Overview

Rendering is the process of generating an image by combining geometry, camera, texture, lighting and shading (also called materials) information using a computer program.

Before an image can be rendered Appearance Materials are applied to the various parts of your design to visualize how your design would look in the real word. Materials contain the visual properties of plastic, glass, metal, paint and wood (and pretty much anything else you can think of) to create photorealistic images.

Learning Objectives

In this section you will learn how to:

- Assign materials to your model
- Edit and replace materials
- Place decals on your model
- Change the environment settings and background color
- Change environment effects
- Render an image using the Real Time Ray Tracer
- Create images using the A360 Cloud Render feature
LAUNCH VIDEO for Applying and Editing Materials.

Open Fusion360 file and go to Render Workspace: In this section you will open the design file for the Utility Knife and go the Render workspace so that you can apply materials.

Step 1 – Open the Data Panel

1. Open the Data Panel by clicking on the icon located at the top left of the menu bar. The Data Panel will slide open.
Step 2 – Open the design

1. At the top right of the Data Panel, select the project from the project drop down list.
2. Double-click on the design called **07_Rendering_UtilityKnife** to open the design in Fusion 360.
3. When the design has opened in your modeling window, click on the icon to close the Data Panel.

Step 3 – Go to Render Workspace

1. Click on the Model icon in the left of the toolbar to view other available workspaces.
2. Select the **Render** workspace.

You may notice that the environment changes slightly, this happens because the environments you use for modeling are different than the environments that have been created specifically for rendering.

The Rendering workspace toolbar contains tools to **Setup** your render and to create a **Render**.

In the **Setup** section you have access to
- Appearance materials library to apply materials to your design
- Environment settings to change the background and how lights are cast on your design
- Decal tools for applying decals to your design

In the **Render** section you have access to
- Start/Stop a RRT Render
- Save an image of your design
Apply Materials

Now that the model is in the Rendering Workspace you can begin assigning appearance materials. There are two types of materials in Fusion360:

Physical Materials dictate what the object is made of and is used in mass calculations. In the absence of any appearance materials that have been applied to your design, you will see the default physical material. The default physical material can be changed in your preferences.

Appearance Materials dictate how the object will look when rendered.

Note: in absence of Appearance material the Physical material will be shown in the render.

Step 1 – Open Appearance tool

1. In the Render Workspace click on Setup > Appearance.
2. The Appearance dialog box opens.

Appearance dialog box has several sections to it:

Apply To – Allows you switch between applying materials to bodies/components or to individual faces

In This Design – Shows which materials have been assigned to parts of your design.

Library – In this section you can switch between the new Fusion 360 Appearance Library and your personal Favorites Library. It also contains the folders and sub-folders of materials broken down by common categories and example swatches of the materials.
Step 2 – Apply a Material directly to geometry

1. In the Appearance dialog box scroll down to Plastic > Opaque > Plastic – Glossy (Yellow).
2. Click and hold on the Plastic – Glossy (Yellow) swatch icon and drag it on to the main side body of the utility knife.
   a. The material on the part changes to Plastic – Glossy (Yellow).
3. Repeat these steps so that Plastic – Glossy (Yellow) is assigned to both sides of the utility knife.

In the Appearance dialog box you will notice that there is only one swatch for Plastic – Glossy (Yellow) even though that material has been assigned to two separate bodies. If you assign the same material to several bodies in your design and do not edit them they will be automatically linked to the one material. Editing the one material will affect all of the bodies that have that material assigned.

Step 4 – Apply a material to a body in the browser

1. In the browser locate the component called Grip 1:1.
2. Click the arrow to the left of Grip 1:1 to expand the contents of the component.
3. Click the arrow to the left of bodies to show the bodies that are assigned to that component.
4. In the Appearance dialog box scroll down to Other > Rubber > Rubber – Soft.
5. Click and hold on the Rubber – Soft swatch icon and drag it on to Grip 1:1 > Bodies > Body 1 in the browser.
   a. The material on the grip changes to Rubber – Soft.

