Intro to Fusion 360

Phil Eichmiller – Autodesk, Lake Oswego, Oregon
Michael Aubry – Autodesk, Lake Oswego, Oregon

CD7017-L   This hands-on lab will introduce the Fusion 360 3D CAD design app as a design tool for designers and engineers of all skill levels. We will focus on the basic functional areas of the Fusion 360 app and lead the attendees through the modeling of a simple consumer product. We will cover T-Spline form creation, basic solid modeling and assembly, and materials and rendering.

Learning Objectives

At the end of this class, you will be able to:

- Create and edit T-Spline forms

- Perform basic solid modeling functions

- Insert and assemble model components

- Apply materials or appearances and render the model

About the Speakers

Phil Eichmiller is a product designer and Inventor user since 2000. Creating amazing product designs, packaging, marketing and tradeshow exhibits for Phoenix Gold International, Inc. He has been teaching Inventor at Portland Community College for 6 years to hundreds of degree seeking drafting students, connecting people to CAD with humor and manufacturing insight. Phil is a QA for Fusion 360 and has been very involved in the local community supporting and teaching Fusion 360 and other Autodesk products at FIRST Robotics events, PCC and the ADX maker space. phil.eichmiller@autodesk.com

Michael Aubry is a Technology Evangelist with the Autodesk Fusion 360 team. He's always questing for better, faster and more exciting ways to digitally design. During the ten years he's worked in the computer aided design field he's had the privilege to work with 100s of customers ranging from boutique furniture designers to massive rock crushers. A mechanical engineer by education, Mike has worked in the bio-medical, wind energy, and computational fluid dynamics simulation industries. He's recently been part of a project to create an unmanned aerial vehicle to help save Rhinos in South Africa. He's very excited about all the recent advances in manufacturing to broaden the availability of prototyping to the everyman and Mike is very excited to help co-instruct this year's Introduction to Fusion 360 seminar.


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Overview

Fusion 360 is a cloud-based CAD/CAM tool for collaborative product development. Let's take a look at the separate parts of that sentence to get a better understanding of Fusion.

- **Cloud-based**: Fusion 360 uses Autodesk A360 to manage all your design data. A360 gives you access to your data anywhere from any machine. With Fusion, we are concerned with 3D designs but A360 supports all your documents, spreadsheets, presentations and other design related files.
- **CAD/CAM**: Fusion 360 contains all the tools you need to design and manufacture your products. There are CAD tools that let you create any shape to meet your design needs. Fusion 360 also supports additive and subtractive manufacturing workflows. Finally, you can create 2D documentation of your designs.
- **Collaborative**: Use Fusion 360 with A360 to share designs and related information. You can also track activity on your projects.

Design History

Fusion 360 can work with or without recording design history. Design history refers to the operations you perform on the design to create and modify geometry. Operations are recoded in the timeline at the bottom of the interface.
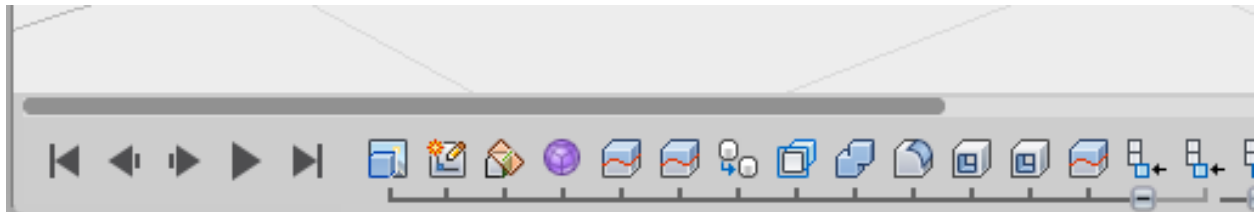

When using parametric modeling, the design history is captured in the timeline at the bottom of the interface. Operations are captured in the order they are performed in. History is captured for commands in the Model and Patch workspaces. You edit the operations in the timeline to make changes to your design.

When using direct modeling, design history is not captured. The same commands are used from the toolbar but there is no timeline. You use commands like Press Pull or Move to move faces and change your design.

So, why use one over the other? Use history when you need downstream operations to recalculate when you change other operations. For example, operations that go through-all or to-next recalculate with changes to upstream features. History is also useful if you plan to go between the model and sculpt workspaces. This allows you to create your shape, then create model operations (shell, split, hole, etc.) then go back and change your shape. If history is enabled, the model operations will recalculate to fit the new shape.

With direct modeling (history is off), you change geometry by moving faces. There are no operations to edit and therefore, no relationships between features in the design. Direct modeling works well for quick concept design or when working the imported data.

You can control the default behavior for new designs using preferences or you can turn design history on/off in the browser after a model is created.
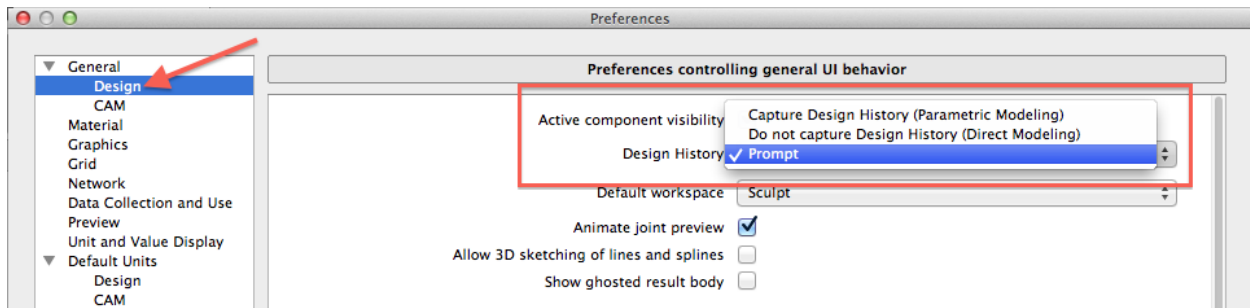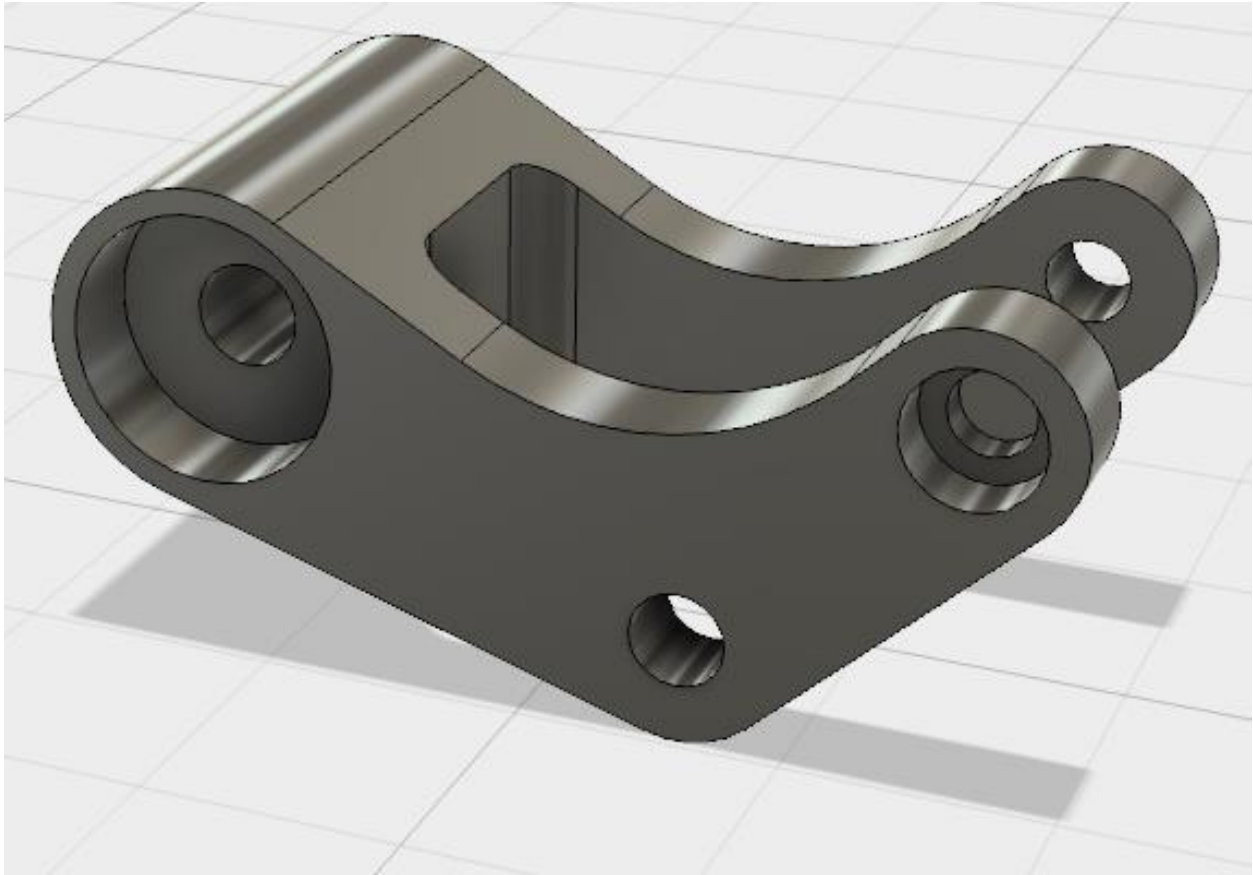

Workspaces

Fusion 360 uses workspaces control the commands that are available and the type of data that is created. There are multiple workspaces available depending on the work you plan to perform.

- Sculpt: create organic shapes by manipulating faces, edges, and vertices.
- Model: create solids with hard edges and flat faces.
- Patch: create open surfaces to stitch into solid bodies.
- Render: set up the environment and create photo-realistic renderings.
- CAM: create and simulate tool-paths then generate g code for subtractive manufacturing.
- Drawing: generate 2D manufacturing drawings.

You also have a drawing workspace for documentation; render workspace for creating photo-realistic renders, CAM workspace for creating tool paths.

It's obvious when to use some workspaces. If you need a 2D manufacturing drawing, you use the drawing workspace. What about model and sculpt? They are both used to create 3D designs so how do you choose to use one over the other?

Use model to create designs with hard edges and flat faces. Model creates bodies requiring exact sizes and edges. Entering exact values is not required but is typical.

Use the sculpt workspace to create bodies with organic shapes. Sculpt bodies are highly curved and the shape is more critical than exact size.
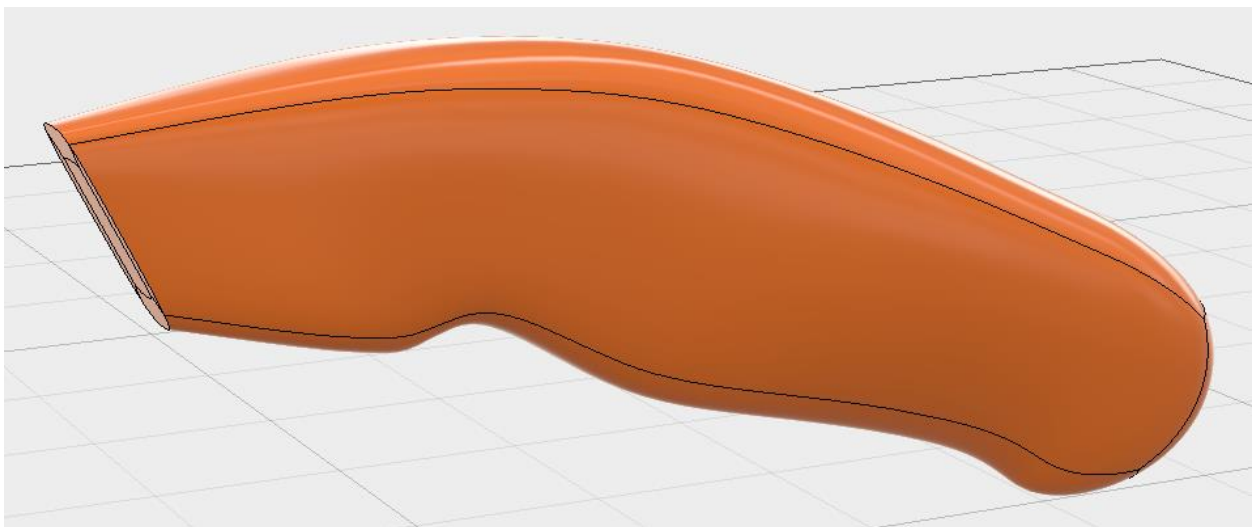

Very frequently, your designs will require that you work in both sculpt and model workspaces, back and forth. You might even throw patch in there to stitch surfaces together into a solid. You

can work entirely in sculpt, entirely in model, or you can combine the two. You can combine sculpt and model to create the shape required as well as precise manufacturing features. Create the organic shape in sculpt then use model for manufacturing features afterwards.
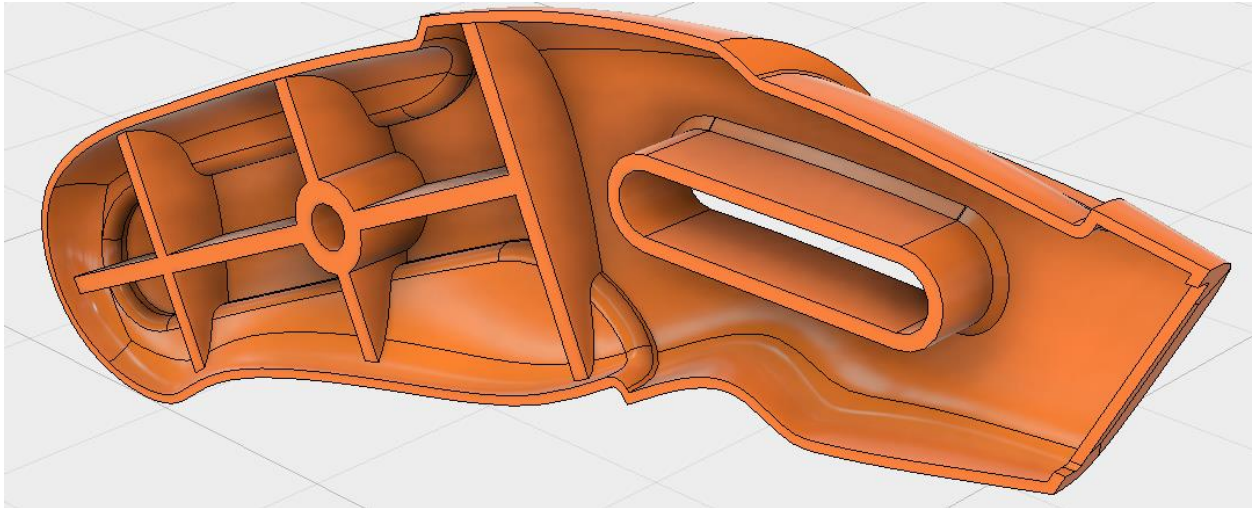
Main User Interface
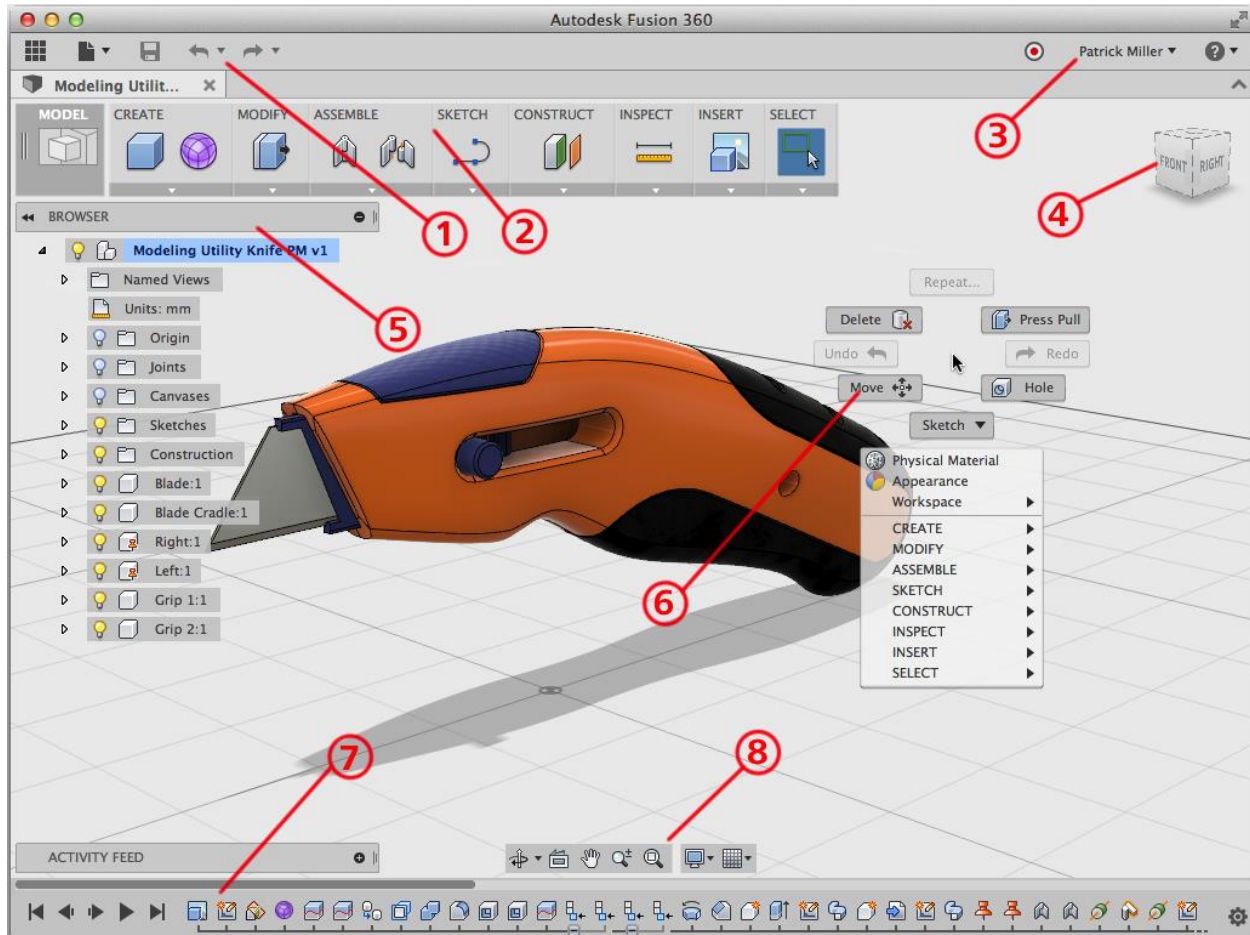
1. Application bar:

   - Data Panel: Display or hide the data panel on the left of the interface.

   - File: Access file operations such as New Design, Save, Export, and 3D Print.

   - Save: Save an untitled design or save the changes to a design as a new version.

   - Undo/redo: Undo or redo operations.

2. Toolbar: Access commands in the toolbar.
3. Profile and help:
   - Profile name: Access preferences and your Autodesk profile.

- Help: Access help, forums, and tutorials, what's new, and feedback.
4. ViewCube: Orbit the view and access orthographic and isometric views.
5. Browser: Lists objects in the design.
6. Marking menu: Another method to access commands. Right-click to display the marking menu.
7. Timeline: List the operations performed on a design if parametric modeling is active.
8. Navigation bar and display settings: The navigation bar contains commands to navigate the view. The display settings control the display of the design in the canvas.

Data Panel Interface
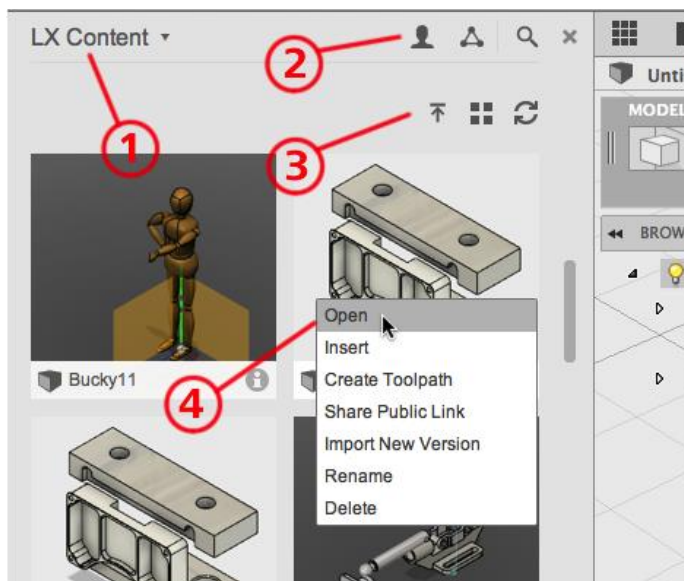
1. Project switcher: Select the active project.
2. Project tools

   - Project Members: Invite members to the active project.

   - Project details: Opens the active project in Autodesk A360 in your default internet browser.

   - Search: Search the active project or all projects you have access to.
3. Data tools

- Upload: Upload files to Autodesk A360. Many CAD data types are supported as well as standard files such as documents, spreadsheets, and presentations.

- Data view: Select how data is displayed in the data panel.

- Refresh: Refreshes data from Autodesk A360.

