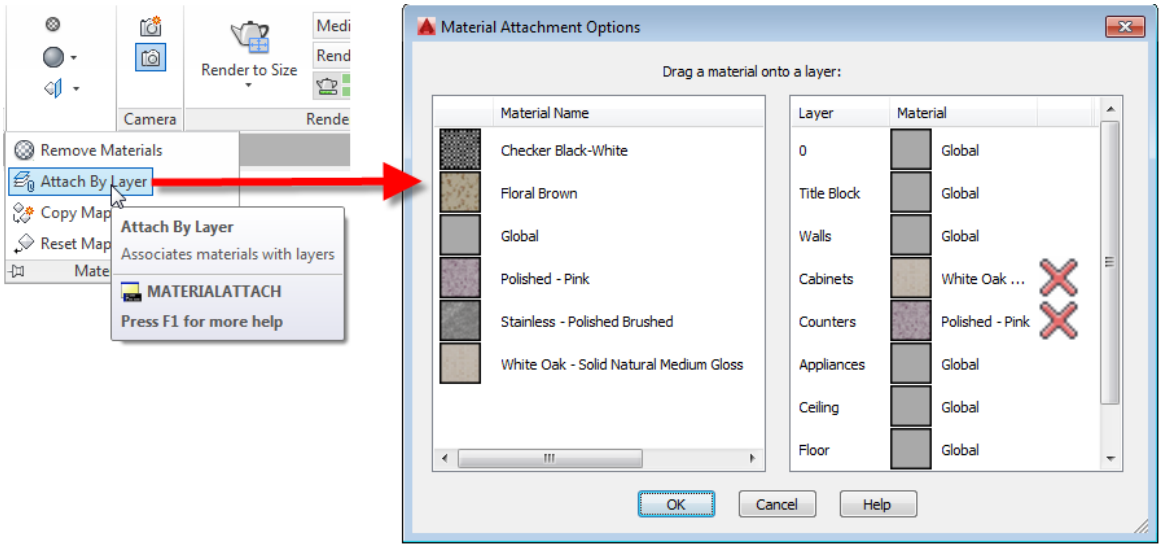
In order to use a material in a model, you must first add that material to your drawing. There are a number of ways to accomplish this. For example, you can locate a material in the library and drag and drop it onto an object in the drawing. This applies the material to the object and adds it to the **Document Materials** area. You can also drag and drop a material from the **Library** into the **Document Materials** area to add that material to the drawing without actually adding it to any objects in the drawing.

Note that the Autodesk Library is locked. You cannot edit any material in the Autodesk Library. But once a material has been added to the **Document Materials** area, you can modify that material. If you wish, you can then save that modified material to a user library so that you can use it again in other drawings. Tools at the bottom of the **Materials Browser** let you create, open, and edit user-defined libraries, create new materials within the current drawing, and open the **Materials Editor**.

Applying Materials to Objects and Faces

You can attach a material to an object, individual faces, or to all objects on a particular layer.

- To attach a material to an object, drag the material from the **Materials Browser** (either from the Document Materials or Libraries area) and drop it onto the object.
- To attach a material to an individual face, press **CTRL** while dragging the material from the **Materials Browser** onto the face of an object.
- To attach materials to objects by layer, expand the **Materials** panel and select the **Attach By Layer** tool to open the **Material Attachment Options** dialog.

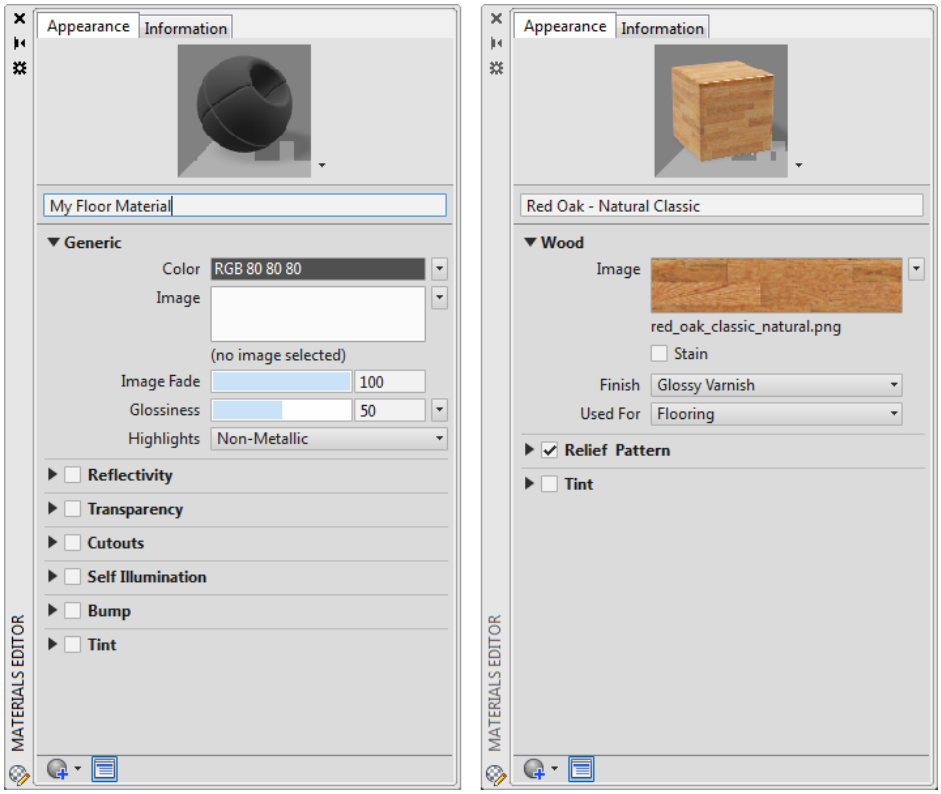


The left side of the dialog shows the materials available in the drawing. The list on the right shows the layers in the drawing. To attach a material to a layer, simply drag it from the list on the left and drop it onto the layer in the list on the right. The material is attached to all objects on the layer whose **Material** property is set to BYLAYER (the default). To remove a material from a layer, click the adjacent **Detach** button (the red X).

Creating and Modifying Materials

A material is defined by a number of properties. The available properties depend on the selected type of material. To create a new material, in the **Materials Browser**, click the **Create New Material** button. Be aware that the material you create will be added to the materials in the current drawing, not to a library.

When you create a new material, you can choose the type of material you want to create, or you can create a generic material. Any of the available choices will open the Materials Editor palette so that you can adjust the properties that define the material. The available properties depend on the selected type of material, whereas a generic material can include all of the properties.



The **Materials Editor** palette has two tabs. The **Appearance** tab contains the various property controls, whereas the **Information** tab lets you specify information about the material. The first thing you should do is to give the new material a name. You can then use the various options to refine your material. Generic material properties you can define include:

Color	specifies the color of the object
Image	controls the diffuse color map by assigning an image or a procedural texture
Image Fade	controls the composite between the base color and the diffuse image (only editable if an image is used)
Glossiness	defines the reflective quality as the degree of glossiness or dullness
Highlights	controls the means for deriving specular highlights (metallic or non-metallic)

You can also toggle on and then control other properties to create specific effects. Additional properties are available, depending on the type of material:

Reflectivity	simulates a scene reflected on the surface of a shiny object
Transparency	controls the transparency of the material (1 = transparent; 0 = opaque)
Cutouts	uses a map to create a perforation effect
Self Illumination	makes portions of the object appear to glow
Bump	uses a map to make an object appear to have a bumpy or irregular surface
Tint	sets the hue and saturation value of the color mixed with white

Rather than create a new material, you may simply want to modify one of the available materials. Once a material has been added to the drawing, you can double-click the material in the Document Materials portion of the Materials Browser to open that material in the Materials Editor and then modify any of its properties. For materials that use an image map, you can double-click the Image in the Materials Editor to open the Texture Editor and then modify any of the properties of the image map.

Using Image Texture Maps

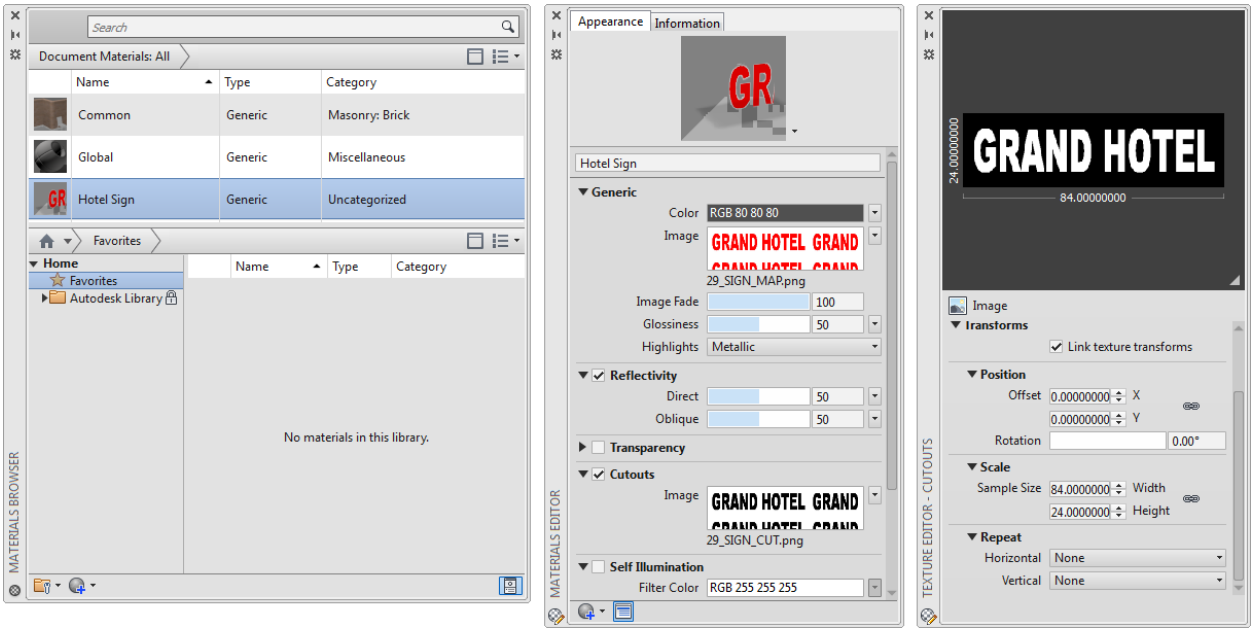
An image assigned to create the appearance of a material is called an *image texture*. For example, a brick material will typically have an image of the bricks assigned as its image texture map. AutoCAD comes with a library of images that you can use with textures. You can also add your own textures using most common raster image formats, including BMP, GIF, JPEG, PCX, PNG, TGA, and TIFF.

