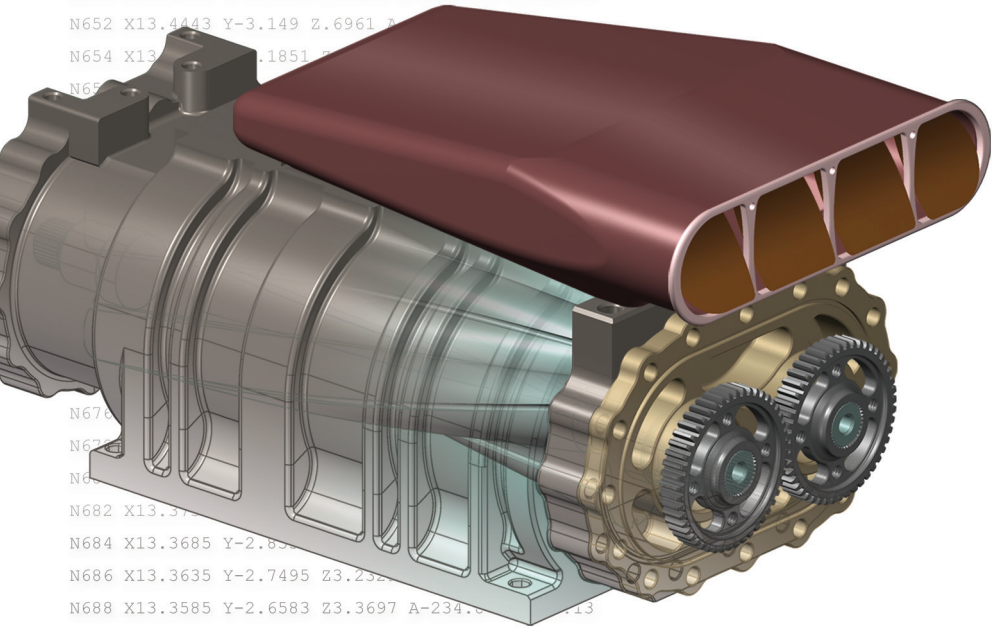
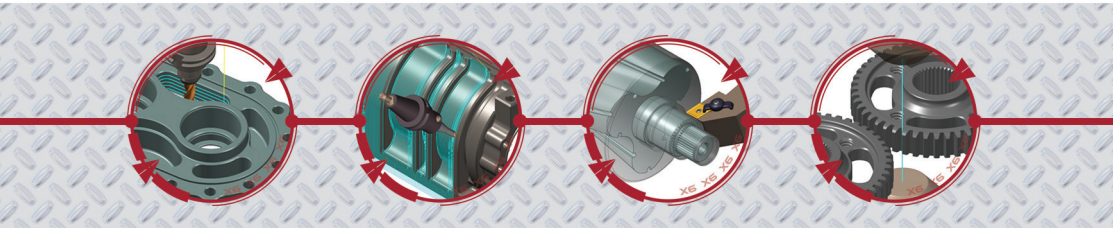
Mastercam X6

Basic 3D Design



When Second Best Won't Cut It.



mastercam x getting started tutorials

Mastercam X6 Basic 3D Design

December 2011

Be sure you have the latest information!

Information might have been changed or added since this document was published. Contact your local Reseller for the latest information.

Mastercam X

Mastercam® X6 Basic 3D Design

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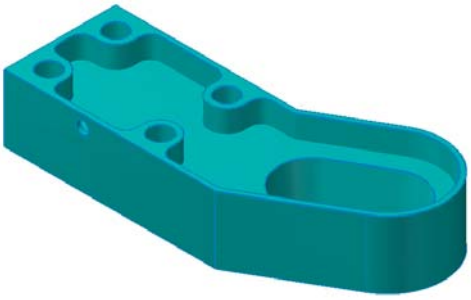
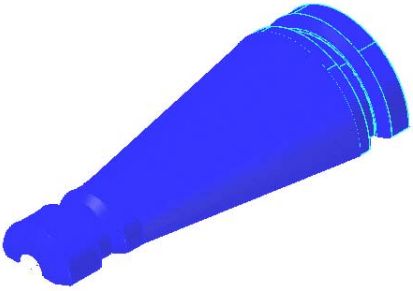
INTRODUCTION

After you have mastered drawing parts with Mastercam's 2D functions, you are ready to move onto 3D part drawing. Drawing in 3D opens a whole new world of possibilities. In this tutorial, you learn many 3D drawing techniques as you construct the connector and tool holder parts, shown in the following pictures.





The tutorial titled *Basic 2D Design* covers 2D drawing with Mastercam. Before attempting this 3D tutorial, you must be familiar with the 2D techniques demonstrated in the 2D tutorial.

