3.1: Sculpting

Sculpting in Fusion 360 allows for the intuitive freeform creation of organic solid bodies and surfaces by leveraging the T-Splines technology. In the Sculpt Workspace, you can rapidly explore forms by simply pressing and pulling on subdivided surfaces. This "hands-on" approach to 3D modeling allows for fast iteration and early stage conceptualization within Fusion 360. Sculpted forms are easily converted to solid bodies, and can be used in conjunction with Fusion 360's solid modeling commands. Modeling with T-Splines is unlike any other subdivision-modeling tool. One of the main advantages of T-Splines is the ability to add detail only where necessary - a single T-Spline surface can be incredibly smooth, while still having areas of high detail and remaining easy to manipulate.

Lesson 1: Creating T-Spline Forms

Learning Objectives

1. Create a T-Spline Primitive Form
2. Create a T-Spline Revolve Form
3. Create a T-Spline Sweep Form
4. Create a T-Spline Loft Form

Datasets Required

In Samples section of your Data Panel, browse to:

Fusion 101 Training > 03 – Sculpt > **03_Sculpting_Introduction.f3d**

Open the design and follow the step-by-step guide below to get started with the lesson.

Step-by-step Guides

Step 1: Go to the Sculpt workspace – Let's go to the Sculpt workspace to access the Sculpt tools.

1. In the Model workspace select **Create Form** to enter the Sculpt workspace
2. A dialog box appears, telling you to click **Finish Form** to return to the model workspace when you are finished sculpting.
3. Select **OK**
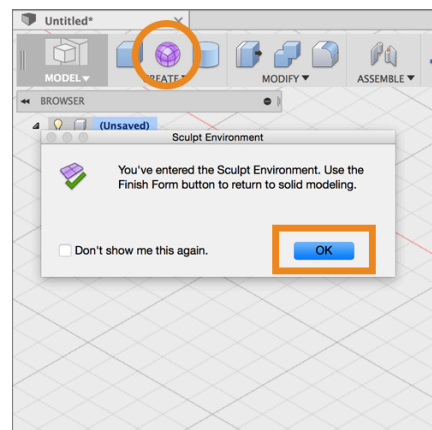
Step 2: – Select the T-Spline Box primitive

1. Select the drop-down arrow under **Create** to expand the list of creation commands.
2. Select **Box** to create a T-Spline box.
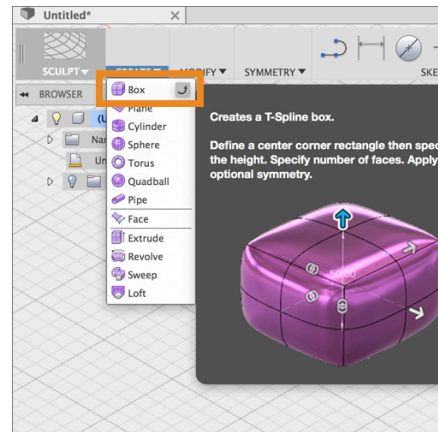
Step 3: Position the Box – When you create a new primitive you first need to indicate which plane you want to build on and then enter the dimensions of the primitive.

1. Select the bottom plane
2. Select the origin to specify the center point of the box 2D profile
3. Drag the mouse and click on the plane again to specify the initial size of the rectangle.
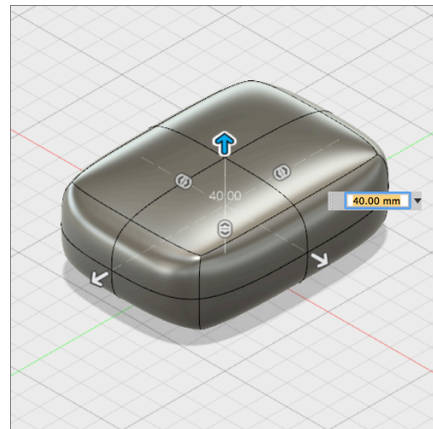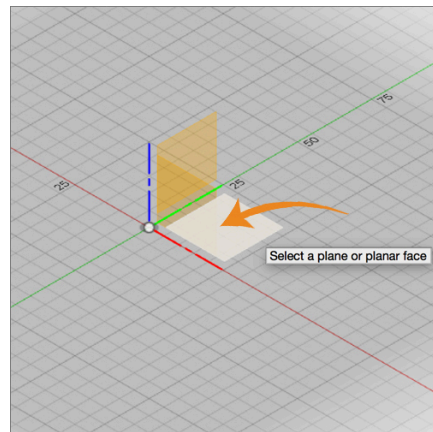
**Step 4:** Set the dimensions for the box

1. In the Box dialog window set the length to **175mm**, and the width to **150mm** respectively by entering these numbers.
2. Drag the arrow pointing up from the box, and set the height equal to **75mm**.

Note: When dragging a manipulator in Fusion 360 the increments for the move are tide to how close or far away the camera is to the manipulator. The closer you are the smaller the move increments, the farther you are the larger the move increments. If you find that the move is changing at too large of increments, simply zoom in to reduce the size of each step.
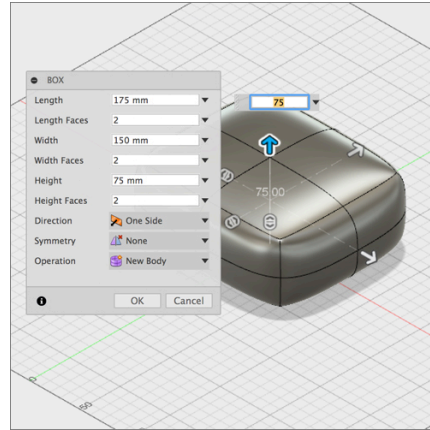
Step 5: Increase the number of faces to the box in Length and Width.

1. In the Box dialog window set the **Length Faces** to **3**
2. To set the width faces, drag the **double-headed arrow manipulator** on the box primitive up to increase the number of width faces until it equals **3**.
3. Select OK to complete the **Box** primitive setup.
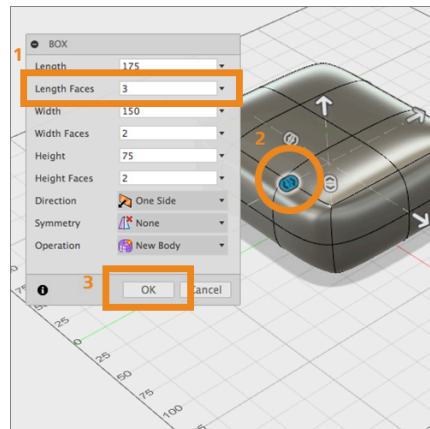
Step 6: Finish the form. You have just created your first T-Spline body. To include this form as part of your solid model you need to indicate that you are done creating T-Spline forms for the moment and that you want to go back to the Model workspace.

1. Select **Finish Form** at the end of the Sculpt workspace toolbar.
2. The T-Spline form is automatically converted to a solid body and you are brought back to the **Model**
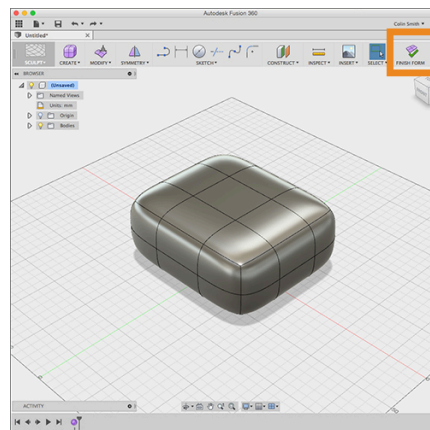
workspace.