To assign a material to all of the bodies in a component, drag the material to the top-level component in the browser.
Step 5 – Apply additional materials

1. Using the method of your choice apply the following materials to the parts listed
   - Plastic – Textured – Polka to Grip 2:1
   - Plastic – Translucent – Matte (Blue) to Blade Cradle:1
   - Metal - Stainless Steel – Satin to Blade:1

If you apply a material to a component and one or more of the bodies in the component already have a material applied you will be presented with an option to remove appearances applied to the bodies.

**Keep** - only the bodies you selected that didn’t already have a material applied will have the new material applied.

**Remove** – all of the existing applied materials will be replaced with the new material you applied to the component.
Editing Materials

**LAUNCH VIDEO** for Applying and Editing Materials.

Now that you have all the base materials applied to your design, you can customize the materials to look the way you want.

There are two levels of editing for materials. The basic or “lite” editor window enables you to quickly change:

- Change the name of the material
- Edit the color – either by dragging the color sliders or by entering an RGB value.
- Change the scale of the texture or bump map that is part of the material (if appropriate)
- Rotate the texture or bump map that part of the material (if appropriate)
- Go to Advanced options

The options in the advanced editor will differ depending on the material you are editing. The example below is for textured plastic.
**Texture Mapping** is a process in which a 2-D image called a *texture map* is wrapped around a 3-D object. In the physical world this is similar to applying wallpaper or veneer to a real object. The texture map can be used to change various properties of a material including the color of the material as is seen in the Wood materials, or the way highlights hit a surface as in the Rubber materials.

**Bump Mapping** is a technique for giving a 3-D surface the appearance of deformities and depth (e.g.: wrinkles or bumps). Although a surface that has a *bump map* applied will appear to have real depth, the surface of the underlying object is not actually changed. The textured plastic materials all use bump maps.

You can use the scale and rotate tools in the material editor to change size and orientation of the images that control the texture and bump results.

**Projection Mapping** is a method for placing one texture across several separate faces in order to give the illusion that it is one solid or continuous object. The texture map is applied to the projection type and “pushed through” the surfaces it projects on to. Fusion 360 has 4 projection types to choose from:

- **Planar**
  - The texture map is projected from a plane in a user defined direction

- **Box**
  - The texture map is applied to a cube that surrounds the object and creates 6 planar projections
Sphere

The texture map is applied to a sphere that surrounds the object. This projection type will show a poll pinch point depending on the axis defined by the user.

Cylindrical

The texture map is applied to a cylinder that surrounds the object.

To change the way the maps are projected on the surface right-click the body of the object in the browser and select **Texture Map Controls** from the drop down menu.
In this section you will swap out one material for another and change the parameters for several of the materials.

**Step 1 – Replace the Yellow Plastic Material**

1. In the Appearance dialog box locate **Plastic – Glossy (Red)**.
2. Drag the swatch from the library on to the swatch for **Plastic – Glossy (Yellow)** in the “In this design” section of the Appearance dialog box.

All the bodies that had Plastic – Glossy (Yellow) applied now have Plastic – Glossy (Red) applied. This is a quick method for swapping out materials in your design.

**Step 2 – Edit Plastic – Glossy (Red)**

1. Double click on the swatch for **Plastic – Glossy (Red)** in the “In this design” section of the Appearance dialog box to open the editor window for this material.
2. At the top of the dialog box is the current name assigned to the material – double click in the name field and change the name to **Plastic – Glossy (Orange)**
   a. This will make it easier to find the material later if required.
3. In the middle of the dialog box there is section that allows you to enter RBG values for a specific color.
4. Enter **240, 114, 14** to change the color of the plastic material to orange.
   a. You can also use the sliders to change the base color and the tone of the color.
5. Click the **Done** button.

You should now see the swatch for the edited material in the In This Design section of the
Appearance dialog box. If you hover over the swatch the modified name will appear.

If you want to see which materials have been applied to which bodies in your design you can right click on the swatch and select **Select Objects Applied** To from the drop down list. Doing so will highlight bodies in your design that have the selected material applied.