Tutorial Goals

- Use construction planes in a 3D environment.
- Create 3D geometry from 2D parts using translation and offsetting.
- Define custom views using 3D Dynamic Planes.
- Use levels to organize 3D geometry.
- Generate 3D surfaces.
- Use construction lines as reference geometry.
- Use Mastercam's Trim features to clean up your part.

TIP: If you have trouble with an exercise, use Mastercam's undo function ([**Ctrl+Z**]) to return to a point where the part is correct and start again from there. If undo does not help, go back to the beginning of the exercise, load the supplied file for that exercise, and start again.

IMPORTANT: Screen colors in the tutorial pictures were modified to enhance image quality; they may not match your Mastercam settings or the tutorial results. These color differences do not affect the lesson or the exercise results.

General Tutorial Requirements

All Mastercam tutorials have the following general requirements:

- You must be comfortable using the Windows® operating system.
- The tutorials cannot be used with Mastercam Demo/Home Learning Edition (HLE). The Demo/HLE file format (`EMCX-6`) is different from Mastercam (`MCX-6`), and basic Mastercam functions, such as file conversions and posting, are unavailable.
- Each lesson in the tutorial builds on the mastery of preceding lesson's skills. We recommend that you complete them in order.
- *Focus Series* and *Exploring Series* tutorials require, at minimum, a mastery of the basic Mastercam skills taught in the *Getting Started Series* modules. A general knowledge of machining principals and practices is also required.
- You must have a seat of Mastercam X6 Design or higher to complete most of the tutorials in the *Getting Started Series*.
- The *Basic 2D Machining* module in the *Getting Started Series* requires, at minimum, a seat of Mill Entry or Router Entry.
- The *Basic 3D Machining* module in the *Getting Started Series* requires Mill Level 3 or Router Pro.
- Additional files may accompany a tutorial. Unless the tutorial provides specific instructions on where to place these files, store them in a folder that can be accessed from the Mastercam workstation, either with the tutorial or in any location that you prefer.
- The *Getting Started Series* tutorials are available in an Adobe® Flash® compatible video format. Additional tutorial videos may also be available. Contact your local Mastercam Reseller for more information.
- You must install Adobe Flash Player to display tutorial videos. You can download Adobe Flash Player from www.adobe.com.

- All Mastercam tutorials require you to configure Mastercam to work in a default metric or English configuration. The tutorial provides instructions for loading the appropriate configuration file.

LESSON 1

Geometry Translation

By translating existing 2D geometry, you can create a 3D part with minimal effort. This lesson takes the completed 2D part from the *Basic 2D Design* tutorial and shows how to use geometry translation to convert it into a full 3D part. The final 3D part is then used as the source file for the *Basic 3D Machining* tutorial, the next book in this tutorial series.

This lesson includes the following files, which you can use as needed:

- `CONNECTOR_START.MCX-6`: The file you load to start this tutorial.
- `CONNECTOR_L01EX01.MCX-6`: The part file after the completion of Lesson 1, Exercise 1. You can use this file to start Exercise 2.
- `CONNECTOR_L01EX02.MCX-6`: The part file after the completion of Lesson 1, Exercise 2. You can use this file to start Exercise 3.
- `CONNECTOR_L01EX03.MCX-6`: The part file after the completion of Lesson 1, Exercise 3. You can use this file to start Exercise 4.
- `CONNECTOR_L01EX04.MCX-6`: The part file after the completion of Lesson 1, Exercise 4. You can use this file to start Exercise 5.
- `CONNECTOR_L01EX05.MCX-6`: The part file after the completion of Lesson 1, Exercise 5. You can use this file to start Lesson 2, Exercise 1.

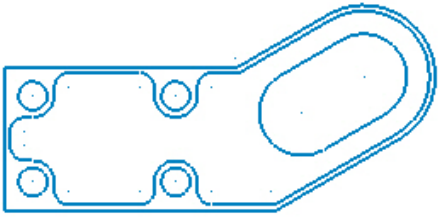
Lesson Goals

- Set up the part for 2D to 3D conversion.
- Use translation to create new geometry.
- Define views for setting the Cplane.
- Toggle between 2D and 3D drawing modes.

Exercise 1: Setting Up the Part

In this exercise, you prepare the 2D part for conversion to 3D. This process includes positioning the part on the screen, setting the construction plane, and creating a new level for the geometry you create in subsequent exercises.