4. Thumbnails: Right-click a thumbnail to access commands for that specific design.

View Navigation

Commands

Use ViewCube to orbit the design in the canvas. Drag the ViewCube to perform a free orbit. Click faces and corners of the ViewCube to access standard orthographic and isometric views.
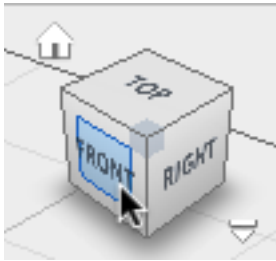
Use the commands in the Navigation bar to pan, zoom, and orbit the canvas. The menus on the right end control Display Settings and Layout Grid options.
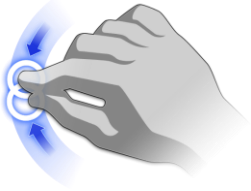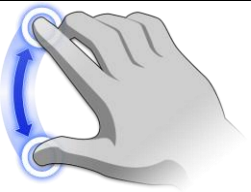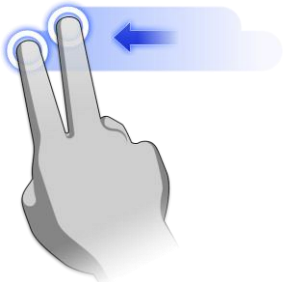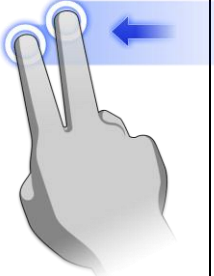

Mouse

SCROLL	**Scroll** the middle mouse wheel to zoom in or zoom out.

HOLD		**Click and hold** the middle mouse button to pan the view.
SHIFT KEY +		Hold the **SHIFT** key and **click and hold** middle mouse button to orbit the view.

Mac Trackpad

	2 finger pinch to zoom out.
	2 finger spread to zoom in
	2 finger swipe to pan the view.

SHIFT +	Hold SHIFT and 2 finger swipe to orbit the view.

Hot Keys

Command	Windows	Mac
Undo	Ctrl + Z	Command + Z
Redo	Ctrl + Y	Command + Y
Copy	Ctrl + C	Command + C
Paste	Ctrl + V	Command + V
Cut	Ctrl + X	Command + X

Sculpt Workspace Selection	Windows	Mac
Grow selection	Shift + Up arrow	Shift + Up arrow
Shrink selection	Shift + Down arrow	Shift + Down arrow
Loop selection	Alt + P	Control + P
Loop grow selection	Alt + O	Control + O
Ring selection	Alt + L	Control + L
Ring grow selection	Alt + K	Control + K
Ring shrink selection	Alt + J	Control + J
Previous U	Alt + Left arrow	Control + Command + Left arrow
Next U	Alt + Right arrow	Control + Command + Right arrow

Previous V	Alt + Down arrow	Control + Command + Down arrow
Next V	Alt + Up arrow	Control + Command + Up arrow
Range selection	Alt + M	Command + M
Invert selection	Alt + N	Command + N
Toggle box mode	Ctrl + 1	Ctrl + 1
Toggle control frame mode	Ctrl + 2	Ctrl + 2
Toggle smooth mode	Ctrl + 3	Ctrl + 3
Select edge ring	Double-click an edge	Double-click an edge
Select face ring	Select two faces then double-click a third face	Select two faces then double-click a third face

Edit Form Command	Windows	Mac
Add geometry	Alt + Drag	Option + Drag
Add geometry and keep creases	Alt + Ctrl + Drag	Option + Command + Drag

Create and edit T-Spline Forms

In this section you will learn how to:

- *Create a T-Spline form*
- *Modify a T-Spline form*
- *Add details to a T-Spline form*
- *Create a T-Spline form based on a reference image*

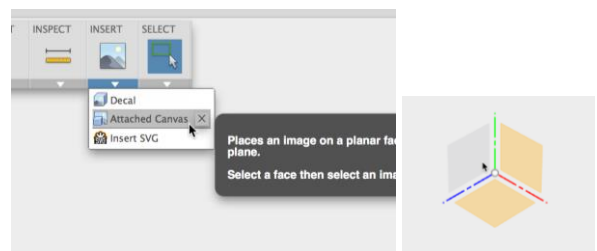## Create a T-Spline Form from a Reference Image

In this section you'll learn how to create a T-Spline form based on a calibrated reference image. With the freeform capabilities that come along with sculpting Fusion 360, this is a very common workflow. Let's get started by creating with a blank slate by creating a **New Design**.

Design Setup – Attach Canvas: The first step is to learn how to attach a reference image to a particular plane and calibrate it to ensure an accurate design.

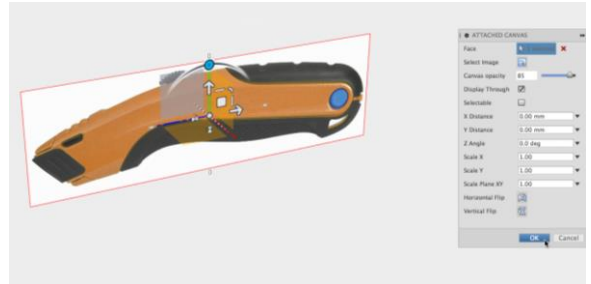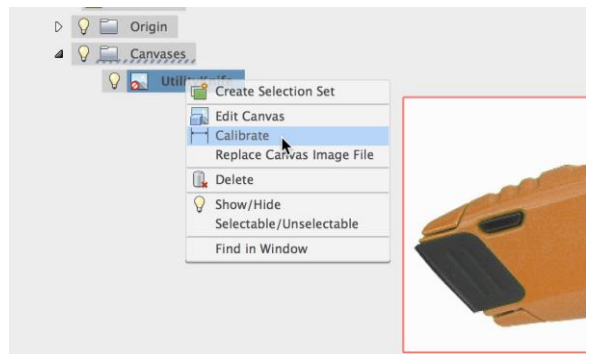| Step 1 – Attach a canvas	
1. Click the drop-down arrow under the **Insert** menu. 2. Click **Attached Canvas**. 3. Select the **YZ Plane** (between the green and blue axes) to set the Canvas' orientation. 4. In the dialog window, click the **Select Image** button and navigate to the **01_UtilityKnife.jpg** file in the class data folder.	 Launch Video

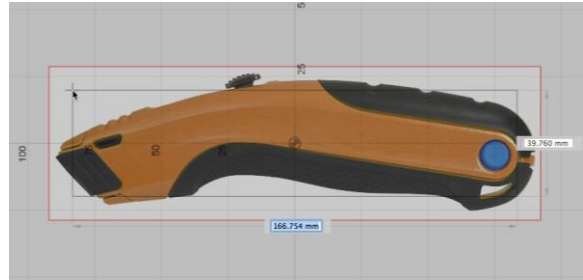| Step 2 – Setup the canvas 1. If necessary, **rotate** the canvas **90 degrees** to orient it properly 2. Lower the opacity to **85**. 3. Check the box for **Display Through** to ensure that the canvas can be seen through your T-Spline form. 4. Click **OK**.	 [Launch Video](#)
Step 3 – Start the calibrate tool 1. We need to calibrate our canvas to make sure our utility knife fits in our palm, and not on our fingertip! 2. In the Browser, click the drop-down arrow next to the **Canvases** folder. 3. Right-Click on **Utility Knife** and select **Calibrate**.	 [Launch Video](#)
Step 4 – Calibrate the canvas 1. Click **Right** on the View Cube to view the utility knife from the side. 2. Click once at the **front** of the utility knife. 3. Click once at the **back** of the utility knife. 4. Enter the approximate length, **180 mm**. 5. The canvas will scale up accordingly.	

Create Primitive Form: With the canvas in place, the next step is to create a T-Spline primitive form on the proper plane.

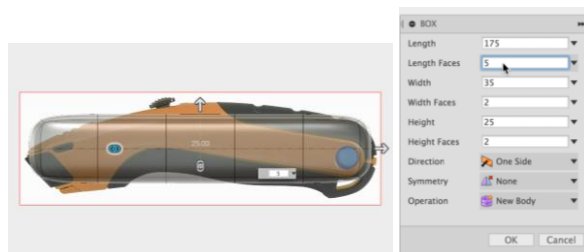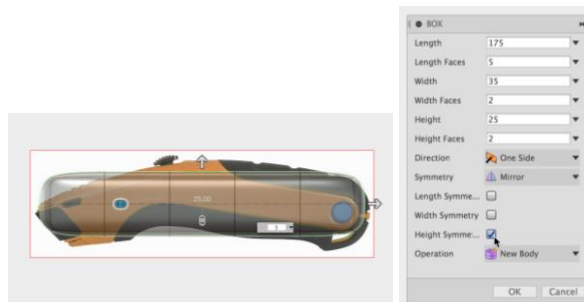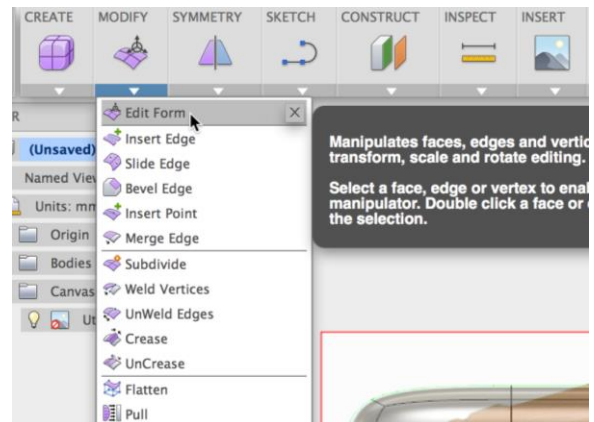|	
Step 1 – Start the Box Primitive 1. Click the **Create Form** icon to enter the Sculpt workspace. 2. Under the Create menu, select a primitive **Box**. 3. Select the same side plane (YZ) as the canvas to specify the plane that the Box is placed on. 4. Click once at the **origin** to specify the Box's center point 5. Move the mouse and **click** again to draw its 2D profile.	 Launch Video
Step 2 – Specify the Box Primitive 1. Set the Box's **Length, Width**, and **Height** equal to **175, 35,** and **25 mm**, respectively. 2. Set the number of **Length Face** equal to **5**, and the width and height faces equal to 2. Looking at the form of the utility knife, the complexity is along the length of the knife, so we set additional faces in that direction. We can always add or remove these later on.	 Launch Video
Step 3 – Add Symmetry 1. In the dialog window, change the **Symmetry** from None to **Mirror**. 2. Check the box for **Height Symmetry**. 3. You'll now see a green line that indicates where we have symmetry set up. 4. With no more symmetry to add to our form, click **OK**.	 Launch Video

Edit the T-Spline Form: Our T-Spline primitive is now in place, but we need to edit its geometry to better match our reference picture. In the following steps, we'll edit our existing geometry to match the canvas as best as we can. After that, we can add and subtract more edges to fine-tune our design.

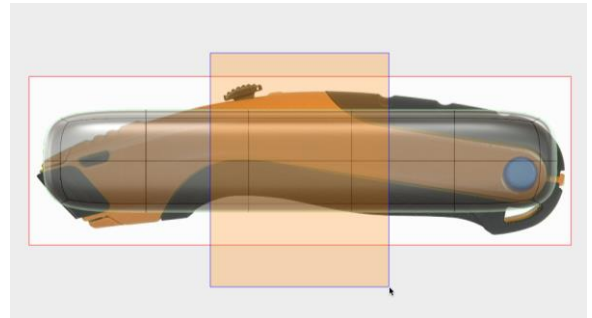|	
Step 1 – Start the Edit Form tool 1. Under the Modify menu, select **Edit Form**. 2. For simplicity, ensure you're looking at the form from the **Right** view. 3. Again, to set this, you can click Right on the view cube. Common to most workflows, we'll stick to modifying our form from just one view, proceeding to 3D manipulations as a final step.	 Launch Video
Step 2 – Select a Loop of Faces 1. Select the middle loop of faces going down the length of the utility knife with a **window selection** (left-click and hold), as shown in the picture. 2. Dragging left to right will select all the geometry that is *fully captured* by the window, while right to left will capture everything that touches the window.	 Launch Video

Step 3 – Start Modifying the Form

1. Using the **Planar Translation** manipulator, move the selected faces to align the top of the T-spline body with the top of the utility knife.
2. To align the bottom in this section, select the bottom face and use the planar translation and **rotate** manipulators.
3. Repeat the previous 2 steps for the rest of the T-spline form. It will also be helpful to use the **single-direction scale** manipulator in some cases.
4. For more controlled editing, try modifying individual edges.
5. Don't worry if the finer details of the contour are not matched, as we will accomplish this in the next step by adding and subtracting edges. Shoot for the image on the right!
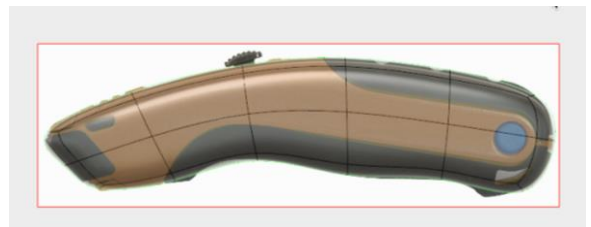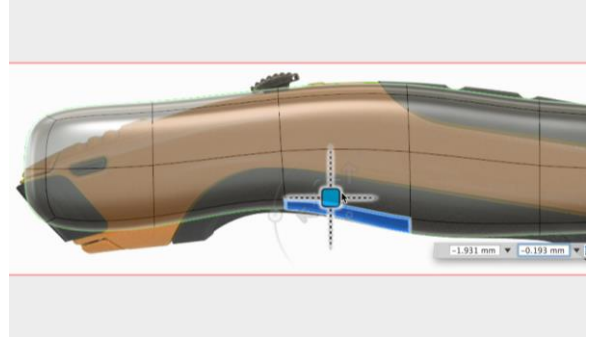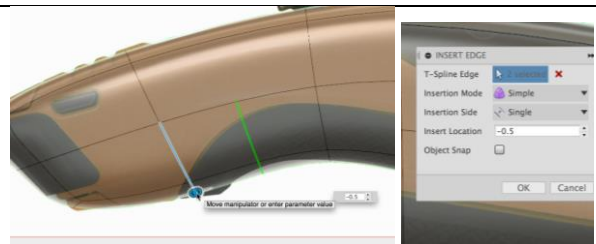
Launch Video

Add Additional Details – Insert Edge: Our T-Spline form is starting to resemble our reference image, but there are without a doubt some details that we'd like to add! As the form is right now, there simply aren't enough edges available to capture all of the details that we'd like. To combat this, you'll implement the earlier-discussed method of inserting and deleting edges into a T-Spline form.

Step 1 – Insert Additional Edges

1. Holding **shift**, select the edges shown.
2. Click the Modify drop-down arrow and select **Insert Edge**.
3. Drag the direct manipulator to the right to position the new edges at an **Insert Location** around **-0.5**.
4. Click **OK**.

We'll now repeat the previous steps to insert another set of edges.

Launch Video

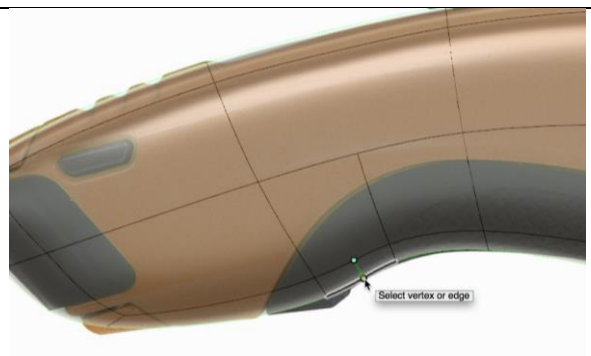|	
Step 2 – Insert more edges 1. Holding **shift**, select the edges shown. 2. Click the drop-down arrow under the Modify section and select **Insert Edge**. 3. Drag the direct manipulator to the right to position the new edges at an **Insert Location** around **-0.5**. 4. Click **OK**. The form will change due to the additional edges. In the next step we will edit our form to our liking.	 Launch Video
Step 3 – Edit Form 1. Using the **Edit Form** tool directly manipulate the recently inserted edges (as well as the surrounding geometry) to achieve the result shown on the right. 2. The planar translation manipulator will be extremely useful. As you can see, the reference image will help us roughly capture the correct form, but the fine details are entirely up to us.	 Launch Video
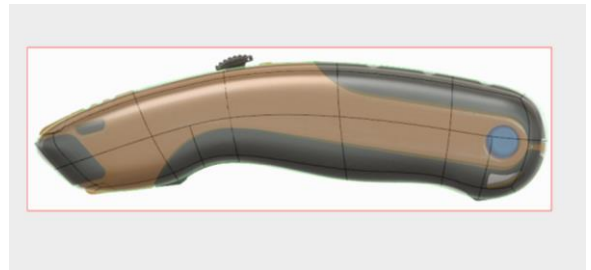
Add Additional Details – Insert Point: To insert the final two edges we need, we'll actually learn a new tool, the Insert Point tool. Slightly different from Insert Edge, the Insert Point tool will easily insert an edge by connecting two midpoints together.

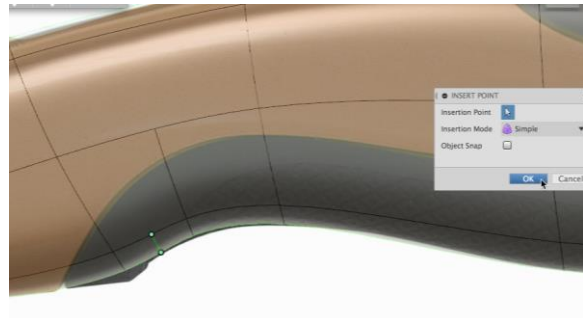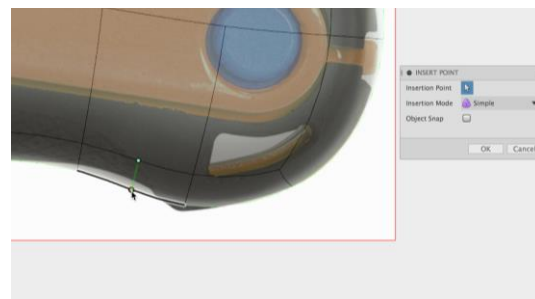|	
Step 1 – Start the Insert Point command 1. Click the Modify drop-down menu and select **Insert Point**. 2. Hover over the middle of the top edge shown until a **red circle** appears. – this signifies the midpoint 3. **Click**, and repeat for the edge directly *beneath*, located along the line of symmetry.	 Launch Video

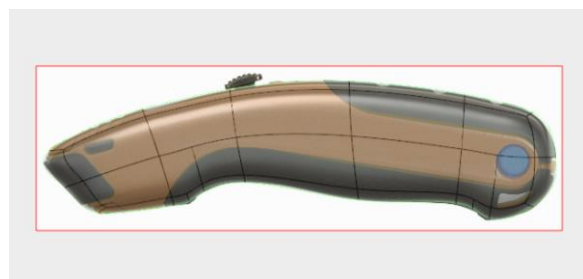| Step 2 – Insert Point details	
1. Leave the **Insert Mode** set to **Simple**. 2. Click **OK**. *Note:* An Insert Mode of **Simple** will add the desired edge, but the form will change slightly. An Insert Mode of **Exact** will add the desired edge, as well as *additional edges* to maintain the previous form. As you can tell, this setting will be a trade-off between maintaining form and reducing the number of edges.	
Step 3 – Repeat Insert Point 1. Click the Modify drop-down menu and select **Insert Point**. 2. Construct an additional edge as shown to the right. 3. Leave the **Insert Mode** set to **Simple**. 4. Click **OK**.	 [Launch Video](#)
Step 4 – Edit Form 1. Using the **Edit Form** tool directly manipulate the recently inserted edges (as well as the surrounding geometry) to achieve the result shown on the right. 2. Click **Finish Form**. Congratulations! You've completed your first sculpting workflow in Fusion 360. Feel free to sculpt the utility knife's sides for even more detail. With a more complex form, a similar workflow can be utilized, but with *multiple* calibrated canvases.	 [Launch Video](#)