**Step 3 – Edit color and texture map for Plastic – Texture – Polka**

1. Change the name to **Textured – Polka - Blue**
2. Using the method of your choice change the color of Plastic – Textured – Polka to blue.
   a. If you wish to match the blue of the blade cradle enter the RGB values of 48, 59, 150
3. Change the scale of the texture map to 41.
   a. The slider can be used to interactive change the size of the texture map.
4. Move the slider next to Rotate to interactive change the orientation of the texture map. When you are satisfied with the orientation, click **Done**.

**Step 4 – Change the texture projection method for Grip 2:1**

**Texture Map Controls** are used to change the type of projection method used on the object with a texture map. Fusion 360 will automatically choose the best projection method when a material with a texture map is applied, if you are not satisfied with the look of the texture you can change the projection setting manually.

1. Close the **Appearance** dialog box by clicking on the **Close** button.
2. In the browser, locate the component
labeled Grip 2:1 and right-click on it.
3. Select Find in Window to bring the part in the center of the screen.
4. Zoom in further so that you can clearly see the texture map on the surface.
5. Right-click on component Grip 2:1 and select Texture Map Controls from the dropdown menu to open the Texture Map Controls dialog box.
6. In the dialog box, change the Projection Type to Box
7. Click OK to accept the change.

Try selecting the other projection types to see the different results. In some cases you may have to choose an axis for a projection direction. In those instances an axis widget will appear, simply click on the axis that best matches the direction you would like to project.

Step 5 – Edit and duplicate a material

1. In the browser locate the component labeled Blade:1
2. Right-click on Blade:1 and select Isolate from the drop down menu list.
   a. All of the other components disappear leaving Blade:1 in the window.
3. Right-click on Blade:1 and select Find In Window from the drop down menu list.
4. Right-click on Blade:1 and select Appearance from the drop down menu list to open the Appearance dialog box.
5. In the Appearance dialog box, double click on the Stainless Steel – Satin material in the In This Design section.
6. Click on the button labeled Advanced... to open the advanced editor window.
7. Change the name to Stainless Steel – Blade by click on the name field.
8. The Roughness setting controls the amount of reflection in the material, change the setting to 0.50.
9. Click OK.
10. Right click on Stainless Steele – Blade and
select **Duplicate** from the drop down menu.

a. This creates a second material called Stainless Steele – Blade that has the exact same settings as the original.

11. Double click on the copy **Stainless Steele – Blade** material to open the Material Editor.

12. Change the name of the material to **Blade Face**

13. Change the color to **75,75,75**.

14. In the Appearance dialog box change the **Apply To:** setting from **Bodies/Components** to **Faces**

   a. Now you can only apply materials to selected faces on a body/component

15. Drag the Blade Face material to the side face of **Blade:1**

16. Repeat this step on the other side of **Blade:1** so that both side faces have Blade Face applied.

17. Close the **Appearance** dialog box.

18. Right-click on **Blade:1** in the browser and select **Unisolate** to show the rest of the design.

**NOTE:** If you apply a material a body that already has a material(s) applied to one or more of it’s faces you will be presented with a choice to keep or remove appearances applied to the faces:

**Keep** - all of the existing materials on the face will not be replaced with the new material you applied to the body.

**Remove** - all of the materials on the faces will be replaced with the new material you applied to the body.
LAUNCH VIDEO for Applying Decals, Change Environment and Rendering

In this section you will apply an image of the Autodesk logo to the body of the utility knife using the decal tool.

Step 1 – Download the image file

1. In the Data Panel find the item named Autodesk Logo.jpg.
2. Double-click on the thumbnail to launch A360.
3. Click on the blue Download button on the upper right side of the window.
4. Place the file in a location where you can easily find it. Your desktop for example.