Note: If you create a closed T-Spline form it will be converted to a solid body when you select **Finish Form**. If you create an open T-Spline form, for example a T-Spline Plane, it will be converted to a surface body when you select **Finish Form**.
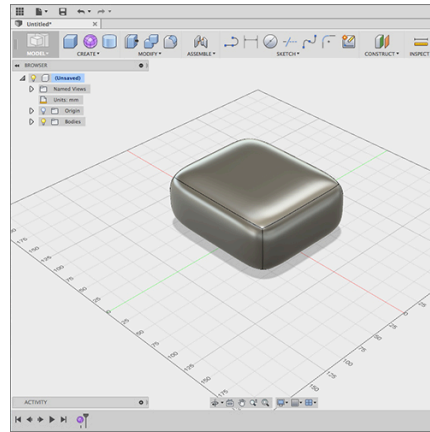
Step 7: Create a T-Spline Revolve Form. Let's create a T-Spline form by revolving a sketch curve. The Revolve command creates a form by rotation 2D geometry about a fixed axis

1. In the **Browser**, select the drop-down arrow next to your **Bodies** folder
2. Click the light bulb next to **Body1** to turn off the visibility.
3. Select **Create > Create Form**.
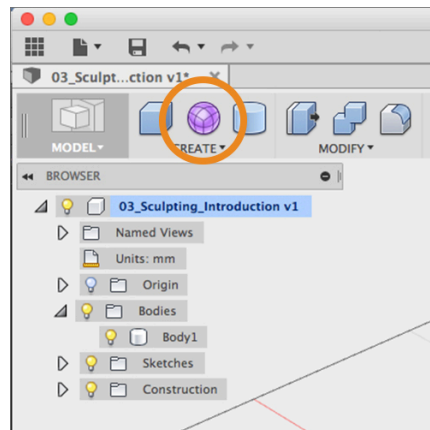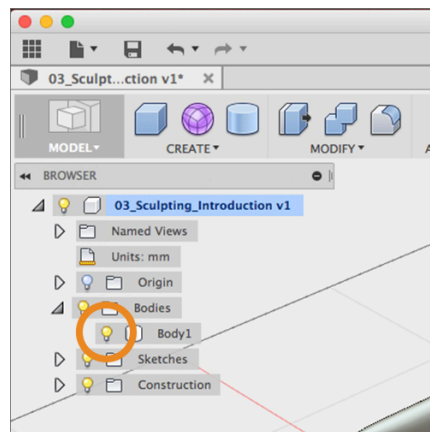
Step 8: – Turn on the visibility of the sketch curve that you will be revolving.

1. In the **Browser**, select the drop-down arrow next to your **Sketches** folder. Select the **light bulb icon** next to **Revolve** to turn on the visibility of the **Revolve** sketch.
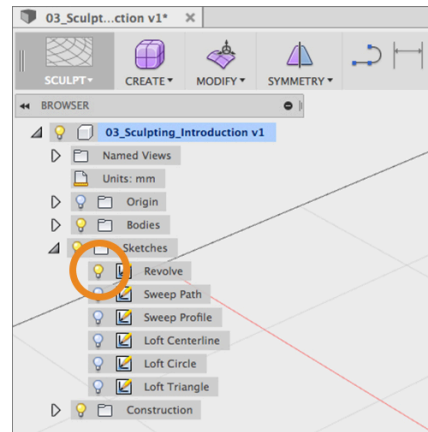
**Step 9:** Revolve a T-Spline using the sketch curve as input.

1. Select **Create > Revolve.**
2. Select on the **sketch curve** to identify it as the Profile curve to be revolved.
3. In the dialog window select **no selection** next to **Axis** to show the axis selector in the workspace
4. Select the **Blue** axis. A T-Spline form is revolved 360 degrees around the Blue axis.
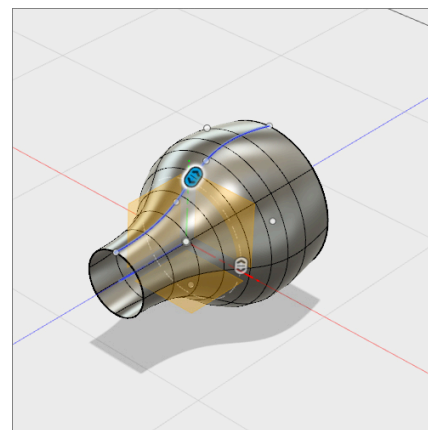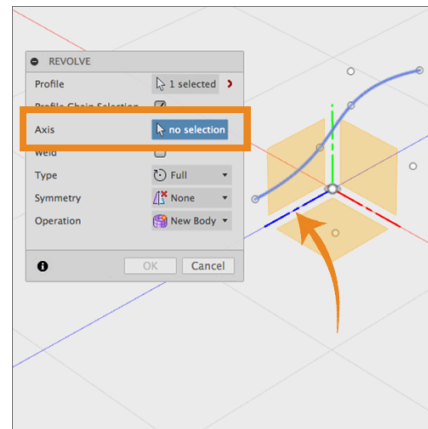
Step 10: Change the Revolve settings. Let's change the settings in the Revolve settings to change the **Angle** the direction that the curve is revolved.

1. In the **Revolve** dialog window, change the **Type** from **Full** to **Angle**.
2. Enter **90 degrees** for the **Angle** field.
3. Change the Direction from **One Side** to **Symmetric**.
4. Select **OK**.
5. Select **Finish Form** to return to the **Model** workspace.

Note: The **Revolve** manipulator can also be used to adjust the number of faces in longitude and latitude of the revolved shape as well as the degree of the **Angle**.
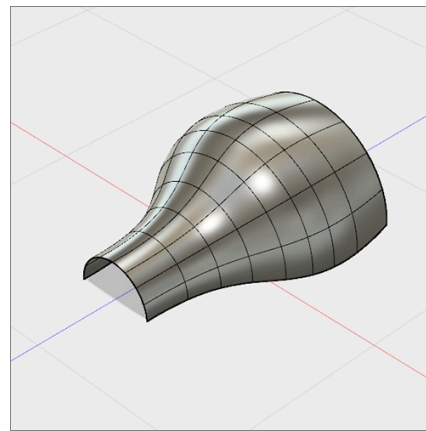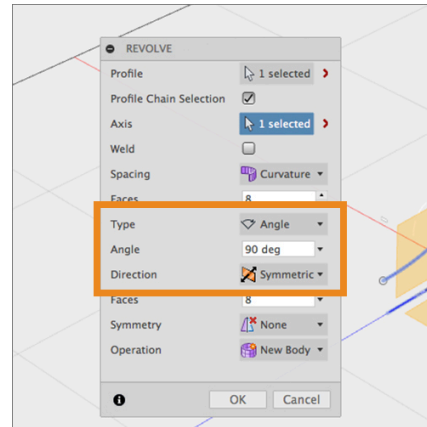
Step 11: Create a T-Spline Form using **Sweep**. The **Sweep** command uses two sketch curves to define a shape. One curve is selected as the **Profile**, which is swept along a **Path** curve to create the shape.

1. In the **Model** workspace hide the previously created **Body 2 (1)**
2. In the Browser in the **Sketches** section select the light bulb icon next to Revolve Sketch to turn off the sketch visibility.
3. Turn on the visibility for the **Sweep Path** and **Sweep Profile** sketches.
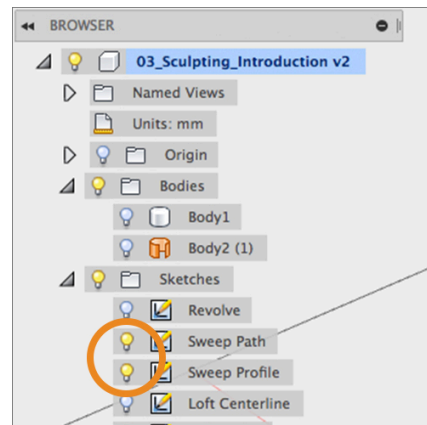
Step 12: Start the Sweep command.