Perform basic solid modeling functions
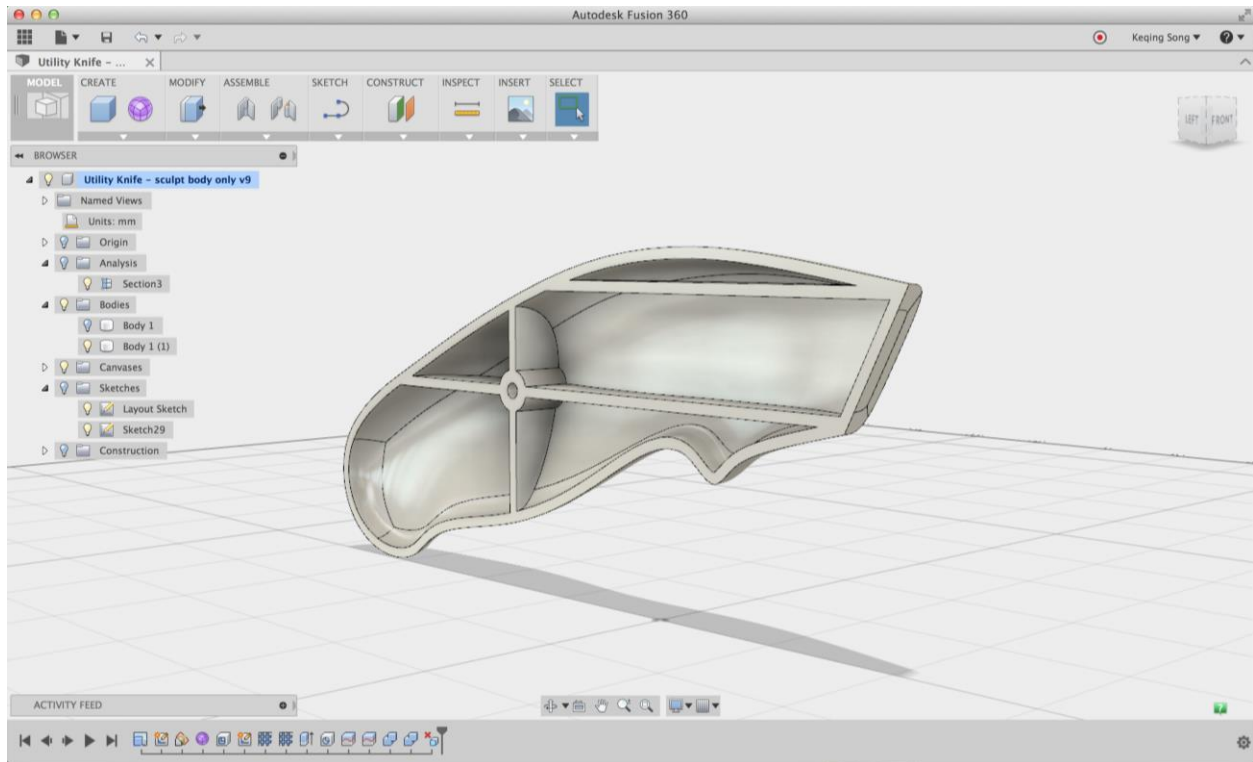
In this part of the modeling module, we're going to work on the sculpted utility knife handle. We're going to look at how to create mechanical features based on a sculpted body. We'll be using tools that we used in the previous lesson, as well as learn some new ones.
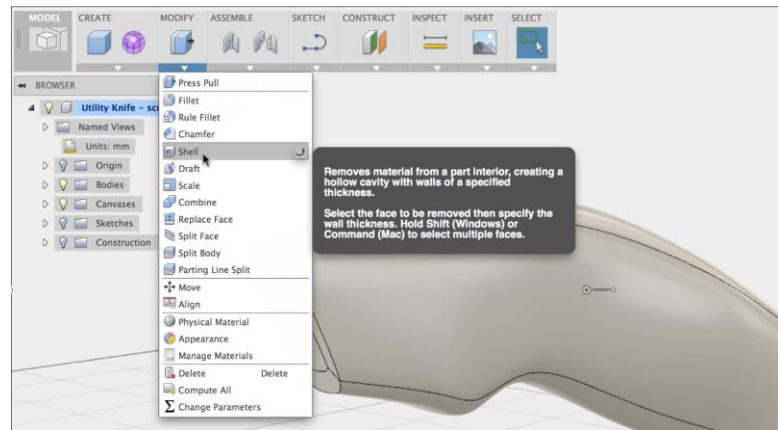
Before moving on, make sure you have the **02_model_from_sculpted_body** design open and in your design environment.
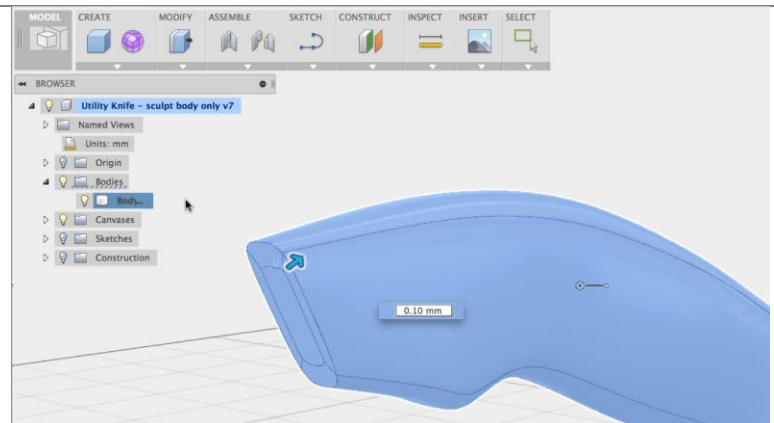
If you like to watch the video to this tutorial, click here: **Launch Video**

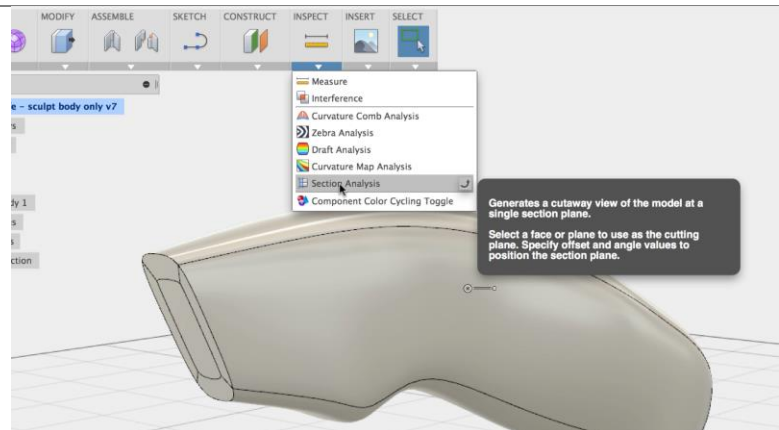|	
Step 1 Let's start by first shelling the body. 1. Go to the **MODIFY** drop-down menu and select the **Shell** command.	
Step 2 1. Go to the browser and locate the knife body. 2. Click it once to select it as the body to shell.	
Step 3 1. Instead of using the arrow manipulator, go to the floating command dialog and change the value to **2 mm**. Hit **ENTER** to finish. Now that the body is shelled, we're going to begin creating features on the inside.	
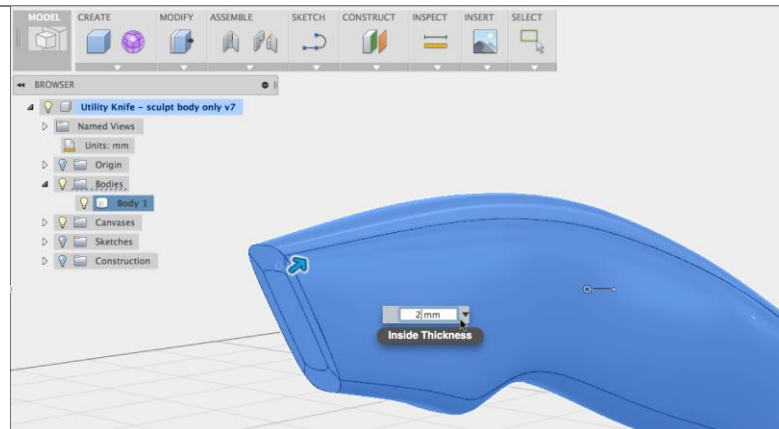
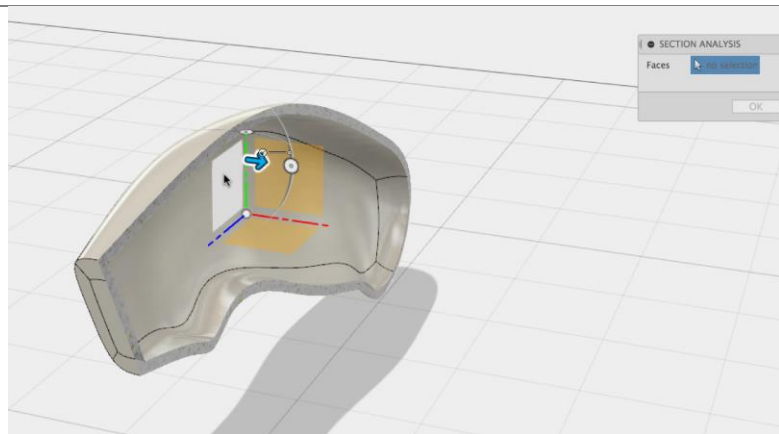|	
Step 4 1. To see the inside, go to the **INSPECT** drop-down and select **Section Analysis**. Note: Section Analysis lets you see a section of the model based on a reference plane or surface.	
Step 5 1. Go to the browser and turn on the **Origin** planes. 2. Select the plane that is in the middle of the knife body, parallel to the length of the model. Click **OK** to confirm. You should see half of the shelled model.	
Step 6 We're now going to set up some web features. 1. Go to the **RIGHT** view on the ViewCube. 2. Go to the **SKETCH** drop-down menu and select the Line command.	
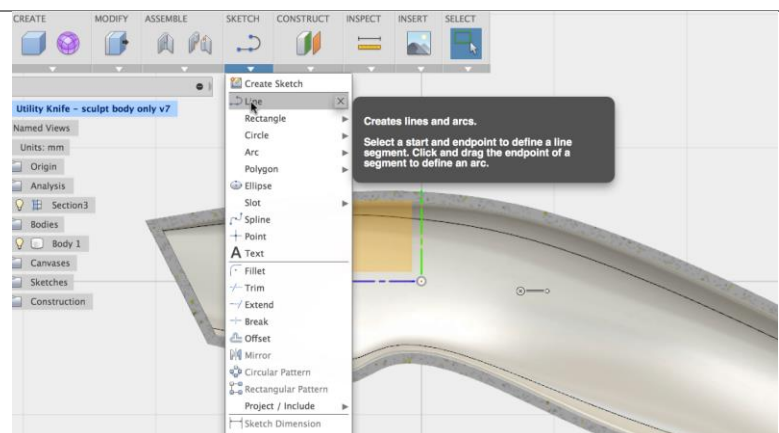
Step 7

1. Choose the plane that is parallel to the section view.
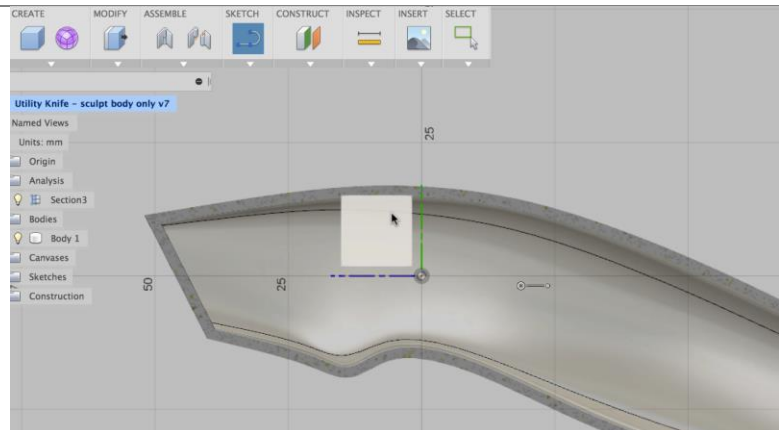

Step 8

1. Go to the browser and turn on **Sketches**. You should see some profile sketches that have been already created.

We're going to use them as references for our line sketch.
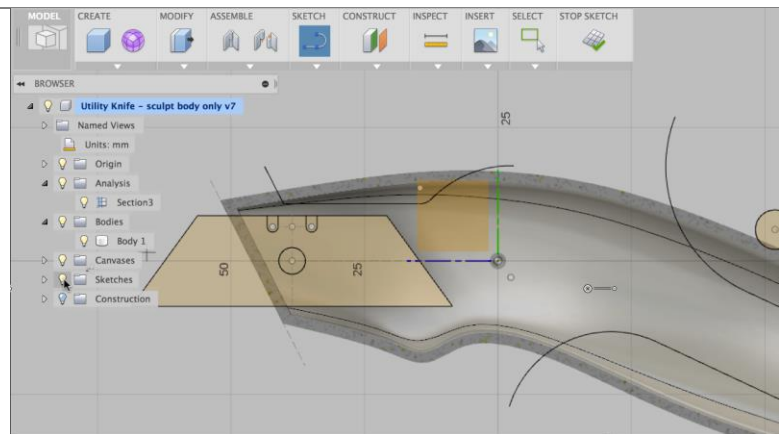
Step 9

1. Hover over to the top of the blade profile until your cursor snaps to a grid intersection. Make sure that it is outside the knife body.

If you're having trouble snapping to the grid intersection, zoom in and the grid will scale accordingly.
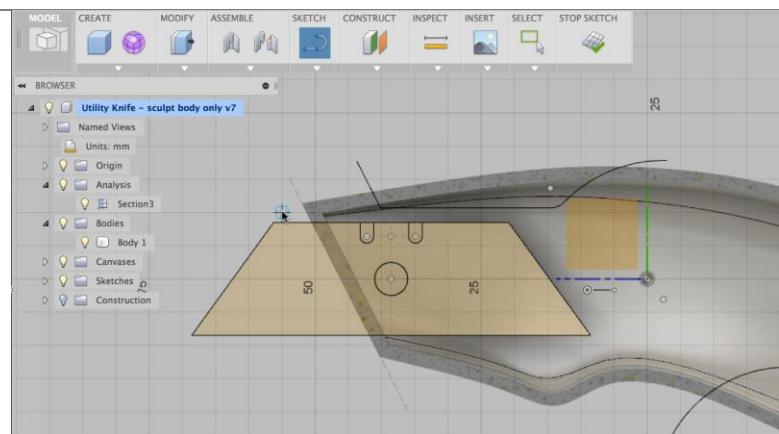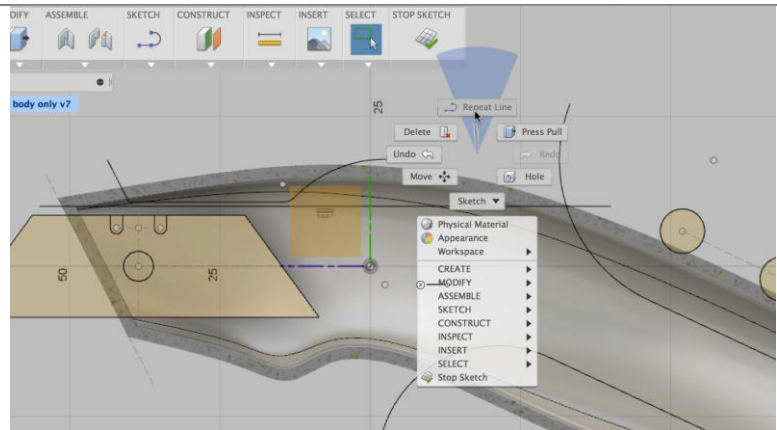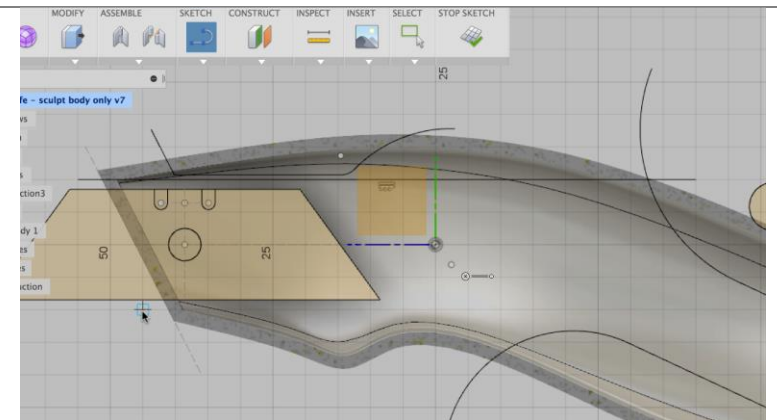
Step 10	
1. Click once to place the start of your line sketch. Stretch the line across the knife body until it is on the other side.	
2. Click again to place the end point of the line.	
3. Press **ESC** key to end the command.	
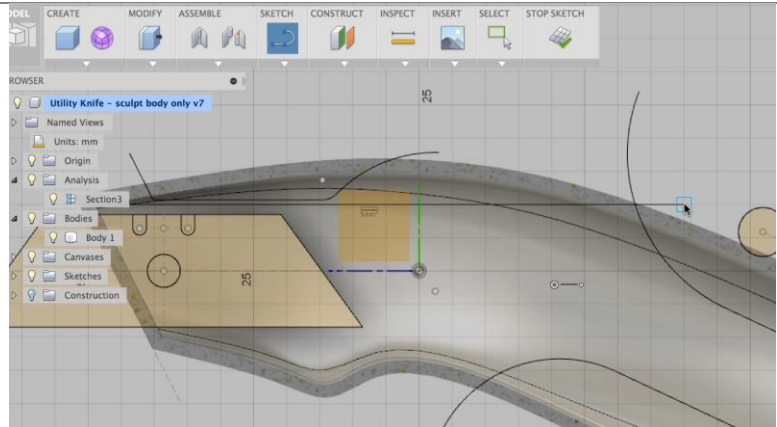
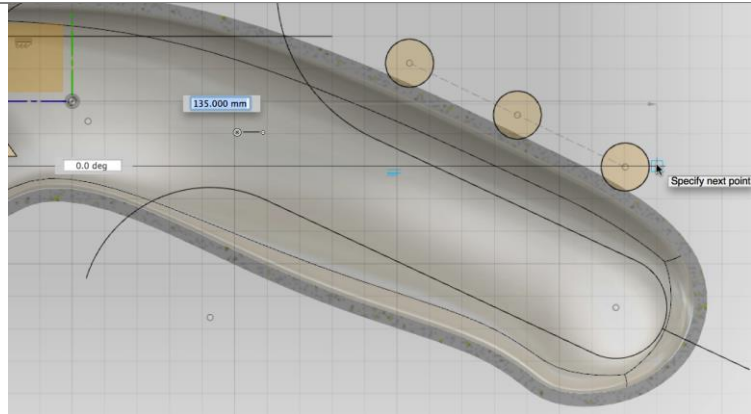| **Step 11**	
1. Right click and select **Repeat Line** to reuse the **Line** command.	

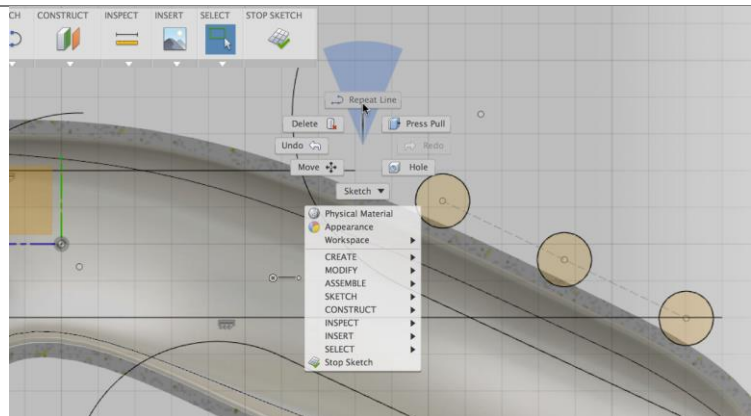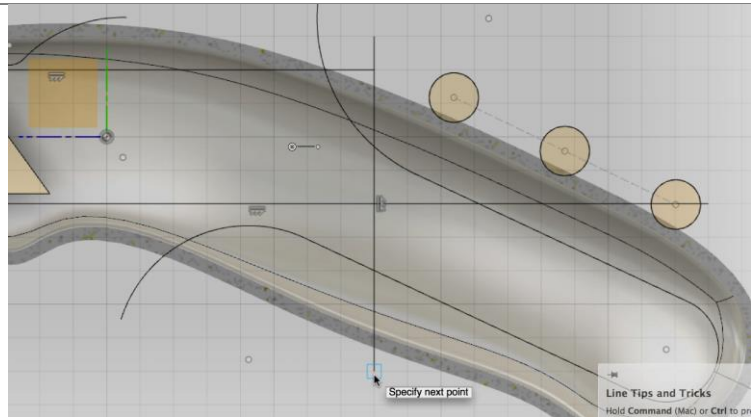| **Step 12**	
1. Now repeat the same task at the bottom of the blade sketch profile. Snap to a grid intersection; click to place the starting point of the line.	

Step 13

1. Extend the line across the knife body until it reaches past the last circle sketch profile. Snap to a grid intersection; click to place the end point of the line.