1 Load the CONNECTOR_START.MCX-6 part file, which is supplied with this tutorial.

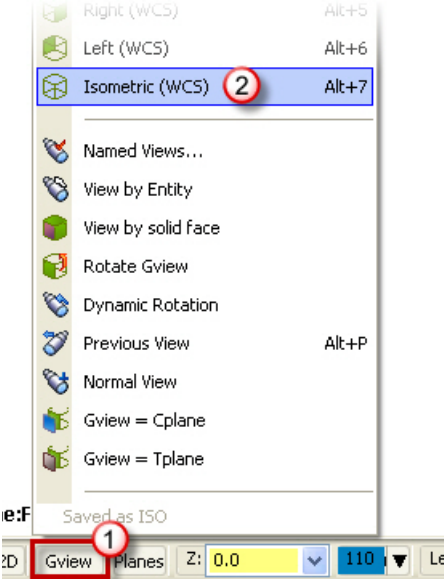


Note: If Mastercam warns you that you are changing units of measurement, click the message's **OK** *button to continue.*

2 From Mastercam's menu bar, choose **File, Save As**, and save the part as CONNECTOR_WORK.MCX-6.

By saving the file under another name, you avoid accidentally overwriting the original file.

3 In the Gview menu on the status bar, select **Isometric (WCS)**.

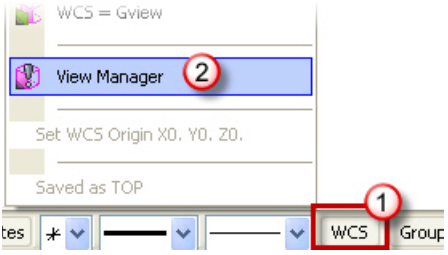


TIP: You can also select a Gview from Mastercam's toolbars. For example, to select the Isometric view, click the **Isometric (WCS)** button in the Graphics Views toolbar.

4 From the toolbar, choose **Fit** and **Un-zoom .8**.

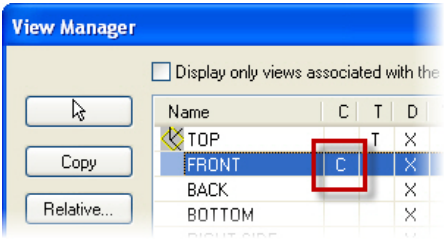
The part now displays at a convenient position and size.

5 In the WCS menu on the status bar, select **View Manager**.



The View Manager dialog box opens.

6 In the View Manager dialog box, click where the FRONT row intersects with the C column, and then click **OK**.

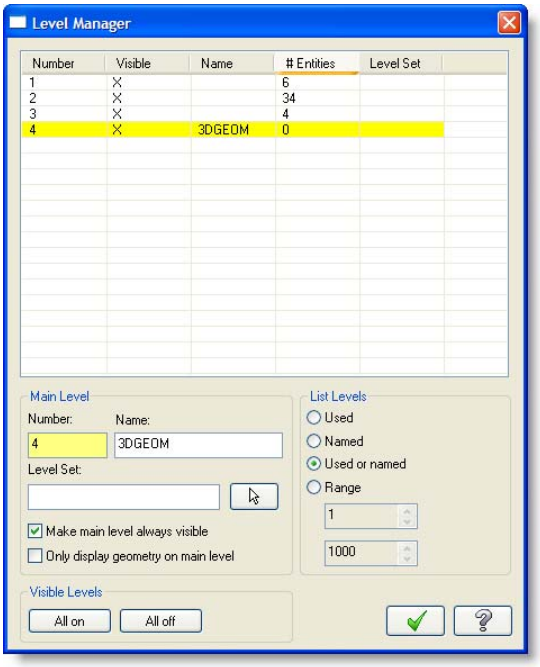


Mastercam sets the construction plane (Cplane) to the Front orientation. The changes you make to the part now are relative to the Front plane.

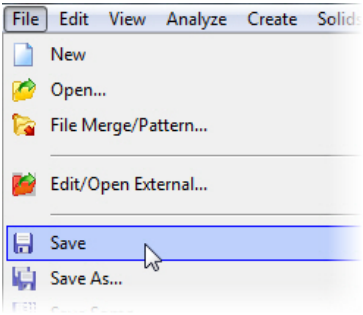
7 On the status bar, click inside the Level drop-down box, type **4:3DGEOM**, and then press [**Enter**].

Note: Although the Level drop-down places spaces on both sides of the colon, you do not need to type the spaces when selecting or creating a level.

Mastercam creates a new level 4 and names it 3DGEOM. Geometry you create in the following steps will now go on the 3DGEOM level. You can manage your file's levels in Mastercam's Level Manager (shown in the picture below). For more information on levels, refer to Mastercam Help.



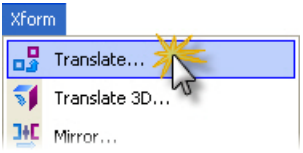
8 Choose **File, Save** to save your work to disk.