Maps can also be used to achieve other effects, and you can use more than one map for the same material. For example, you can use an image map to create the appearance of brick and add a bump map to make the surface of the bricks appear uneven and the mortar joints to appear recessed. You can also use a cutout map to make portions of an image disappear, creating a perforation effect. Here is an example of how you can use maps to create a material that looks like individual raised letters for a sign.

First, create two images of the letters. The first one, using the actual color of the letters, will be the image map. The second, showing the same letters but with the letters in black against a white background, will be the cutout map. The black areas will appear solid and the white areas transparent.

In the **Materials Browser**, create a new Generic material named "**Hotel Sign**". In the **Generic** area, click the **Image** field. The program displays a file open dialog. Select the first image as the image texture map and click **Open**. AutoCAD immediately displays the **Texture Editor** and you can see the red letters that say "GRAND HOTEL." Before adjusting the image map, select the **Cutouts** checkbox. As soon as you do, you again see a file open dialog. Select the cutout map image and click **Open**.

Now you are ready to adjust the sample size. In the **Texture Editor**, in the **Transforms** area, select the **Link texture transforms** checkbox so that any changes you make to one image map are automatically applied to the other. Then, in the **Scale** area, unlock the aspect ratio so that you can adjust the sample size width and height values separately. Then, set the **Width** to **84** and the **Height** to **24**. These values match the size of the solid onto which the sign material will be mapped.

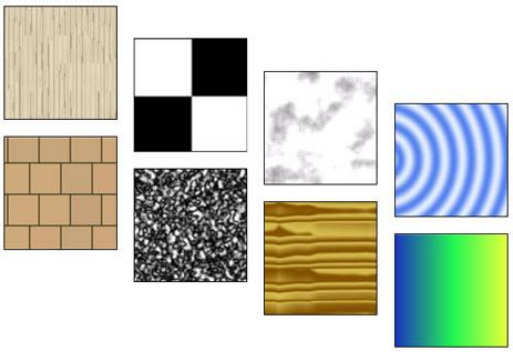


Next, in the **Repeat** area, you need to change the way the material is mapped. Typically, materials such as brick need to repeat to fill the entire surface of the object onto which they are applied. But in this case, you only want one instance of the sign, so change both the **Horizontal** and **Vertical** settings to **None**. Make a few more adjustments. In the **Materials Editor**, in the **Generic** area, expand the **Highlights** drop-down and choose **Metallic** so that the letters appear to be made of a metallic material. Also select the **Reflectivity** checkbox so that the letters appear a bit reflective as well.

Finally, in the **Materials** Browser, all you need to do is drag and drop the new **Hotel Sign** material onto an object. As soon as you do, the sign appears in the model, and looks as if the individual letters attached to the brick wall.

Using Procedural Texture Maps

Procedural texture maps add further realism to a material. AutoCAD includes a number of procedural texture maps, including checker, gradient, marble, noise, speckle, tiles, waves, and wood.

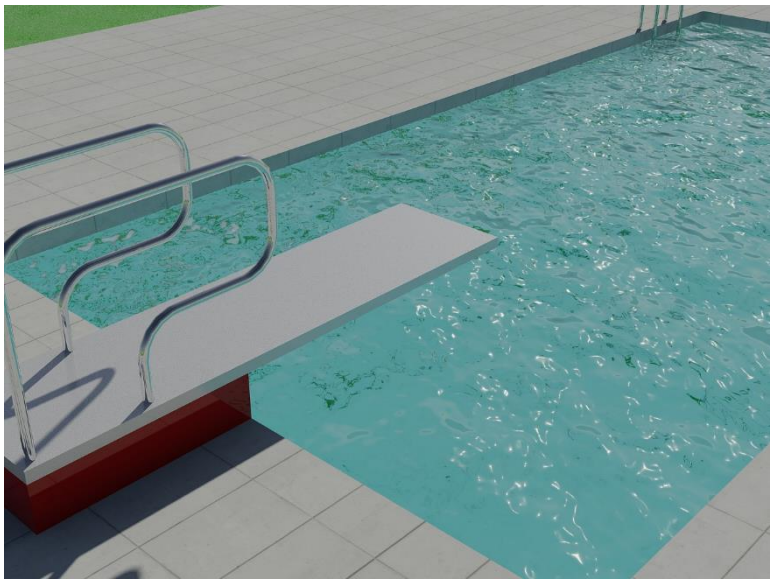


Unlike image texture maps, which use bitmap images, a procedural map is generated by a mathematical algorithm. As a result, the types of controls vary depending on the capabilities of the particular procedural map. Procedural maps can be generated in two or three dimensions, and you can nest them to add depth and complexity to the material.

For example, you could use a procedural map to create a material representing water in a swimming pool. But remember, before you create a totally new custom material, check the Autodesk Library to see

if there is an existing material you can use or modify to achieve the desired appearance. It is usually easier to modify an existing material than to create a new material from scratch.

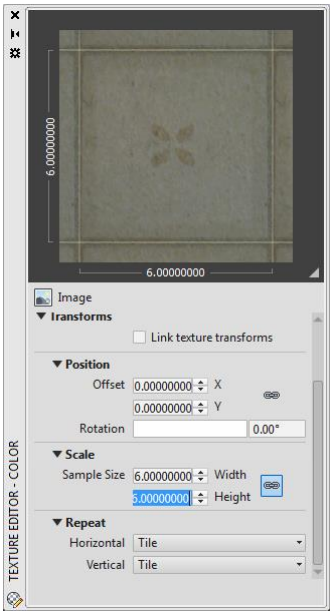
AutoCAD does indeed include several water materials, including one that represents a swimming pool. You can even adjust the height of the waves in the pool. Just remember that in order for the water in the pool to look realistic, you must enable sky illumination so that the scene is lit by both direct sunlight and the atmosphere, otherwise the water in the pool will look like ink.



Using Your Own Bitmap Image Texture Maps

If you find that the Autodesk Library does not include a material that closely matches what you need, you can create your own custom materials by first scanning or photographing the actual material and saving its image using one of the supported raster image formats.

After capturing the image, load it into a paint program and isolate a portion of the image so that the material will tile properly without obvious seams. You should also adjust the size of the image so that it matches its real-world units. Then, save that image. You can then use that image as the basis for a new material.

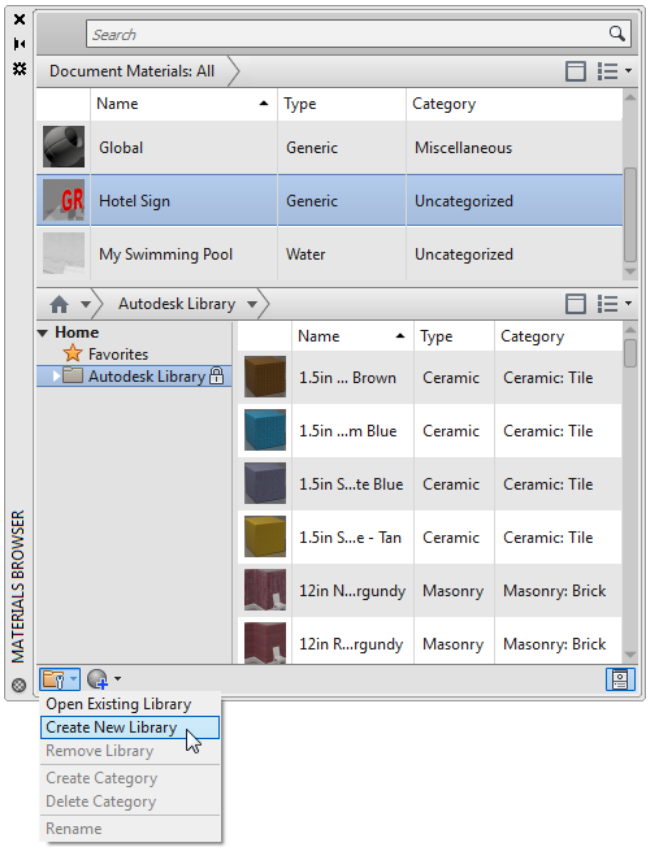


In AutoCAD, open the **Materials Browser**, create a new generic material, and assign it a name. Then, click in the **Image** panel, select the image of the material you just saved, and click **Open**. In the **Texture Editor**, you can make any other necessary adjustments.

The key to creating your own material is ensuring that the material is the correct size when it is applied to objects in your model. Also, make sure that the image will tile properly, without any unwanted seams, so that once it is applied to an object in the drawing, it appears as if it extends across the entire object to which it is applied.

Saving Materials to a User Library

When you create a new material or modify a material, the material only exists within the drawing in which it was created or modified. Materials in the AutoCAD Library are locked—you cannot make changes to the materials library that comes with AutoCAD. Therefore, in order to use your custom materials in other drawings, you must save them to a user library.



To add a material to the Favorites library, right-click the material in the **Document Materials** list and then choose **Add To > Favorites**. Note that at this point, you could also add the material to the current active tool palette.