2. Press ESC to end the command.

Step 14

1. Right click and select **Repeat Line** to reuse the **Line** command.

Step 15

1. Draw a line that is perpendicular to the first and second line, making sure that it also extends past the knife body.

2. When you're done placing the end point of the 3rd line sketch, press **STOP SKETCH** to end sketching.
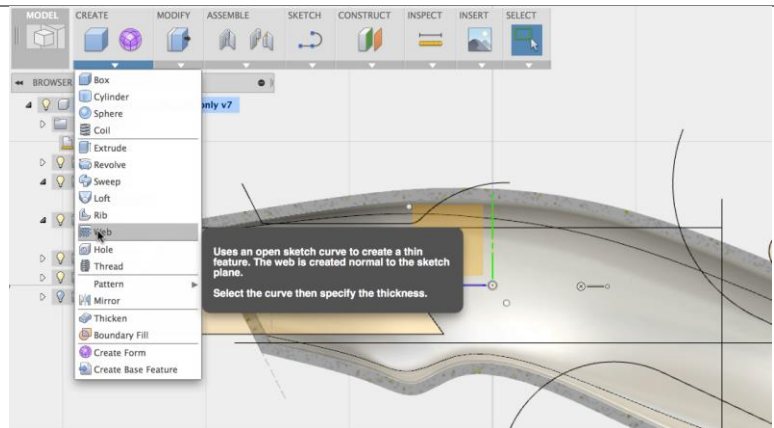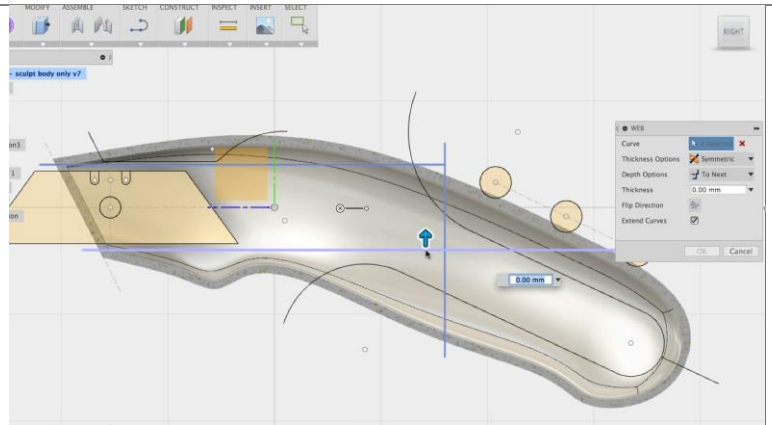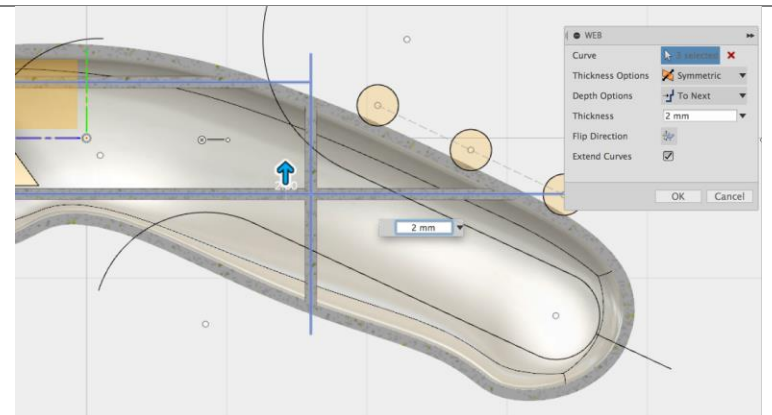
Step 16

We're now ready to model the webs.

1. Go to the **CREATE** drop-down menu and select the **Web** command.

Step 17

1. Click on the 3 line sketches you just made so that they are selected as the references lines for your web.
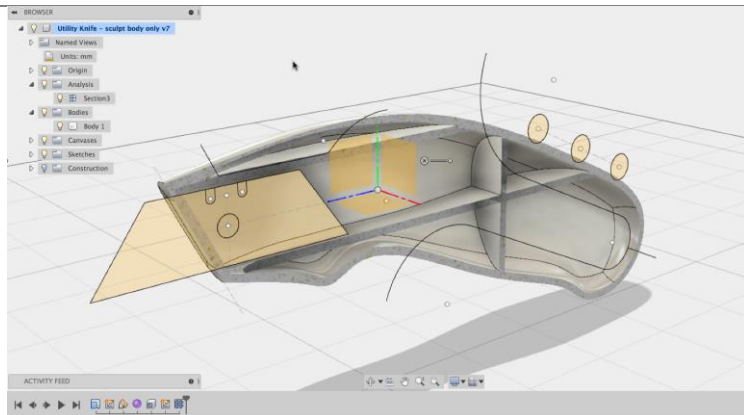

Step 18

1. Change the thickness value to **2 mm** and hit **ENTER** to finish.

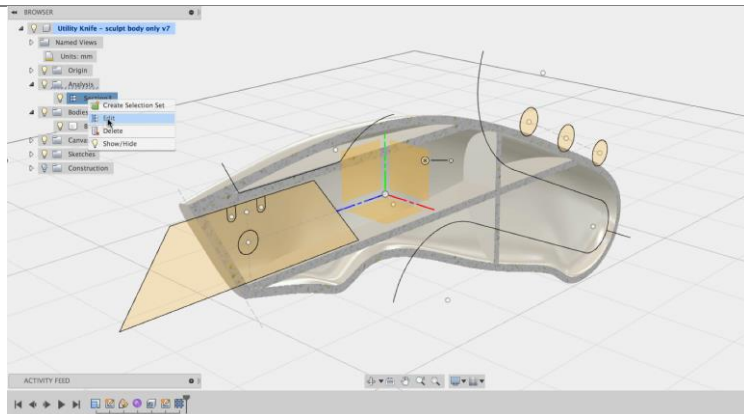**Step 19**

Now that you've created webs for one side, you'll need to duplicate the task on the other. We're going to do this by editing the **Section Analysis.**
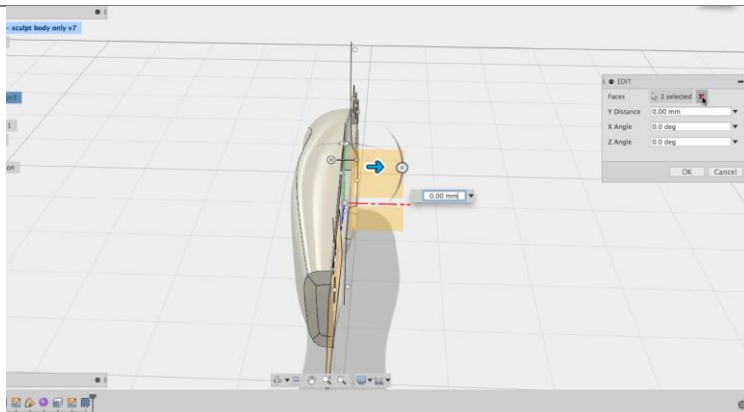
1. Go to the browser and expand the Analysis folder.

Step 20

1. Right click on the analysis and select **Edit**.

Step 21

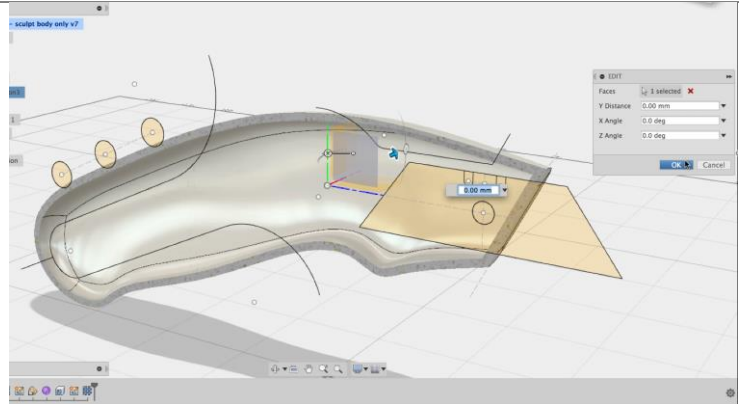1. In the command dialog to the right, click the red **X** to de-select previously selected plane.

Step 22

1. Rotate the model around to the Left side, and then select the left side of the middle plane.
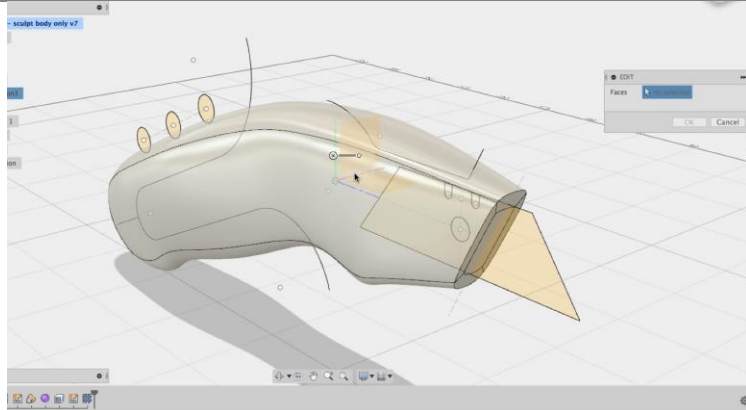
Step 23

1. You should be seeing the other half without the webs. Click **OK** to finish.

Note: If you are having trouble selecting the plane, then click

Step 24

1. Go to the browser and turn on the sketch for the web.
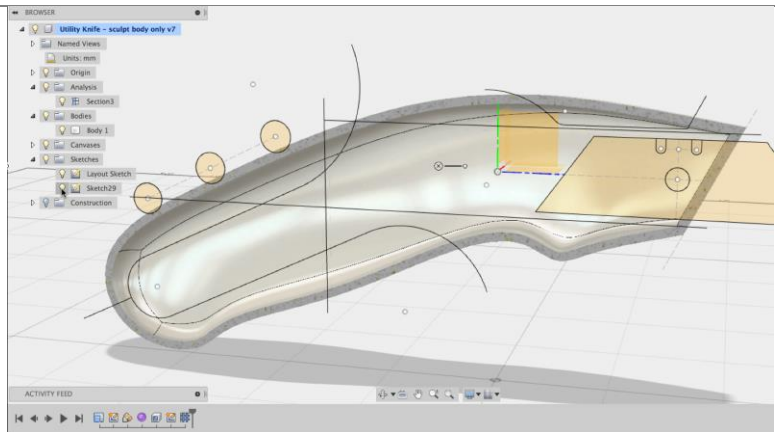
Step 25

1. Repeat the **Web** command.

2. Select the 3 line sketches.

3. Before setting a thickness, click **Flip Direction** in the command dialog so that the webs will be going in the right direction.
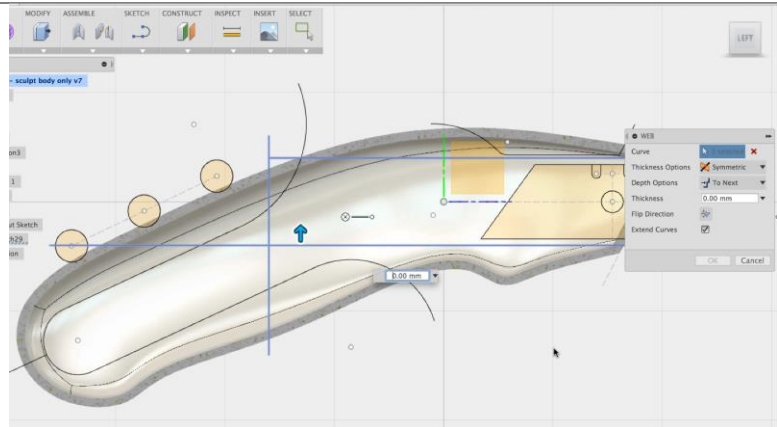
Step 26

1. Set the thickness to **2 mm**.

Click OK to finish.

You now have webs on both sides of the model.
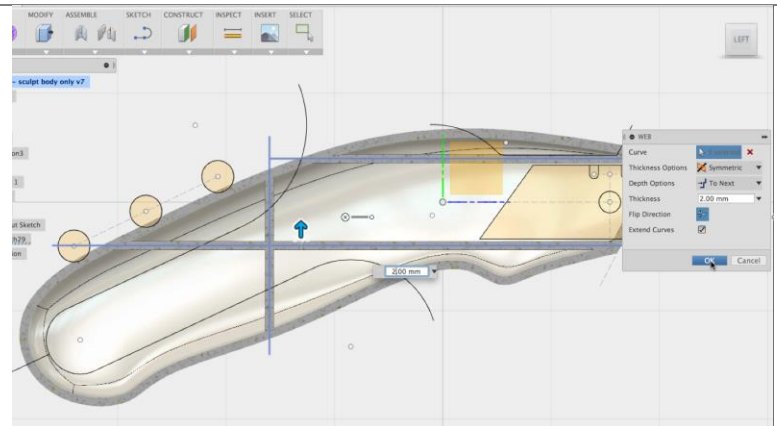
Step 27

We're now going to create a boss hole right in the middle of where the webs intersect.

1. Go to **SKETCH** drop-down menu, then Circle, and select **Center Diameter Circle**.
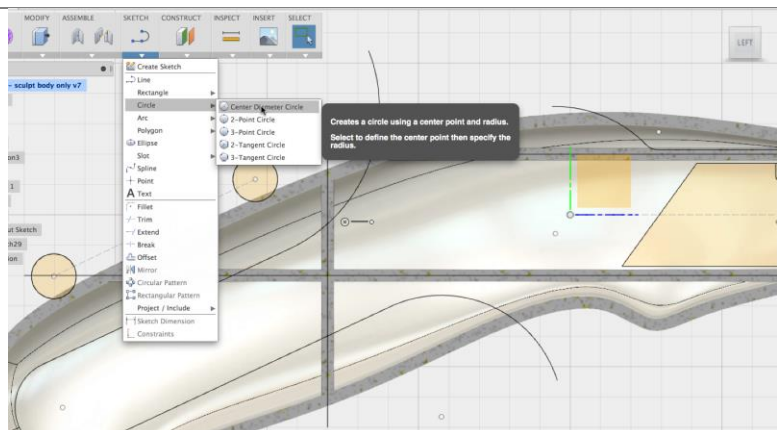
Step 28

1. Click on the plane where the web line sketches were drawn, then hover to the intersection until the cursor snaps to the center. Place your circle there.
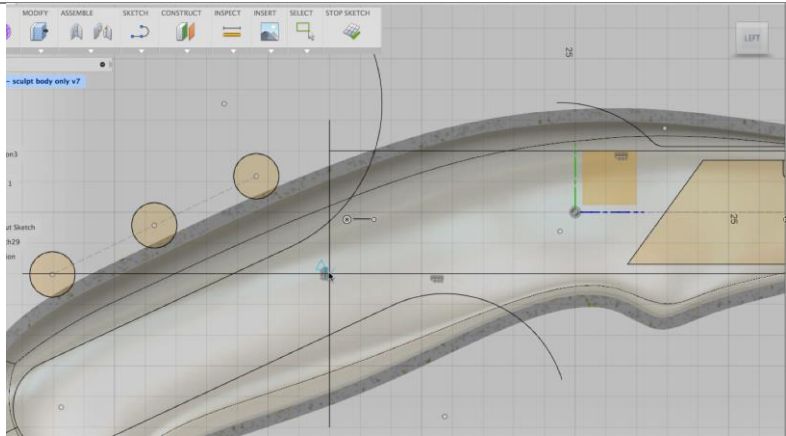
Step 29

1. Enter a value of **8 mm** as the diameter. Press **ENTER** to confirm.

2. Click **Stop Sketch** to exit the Sketch environment.
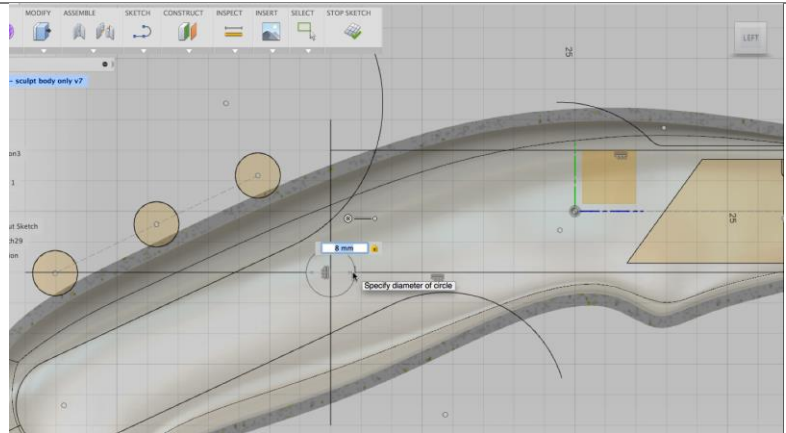
Step 30

We're now going to create a cylinder using the circle sketch profile.

1. Select the entire circle profile. Hold the **SHIFT** key to add onto each selection.
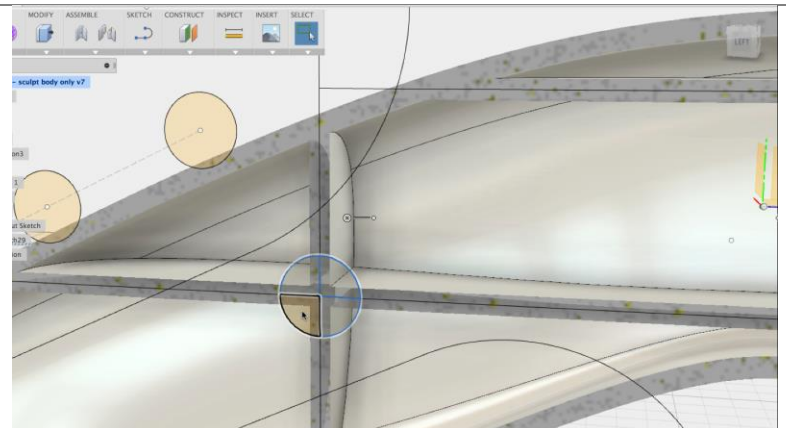
Step 31

1. Right click on the selected circle profile and select **Extrude**.
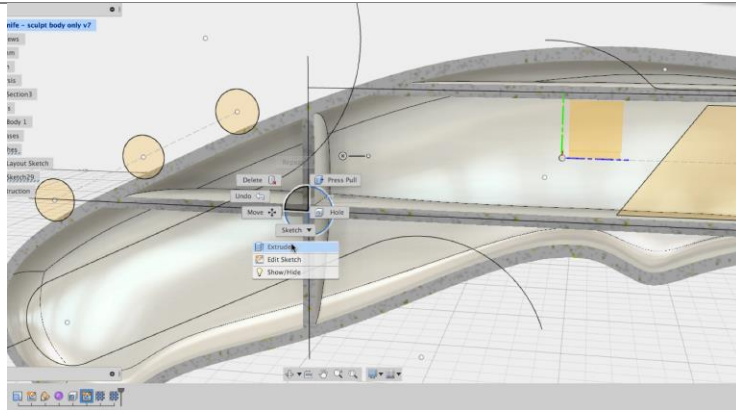
Step 32

1. In the command dialog, make sure that the Direction is set to **Symmetric**.

2. Drag the **arrow manipulator** to a value of **19 mm**.
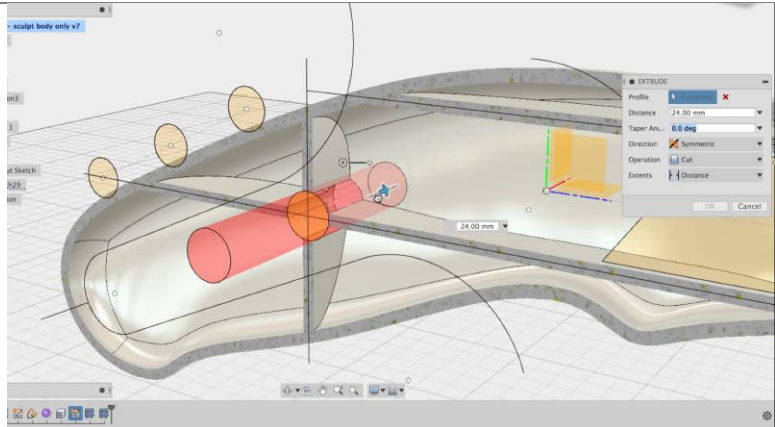
Step 33

1. Change the Operation from Cut to **New Body**. Click **OK** to finish.
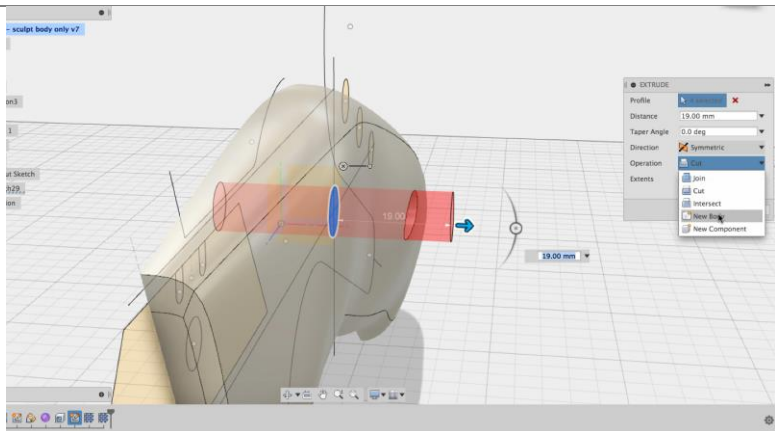
Step 34

1. Turn off the **Analysis** in the browser.

You should now see a cylinder body protruding from both sides of the knife body.
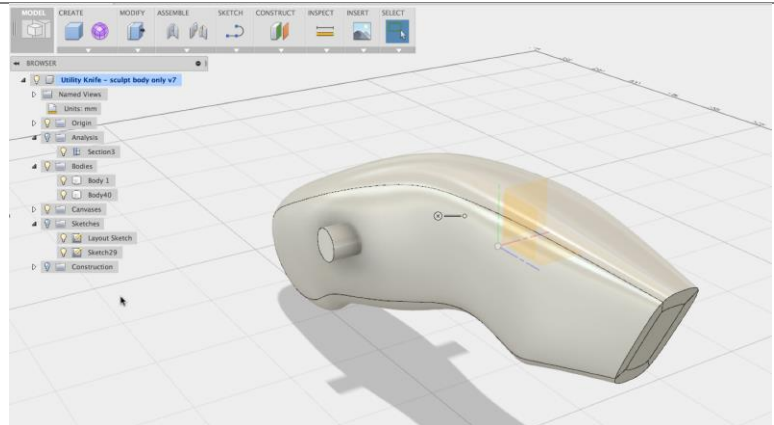
Step 35

We're now going to create a counter-bore hole through the cylinder.