1. Select **Create Form** in the **Model workspace** to change to the **Sculpt Workspace.**
2. Select **Create > Sweep** to launch the Sweep dialog window.
3. Select the **Sweep Profile** sketch to identify this sketch as the **Profile**
4. Select **no selection** next to **Path**.
5. Select the **Sweep Path** sketch to identify this sketch as the **Path**. The swept T-Spline Form is generated.
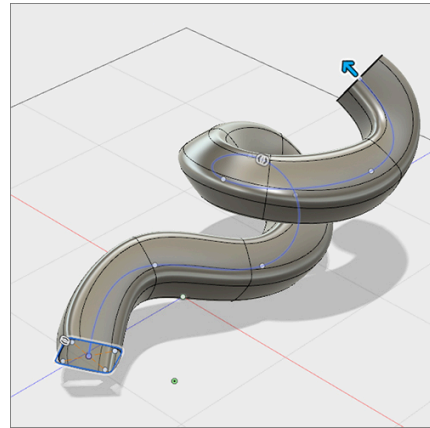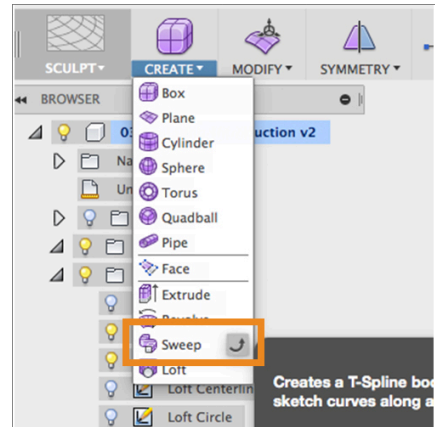
Step 13: Add faces to the swept surface. In order to match our rounded-square profile, we need to increase the number of faces for the profile.

1. In the dialog window, set the number of faces for the **Profile** equal to **24**.

Note: The greater number of faces, the closer the body matches the path.
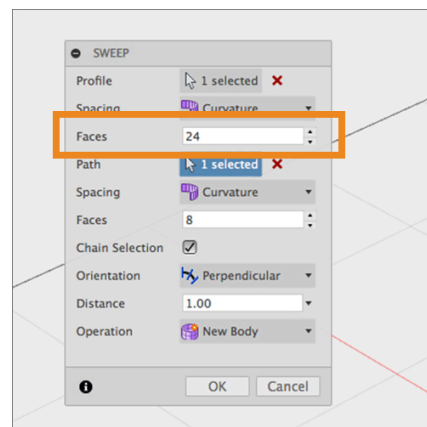
Step 14: Change the sweep orientation. There may be instances where the orientation of the profile as is moves along the path will give you a more desirable result. Use the **Orientation** option to change the sweep behavior.

1. In the dialog window, change the **Orientation** from **Perpendicular** to **Parallel**. Observe how the sweep behavior drastically changes.
2. Change the Orientation **back** to **Perpendicular**.
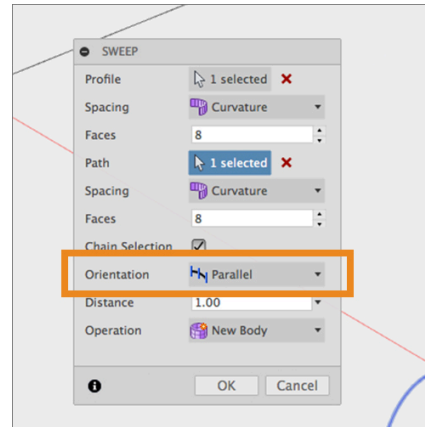
Step 15: Change the sweep distance. The Sweep command allows you to alter the amount of the path curve that is used to create the T-Spline form.

1. Drag the arrow at the end of the **Path** to alter the sweep distance. In addition to using this arrow, we can set the distance in the dialog window.
2. In the dialog window, set the distance equal to **0.5**.
3. The sweep now travels half the length of our Path curve.
6. Select **OK**.
7. Select **Finish Form**.
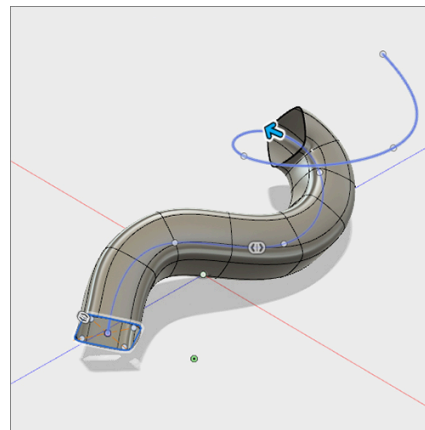
Step 16: Create a T-Spline Form with **Loft** using 3 sketch profiles as input to create a lofted shape.

1. Turn off visibility of **Body 3 (1)**
2. Turn off visibility of the two **Sweep** sketches.
3. Turn on visibility for sketches labeled **Loft Centerline**, **Circle**, and **Triangle**.
4. Select **Create > Create Form** to change to the Sculpt workspace
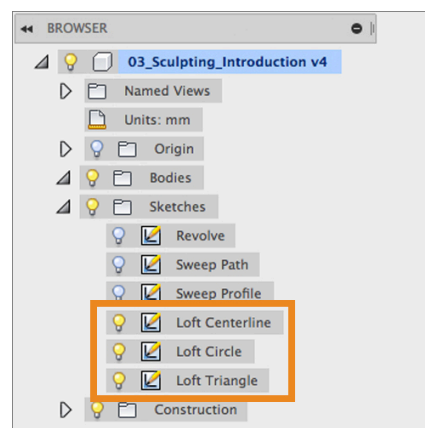
**Step 17**: Select the profiles to create the loft form.

1. Select Create **> Loft.**
2. Click the **Triangular** profile in the canvas.
3. Click the **Circular** profile in the canvas. This creates a straight lofted shape transitioning between the triangle and the circle.

Note: You can have multiple profile shapes to loft between.
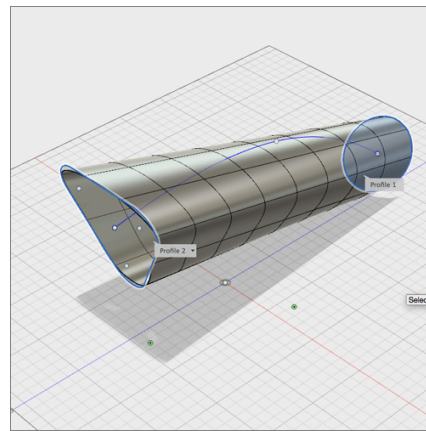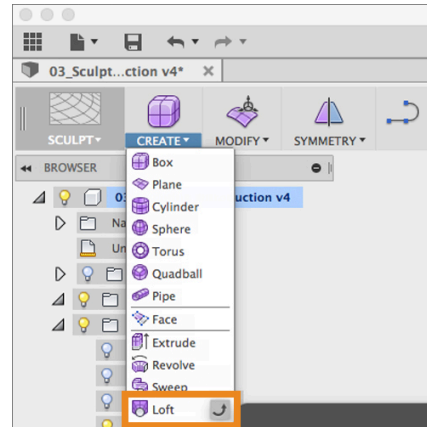
Step 18: Change the Loft shape by defining a centerline. By default the loft will always create straight transitional surfaces between profiles. To control the direction of the surface between the profiles you can add a sketch curve a centerline.