Step 2 – Apply the decal

1. Select Setup > Decal
   a. The Decal dialog box opens.
2. Click on the body of the utility knife to highlight it. This is the surface you will apply the decal to.
3. In the Decal dialog box, click on Select Image
4. From the file menu go to the location where you saved Autodesk Logo.jpg, select the file and click Open.
   a. The image appears on the face you selected with a move manipulator similar to the one you use for moving objects.
   b. The Decal dialog box also expands to show additional inputs for distance, angle and scale.
Step 3 – Adjust the decal

1. Adjust your view of the knife so that you can see the side of the handle
2. Use the rotate handle on the manipulator to rotate the decal so that it is lined up with the handle.
3. Use the XY Plane scale handle to scale the decal down.
   a. You can also input 0.85 in the Scale Plane XY field in the Decal dialog box.
4. Click OK to accept the decal location.

Environment Settings

The Environment Setting controls the lighting, background color, and visual effects in the rendering workspace. In Fusion 360 an environment dome with an environment image map (called a high dynamic range image or HDRI) attached to it constantly surrounds the 3-D model. These images reflect in the surface of your model and are used to simulate lighting.
In this section we will choose the environment, change the background color and turn on effects.

**LAUNCH VIDEO** for Applying Decals, Change Environment and Rendering

**Step 1 – Change the Environment settings**

In the Environment section you can pick the type of environment map you want to use. There are eight maps to choose from. Six of them are designed to simulate a photo studio set up. The remaining two (Plaza and Snowfield) are HDR photos of outdoor environments.

5. Click on **Setup > Environment**.
   a. There are 3 main sections to this tool:
      i. Environment
      ii. Background Color
      iii. Effects
6. Select several styles from the dropdown list. Notice that the reflections change as well as the pre-assigned background color for each style.
7. From the Style dropdown list select **Sharp Highlights**.
8. Use the slider next to **Exposure** to change the light level in the scene. Pick an exposure setting you like.
   a. If you want to go back to the default setting type 0.0 in the field next to the slider
9. Use the slider next to **Rotation** to rotate the environment image around the dome.
   b. As you move the slider you will see reflected highlights change on the design.
10. Rotate the environment until you see a highlight across the right side of the knife.
    c. You can also type **57** in the field next to **Rotation**.
Step 2 – Choose a background color

By default the **background color** is defined by the **environment style** you choose. You have the option to change the background color to whichever color you want.

1. In the **Background Color** section click on **Custom Color**.
   a. The background changes to white.
2. Click on the white swatch next to **Custom Color** to open the color chooser dialog box.
   a. This dialog box is similar to the color chooser in the material editor. You can pick colors by using the sliders or enter an RGB value.
3. Keep the background color as white.

Step 3 – Change the Ground Effects

You have the option to have your design cast a shadow or to reflect your model on the ground plane of the environment.

1. Click on the button next to **Ground Shadow**.
   a. Now you can see a shadow being cast on the ground plane.
2. In the **Environment** section change the rotation value.
   a. Notice that the shadow location is changing based on the location of the light sources in the chosen environment style.
3. Click on the button next to **Ground Shadow** to turn it off.
4. Click on the button next to **Ground Reflection**.
   a. Now you can see a reflection of your design on the ground plane.

Correct shadow computation takes a lot of time to render. If you want to speed up the render time avoid using ground shadows.

In the Display Settings at the bottom of your screen there are Effects setting that can affect your rendering. In particular:
**Ground Plane** – turning off the ground plane will turn off ground shadows and ground reflections.

**Ground Shadows** and **Ground Reflections** – are the same commands that are in the Environment > Effects section.

All the other commands in Display Settings only affect the GPU rendering in your modeling window (See Rendering section for definition of GPU rendering) and will not affect the results of Rapid Ray Tracer or Cloud renderings.
Rendering

Now that the design has materials applied and the environment is set correctly it is time to create a rendered image. There are 2 types of rendering methods in Fusion 360:

**Graphics Processing Unit rendering (GPU)** is the rendering you see in the modeling window and uses your computer’s graphics card to show the materials and lighting that have been assigned to your model and is similar to the technology used in computer gaming. This method uses the least amount of resources on your computer to create the images. It shows the materials assigned to your design in real time but is not photo-realistic. The analysis tools in the **Model >Inspect** dropdown (zebra, draft and curvature map) also use GPU rendering to show the results.