1. Go to the **CREATE** drop-down menu and select the **Hole command**.
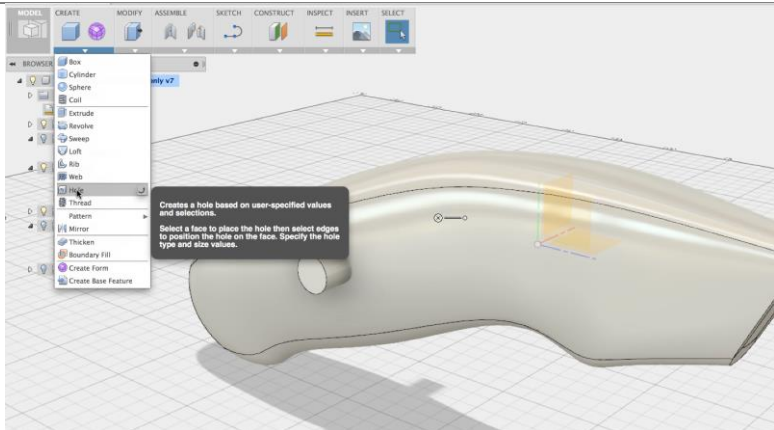
Step 36

1. Rotate around the model so you see the left side of the knife.
2. Hover over the surface of the cylinder body until you see a center point appear.
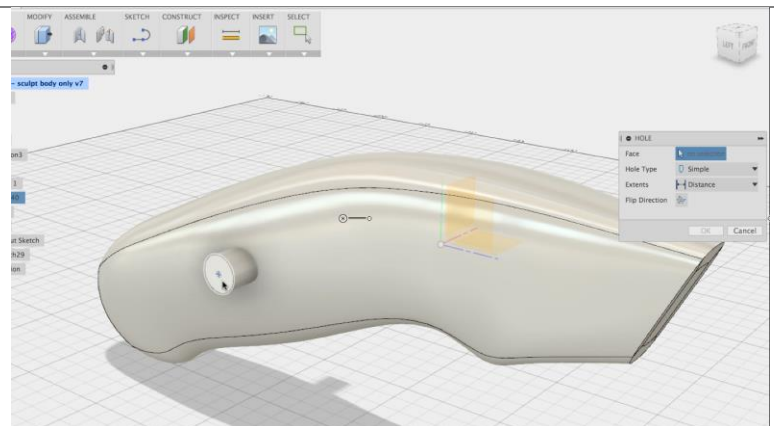
Step 37

1. Click on the surface with the center-point visible. This will snap the hole to the center-point.

2. In the command dialog, change the **hole-type** to **Counterbore**.
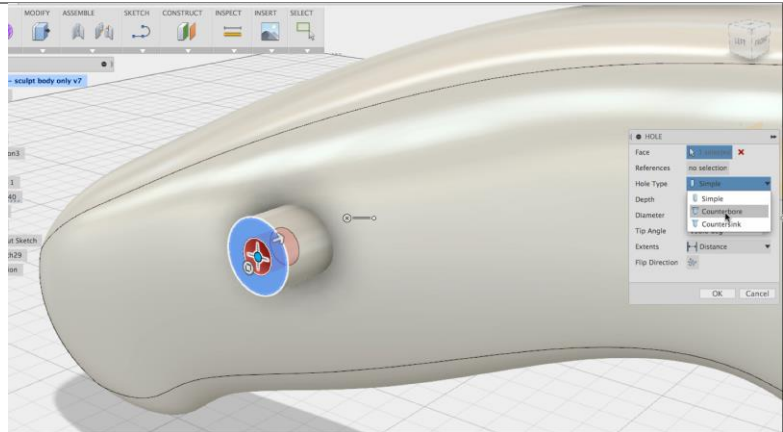
Step 38

1. Drag the arrow that determines the depth of the hole to **28 mm**.
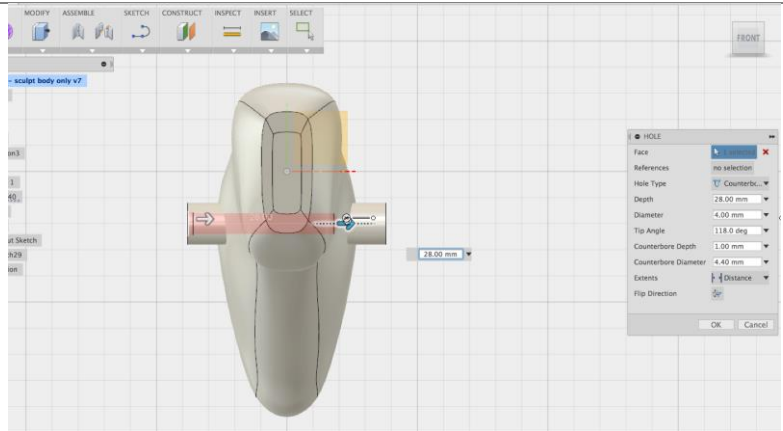
Step 39

In the command dialog, set the diameter of the hole to **3 mm**.
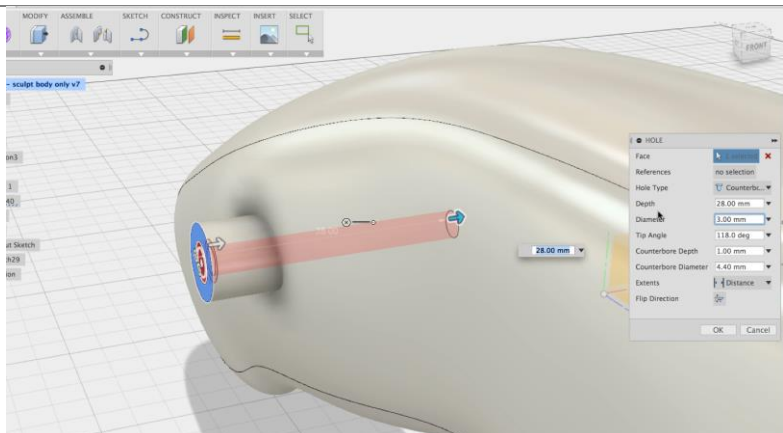
Step 40

1. Now drag the arrow that determines the depth of the Counterbore to **15 mm**.
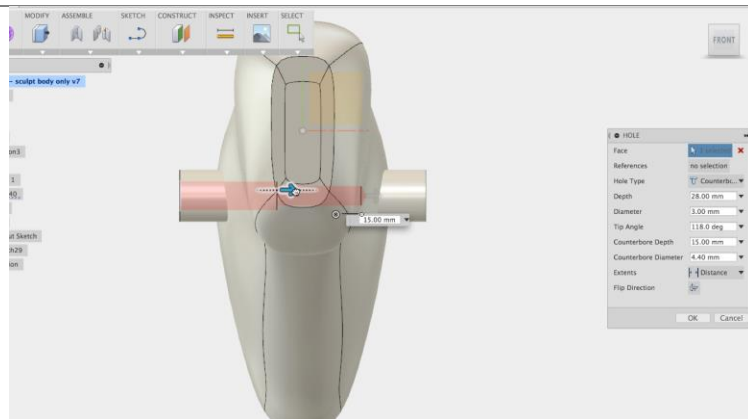
Step 41

1. In the command dialog, change the Counterbore diameter to **6 mm**.

Click **OK** to finish.
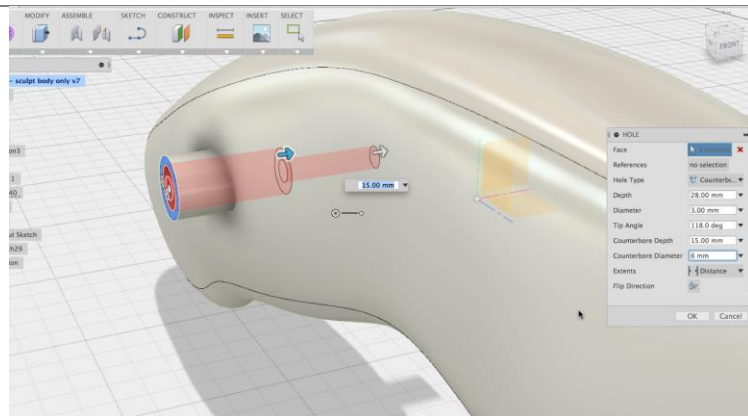
Step 42

We're now ready to split the body into 2 halves.

1. Go to the **MODIFY** drop-down menu and select the **Split Body** command.
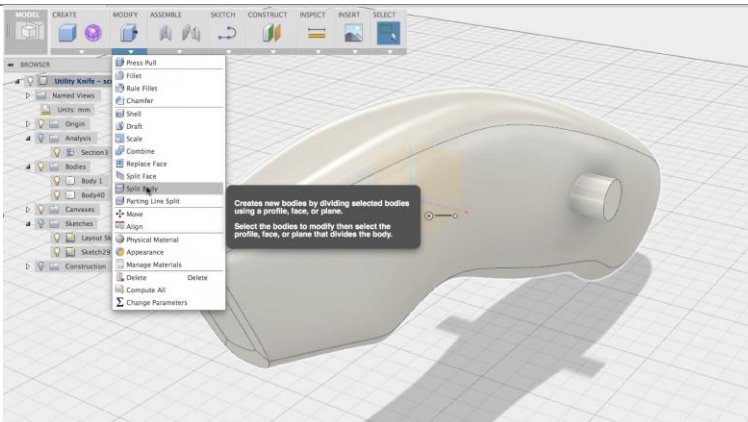
Step 43

1. Click on the knife body as the Body to **Split**.

2. Hover over the middle plane, click and hold the click until a selection dialog shows up. Choose the first Work plane as the **Splitting Tool**.
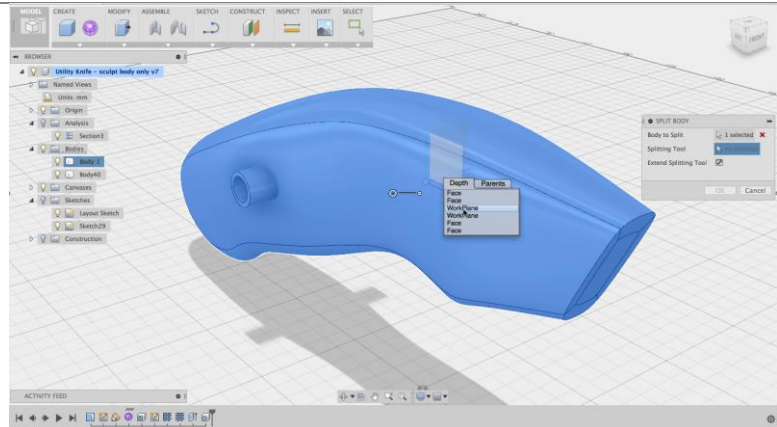
Step 44

You should see this as a result. Click **OK** to finish.
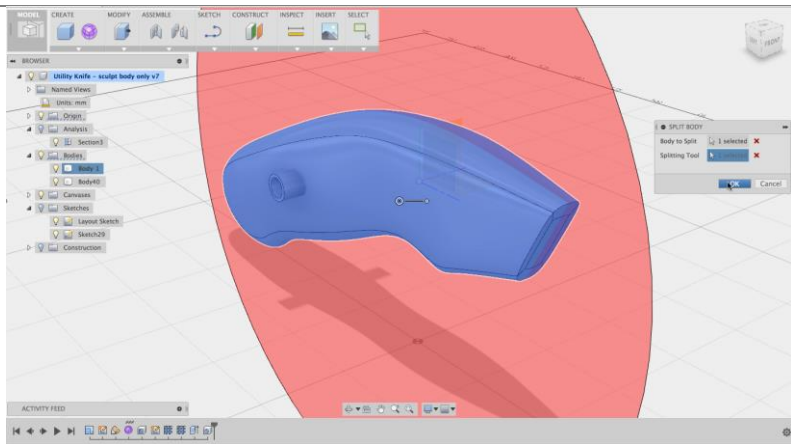
Step 45

Now that we split the knife body into two pieces, let's split the cylinder body as well.

1. Right click and select **Repeat Split Body**.
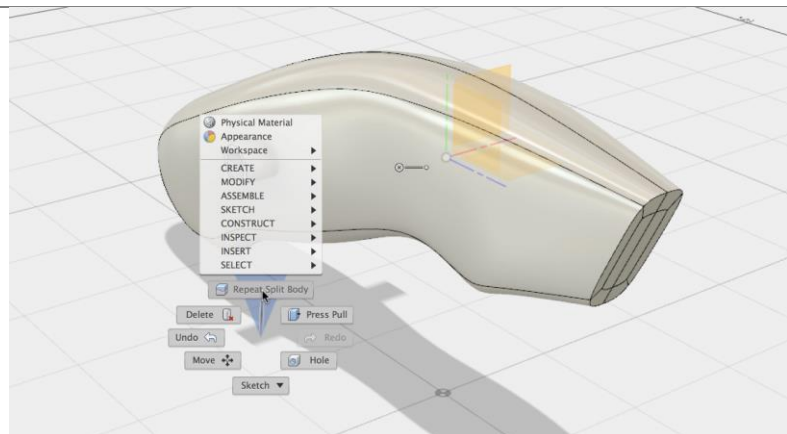
Step 46

1. Click on the **cylinder** body as the **Body to Split**.
2. Select the **middle origin** plane as the **Splitting Tool**. Click OK to finish.
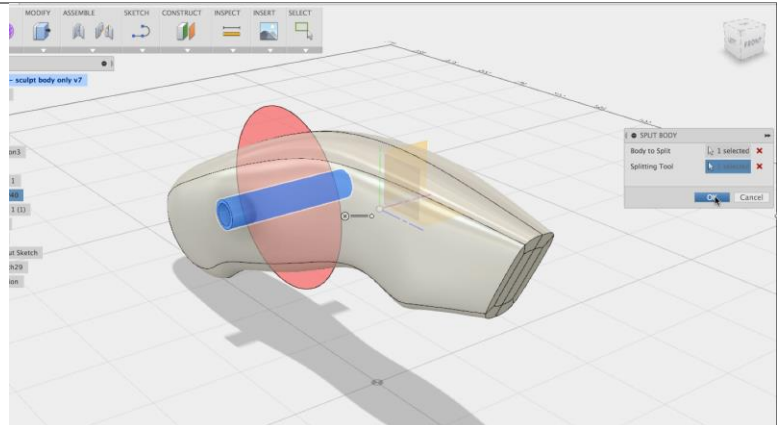
Step 47

After the split body commands, you'll see that you have 4 bodies in your Bodies folder in the browser. We'll want to combine the left cylinder with the left knife body, and the right cylinder with the right knife body so that we are left with two bodies total.

1. Hide the right side bodies so only the left side is visible.
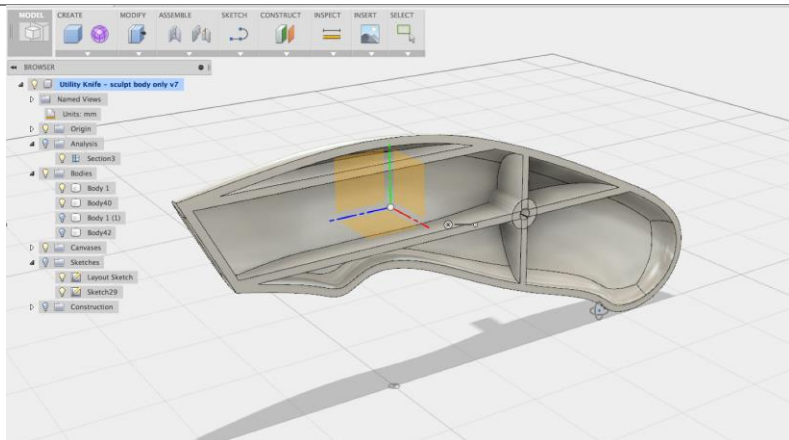
Step 48

1. Go to the **MODIFY** drop-down menu and select the **Combine** tool.

We're going to use this tool to join the knife body with the cylinder body where we have our counter-bore hole.
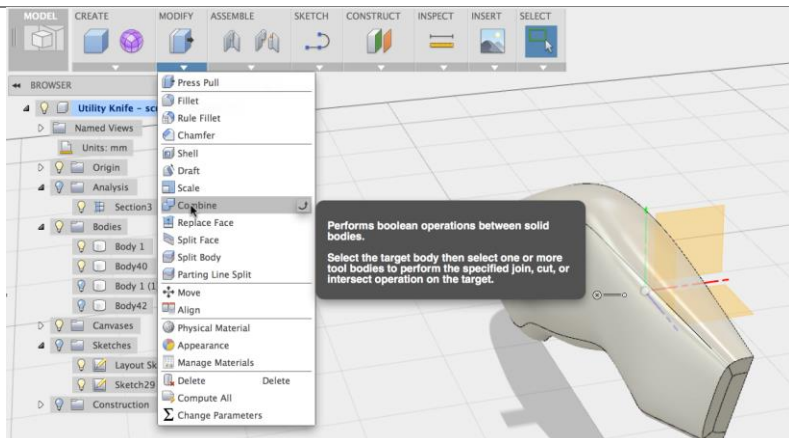
Step 49	
1. First, select the utility knife body as the **Target** body.	
Step 50	
1. Then select the cylinder body as the **Tool body** for the target body to combine with. 2. Leave the Operation as **Join** and then click **OK** to finish.	
Step 51	
1. Hide the left side and make the right side bodies visible. 2. Right click and select **Repeat Combine** to reuse the last used command, which was the Combine tool.	
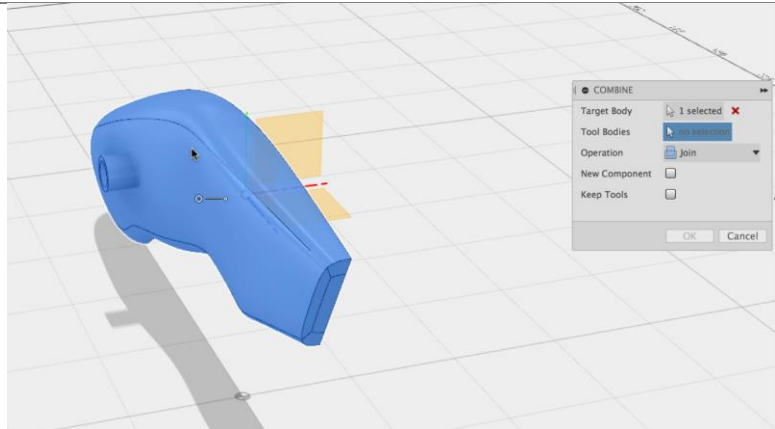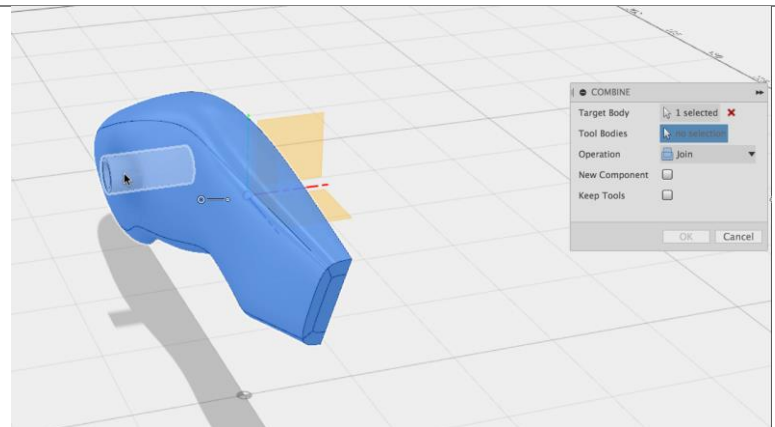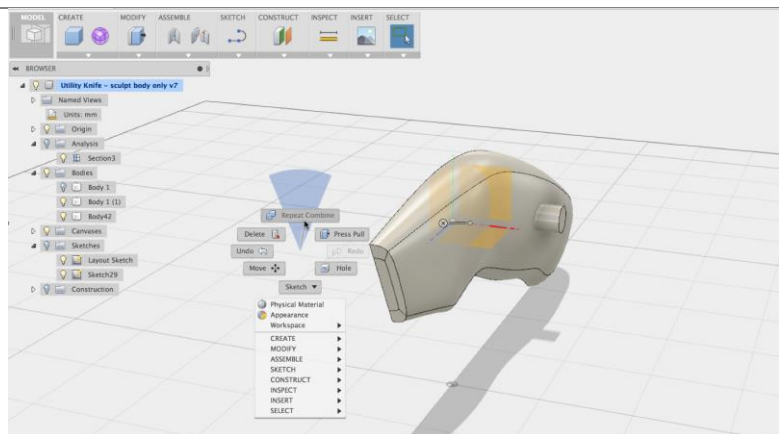
Step 52

We're going to repeat the last combine steps, but now for the right side bodies.