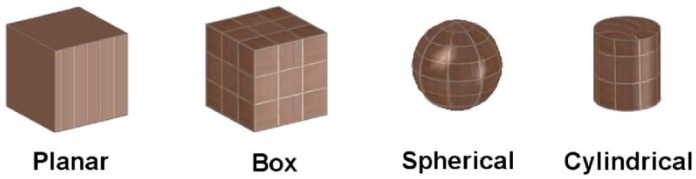
You can also create additional user libraries. Click the button in the lower-left corner of the **Materials Browser** and choose **Create New Library**. The program displays the **Create Library** dialog. Navigate to the folder in which you want to save the new library file, enter a name, and click **Save**. As soon as you do, the new library appears in the library list and is the current library. Now you can add any custom materials to your new library.

Once you have added materials to a user library, you can use tools in the Materials Browser to create categories so that you can organize your custom materials.

If you no longer need to see a user library, you can select it and then choose **Remove Library** to remove it from the list of open libraries. The library still exists, but no longer appears in the list of libraries. To open it again, expand the tool and choose **Open Existing Library…**, locate the library, and click **Open**. To delete the actual library file, use Windows Explorer to delete the .adsklib file.

Adjusting Material Mapping

After you apply a texture to a material, you can adjust the orientation of the texture to fit the shape. Mapping adjustments reduce inappropriate pattern distortion. There are four possible mappings:

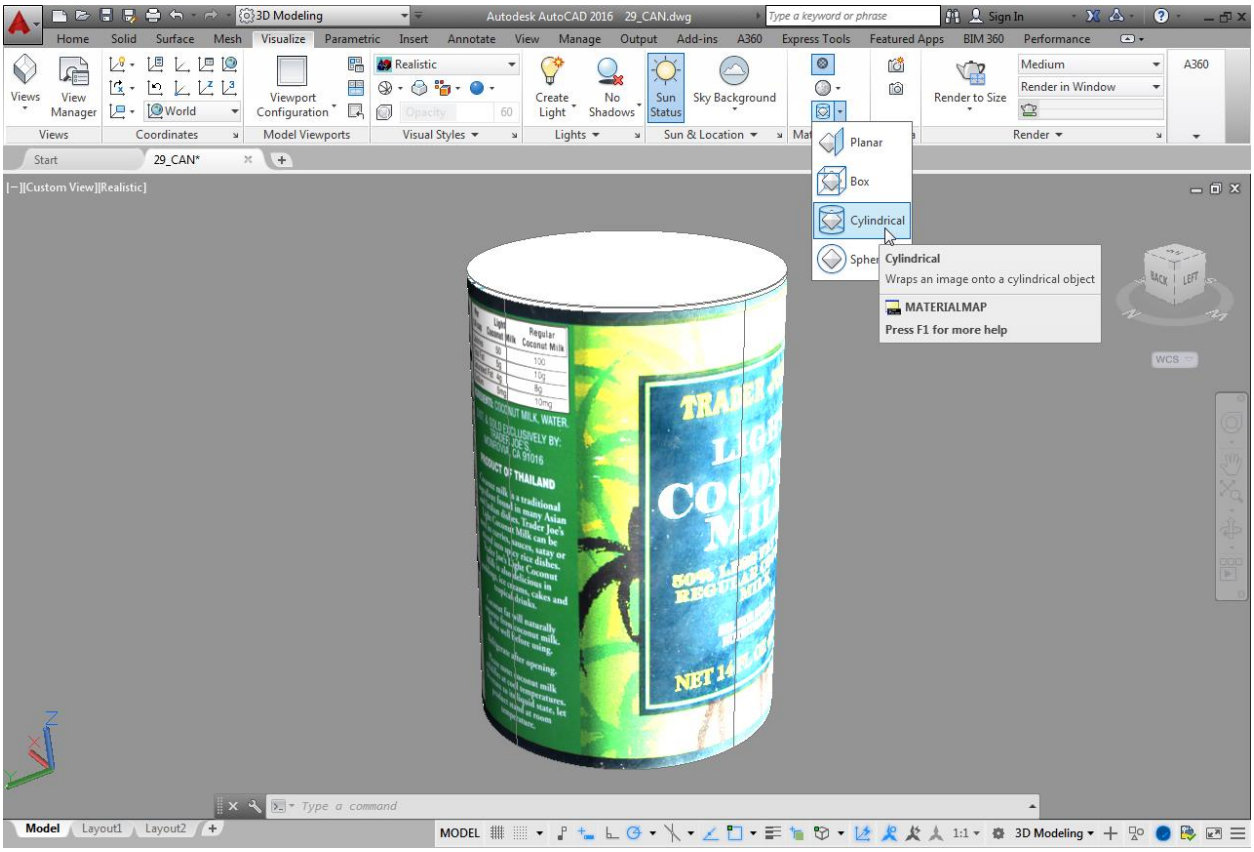


- **Planar** maps the image onto the object as if was projected from a slide projector onto a flat plane. The image is not distorted, but the image is scaled to fit the object. This mapping is most commonly used for faces.
- **Box** maps an image onto a boxlike solid. The image is repeated on each side of the box.

- **Spherical** wraps the image both horizontally and vertically. The top and bottom edges of the bitmap are compressed to points at the north and south poles of the sphere.
- **Cylindrical** maps the image onto a cylindrical object so that the bitmap's horizontal edges are wrapped around the object. The height of the image is scaled along the cylinder's axis.

Suppose you are creating a rendering in which you need an image of a can of coconut milk. To prepare for this, you have removed the label from an actual can, scanned it, and saved the image as a raster image file. You can then create a new material using that image as an image texture map. In the drawing, you create a cylinder to represent the can and apply the new material to that cylinder. When you do, however, even after adjusting the image texture map so that it is the proper size and is not tiled, it still does not look right because the label is not properly wrapped around the cylinder.

To fix this, in the **Materials** panel, expand the **Material Mapping** split button and choose **Cylindrical**. Then, select the cylinder representing the can and complete the command. The label now wraps properly around the can.



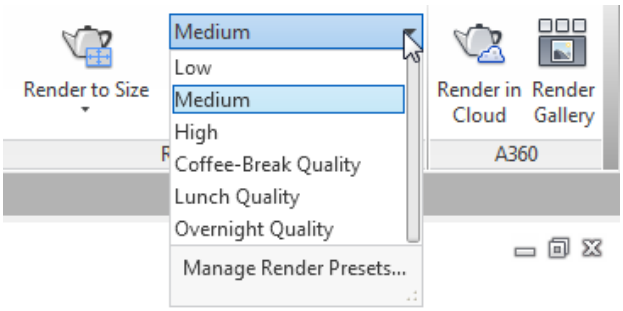
You can also use material mapping to move or rotate materials that have already been applied to objects. For example, to change the orientation of a wood plank floor, rather than changing the rotation of the texture map within the material definition, you can choose **Material Mapping > Planar**, select the floor object, and then rotate the material that has been applied to that object.

Creating a Rendering

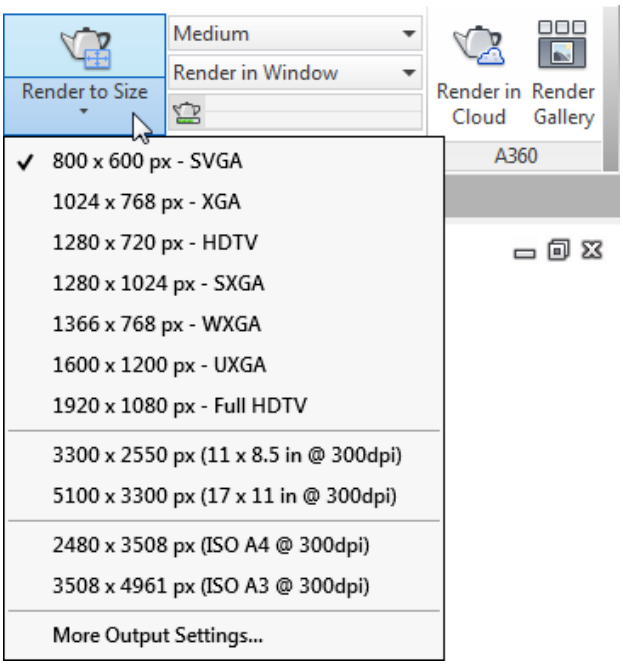
Once you have built a model, attached materials to objects in the model, and added lights to illuminate the scene, you are ready to create a rendering.

Creating a rendering in AutoCAD can be quite simple. Most of the tools you need to actually produce the rendering are located on the **Visualize** ribbon in the **Render** panel. For example, you can simply click **Render to Size**.

Before you do, however, you may want to select an appropriate render preset and select the render size. Expand the **Render Presets** split button. A render preset is a collection of rendering settings. A drawing can contain two types of render presets: standard and custom. AutoCAD comes with six standard render presets: Low, Medium, High, Coffee-Break Quality, Lunch Quality, and Overnight Quality. Each applies a specific set of rendering settings. Standard render presets cannot be modified, but are available in each opened drawing. Custom render presets can be modified and removed from a drawing, but are available only in the drawing in which they were defined. Any custom render presets appear near the top of the drop-down, and standard render presets are listed near the bottom.



Expand the **Render to Size** button. Here, you can see a list of predefined render sizes. Again, AutoCAD comes with a number of predefined render sizes, but you can define a unique output size if you wish.

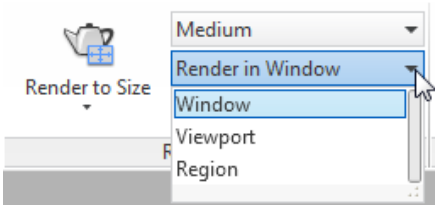


Other controls enable you to select where and how the rendered image is displayed, view the render progress bar, control the render environment and exposure, and create and manage render presets.