**Rapid Ray Tracer (RRT)** in the **Rendering Workspace** can be used to create photo realistic images from your Fusion 360 models. Ray Tracing attempts to simulate the natural flow of light in your scene using a technique called **Global Illumination (GI)** which takes in to account not only the direct light that comes from a light source but also indirect light that reflects off of other surfaces in your scene. The Real Time Ray Tracer requires you to let the rendering engine complete multiple iterations in order to get a high quality image – during this time you cannot interact with the workspace or the rendering will restart.

Under **Render – Ray Tracing** there are 3 quality settings **Quick**, **Normal** and **Advanced**

**Quick**: At this setting the materials in the scene are approximated as either completely polished or completely diffuse and completely ignores indirect light. In the rendered image you will see reflections but you don’t get any indirect light. This can be considered as a type of enhanced GPU mode.

**Normal**: At this setting the materials are approximated as either completely polished or completely diffuse and the indirect light in the scene is also approximated. This setting allows you to get to a noise free image quickly and get a good view of the total light in the scene.

**Advanced**: This setting does a full physically based rendering with full and accurate simulation of direct and indirect light and a full simulation of all material properties. In this mode the image will start off noisy before the image has converged and can take a long time to generate a photo realistic image.
**Autodesk Fusion 360: Render**

**LAUNCH VIDEO** for Applying Decals, Change Environment and Rendering

**Explore Fusion 360 rendering:** In this section you will change the settings of the **Render > Ray Tracing** quality settings to observe the differences, and use **Render > Capture Image** to save a PNG file to your desktop.

<table>
<thead>
<tr>
<th>Step 1 – Start the Rapid Ray Tracer</th>
<th><img src="sample_screenshot" alt="Ray Tracer" /></th>
</tr>
</thead>
</table>
| 1. From the Render toolbar select **Render > Enable Ray Tracing.**  
  a. The Rapid Ray Tracer starts and the **Ray Tracer** dialog box opens. | **RAY TRACING**  
  ![Ray Tracer Settings](sample_screenshot)  
  **Quality** Normal  
  **Elapsed time:** 9 sec  
  **Iterations:** 13  
  **Image refinement will continue until interrupted.**  
  **Pause** **Disable**  
  Close |

<table>
<thead>
<tr>
<th>Step 2 – Change the Quality setting</th>
<th><img src="sample_screenshot" alt="Rapid Ray Tracer" /></th>
</tr>
</thead>
</table>
| 1. Set the **Quality** setting to **Quick**  
  a. The image clears up rapidly but the image is not high quality  
  2. Change the **Quality** to **Normal**  
  a. The image clears quickly but you will notice that the edges of the model look jagged or pixelated and will slowly smooth out as the number of iterations rise.  
  3. Change the **Quality** to **Advanced.**  
  a. The image is very noisy to start and will continue to clear up over time. |![Rapid Ray Tracer](sample_screenshot) |

The **Rapid Ray Tracer** is a real-time ray tracer, meaning that as soon as you click on the **Enable Ray Tracing** icon your computer will start rendering the image immediately. The image will start off noisy and will start clearing up. If you change the orientation of the model or change materials and environment the Rapid Ray Tracer will restart the rendering process.

The length of time needed to create the image is dependent on the **Quality** setting and the number iterations (or passes) that are needed to create the image.

Because materials and lighting are approximated, **Quick mode** creates an image in a short amount of time.
For the **Normal mode** you usually only have to run around 10 iterations to get nice anti-aliased edges and get the noise in shadows to disappear. This will vary somewhat depending on materials and lighting but in general you would need quite few iterations. Once the image is free of noisy shadows or aliasing the image will not get better by letting it render longer.