1. Select the knife handle as the **Target body**, and then select the cylinder as the **Tool body**.

2. Leave the Operation to **Join** and then click **OK** to finish.
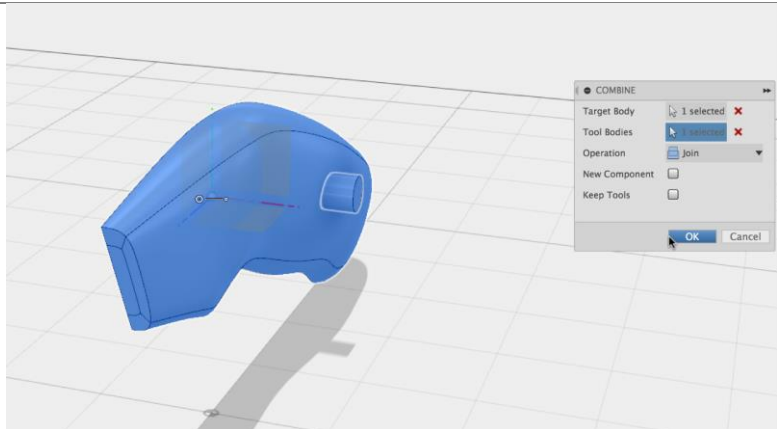
Step 53

1. Let's get rid of the 2 protruding cylinders by holding **SHIFT** and then selecting the 2 bodies.
2. Press **DELETE** or **BACKSPACE** on your keyboard and the 2 bodies should just go away.
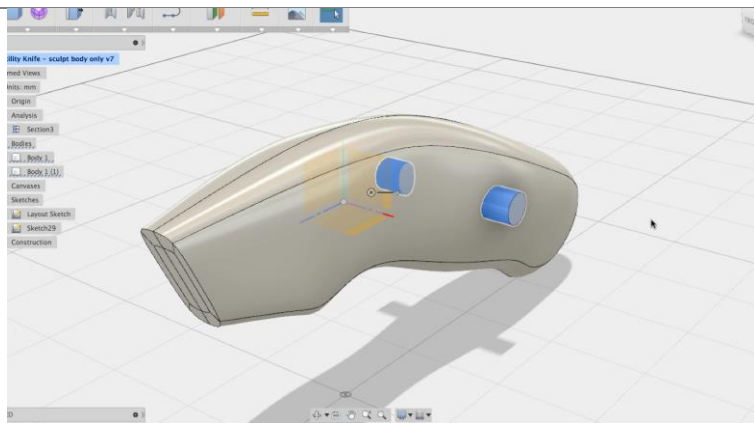
Step 54

Now you can see that the utility knife has a counter-bored hole that extends across the split bodies, just the way it would be manufactured.
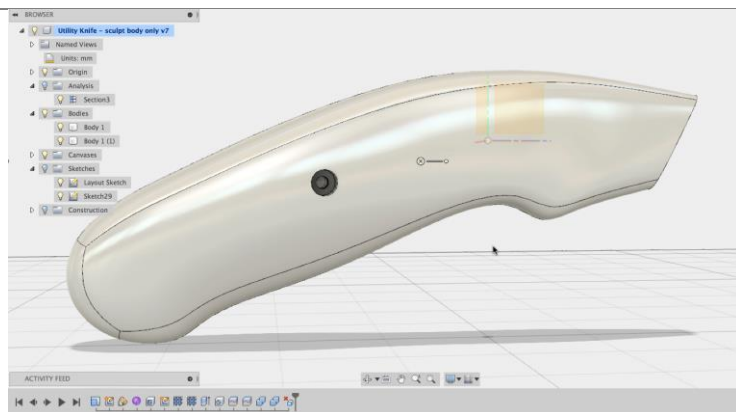
Step 55

Let's make a change!

1. Locate the sculpt operation in the timeline, right click and select **Edit**.

This will allow you to get back into the sculpt environment and make change to the knife body itself.
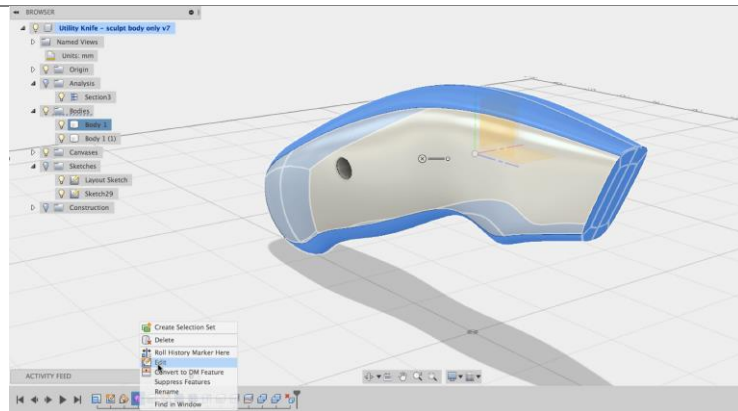
Step 56

1. Select **Left View** on the ViewCube

2. Click on the bottom surface

3. Right click and select **Edit Form**
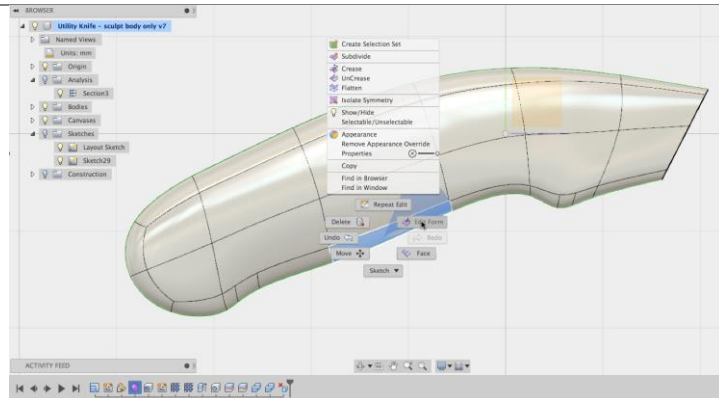
Step 57

1. Use the vertical arrow manipulator and drag the surface down to **-5mm**.
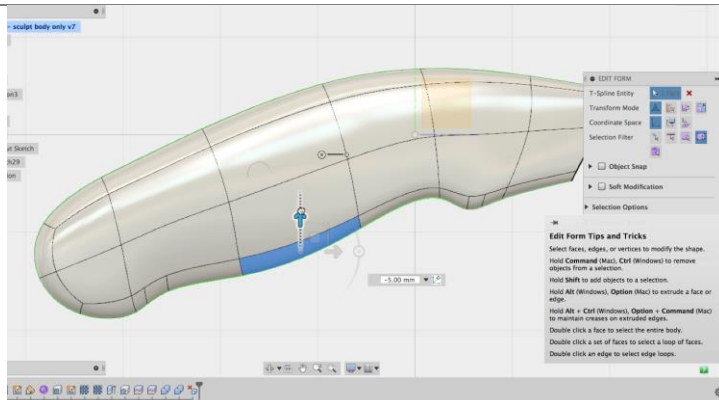
Step 58

1. Now select the lower edge of the finger guard, and again, use the arrow manipulator and drag that edge down **-5mm**.
Click **OK** to confirm.
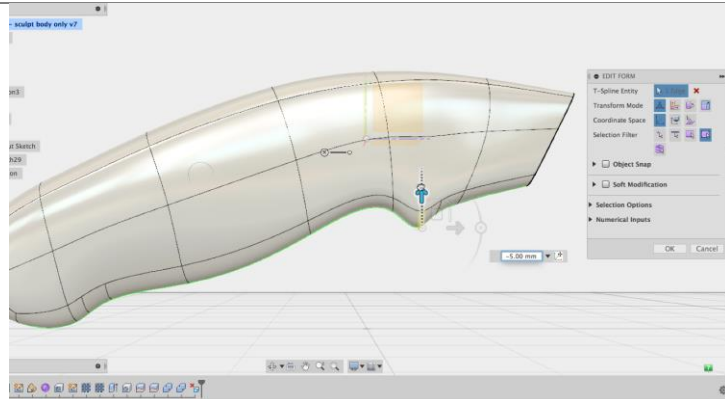
Step 59

1. Now click **FINISH FORM** to finish the changes.

2. Once clicked, the model will update automatically with all your downstream features still intact.
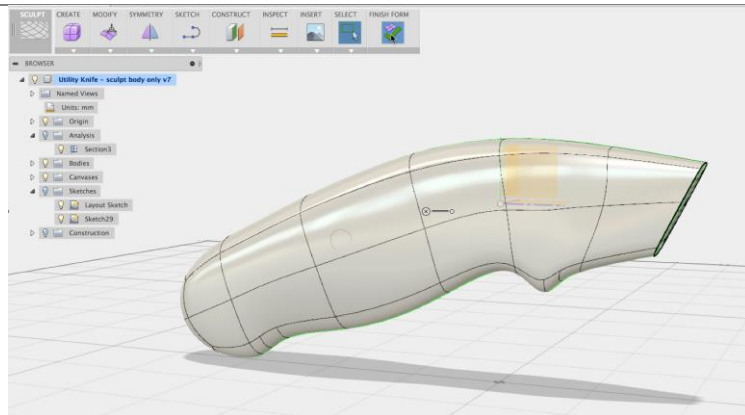
Step 60

1. Hide one of the bodies and notice that the webs and hole updated along with the change you made to the sculpted body.
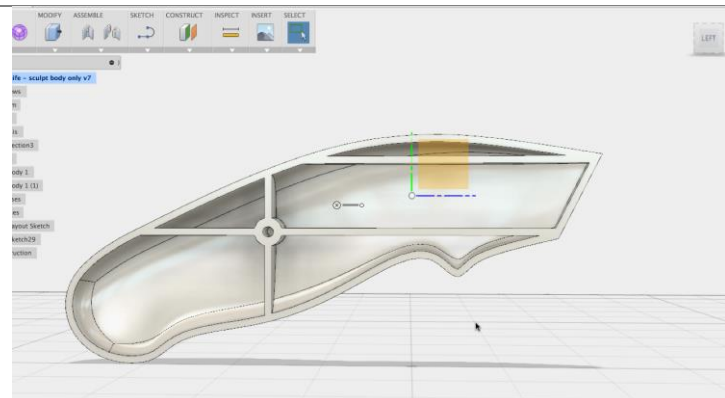
And we're done! Now that you know how the timeline works, you can select any of the commands used and make appropriate changes, such as web thickness, hole depth and diameter, shell thickness, as well as sketch dimensions.
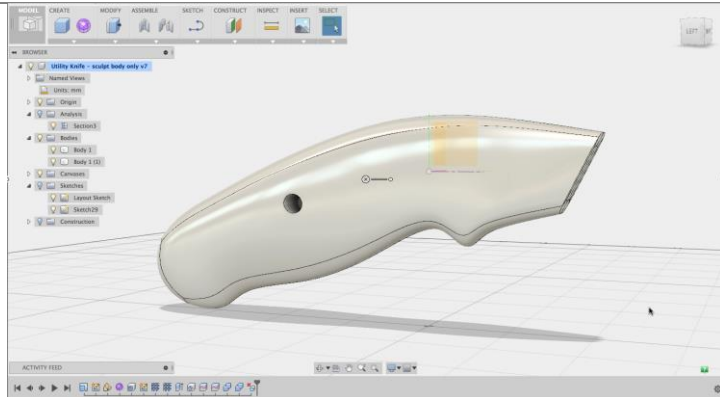
Organize and assemble model components
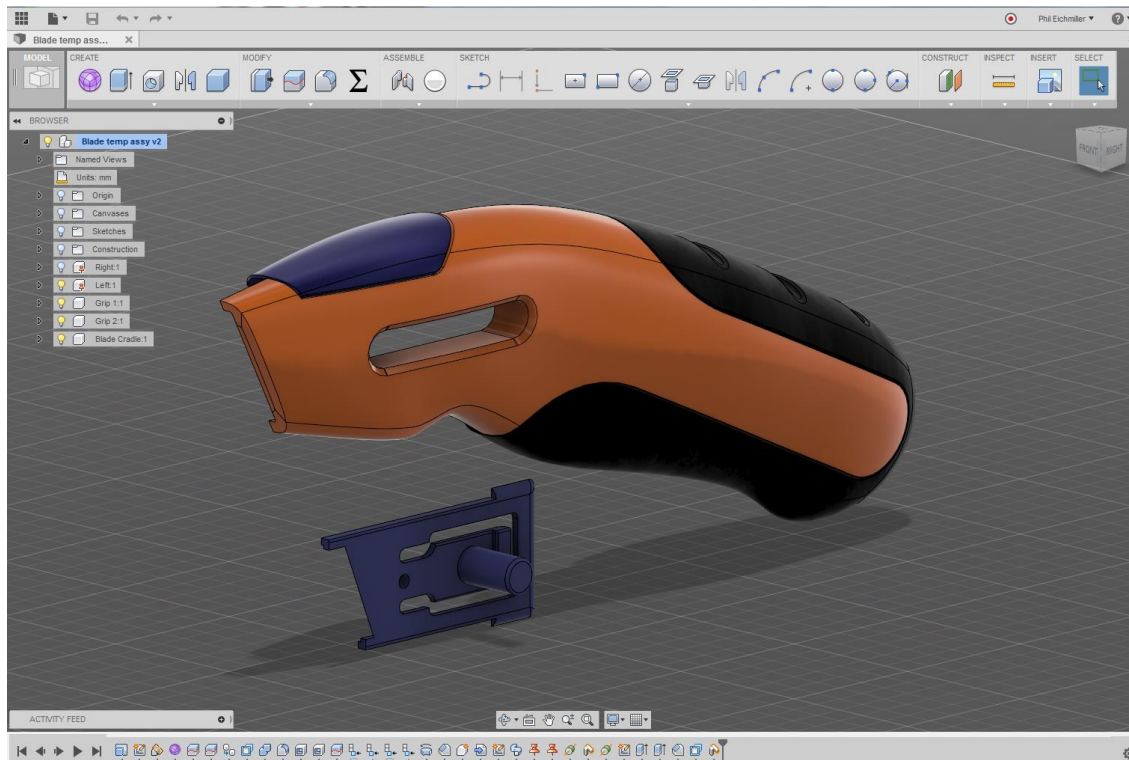
In this part of the class we perform some basic assembly operations to assemble the blade cradle to the knife body. We'll also insert the blade into this design and assemble it to the blade cradle.

Before moving on, make sure you have the **03_Utility_Knife_blade_assembly** design open and in your design environment.

If you'd like to watch the video to this tutorial, click here: **Launch Video**

Step 1 Let's start by applying a joint between the blade cradle and the knife body. 1. Go to the **ASSEMBLE** menu and select the **Joint** command. 2. Select Pin-Slot as the joint type	
Step 2 1. Select the middle joint position on the blade cradle pin. 2. Select the middle joint position on the knife body slot, on the side for the blade to be fully retracted.	
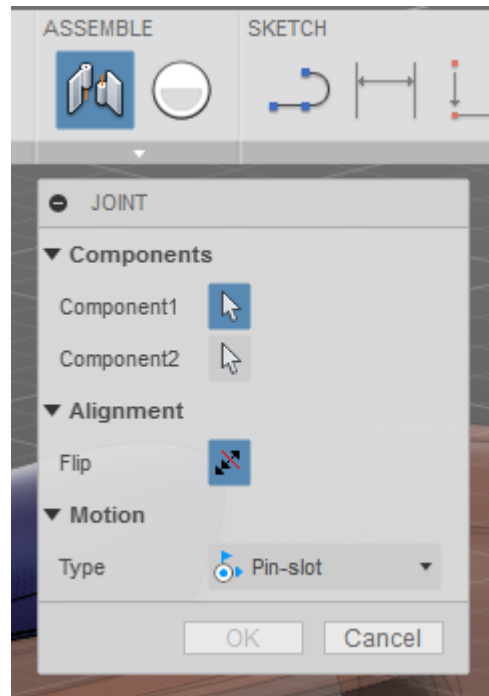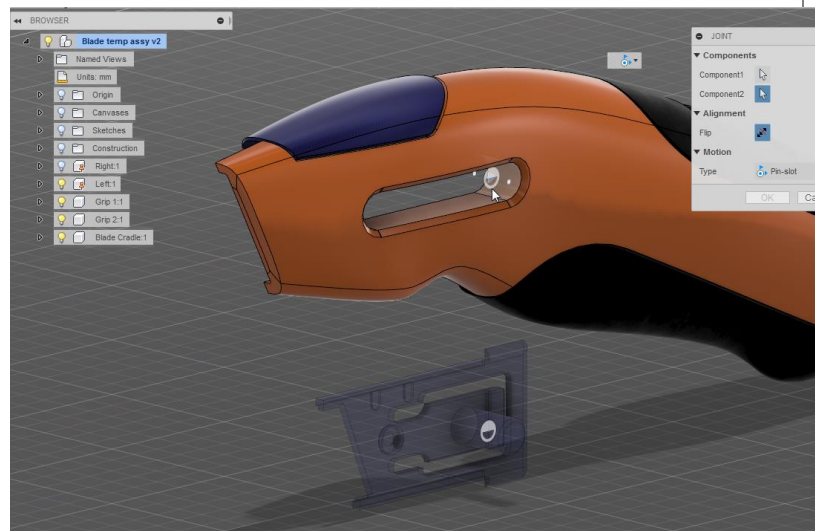
Step 3

1. Enter -1.5mm for the offset.
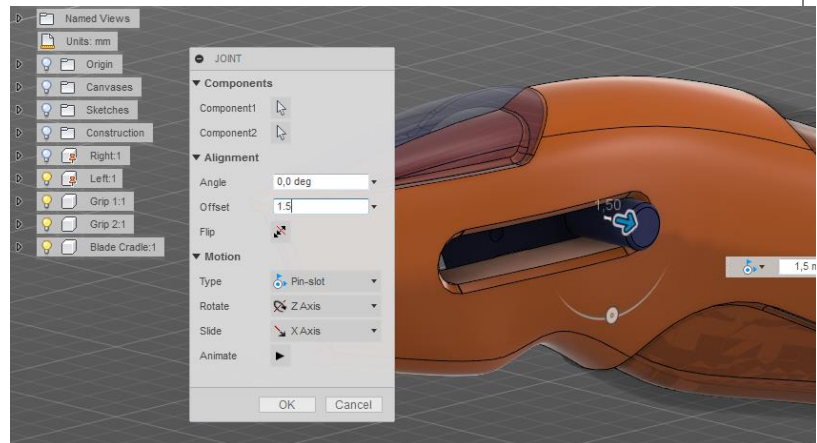
Step 4

1. Find the joint in the browser, use the attached tool to edit the joint limits.
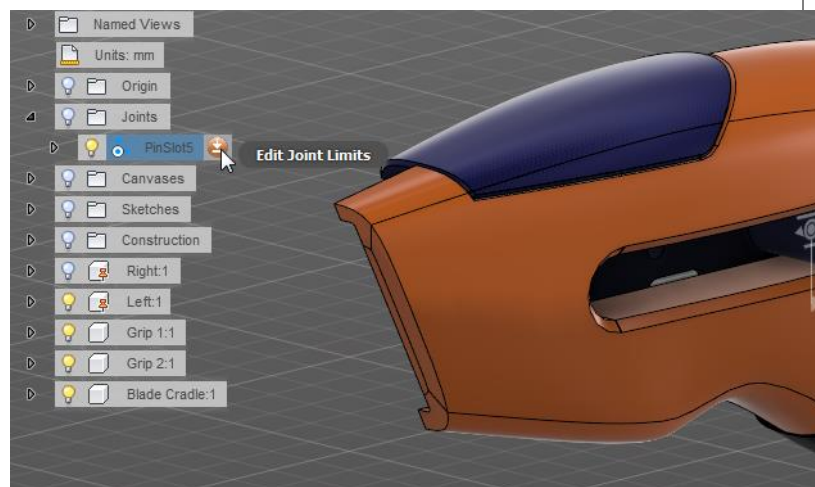
Step 5

1. For Rotation, just click once to set min and max to 0°.

2. For Slide, set min to 0 and max to 28mm

3. Slide it back and forth; click Revert on the snapshot panel, so as not to capture unwanted assembly positions.
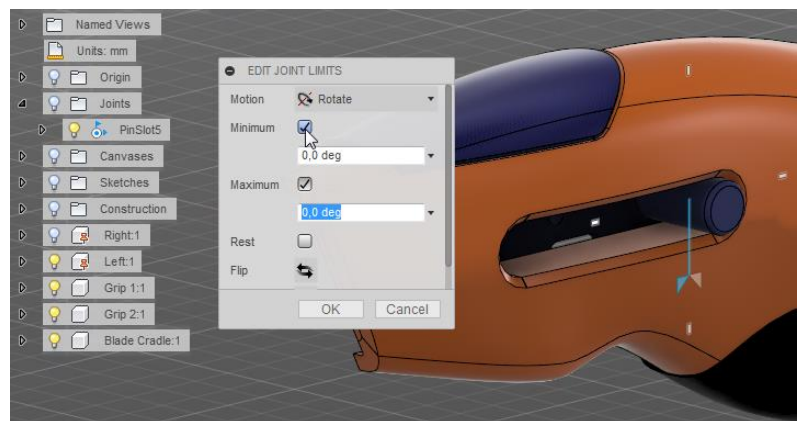
Step 5

Time to insert the blade and assemble it to the cradle.

1. Go to the data panel, find the model: **03_blade**, right click on it and pick Insert.

When the blade inserts, click OK to accept the default insert location.