1. Click the **centerline** curve
2. You receive an error because initially the software assumes that you are adding another profile for the loft.
3. To specify this curve as a centerline select **Convert to Centerline** under **Swap** in the dialog window.
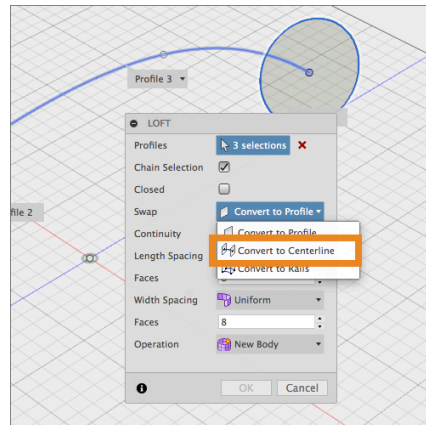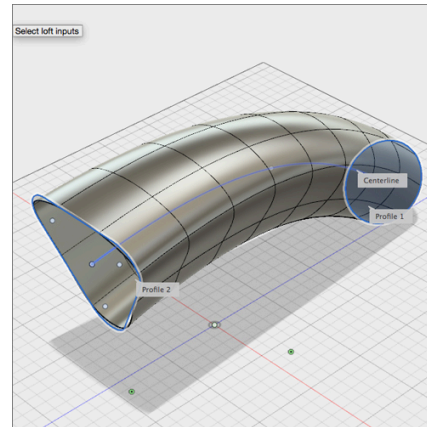
Step 19: The T-Spline surface is not matching well to the triangle profile. Let's increase the number of faces to improve the match.

1. In the dialog window, set the number of faces for the **Width** equal to **16**.
2. Click **OK**.
3. Select **Finish Form.**
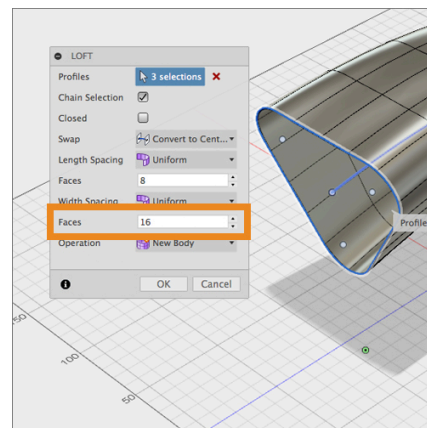
Lesson 2: Modify a T-Spline Form

The real power of T-Splines is that it allows for freeform shape manipulation of shapes by moving, rotating and scaling vertices, edges and faces of a T-Spline surface. The most common command you will use to do this is Edit Form. You can also add and remove faces in your forms to get detail where you need it without making the entire form overly complex.

Learning Objectives

1. Move, Rotate and Scale T-Spline geometry with Edit Form
2. Add geometry to a T-Spline body with Edit Form
3. Change the display mode
4. Insert Edges

Step 1: Turn off the visibility of the Loft body

1. Turn off visibility of the previously created **Body 4 (1)** from the last lesson.
2. Turn off visibility for any visible sketches.
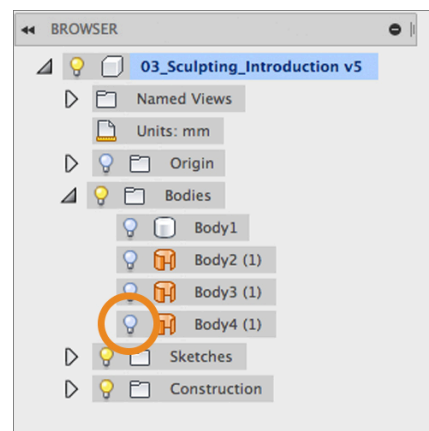
**Step 2**: Edit the T-Spline shape in the Timeline

1. In the **parametric timeline** at the bottom of the Model window, located the 4 T-Spline form icons.
2. Hover your pointer over the first form icon and you will notice that the primitive box is highlighted on the screen.
3. Right-click on the form icon in the timeline and select **Edit**.

Note: When using Fusion 360 with history turned on, T-Spline operations do not have history in the same way that the operations in
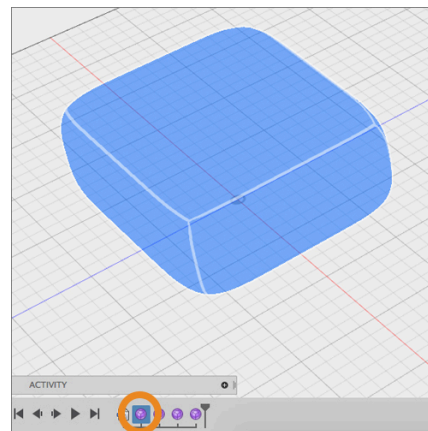
the Model and Patch workspaces do. However you can go back in history and make adjustments to your T-Spline shapes and those changes will be recomputed in the history of your model when you exit the Sculpt workspace.
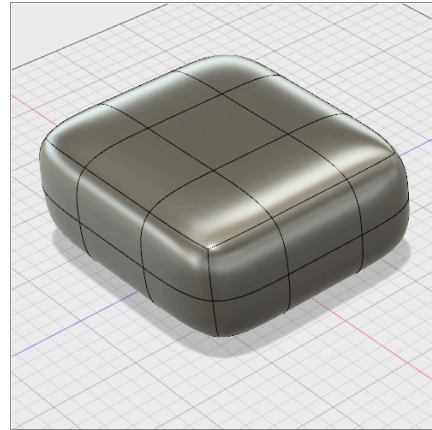
Step 3: Start the Edit Form command

1. Click **Modify > Edit Form**. The Edit Form command can be used to directly manipulate **Faces**, **Edges**, and **Vertices**.
2. Click on a top face located at one of the corners of the box.
3. The manipulator displays on the face with an assortment of tools.

Note: Directly manipulating a face creates the greatest changes in your form, while manipulating a single vertex will result in smaller changes.
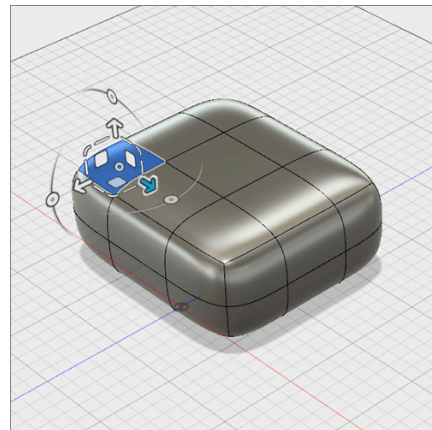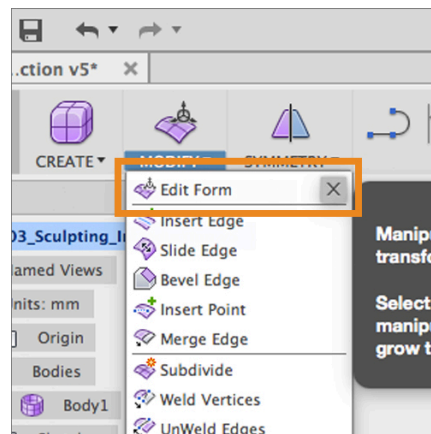
Step 4: Move a face in a single axis direction.

1. Click and drag on the arrow pointing up to translate (move) the selected face up by 30 mm.

Note: When you move a face on a surface the surrounding faces move to maintain continuity.
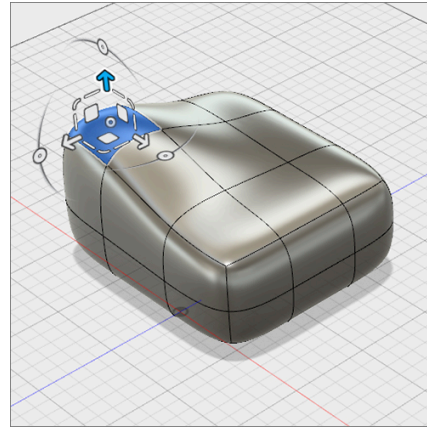
**Step 5:** Move a face in a planar direction.