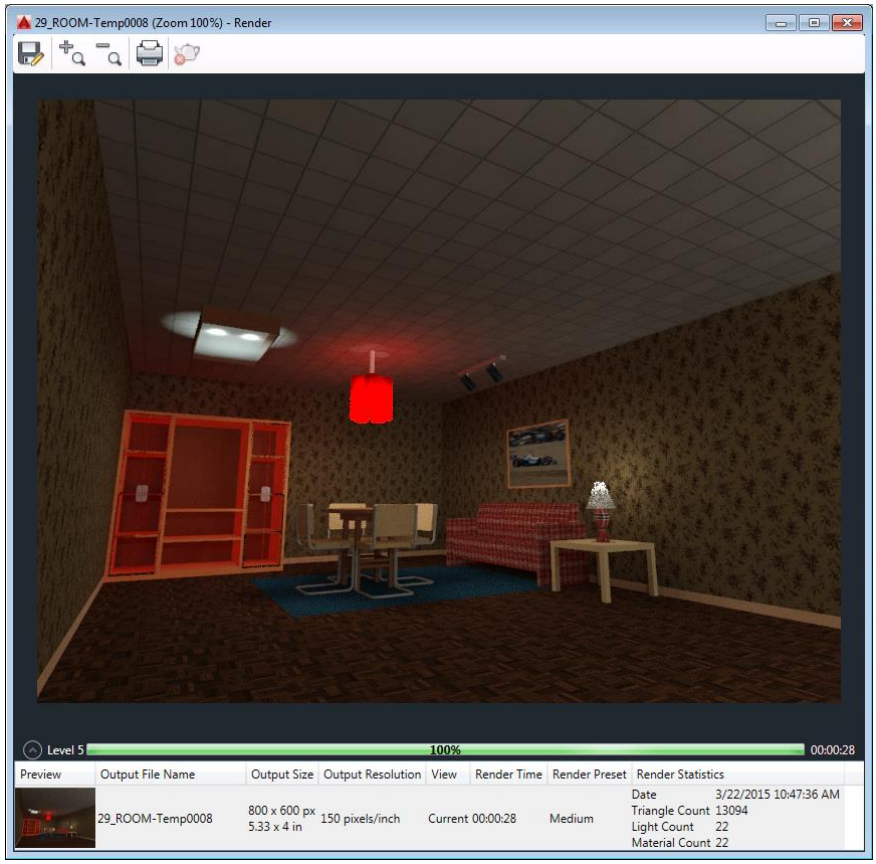
Setting the Render Destination

When you create a rendering in AutoCAD, that rendering typically appears in the Render window, but you can also render the entire current view or a region of that view within the current viewport.

To render to the Render window, on the **Visualize** ribbon, in the **Render** panel, expand the **Render In** split button and choose **Window** if it is not already selected. Then, after selecting the render preset and render size, click **Render to Size**.



The Render window opens and the program begins to render the scene. In the Image pane, you can see the rendering as it progresses, and a progress bar at the bottom of the pane shows you the progress. To stop the rendering, in the **Render** window, you can click the **Cancel rendering** button. When you render to the Render window, you can easily save the image to a file using tools in the Render window. In addition, you can select any rendering in the History and Statistics pane at the bottom of the Render window to redisplay that image or save it to a file.



To render the entire view within the current viewport, on the **Visualize** ribbon, in the **Render** panel, expand the **Render In** split button and choose **Viewport**. Then, click the **Render to Size** button. The program immediately begins to render the scene in the current viewport. You can see the rendering as it progresses, and the progress bar in the ribbon displays the progress. When the rendering is complete, you see a message to that effect in the command line. Note that when rendering in the viewport, you cannot select the render size. The resolution is determined by the size of the viewport. When you render in the viewport, you can use the SAVEIMG command to save a copy of the displayed image to an image file. Once the image in the viewport changes, however, you can no longer save the rendered image.

You can also render a selected region within the current viewport. To do this, expand the **Render In** split button and choose **Region**. Then click **Render to Size**. The program prompts you to pick a crop window to render. Click to select the opposite corners of a rectangle. As soon as you do, the program immediately begins to render the area defined by the rectangle. The same rules that apply when rendering in the viewport also apply when rendering a selected region.

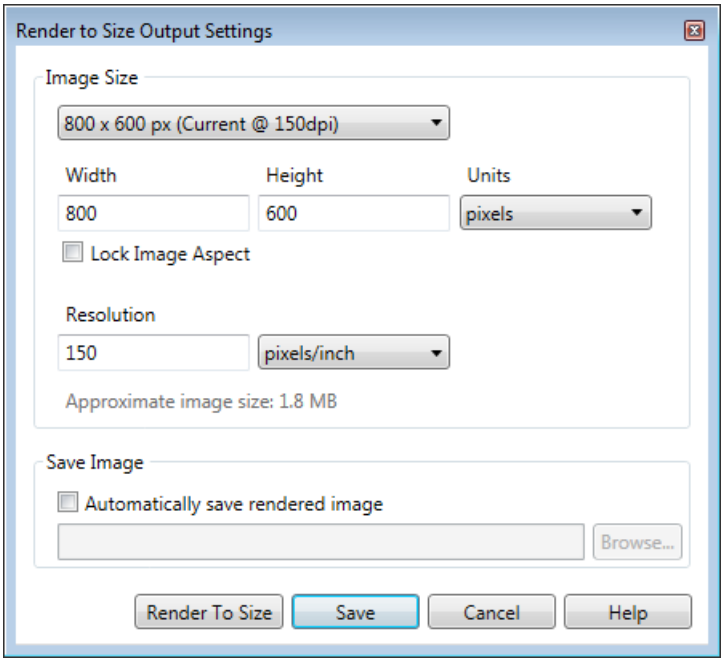
Setting the Render Output Resolution

You can control the resolution of the rendered image by specifying the width and height of the image, measured in *pixels***,** or picture elements. A pixel is a single point in a raster image. The default output resolution is 800 by 600 and can be set as high as 12,000 x 12,000 pixels. Higher resolution settings result in smaller pixels and finer detail, but also increase the time it takes to generate a rendered image and the size of the image file.

When you expand the **Render to Size** drop-down, you can see a list of predefined resolutions as well as any custom resolutions that may have already been established. Custom resolutions are saved with the current drawing and appear near the top of the drop-down.

To specify a custom render output size, select **More Output Settings…** to open the **Render to Size Output Settings** dialog. After specifying the Width and Height values, if you select **Lock Aspect Ratio**, the Width and Height values are locked relative to each other. Changing one then also changes the other to maintain the same aspect ratio.

The **Resolution** value specifies the number of pixels per inch or per centimeter for the rendered image. Resolution is often referred to as DPI, or dots per inch. A large value increases the size of the resulting file, but can improve the quality of the image if printed at a size larger than its original rendered size.



In the **Width** and **Height** fields, you can specify custom width and height resolution values. You can also specify the units of measurement for these values. They are typically measured in pixels, but they can also be specified in inches or centimeters.

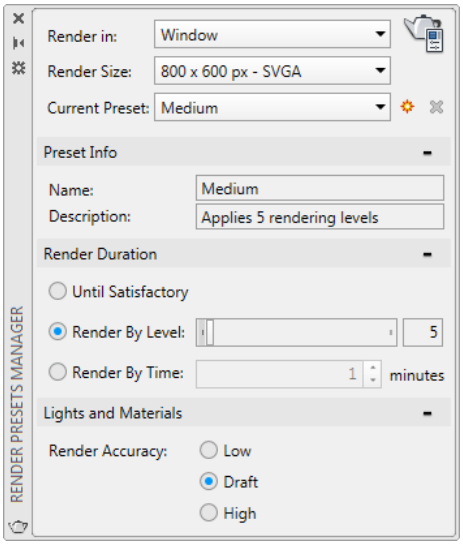
The *aspect ratio* describes the proportions of the rendered image, expressed as the ratio of width to height, regardless of the resolution of the image. The aspect ratio is usually expressed as either a ratio of width over height (such as 4:3) or as a multiplier (such as 1.333). For example, an image with a resolution of 800x600 has an aspect ratio of 4:3, because the image is 4 pixels in width for every 3 pixels of height.

Creating Render Presets

A render preset is a collection of rendering settings. A drawing can contain two types of render presets: standard and custom. AutoCAD comes with six standard render presets. Each applies a specific set of rendering settings. Standard render presets cannot be modified, but are available in each opened drawing. Custom render presets can be modified and removed from a drawing, but are available only in the drawing in which they were defined. If you create and save custom render presets in a template file, however, those custom presets will be available in any drawing you create based on that template.

When you expand the **Render Presets** split button, you can see a list of render presets. Any custom render presets appear near the top of the drop-down, and standard render presets are listed near the bottom.

When you pause the cursor over a preset, a tooltip displays information about that preset. For example, when you hover over the **Low** preset, the tooltip indicates that this preset applies 1 rendering level. And when you hover over the **Lunch Quality** preset, the tooltip indicates that the program will render for 60 minutes.



To define a custom preset, click **Manage Render Presets…** to open the **Render Presets Manager** palette. Note that you can also toggle the display of this palette by clicking the **Render Presets Manager** dialog box launcher on the **Render** panel.

You can use the controls in this palette to specify primary settings and even start a rendering by clicking the **Render** button in the upper-right.

When creating a custom preset, you can specify a name and description.

Under **Render Duration**, you can specify the length of time or number of levels the renderer iterates to create the rendering:

- **Until Satisfactory** renders until you cancel the rendering process.
- **Render By Level** lets you specify the number of levels, or iterations, the rendering engine performs to create the rendered image.
- **Render By Time** lets you specify the number of minutes the rendering engine uses to iteratively refine the rendered image.