CD7017-L Intro to Fusion 360 ▾

03_blade

Open
Insert
Create Toolpath
Create Drawing
Share Public Link
Import New Version
Rename
Delete
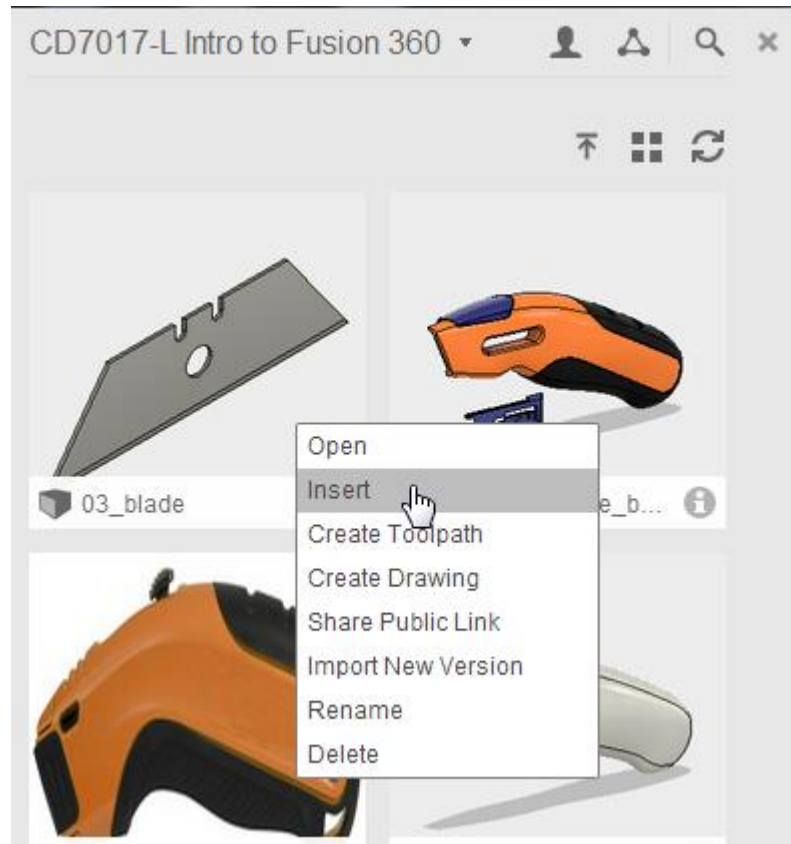
Step 6

1. From the assemble menu pick Joint. Use Rigid joint type.

Named Views
Units: mm
Origin
Joints
PinSlot5
Canvases
Sketches
Construction
Right:1
Left:1
Grip 1:1
Grip 2:1
Blade Cradle:1
03_blade v1:1

JOINT
▼ Components
Component1
Component2
▼ Alignment
Flip
▼ Motion
Type   Pin-slot
              Rigid
              Revolute
              Slider
              Cylindrical
              Pin-slot
              Planar
              Ball
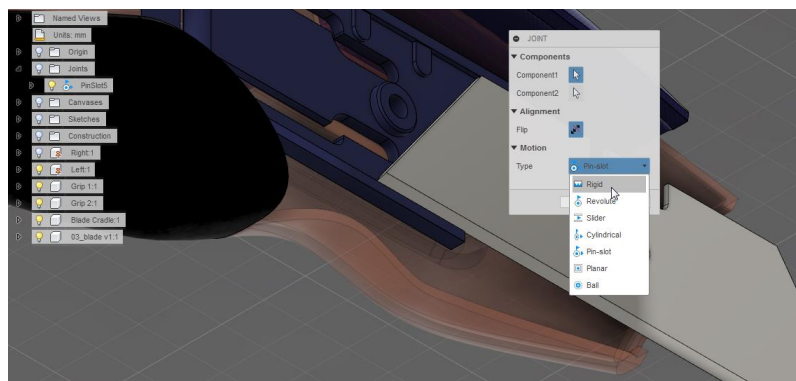
3. For Component 1, select the hole edge on the blade, on the side nearest the cradle. 4. For Component 2, select the root of the pin on the blade cradle. 5. Drag the cradle back and forth!	(images below)
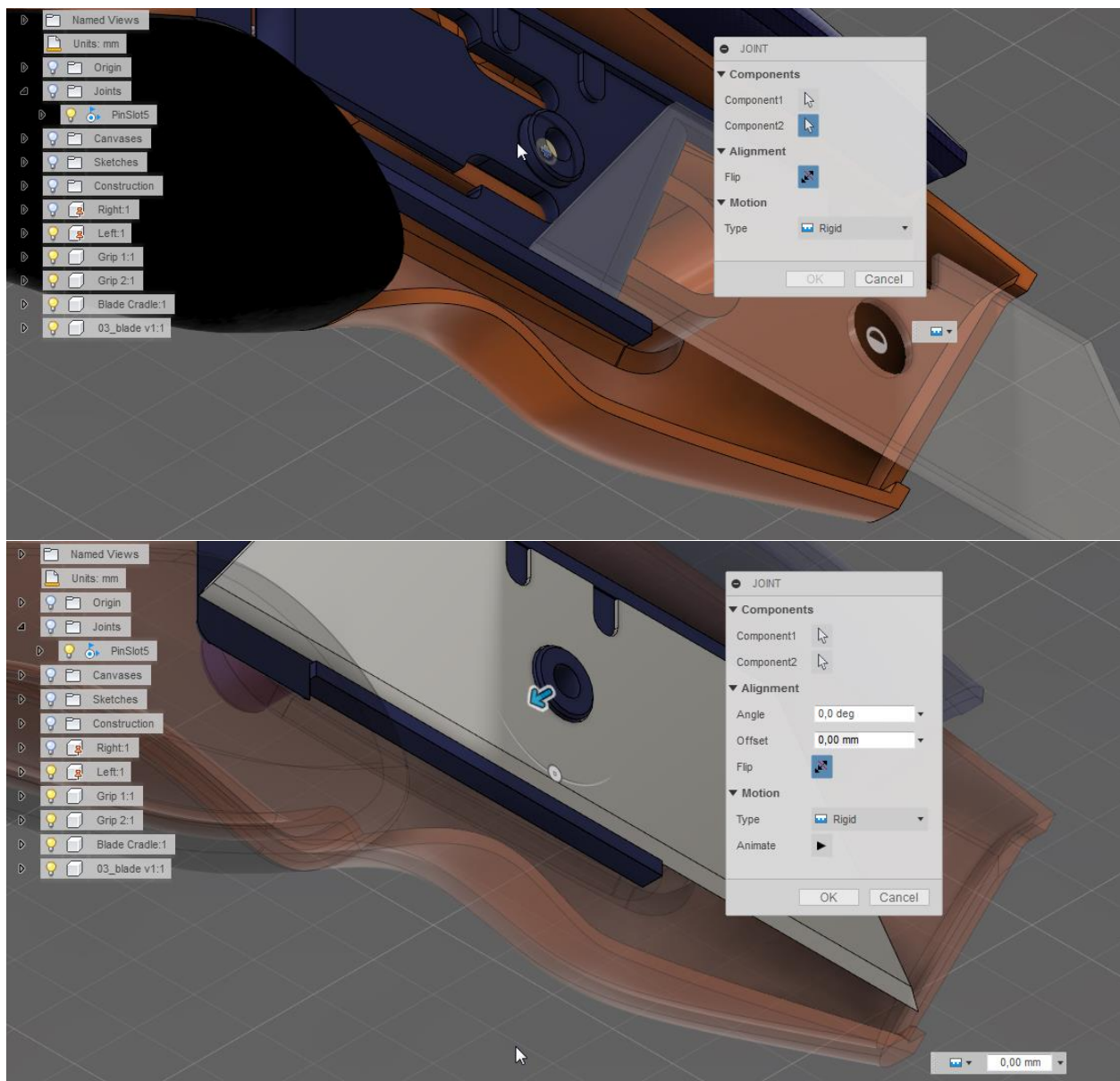
Apply materials or appearances and render the model

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 photo-realistic 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. 1. The Data Panel will slide open.	
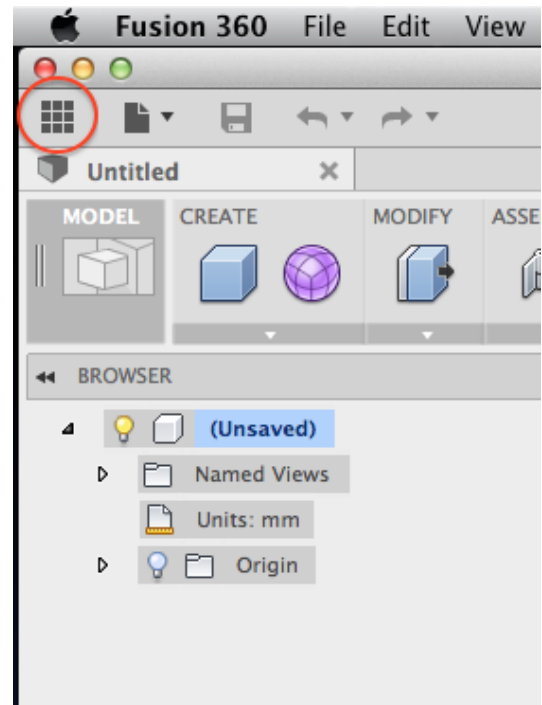
Step 2 – Open the design 1. At the top right of the Data Panel, select project from the project drop down list. 2. Double-click on the design called **04_RenderUtilityKnife** to open the design in Fusion 360. 3. When the design has opened in your modeling window, click on the icon to close the Data Panel.	
Step 3 – Go to Render Workspace 1. Click on the Model icon in the left of the workspace 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	
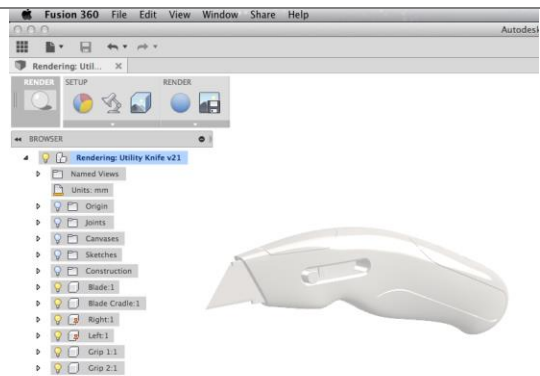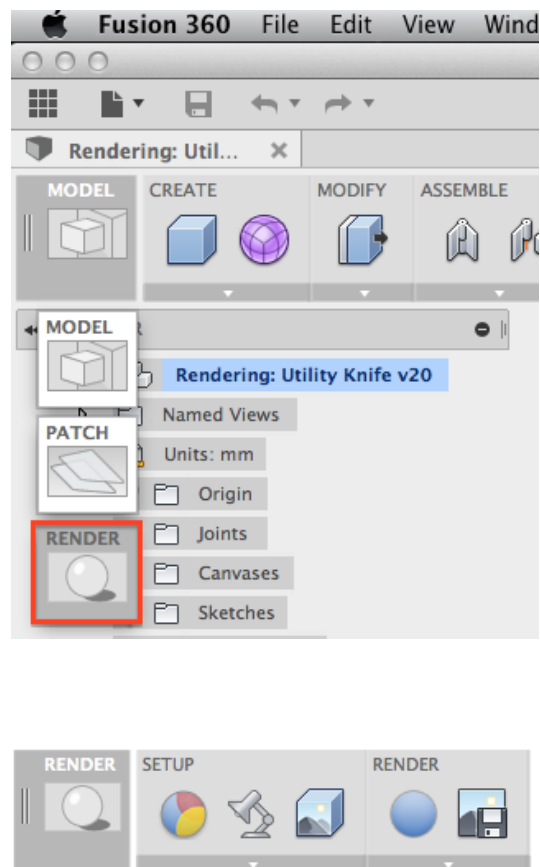
Apply Materials

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.	
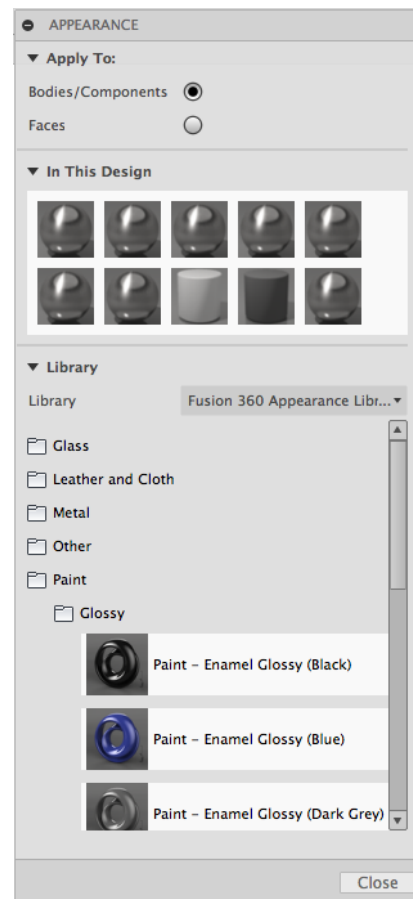
Step 2 – Apply a Material directly to geometry

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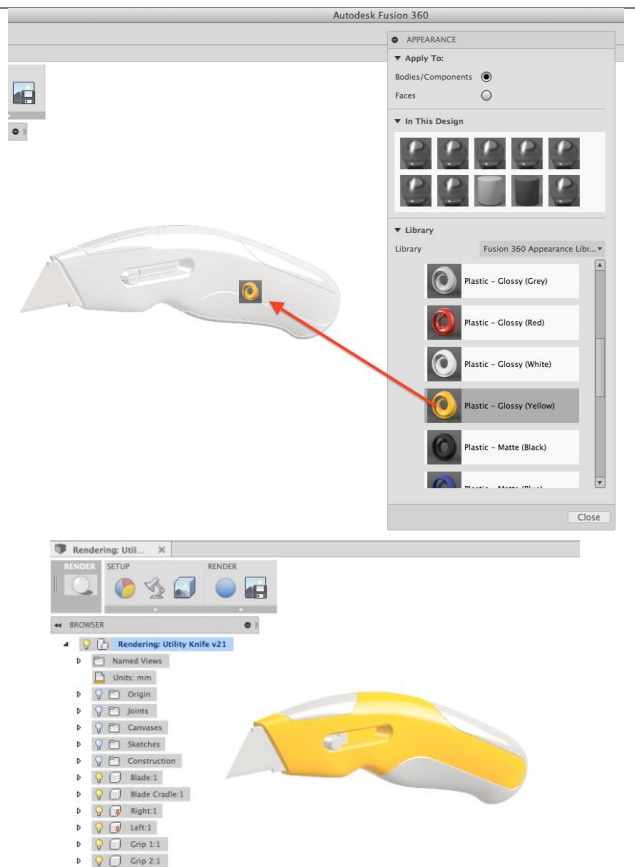
Step 4 – Apply a material to a body in the browser

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**

TIP: To assign a material to all of the bodies in a component, drag the material to the top-level component in the browser.

52
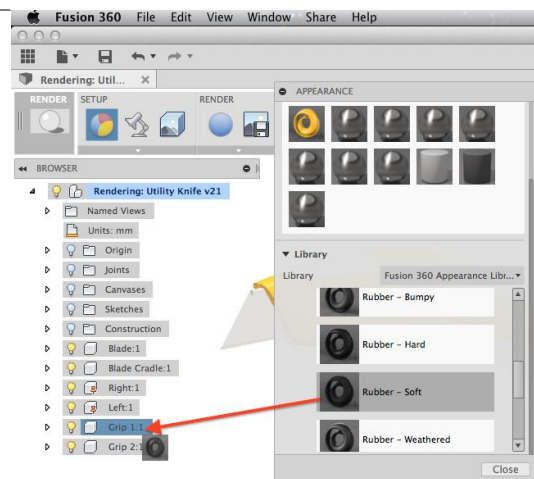
Step 5 – Apply additional materials

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**

NOTE: _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
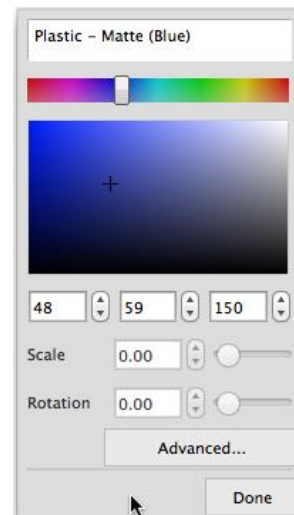
The options in the advanced editor will differ depending on the material you are editing. The example below is for textured plastic.
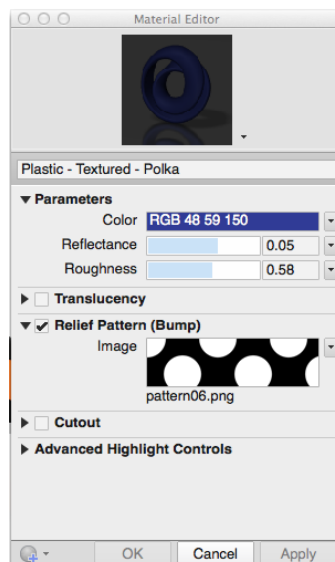
Texture Mapping is a process in which a 2-D image called a *texture map* is wrapped around a 3-D object. In the physical world this is similar to applying wallpaper or veneer to a real object. The texture map can be used to change various properties of a material including the color of the material as 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
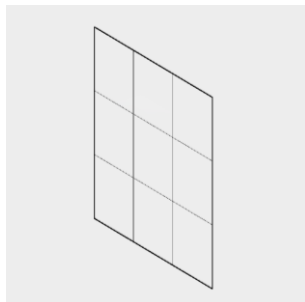
The texture map is projected from a plane in a user defined direction
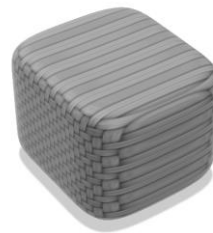
Box
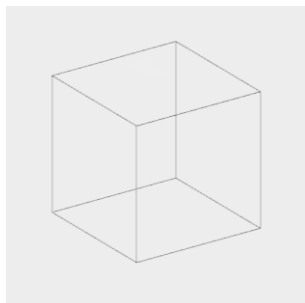
The texture map is applied to a cube that surrounds the object and creates 6 planar projections
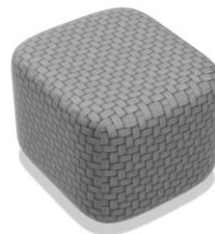
Sphere
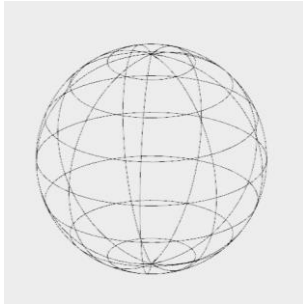
The texture map is applied to a sphere that surrounds the object. This projection type will show a poll pinch point depending on the axis defined by the user.
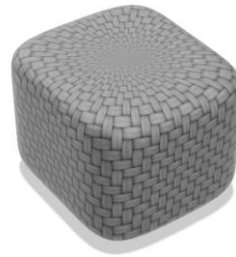
Cylindrical
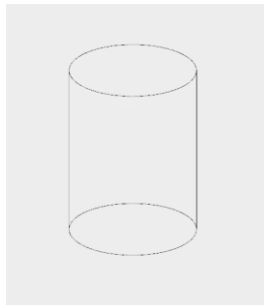
The texture map is applied to a cylinder that surrounds the object.

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. *TIP: 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.*	
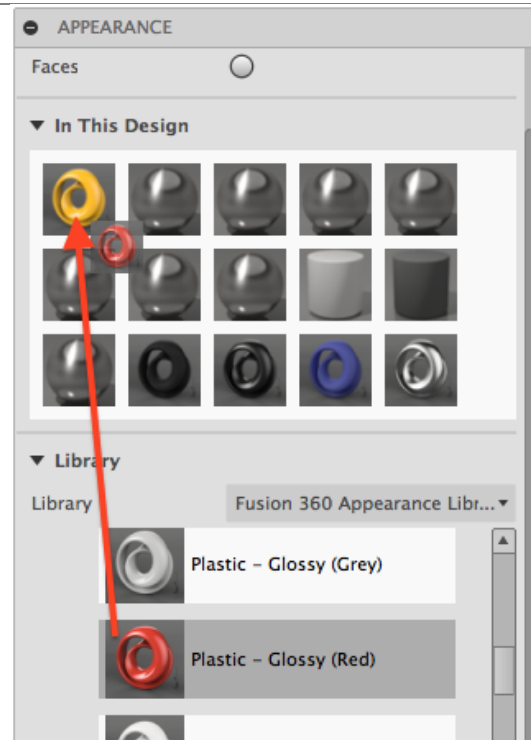
Step 2 – Edit Plastic – Glossy (Red)
 	
1. Double click on the swatch for **Plastic – Glossy (Red)** in the "In this design" section of the Appearance dialog box to open the editor window for this material.
2. At the top of the dialog box is the current name assigned to the material – double click in 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.	
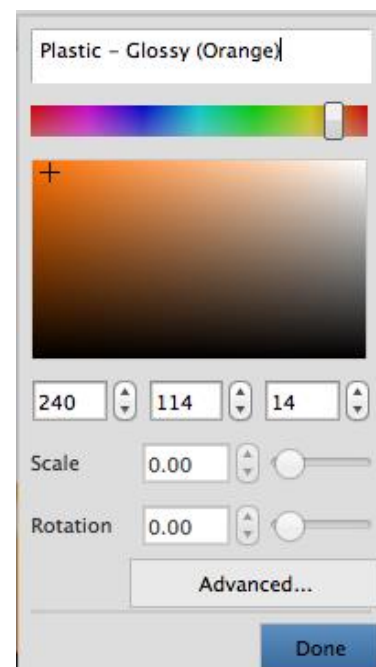
You should now see the swatch for the edited material in the **In This Design** section of the Appearance dialog box. If you hover over the swatch the modified name will appear. *TIP*: *If you want to see which materials have been applied to which bodies in your design you can right click on the swatch and pick **Select Objects Applied To** from the drop down list. Doing so will highlight bodies in your design that have the selected material applied.*	
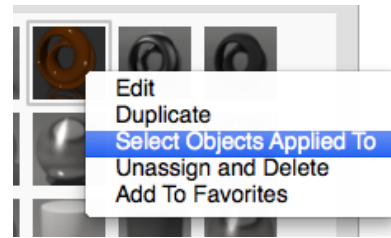
Step 3 – Edit **color and texture map for Plastic – Texture – Polka**
 	
1. Change the name to **Textured – Polka - Blue**
2. Using the method of your choice change the color of **Plastic – Textured – Polka** to blue.
   a. If you wish to match the blue of the blade cradle enter the RGB values of **48, 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 interactively change the orientation of the texture map. When you are satisfied with the orientation, click the **Done** button.	
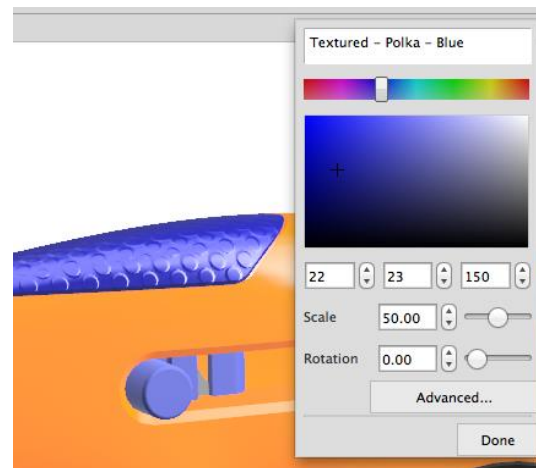
Step 4 – Change the texture projection method for Grip 2:1

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.