1. Click and drag on one of the **white squares** to translate the selected face on a plane parallel to a given plane in world space.

Note: By default the **Edit Form** manipulator uses the World Space coordinates, you can also use View space (based on the camera view) and Local space (based on the normal direction of the surface). These can be changed in the **Coordinate** options in **Edit Form**.
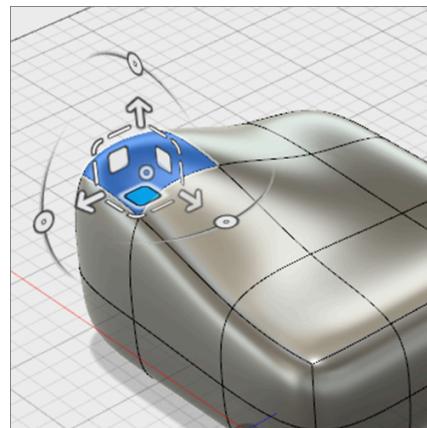
Step 6: Move a T-Spline edge and vertex.

1. Select a single **edge**.
2. Use any of the translate manipulators to compare the effect.
3. Select a single **vertex**.
4. Translate this vertex to see how this creates more subtle changes
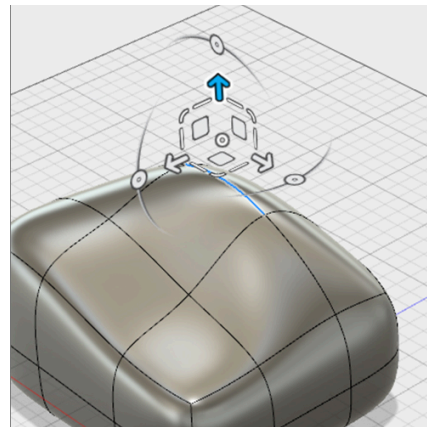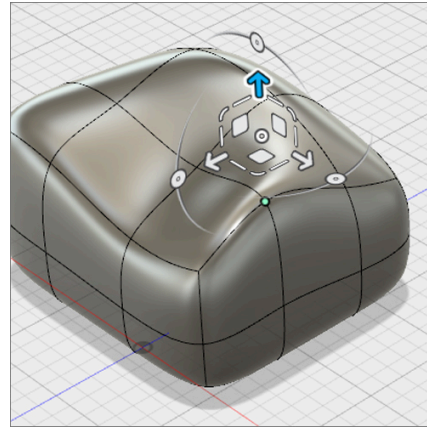
Step 6: Rotation with Edit Form

1. Make sure that at least one **face** is selected.
2. Click and drag one of the **circular arcs** to rotate the selected geometry about a single axis.

Note: Be careful not to rotate geometry too far, as self-intersecting faces, or geometry that twists through itself will result in not being able to convert it in to a solid body.
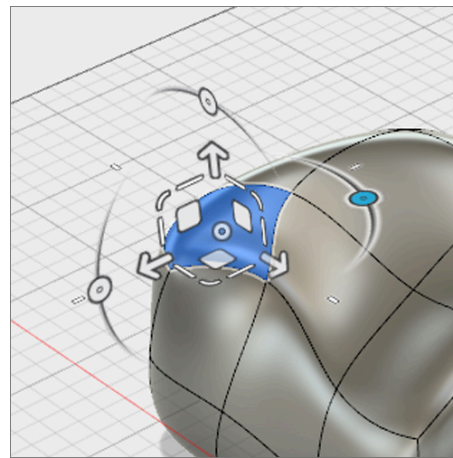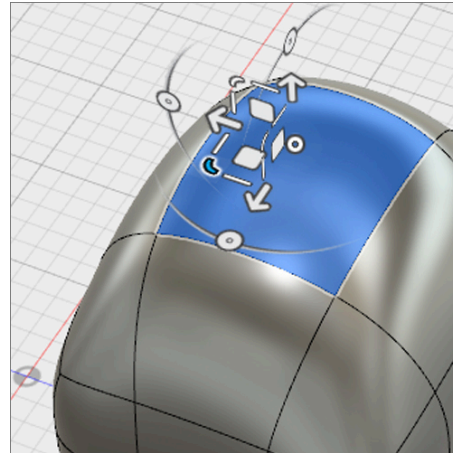

Step 7: Single direction scaling

1. Make sure that at least one **face** is selected.
2. Click and drag one of the **straight lines** to scale the selected face in one direction.
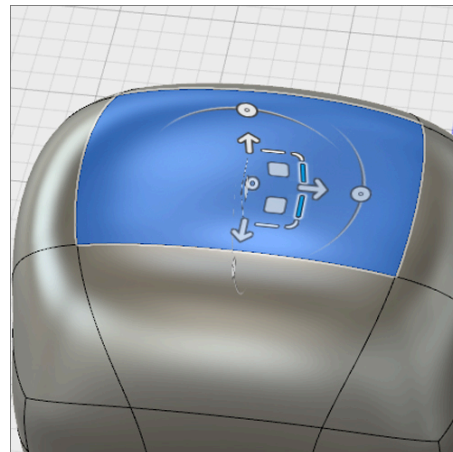
Step 8: Planar scaling

1. Make sure that at least one **face** is selected.
2. Click and drag one of the small **corner manipulators** to scale the selected face along a plane – or in two directions.

Step 9: Universal scaling

1. Make sure that at least one **face** is selected.
2. Click and drag the **circular manipulator** at the center of the manipulator.
3. Dragging **left** or **right** will scale the geometry in all directions **up** or **down**.
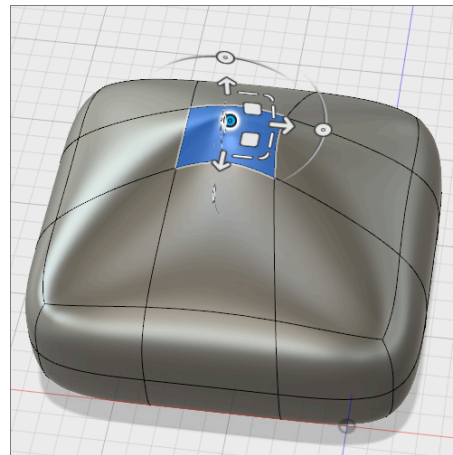
Step 10: Extrude a face to add geometry

1. Select a **single face** of your T-Spline form.
2. With the Edit Form command still active, hold the **alt-option** on Mac or **alt** key on Windows.
3. Click and drag the **single arrow** to add geometry outward from the selected face.
4. Let go of the **alt-option/alt** key as well as the left-mouse button.
5. Select OK to close **Edit Form**
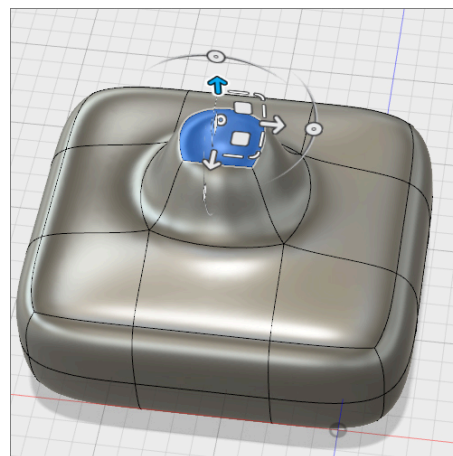
Note: You can use this hotkey function to extrude any edge(s) or face(s) that are selected on a T-Spline form.