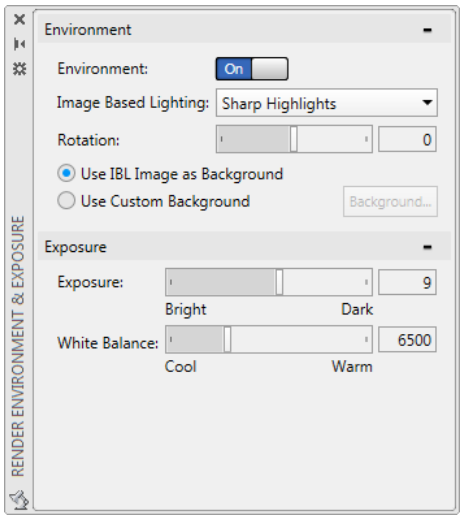
Under **Lights and Materials**, you can control the accuracy of the lighting and material calculations used for the rendered image:

- **Low** uses a simplified lighting model and produces the fastest and least realistic rendering. Global illumination, reflection, and refraction are turned off.
- **Draft** uses a basic lighting model and provides a balance between performance and realism. Global illumination is turned on, while reflection and refraction are turned off.
- **High** uses the most advanced lighting model. Global illumination, reflection, and refraction are all turned on. Although slower, it produces the most realistic renderings.

Controlling the Rendering Environment

You can enhance a rendered image with environment effects such as image-based lighting (IBL) or by adding a bitmap image to a scene as a background.

Image-based lighting affects the lighting and shadows calculated by the renderer. Based on the image specified, it can adjust the brightness and contrast of the final rendered image. Optionally, the image map used for image-based lighting can be applied to the background of a scene when rendering.



To use image-based lighting and control the rendering environment, on the **Visualize** ribbon, expand the **Render** panel and click **Render Environment and Exposure** to open the **Render Environment & Exposure** palette. Initially, the Environment is Off. In order to use image-based lighting, this must be turned on. Under **Environment**, click to turn the **Environment** to **On**. As soon as you do, the other tools in the Environment area become active.

Expand the **Image Based Lighting** drop-down. There are five image maps that include backgrounds and six image maps that only apply lighting effects.

You can use the **Rotation** value to adjust the rotation of the image map, by either dragging the slider or by entering a rotation value. The IBL background image rotates in relation to the model.

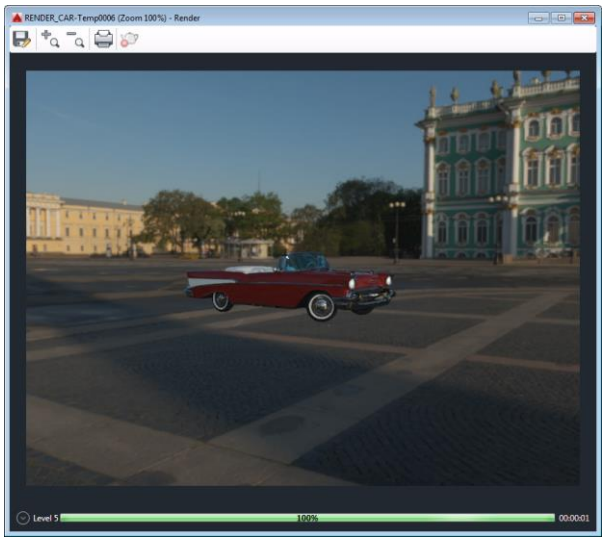
You can also control the background by choosing one of the two options:

- **Use IBL Image as Background** applies the IBL image to the background of the rendered image. This is a 360-degree image that will surround the scene.
- **Use Custom Background** lets you specify a solid color, a gradient, or a custom image file for use as the background of the rendered image. This results in a 2D image aligned perpendicular to the viewport of the rendered image.

Under **Exposure**, you can also adjust the Exposure and White Balance settings. These simply duplicate the controls that are available when you expand the Lights panel on the ribbon.

To render the scene using image-based lighting, select the render preset, destination, and image size as you normally would, and then render the scene.

To render using your own custom background, select **Use Custom Background** and then click the **Background…** button. You can then use a solid color, a gradient, or an image file.

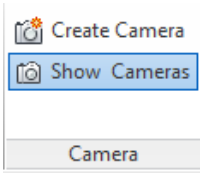


Working with Views

In addition to creating the model and adding lights and materials, an effective rendering also depends a great deal on what you see—and do not see—within the rendering. You can use any of AutoCAD's view manipulation tools—pan, zoom, orbit, and so on—to get your view set up just right. In order to get back to those views, you can save them as named views. And when working with named views, you can include a background image. (Remember that you can also include a background when using image-based lighting.)

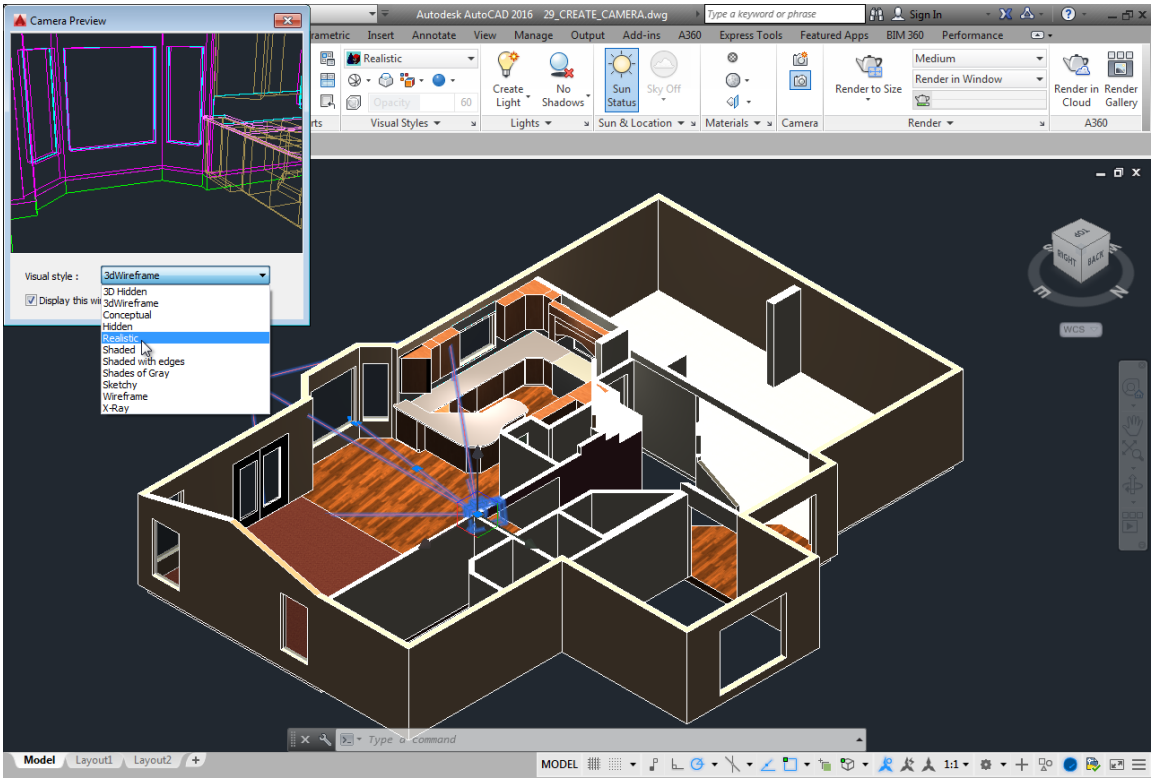
Placing Cameras and Creating Views

Sometimes it is difficult to use the pan, zoom, and orbit tools to set the precise view that you want to render. But there is actually a very simple and elegant solution to this. You can simply place a camera into your drawing so that you can see what the camera would see. Since most people have used a camera to take a picture, this metaphor works quite well.



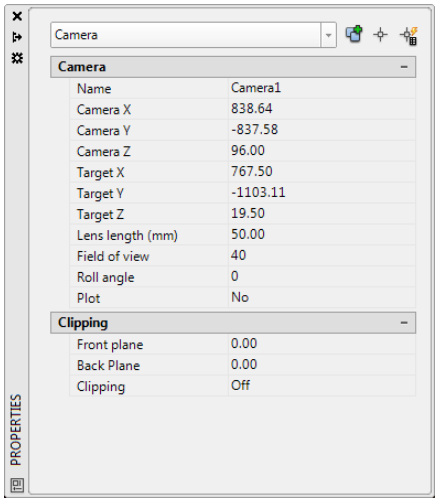
The **Camera** tool is located in the **Camera** panel on the **Visualize** ribbon. The camera panel contains only two tools: **Create Camera** and **Camera Display**. You use the **Create Camera** tool to create and place cameras into the drawing, and the **Camera Display** tool to toggle the visibility of camera glyphs on and off.

To place a camera into the model, click the **Camera** tool. As soon as you do, the program prompts you to specify the camera location, and you can see a camera glyph attached to the cursor. Place the camera and then locate the target point (it helps to use object snap). You can then give the camera a name, change its location, change its height, change the target, adjust its lens, and so on. Most users find that it is easier to simply accept all of the defaults and then make changes once you see the initial results.



After placing the camera, you can use the **Camera Display** tool in the ribbon to toggle the display of camera glyphs on and off. When you select a camera glyph, AutoCAD displays a **Camera Preview** window, showing the view seen by that camera. You can then expand the **Visual Style** drop-down and change the visual style used to display the camera view. If you click back in the drawing and move the camera or target location, that view immediately updates.

In the **Properties** palette, you can see and change any of the properties of the camera. For example, you could change its name, which will also change the name of the view. You can change the **Lens Length**, the focal length of the lens (measured in millimeters). Most people who have used a camera are at least somewhat familiar with this value. A 50mm lens is standard. A lens with a shorter focal length (smaller value) is a wide angle lens and a lens with a higher value is a zoom or telephoto lens.



As you change the **Lens Length**, the **Field of View** value also changes. A 35mm lens shows a 54-degree field of view. Although you could simply adjust the **Field of View** value or use the field of view grips in the model, most users who have ever done any photography generally find it easier to work with the **Lens Length**.

When you open the **View Manager**, you can see the new camera view in the list of model views. And if you select the view, you can use the controls in the **View Manager** dialog to adjust the properties associated with the view.