TIP: 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.
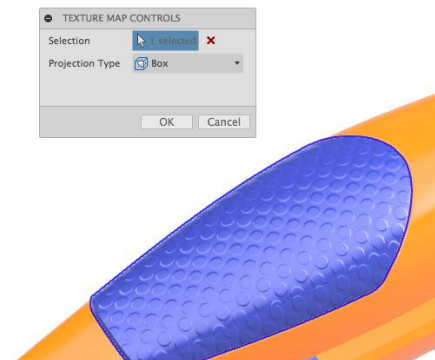
Step 5 – Edit and Duplicate a material

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 Steele – 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 **.50**.
9. Click on the Ok button to close the window.
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
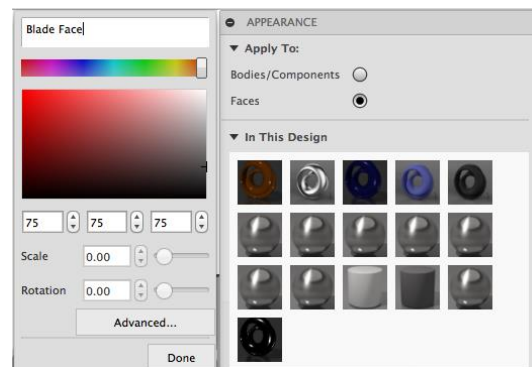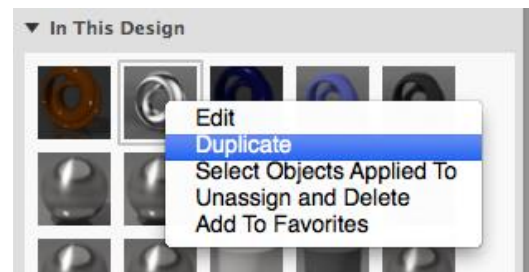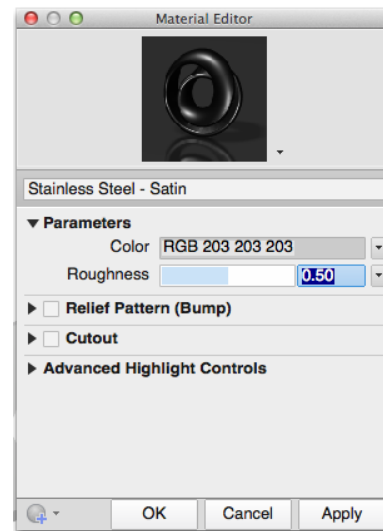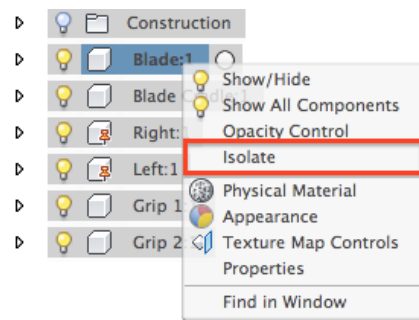
15. Drag the Blade Face material to the side face of **Blade:1**
16. Repeat this step on the other side of **Blade:1** so that both side faces have Blade Face applied.
17. Close the **Appearance** dialog box.
18. Right-click on **Blade:1** in the browser and select **Unisolate** from the drop down menu list 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.
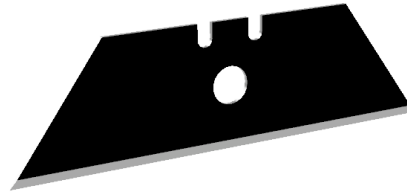
Apply a Decal

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** and double-click on the information icon to launch A360. 2. Click on the blue Download button on the upper right side of the window 3. Place the file in a location where you can easily find it. Your desktop for example.	
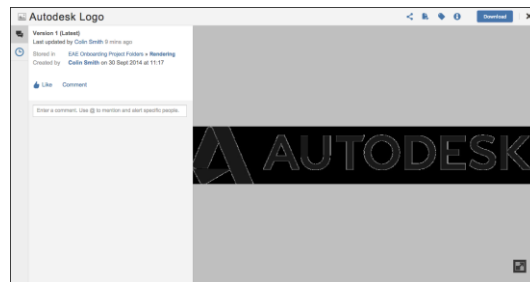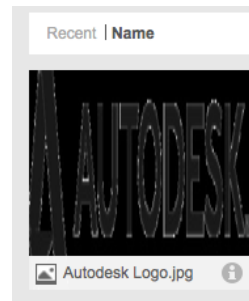
Step 2 – Apply the decal
 	
1. In the **Render** toolbar select **Setup – Decal**
   a. The Decal dialog box opens.
2. Click on the body of the utility knife to highlight it. This is the surface you will apply the decal to.
3. In the **Decal** dialog box click on **Select Image**
4. From the file menu 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 widget 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.	
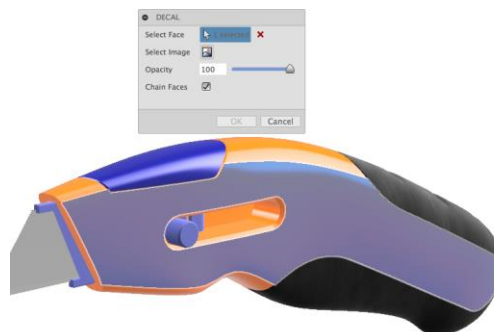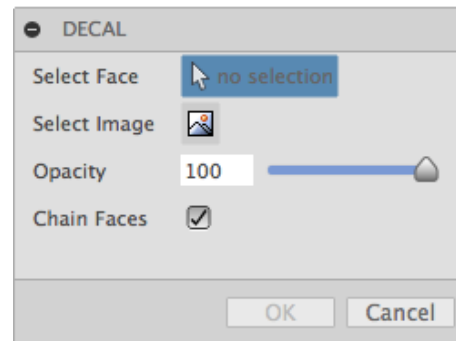
Step 3 – Adjust the decal

1. Adjust your view of the knife so that you can see the side of the handle
2. Use the **rotate** handle on the widget 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 on the OK button 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.
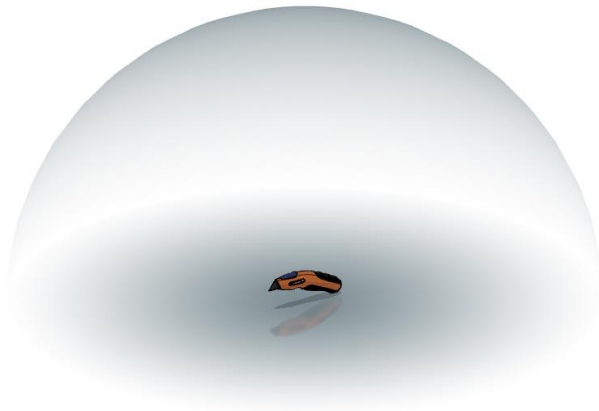
In this section we will choose the environment, change the background color and turn on effects.

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 8 maps to choose from. 6 of them are designed to simulate a photo studio set up. The remaining 2 (Plaza and Snowfield) are HDR photos of outdoor environments.

4. In the Render workspace click on **Setup > Environment**.
    a. There are 3 main sections to this tool:
        i. Environment
        ii. Background Color
        iii. Effects
5. Select several styles from the dropdown list. Notice that the reflections change as well as the pre-assigned background color for each style.
6. From the Style dropdown list select **Sharp Highlights**.
7. 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
8. 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.
9. 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**.
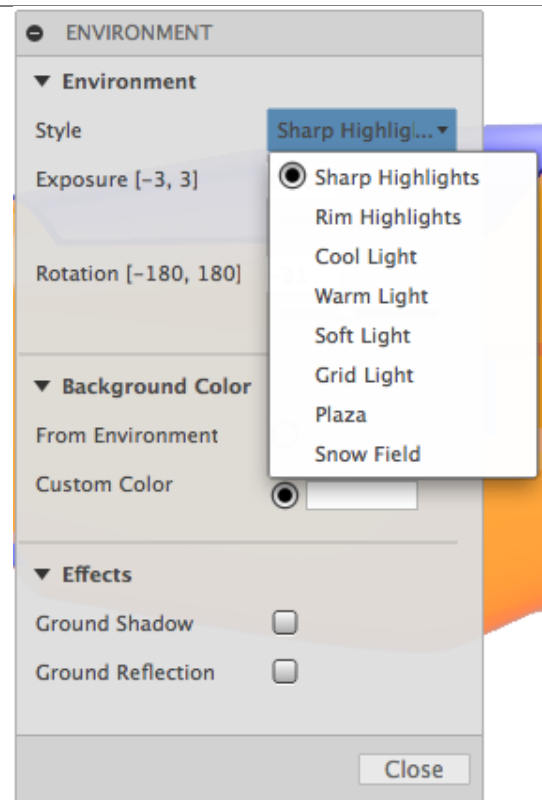
Step 3 – Choose a background color

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.

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

NOTE: 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
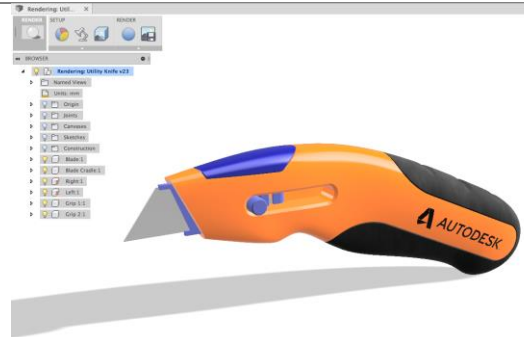
GPU rendering in your modeling window (See Rendering section for definition of GPU rendering) and will not affect the results of Rapid Ray Tracer or Cloud renderings.	

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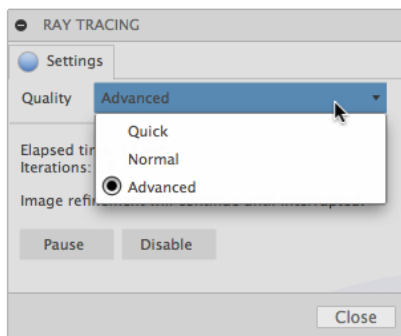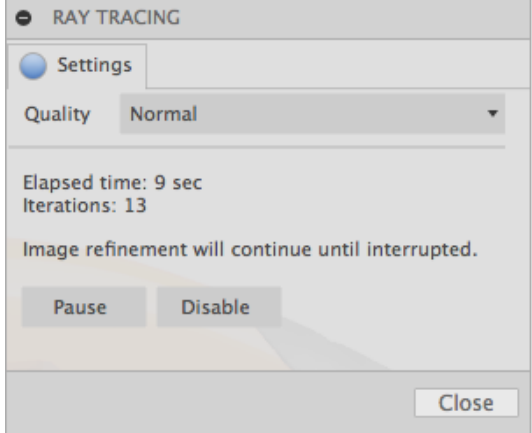
Quick*: At this setting the materials in the scene are approximated as either completely polished or completely diffuse and completely ignores indirect light. In the rendered image you will see reflections but you don't get any indirect light. This can be considered as a type of enhanced GPU mode.*

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.*

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.

Step 1 – Start the Rapid Ray Tracer 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** Settings Quality Normal Elapsed time: 9 sec Iterations: 13 Image refinement will continue until interrupted. Pause Disable Close (Sample screenshot)

Step 2 – Change the Quality setting
 	
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.	

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.*
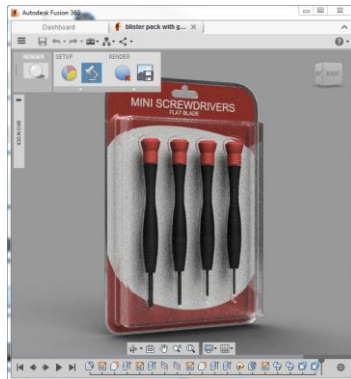
*Advanced Mode – 50 iterations*
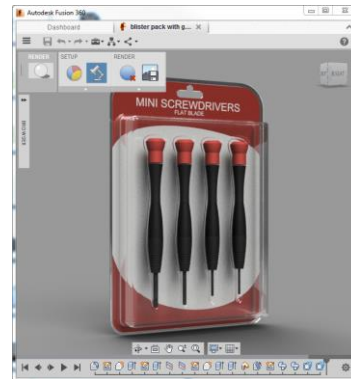
Advanced Mode – 500 iterations
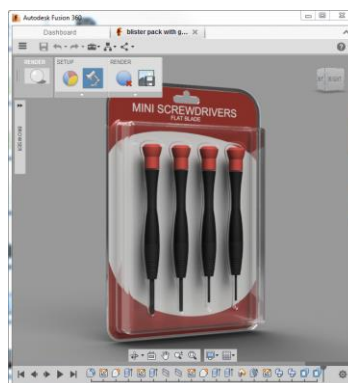
Advanced Mode – 5000 iterations

For the image above a range of 1500 – 2000 iterations should be sufficient to create a high-quality image.

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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.** *NOTE: You can also click on the **Disable Ray Tracing** icon in the tool bar to disable the render.*	
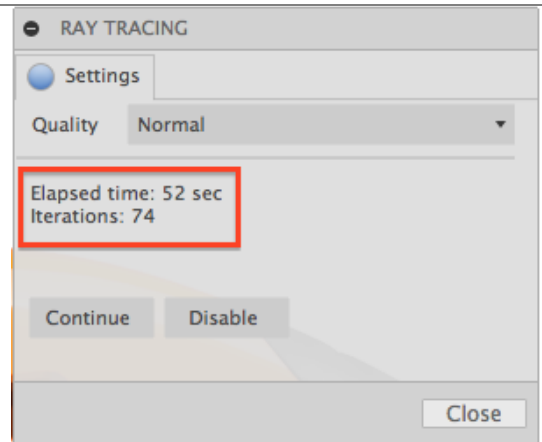
Step 4 – Create a Normal quality Ray Trace and Capture an image.
 	
1. From the Render toolbar select **Render > Enable Ray Tracing**.
2. Change the Quality setting to Normal
   a. Let the Ray Tracer run for about 120 seconds or until you are satisfied with the look of the rendering.
3. Hit the **Pause** button in the **Ray Tracing** dialog box.
4. From the **Render** toolbar 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.
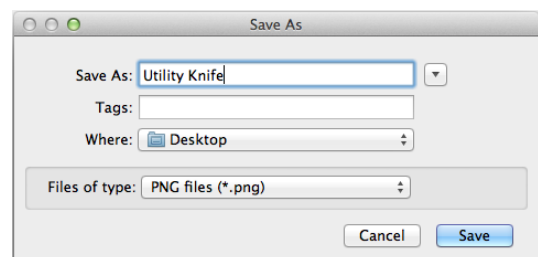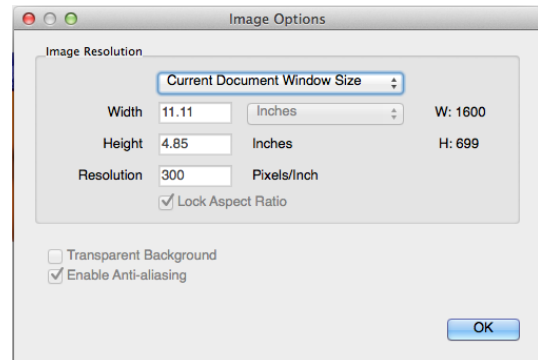
A360 Cloud Render is also a ray trace renderer that uses the cloud resources in A360 to do the image calculation rather than your desktop resources so you can continue to work while the images are being created. The cloud renderer automatically creates small sized rendered images based on the Top, Front, 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.

| 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**
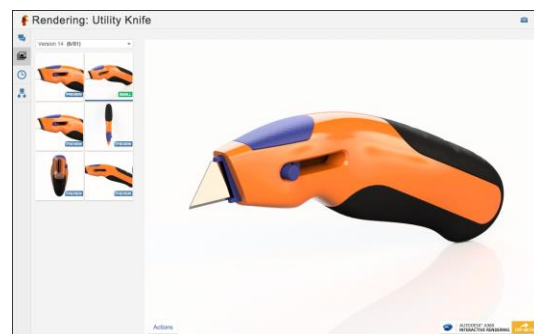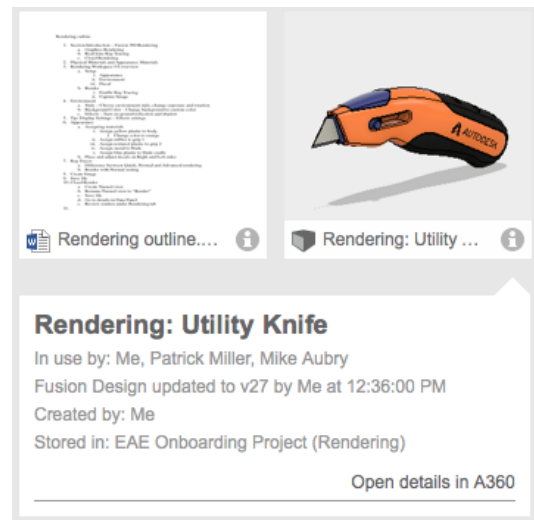
Step 2 – Create new Named View

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.

TIP: *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**.
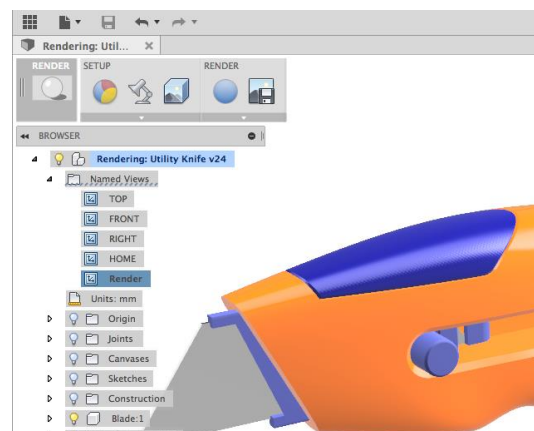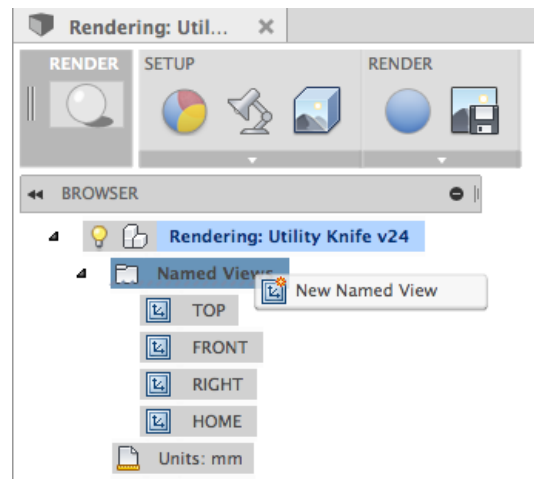
Step 3 – Download the image from A360 1. Following the previous steps navigate back to the thumbnails of the **A360 Cloud Render**. a. A new thumbnail has been added called **Render.** 2. Select any of the rendered thumbnails to see the larger image in the middle of the screen 3. Click on the Actions button at the bottom of the window. 4. Select Download Image from the menu NOTE: 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.	
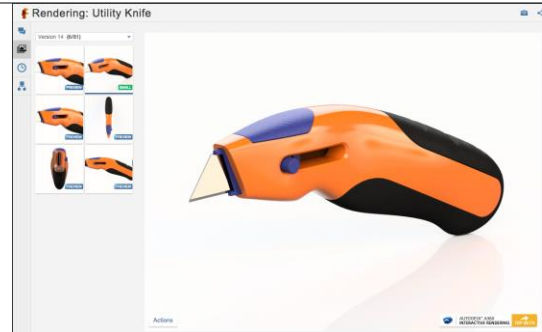
Thank you from Autodesk and the Fusion 360 team!