Step 11: Change display mode. When modeling with T-Splines you have 3 different display modes to choose from. Changing the display mode can help you find problem areas on your model and increase performance by not having to constantly smooth the T-Spline shape. For this example we will switch the display to Box Mode – a polygon version of the T-Spline form.

1. Select **Modify > Performance > Display** Mode to bring up the Display Mode window
2. In the Display Mode window select **Display Mode > Box Display** to show a unsmoothed version of the T-Spline form.
3. Select **Display Mode > Control Frame Display** to see a combination of the unsmoothed and smoothed versions of the T-Spline.
4. Select Display Mode > Smooth Display to go back to the smoothed version.
5. Select **Display Mode > Box Display**
6. Select **OK** to close the window

Note: Display mode can also be switch by using the combination of **Control + 1 for Box**, **Control +2 for Control Frame** and **Control + 3 for Smooth** on a Mac. Or **Alt +1**, **Alt +2**, **Alt +3** respectively on a PC.   You can also find these controls in the **Selection Options** section of the **Edit Form** window.
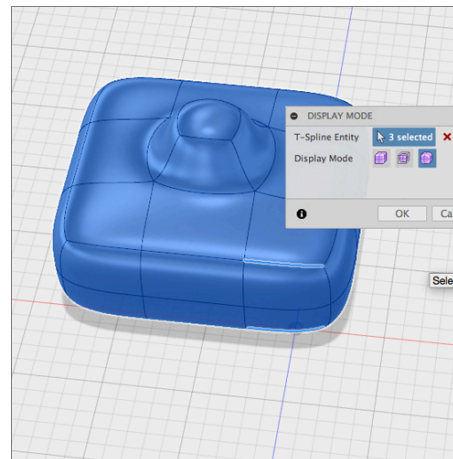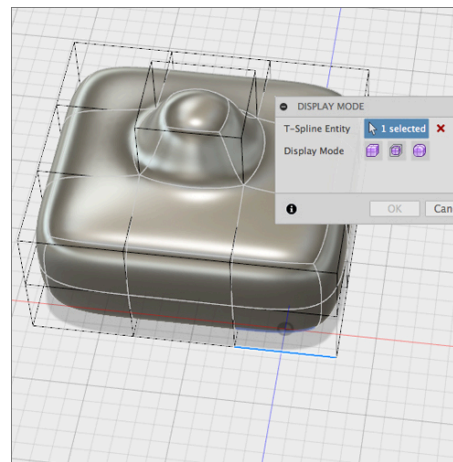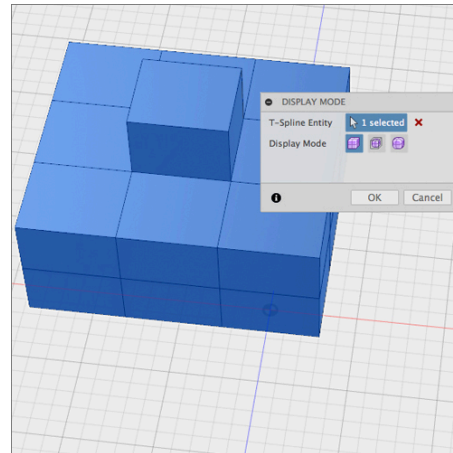
Step 12: Working in Box Display Mode.

1. Hold down the **right mouse button** to bring up the radial menu.
2. Select **Edit Form** in the radial menu
3. Select a face and hold **alt-option/alt** while dragging the blue arrow up to extrude the face. You will notice that the performance is faster in Box mode that in Smooth mode.
4. Hold **control/alt +3** to return to smooth mode.
5. Hold down the **right mouse button** and select **OK** from the radial menu to close the **Edit Form** window.
6. Select **Finish Form** from the menu bar to go back to the Model workspace.
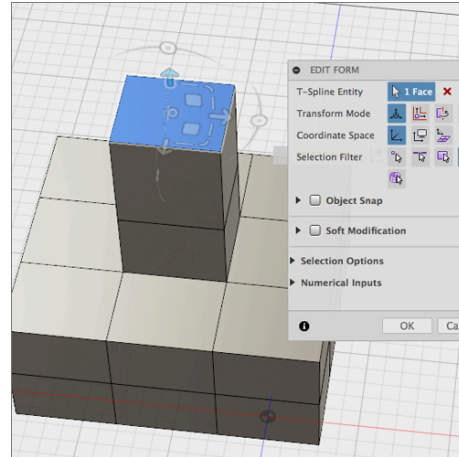
Step 13: Add edges to a T-Spline form

7. Enter the Sculpt workspace by selecting **Create > Create Form**.
8. Create another **Box** primitive whose length, width, and height are **100mm, 100mm**, and **200mm.**
9. Set the number of length, width, and height faces equal to **4, 2,** and **2.**
10. Click **OK**.
11. Click **Modify** > **Insert Edge**.
12. **Double-click** on one of the middle edges to select the entire middle loop.

Note: Double clicking on an edge will select the complete edge loop. Selecting a single edge inserts an edge to a face on either side of the selected edge. Selecting an edge loop adds a second loop.
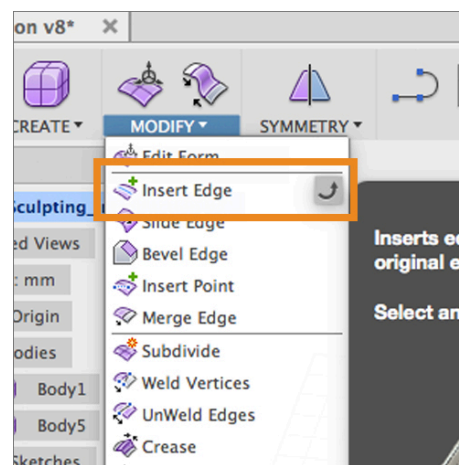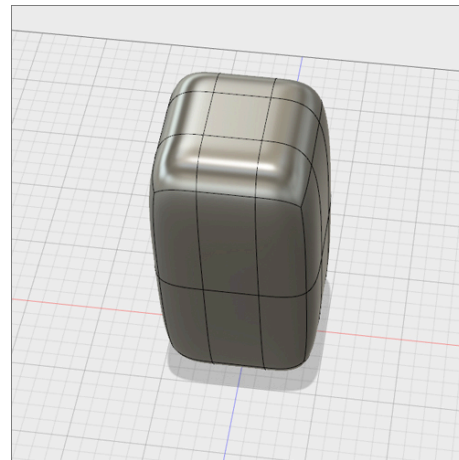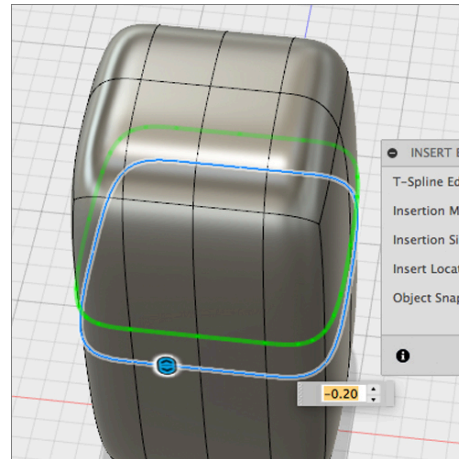
Step 14: Adjust the insert location

1. Click and drag the double arrow to adjust the position of the inserted edge.
2. By hand, or with the text field, set the **Insert Location** equal to **0.75**.
3. Change the **Insert Side** from Single to **Both**.
4. Click **OK**.