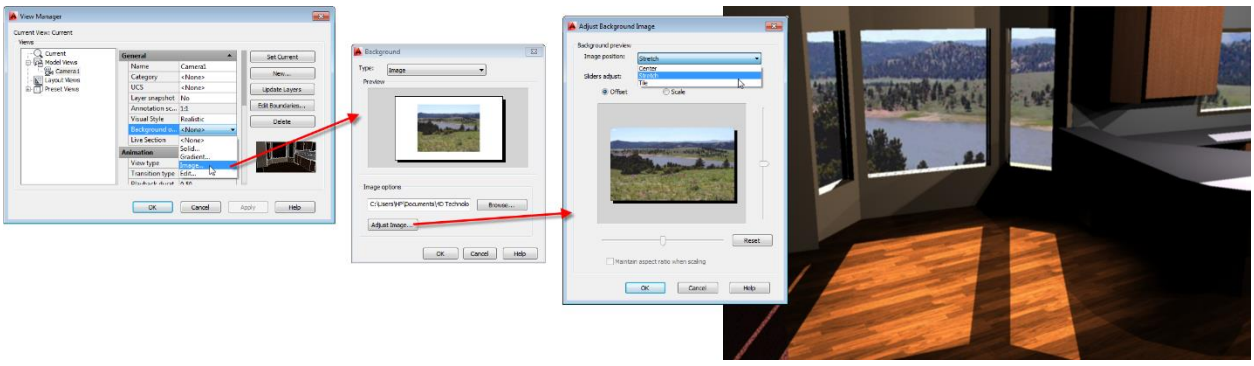
Adding a Background to a View

You can add a background to a named view so that the background appears whenever the view is restored. That background is also included whenever you render the view.

A background is basically a backdrop that displays behind your model. Backgrounds can be 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 does not change very much.

Backgrounds are controlled using the **View Manager** dialog, 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 landscape that would be visible through the windows of a room you have modeled, you could take a digital photo of what you would see through the window, and then associate that image with the view.



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

Saving and Redisplaying Rendered Images

Being able to see your images on screen is great, but you probably also want to be able to save a copy so that you can redisplay it again later, send a copy to a colleague, or print the image. The easiest way to do this is to first render to the Render window and then save the rendered image. You can actually create several renderings, compare the results, and then save the ones you want as a BMP, PCX, TGA, TIF, JPEG, or PNG raster image file.

To save a rendering that has been rendered to a viewport, you must use the SAVEIMG command.

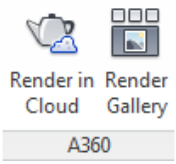
Rendering in the Cloud

When you render an image on your computer, you cannot do anything else in AutoCAD while the rendering is being calculated. If your model is relatively complex, contains a number of light sources, or is being rendered at a high resolution or high render quality, this means your computer may be unavailable for quite a while, even several hours. In the past, if you planned to do a great deal of rendering, you would probably want to invest in a computer with a very fast CPU with many processor cores and a very large memory. But that is no longer necessary.

Rather than rendering on your local computer, you can use the resources and services available with the Autodesk A360 account to render 3D models online. Rendering online provides a number of benefits:

- The results are often available much sooner.
- Rendering does not consume local processing power.
- Images can be organized in Autodesk A360 and do not require local disk space.
- Images can be shared securely with people to whom you grant access.

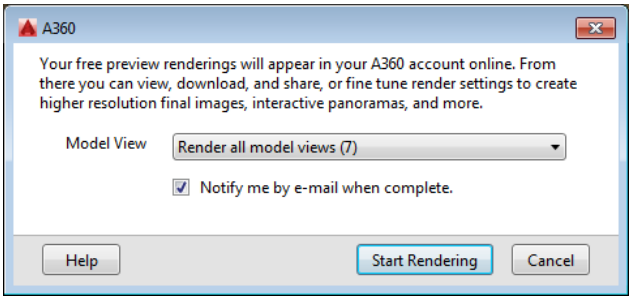
The online rendering service provides the greatest value for 3D models that use a great many materials, textures, or photometric lights. And a free render preview option is included to help reduce errors that would otherwise require you to re-render a scene.



Rendering online is really quite simple. On the **Visualize** ribbon, in the **A360** panel, click **Render in Cloud**.

If you are not already logged into your A360 account, the program will display a sign-in dialog. Once you sign in, if you have made any changes since you last saved the drawing, including simply changing the current view, the program will prompt you to save the drawing. Click **OK**.

Once the drawing has been saved, you will see a dialog informing you that your free preview rendering will appear in your A360 account online. From there, you can view, download, and share it, or fine-tune render settings to create higher resolution final images, interactive panoramas, and more. If the drawing contains multiple views, you can choose to render all of the model views, the current view, or one of the named views. By default, the **Notify me by e-mail when complete** checkbox is selected, so that you will be notified by e-mail when the renderings are complete.

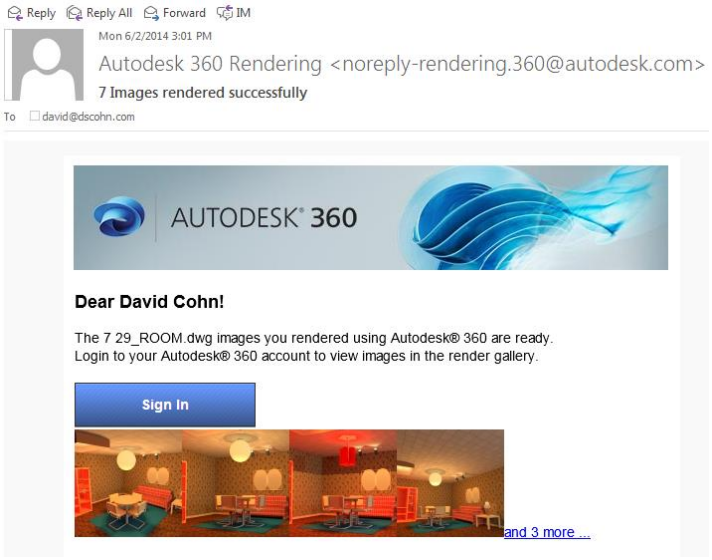


Click **Start Rendering**. A status dialog informs you that the rendering job is being prepared. You also

see a balloon notification at the top of the screen, below the InfoCenter toolbar.

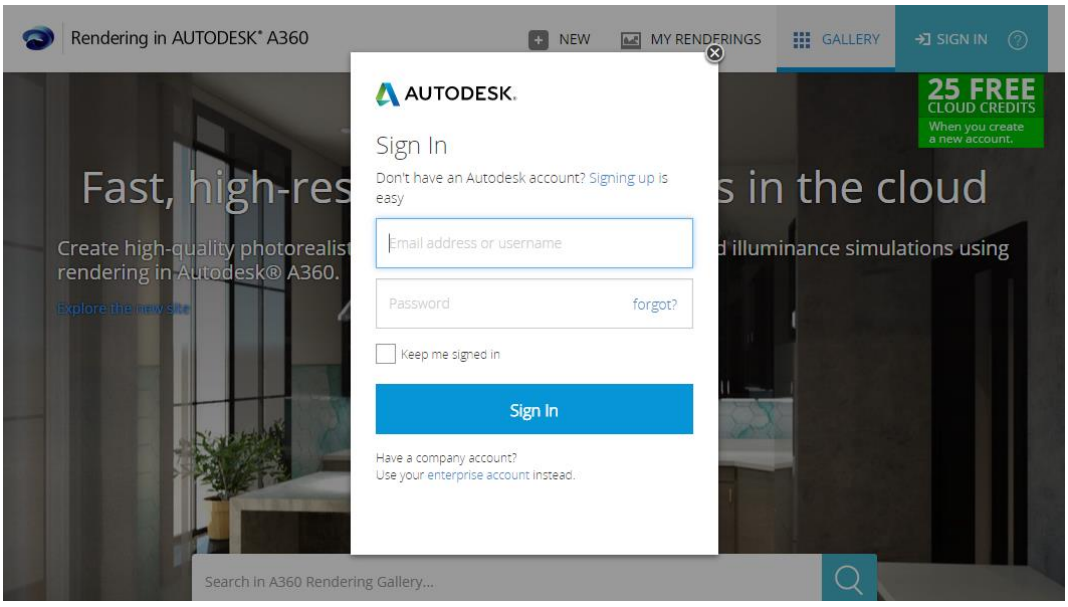
Once the renderings have been completed, you will receive an email informing you that the image or images you requested are ready.

You can click the link in the email message to open the Autodesk A360 Render Gallery in a web browser. Once you log in, you will be able to see a thumbnail image of the rendering. Click this thumbnail, and you can see the full version of the free preview rendering. You can also then use the other tools available in the Autodesk A360 Render Gallery.