For the **Advanced mode** the amount of time needed to create a good image will vary a lot more. Some scenes and some materials will take a lot longer to get noise free. Frosted Glass is one such material for instance. In general you usually need a couple of hundred iterations for a relatively complex scene to get totally noise free. The length of time needed is totally scene and material dependent so really complex scenes may need up to 500 iterations or more. In the **Advanced mode** you can generally see if that if an image looks noisy, it will benefit from longer rendering time.

For the image above a range of 1500 – 2000 iterations should be sufficient to create a high-quality image.
Step 3 – Pause and Disable the Ray Tracer

1. In the Ray Tracer dialog box – click on the Pause button
   a. The render pauses and both the Elapsed Time and Iterations stop counting.
2. Click the Continue button to let the Ray Tracer continue rendering where it left off.
3. Click on the Disable button to turn off the Ray Tracer.

You can also click on the Disable Ray Tracing icon in the tool bar to disable the render.

Step 4 – Create a Normal quality Ray Trace and Capture an image.

1. Select Render > Enable Ray Tracing.
2. Change the Quality setting to Normal
   a. Let the Ray Tracer run for about 120 seconds or until you are satisfied with the look of the rendering.
3. Hit the Pause button in the Ray Tracing dialog box.
4. Select Render > Capture An Image
   a. The Image Options dialog box opens
   b. In the Image Options you can change the size of the image you want to save and have an option to create a transparent background.
5. Leave the Image Options at the default and click on OK.
6. In the Save As box enter a name for the file and set a location to save the image.
7. Click on the Save button.
**Autodesk Fusion 360: Render**

**A360 Cloud Render** is also a ray trace renderer that uses the cloud resources in A360 to do the image calculation rather than your desktop resources so you can continue to work while the images are being created. The cloud renderer automatically creates small sized rendered images based on the Top, Front, Right and Home named views in your browser every time you save a new version or an auto save is done.

If you want to create an A360 Cloud Render of a specific view you need to create a new named view.

In this section you will locate the cloud rendered versions of the knife design and create new named view for a custom rendering.

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**Step 1 – Open data details in A360**

1. Click on the icon in the upper left corner of the screen to open the Data Panel.
2. Find the **Rendering: Utility Knife** file in the list and click on the information icon in the bottom right.
   a. A window opens below the file to show additional information.
3. Click on **Open details in A360**
   a. Your default browser will launch and take you the item details page of the A360 project
   b. By default a lite 3D version of the model is shown
4. Click on the picture icon on the left hand side of the window to show the renderings
   a. You are now able to see the renderings that were automatically generated using the A360 cloud render. By default you can see the last version you saved. Thumbnails of the rendered named views are visible on the left side of the window. Clicking on any of them will show you larger version in the main window.
5. Hover your cursor on any of the thumbnails to show additional information about the image.
6. Close the window by clicking the X in the right corner.
7. Close your browser window.
8. Return to Fusion360.
9. Close the **Data Panel**
Step 2 – Create new Named View

1. In the browser click on the small arrow next to Named Views to expand the list of current named views.
   a. Named Views are basically preset camera shots. By default there are Top, Front, Side and Home
2. Click on any of the named views to see that preset.
3. Arrange your design in the main window in a way that you would like your A360 Cloud Rendered image to look.
4. Right click on the Named View heading in the browser.
5. Click on New Named View in the drop down menu.
   a. A new named view is created based on the current window configuration with the label NamedView
6. Double click on NamedView to highlight it and type Render to change the label and hit enter
   a. The label has changed to Render
7. Click on the Save icon to save a new version of the design.

Name views can also be deleted or updated to a new camera position by right clicking on the named view and selecting Delete or Update Named View.

Step 3 – Download the image from A360

1. Following the previous steps navigate back to the thumbnails of the A360 Cloud Render.
   a. A new thumbnail has been added called Render.
2. Select any of the rendered thumbnails to see the larger image in the middle of the screen.
3. Click on the Actions button at the bottom of the window.
4. Select Download Image from the menu.

A360 Cloud Rendering service offers you the opportunity to re-render any of your current thumbnail images with new render settings. Depending on the type of entitlement you have some of these options will cost cloud credits.