Note: You probably noticed that the shape of the T-Spline form changed after you inserted additional edges. The top and the bottom of the box became sharper by adding more edges near the existing top and bottom edges. If you want to insert an edge(s) and not change the shape of the T-Spline form, change the **Insertion Mode** to **Exact**.
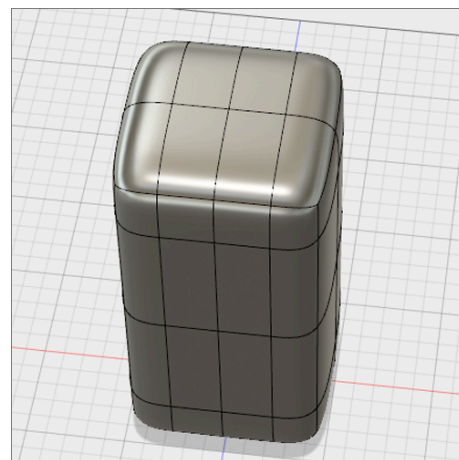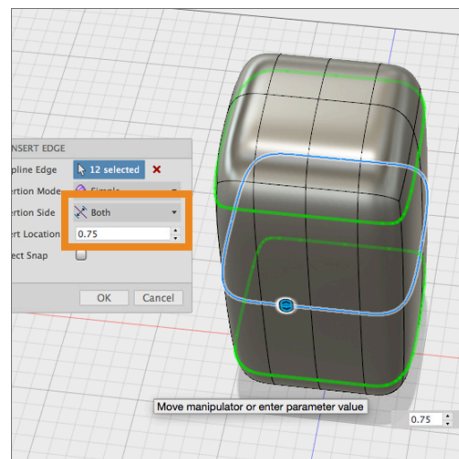
Step 15: Delete and edge

1. Select the recently added the **upper edge loop**.
2. Select **Modify > Delete** or press the **Delete** key on your keyboard.
3. Select **Finish Form**.
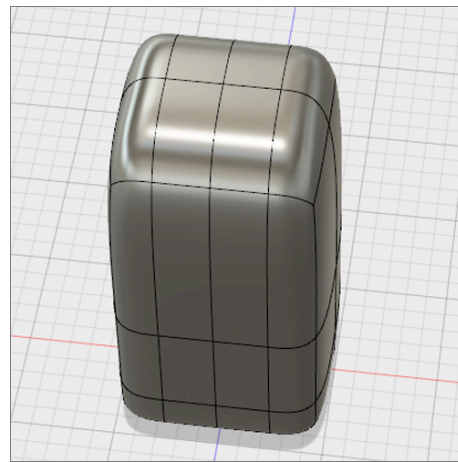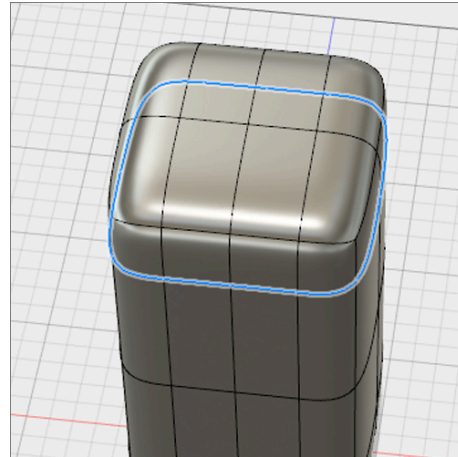
Lesson 3: Create a T-Spline Form using a reference image

When sculpting a shape with T-Splines it is helpful to have a reference image to guide you. Reference images can be plan view sketches or photographs that are set in the background of the workspace to model from. In Fusion 360 you can attach an image to a work plane and then calibrate the image so that you are modeling in the correct scale. In this lesson we will use a side view photograph of a utility knife as reference to sculpt a T-Spline body that will be the outer shape body of the knife.

Learning Objectives

1. Insert and image in to the workspace using **Attach Canvas**
2. Use **Calibrate** to set the proper scale for the reference image
3. Invoke **symmetry** when modeling a T-Spline box
4. Use **Insert Point** to draw edges on a T-Spline face(s)

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Step 1: Attach a canvas

1. Select **Insert > Attached Canvas**.
2. Select the **YZ Plane** (between the green and blue axis) to indicate which plane the image should be attached to.
3. In the dialog window, click the **Select Image** button and navigate to the **03_UtilityKnife.jpg** file.
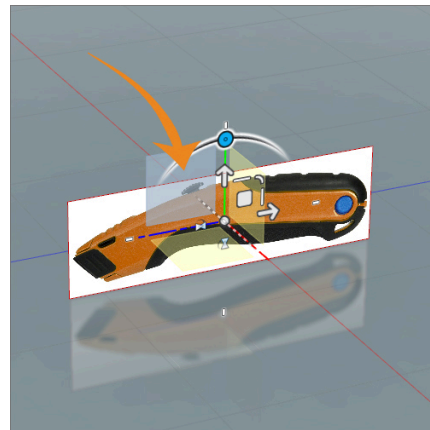

Step 2: Adjust canvas settings

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**.

Note: You don't need to be concerned about the size and scale of the image at this point. We will adjust the scale using the **Calibrate** tool. Calibrating the image ensures that you are modeling in the correct scale in the workspace.
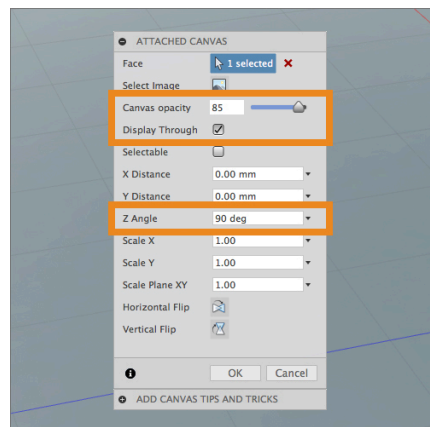
Step 3: Calibrate the image.

1. In the Browser, click the drop-down arrow next to the **Canvases** folder.
2. Right-click on **UtilityKnife** and select **Calibrate**.
3. Click **Right** on the ViewCube to view the utility knife from the side.
4. Click once at the **front** of the utility knife.
5. Click once at the **back** of the utility knife.
6. Enter **180 mm** in the length field and hit enter.
7. The canvas will scale up accordingly.
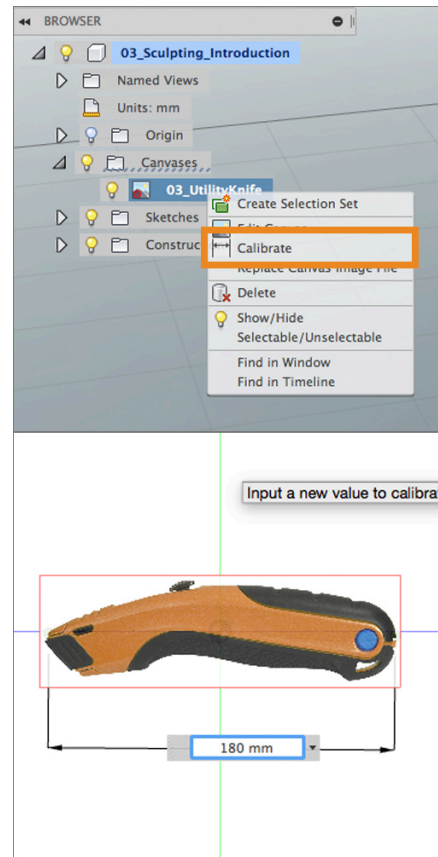
Step 3: Create a box primitive