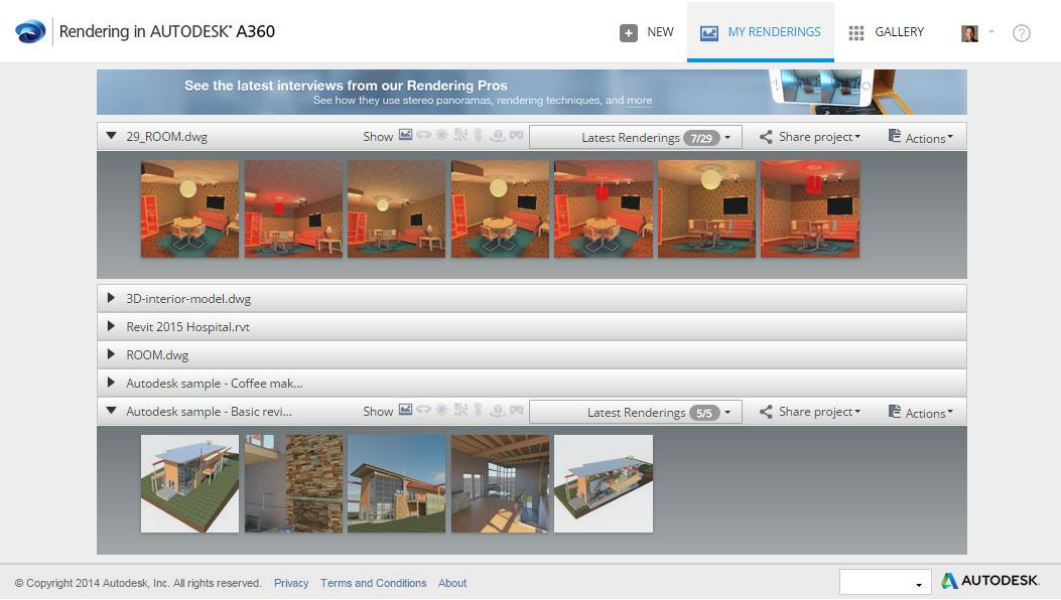


Understanding the Render Gallery

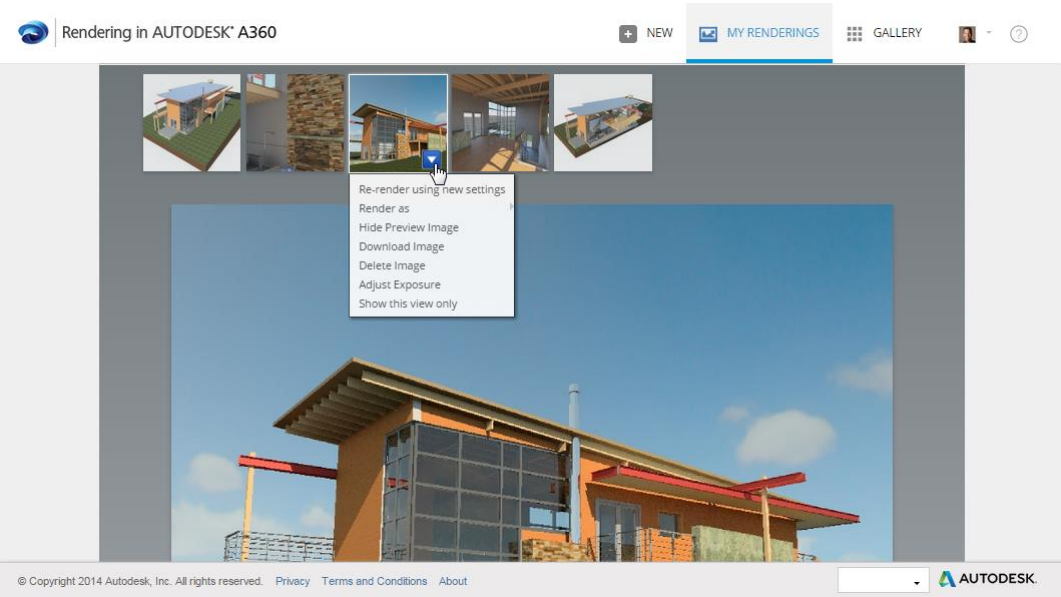
The Autodesk A360 Render Gallery is the interface to the service you can use to render 3D models online. You can access the A360 Render Gallery from within AutoCAD. On the **Visualize** ribbon, in the **A360** panel, click the **Render Gallery** tool to open the Autodesk A360 website.



Once you sign into your A360 account, you will see all of the renderings you have already created, arranged by drawing name. You can expand a drawing to see multiple images and click a thumbnail to view the full image.

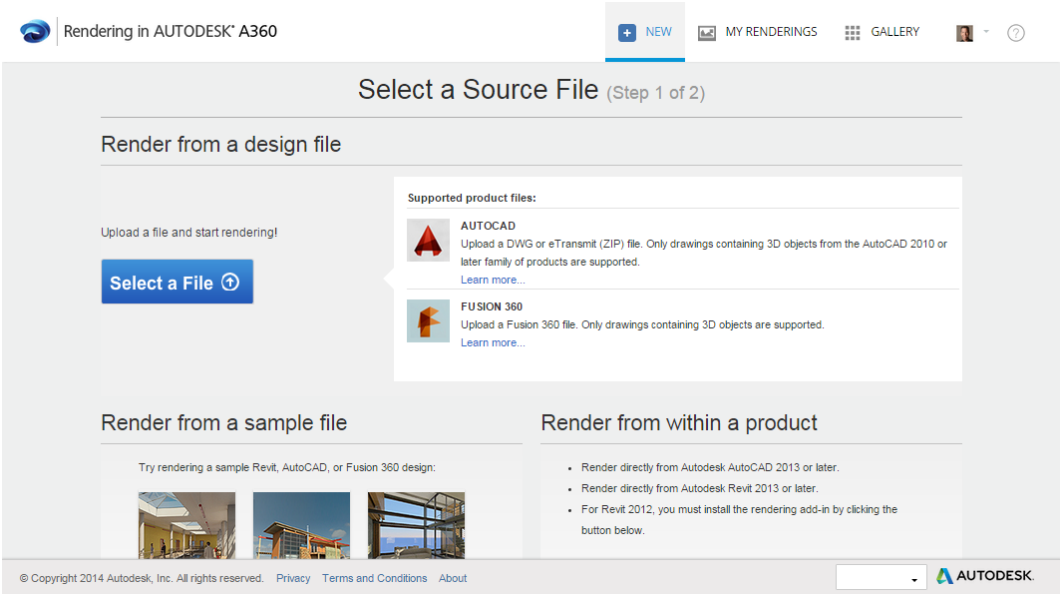


Other tools enable you to re-render the image using new settings, so you can render at higher quality, or with different backgrounds. You can also download the image, delete the image, adjust the exposure, and so on. One of the advanced features is the ability to render a project as a panoramic 360-degree image.

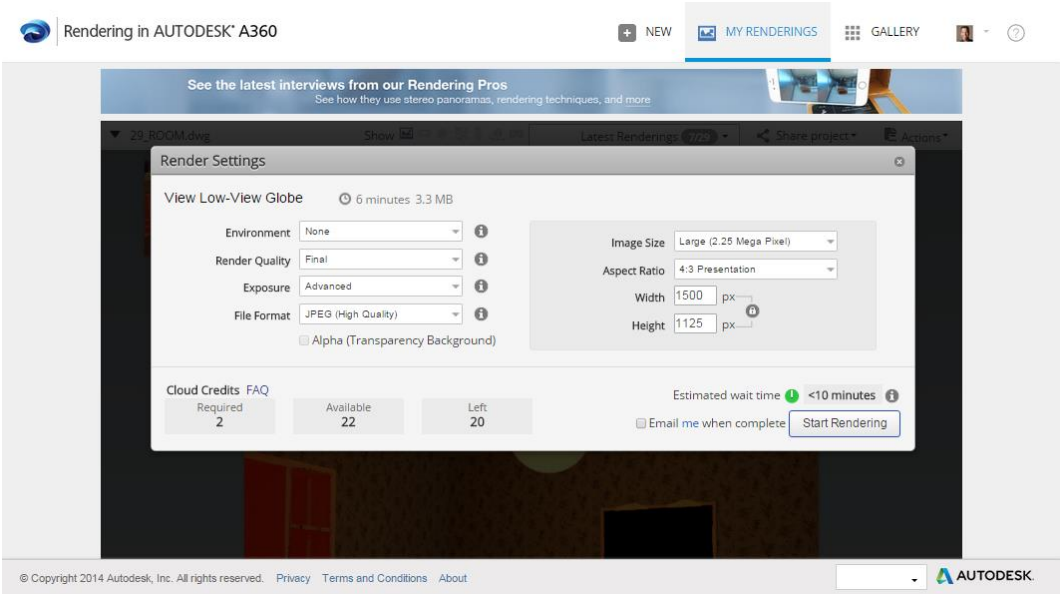


Note that you can also switch to the **New** tab. Here, you can upload a DWG or eTransmit ZIP file and render images of that file online. There are also several sample files that you can use to try out the rendering service.

You can also switch to the **Gallery** page to view renderings that have been shared by other users. Remember that your A360 account is free and comes with 5GB of online storage and 75 cloud credits that you can use to create renderings. If you are a subscription customer, you have even more storage and more cloud credits you can use.



When you use the online service to create a high-quality image, you will be able to adjust the render settings and see exactly how many cloud credits it will use, how many credits you currently have available, and the number of cloud credits that will remain after completing the rendering.

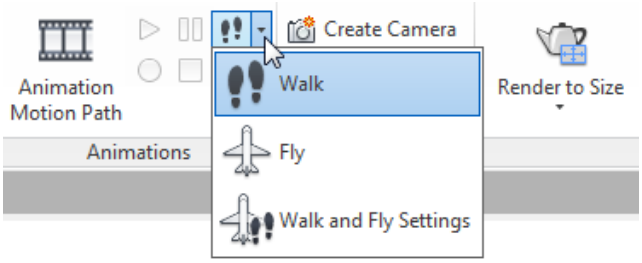


Creating Walkthroughs and Flythroughs

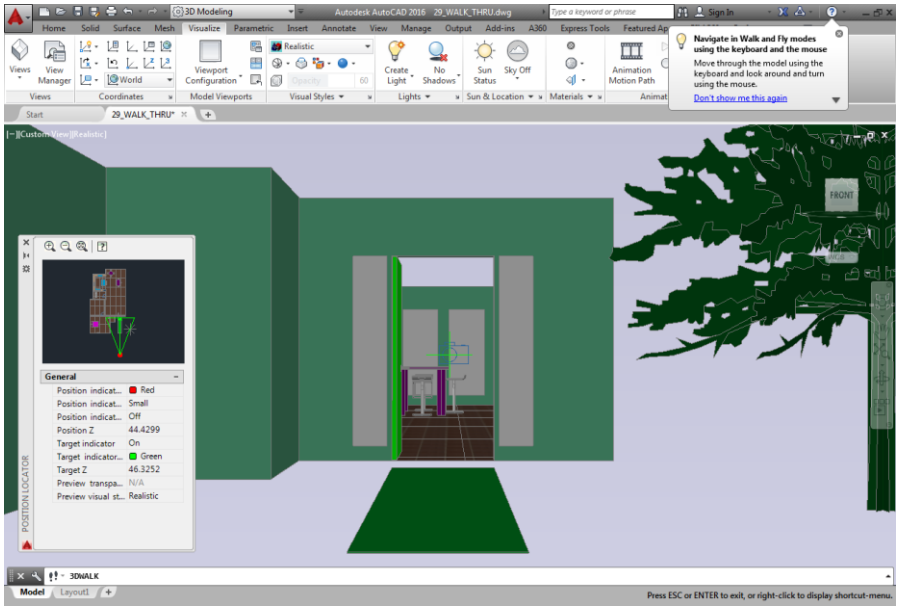
In addition to creating rendered still images, you can create animated walkthroughs and flythroughs of your AutoCAD models.