1. Click the **Create > Create Form** icon to enter the Sculpt workspace.
2. Click **Create > 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 at the outer edge of the reference image to draw its 2D profile.
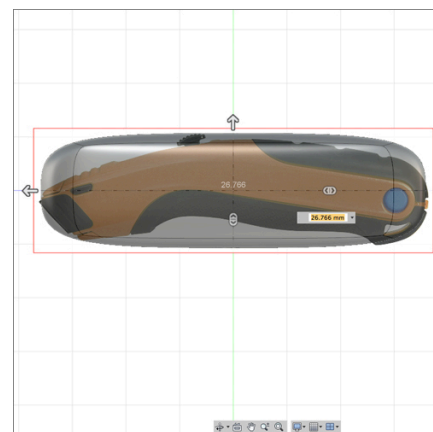
Step 4: Set box dimensions and add symmetry

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**.
3. In the dialog window, change the **Symmetry** from None to **Mirror**.
4. Check the box for **Height Symmetry**.
5. Select **OK**.
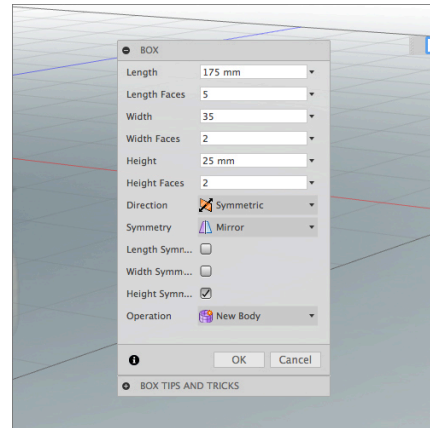
Step 5: move faces to the top of the knife image.

1. If you are not in the right side view still, click on the **Right** side of the **View Cube.**
2. Select **Modify > Edit Form**.
3. Select the middle set of faces by holding the **left mouse button** and dragging to the lower right over top of the faces you want to select.
4. 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 image.
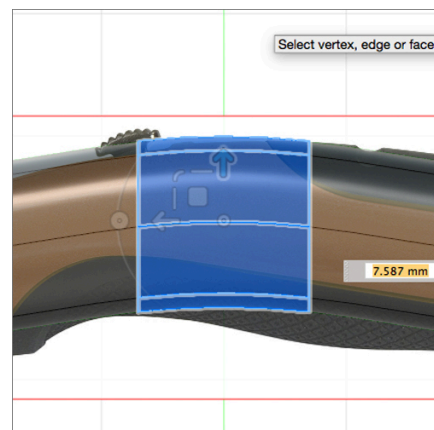
Step 6: move faces to the top of the knife image.

1. To align the bottom in this section, select the **bottom face** and use the **planar translation** and **rotate manipulators**.
5. 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.
6. For more controlled editing, try modifying individual edges.
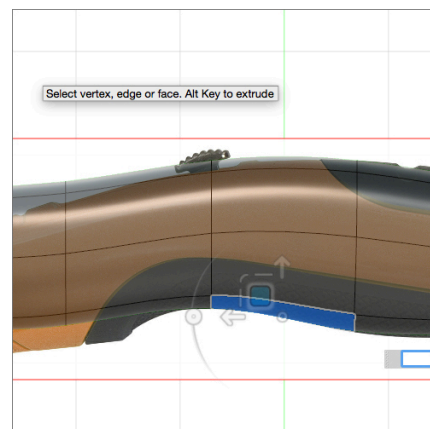
Step 6: Insert edges to get closer to the knife shape. Our T-Spline form is starting to resemble our reference image but there aren't enough edges in the T-Spline to capture all the detail of the Knife.

1. Hold **Shift** then select the edges shown at the front of the knife.
2. Click **Modify > 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**.

Note: With Symmetry enabled you only need to select the edges one side of the symmetry plane, the matching ones on the other side will be automatically selected also and will be displayed in yellow.
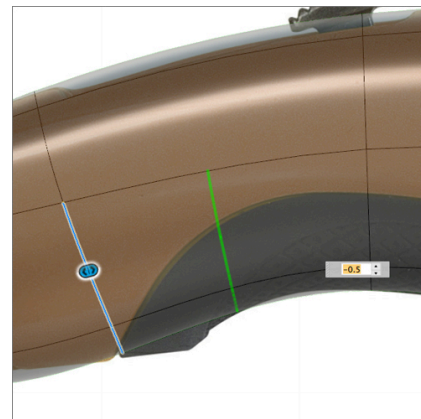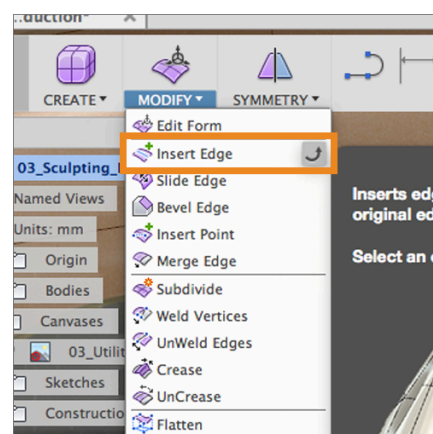
**Step 7**: Insert additional edges with **Insert Edge**.

1. Holding **Shift** then select the edges shown at the back of the knife.
2. Select **Modify > 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**.
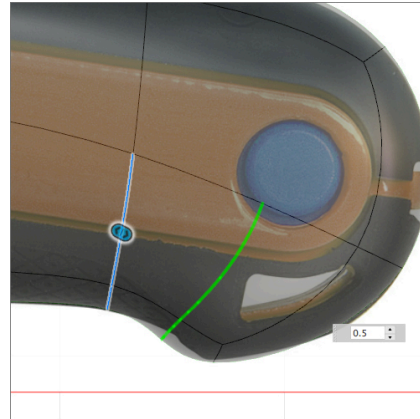
**Step 8**: Move the inserted edges with **Edit Form**.
1. Use the **Edit Form** command to manipulate the recently inserted edges to achieve the result shown in the image.

Note: The planar translation manipulator will be extremely useful.
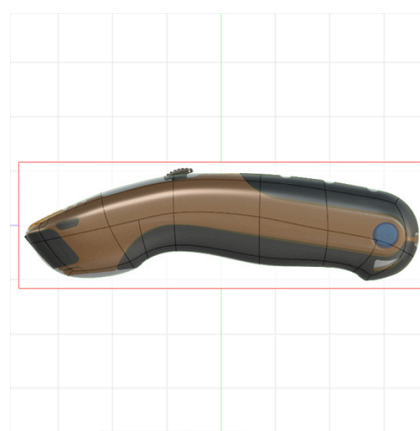
Step 9: Use **Insert Point** to draw edges on a face. To insert the final two edges we need, we'll use the **Insert Point** command. Slightly different from Insert Edge, the **Insert Point** command will easily insert an edge by connecting two points together.

1. Click **Modify > Insert Point**.
2. Hover over the middle of the top edge shown until a **red circle** appears – this indicates the midpoint
3. **Click** and repeat for the edge directly beneath, located along the line of symmetry.
4. Ensure the **Insert Mode** set to **Simple**.
5. Click **OK**.
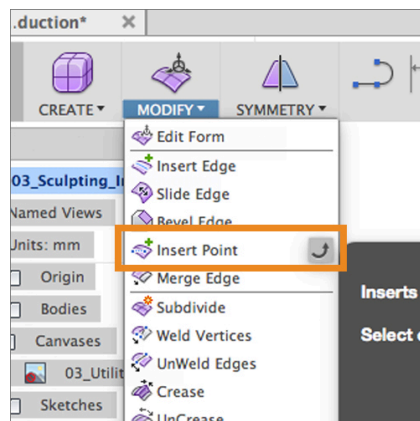
Step 10: Use **Edit Form** to move faces and edges until you have matched the T-Spline body to the profile of the Knife image.

1. Use the **Edit Form** command to manipulate the recently inserted edges (as well as the surrounding geometry) to get the T-Spline primitive to match as closely as possible.
2. When you are satisfied with the shape of the T-Spline body select Finish **Form** from the Sculpt Menu bar.