The tools for creating animations are located in the **Animations** panel on the **Visualize** ribbon. But by default, this panel is not initially visible, so you will need to turn it on. Right-click any panel in the ribbon and select **Show Panels > Animations**.

The Animations panel contains a number of tools. The **Walk** and **Fly** tools are quite similar. The only real difference is that when using the **Walk** tool, the viewpoint of the animation only moves along the XY-plane, whereas when using the **Fly** tool, the viewpoint can move in the Z-direction as well.

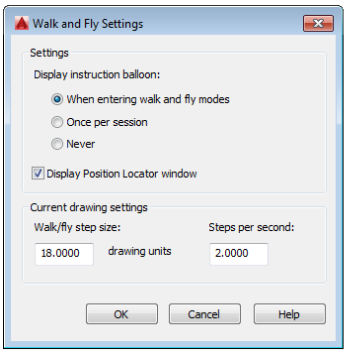


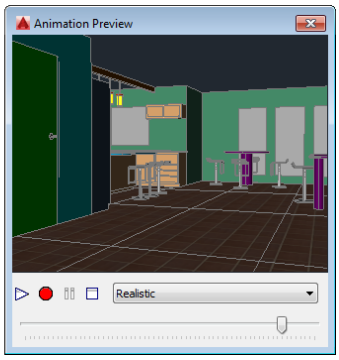
When you click the **Walk** tool, the walk mode is activated in the current viewport, and AutoCAD displays a **Position Locator** palette. By default, this palette shows your position in the drawing from a top view.



You may also see a balloon near the top of the screen, in the InfoCenter area, with information about how to move around when using the Walk tool. It explains that you can use on the keyboard to move within the viewport. You can use the **Up-Arrow** or **W** key to move forward, the **Left-Arrow** or **A** key to move left, the **Down-Arrow** or **S** key to move backwards, and the **Right-Arrow** or **D** key to move to the right. You can also drag the mouse to change the direction in which you are looking, or use tools in the Position Locator palette itself.

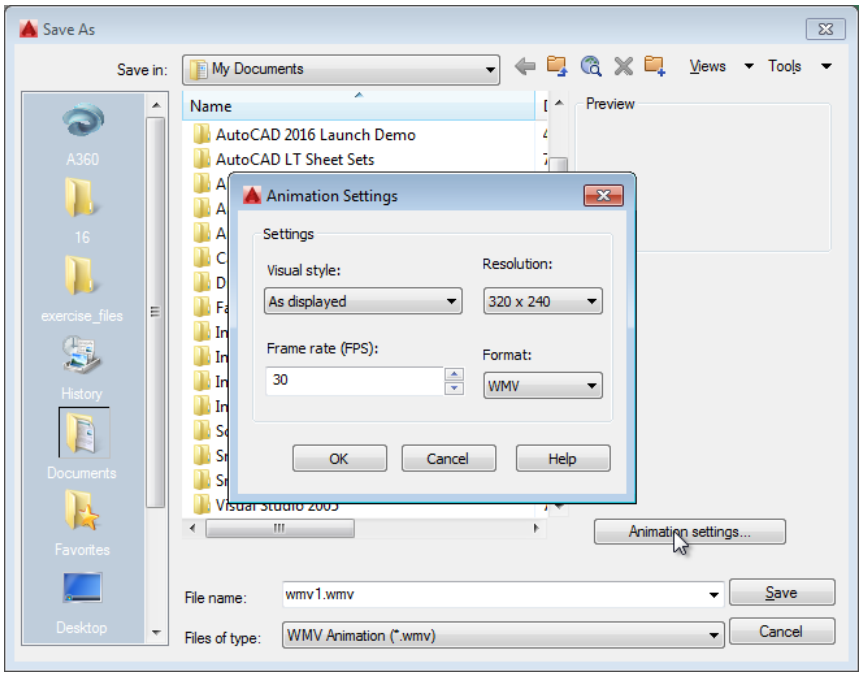
You can also use the controls in the **Walk and Fly Settings** dialog to adjust the walk and fly settings, such as the step size and the steps per second.





While walking into a model can be quite interesting, this tool is much more useful when you record your movements. If you click the **Record Animation** button in the **Animations** panel and then use the **Walk** or **Fly** tools to move around in the model, AutoCAD will record all of your movements. Once you have reached a stopping point, go back to the ribbon and click the **Play** button. The program opens an **Animation Preview** window and you immediately see the animation that was recorded. You can even change the visual style as the animation is playing.

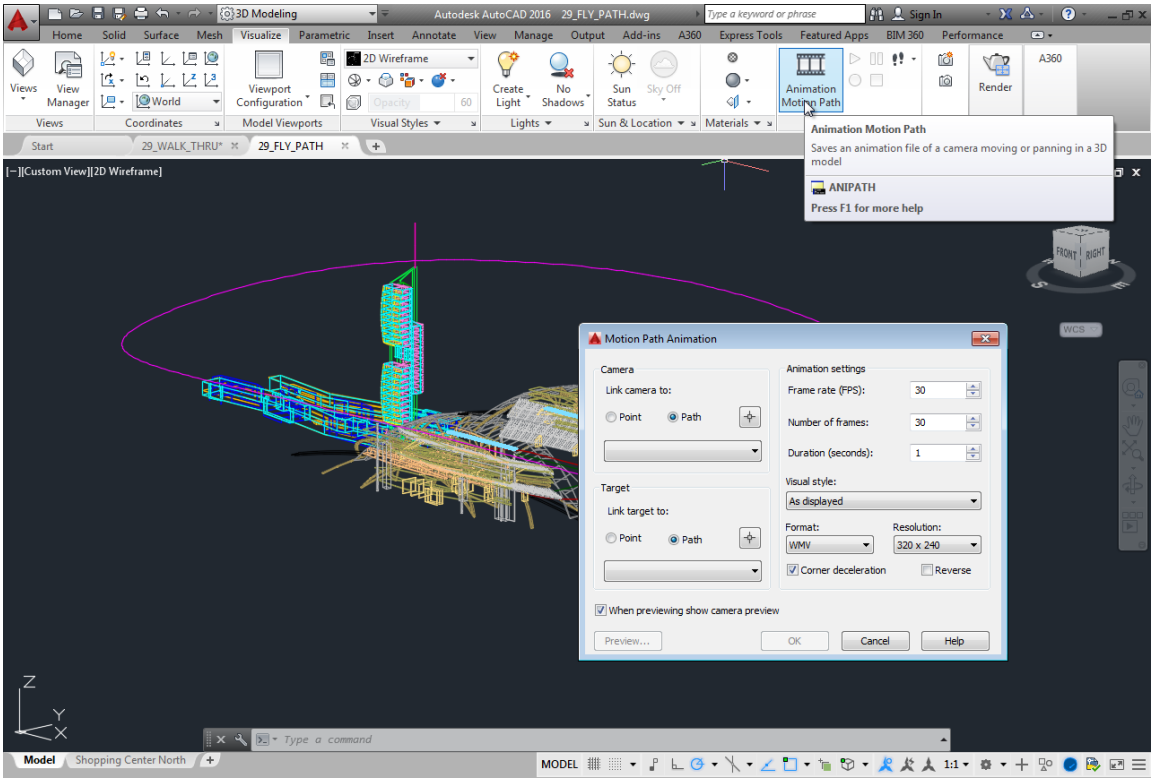
If you are satisfied with the animation, you can save it to a file. In the **Animation Preview** window, click the **Save** button. There is also a **Save** button in the **Animations** panel on the ribbon.



When you save an animation, AutoCAD displays a **Save As** dialog. Initially, the only file type available is WMV. But if you click the **Animation Settings** button, AutoCAD displays the **Animation Settings** dialog. Here, you have much more control over the resulting animation. For example, you can change the visual style to **Rendered** so that AutoCAD will render each frame of the animation using the selected render preset. In the **Resolution** drop-down, you can choose the resolution of the animation file. In the **Format** drop-down, you can choose the animation type as AVI, MOV, MPG, or WMV. And in the **Frame Rate** drop-down, you can specify the number of frames per second to create in the finished animation. Just remember that if you render each frame of your animation and use the standard frame rate of 30 frames per second, it could take quite a while to produce the animation file.

You can also create a walkthrough or flythrough using the **Animation Motion Path** tool, which is located in the **Animations** panel on the **Visualize ribbon**. This tool enables you to first define a path along which you want the camera to move, so that you can plan your movement in advance.

When you click this tool, AutoCAD displays a **Motion Path Animation** dialog. The controls in this dialog 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. You can click the **Preview** button to display a preview of the resulting animation. When you click **OK**, AutoCAD saves the animation to the specified file. Remember that depending on the settings you choose, it could take many hours to compute and save your finished animation.



Conclusion

That concludes this class on AutoCAD's Rendering tools. As you have seen, there are a wealth of tools available right inside AutoCAD that you can use to convert your 3D models into finished, photorealistic renderings and animations, complete with lights, materials, and textures.