Exercise 2: Creating the Drill Holes

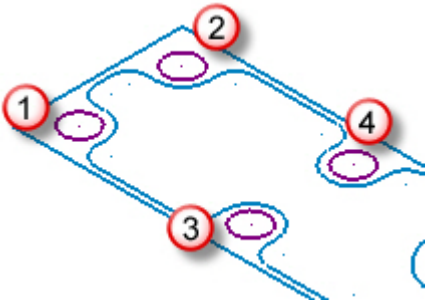
The part has four holes that must be drilled. In this exercise, you use translation to create copies of the four holes at their required depth. You can continue with the file you started in Exercise 1, or you can start this exercise by loading `CONNECTOR_L01EX01.MCX-6`. If you choose to load `CONNECTOR_L01EX01.MCX-6`, be sure to save it under a new name, so that you do not overwrite the original file.

1 From Mastercam's menu, select **Xform, Translate**.



2 Select the four small circles, as shown.

The order in which you select the holes is unimportant.



3 Click **End Selection** on the ribbon bar.

Mastercam sets the circles as the currently selected geometry, which is the geometry that gets translated in the following step.

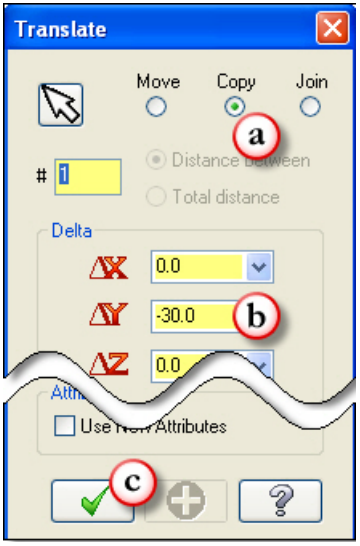
4 In the Translate dialog box, do the following:

a Select **Copy.**

b Set **Y** to **-30.**

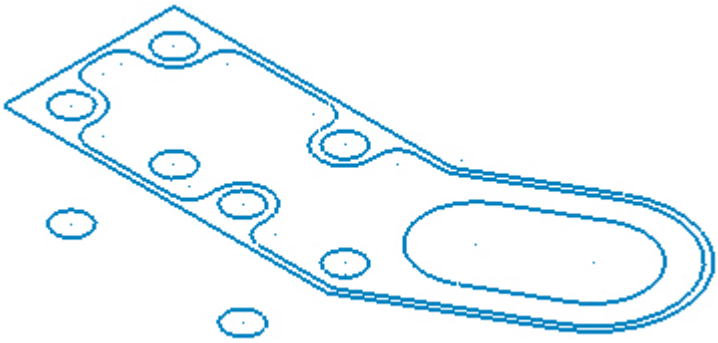
c Click **OK**.

Mastercam creates copies of the selected geometry, 30 mm down the Y axis.



5 On the toolbar, click **Clear Colors**.

Mastercam sets the new geometry to the default color. The following image shows the part at this point.



6 Choose **File, Save** to save your work.

Exercise 3: Creating the Pocket and Slot

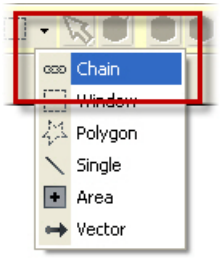
The connector part features a large pocketed area, as well as a wide slot at its rounded end. In this exercise, you use translation and offsetting to create additional geometry for these features. You can continue with the file you worked on Exercise 2, or you can start this exercise by loading `CONNECTOR_L01EX02.MCX-6`. If you choose to load `CONNECTOR_L01EX02.MCX-6`, be sure to save it under a new name, so that you do not overwrite the original file.

Creating New Geometry for the Pocket

1 From the MRU function bar (located on the right side of Mastercam's window), select **Xform Translate**.

The MRU toolbar provides a convenient way to select functions that you have used recently in the current Mastercam session.

2 On the General Selection ribbon bar, set the selection mode to **Chain**.



You can now use the chaining function to select the geometry to translate.

3 Click the inner pocket, as shown in the following picture, and then click **End Selection** on the ribbon bar.

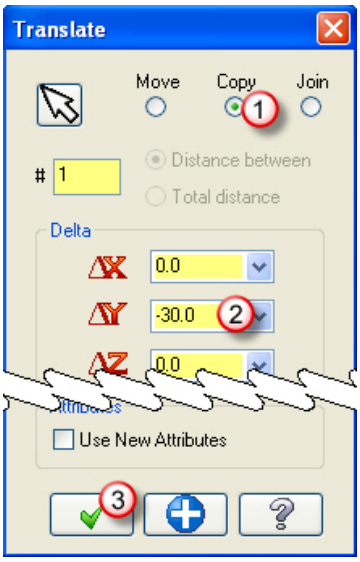
The Translate dialog box opens.

4 In the Translate dialog box, do the following:

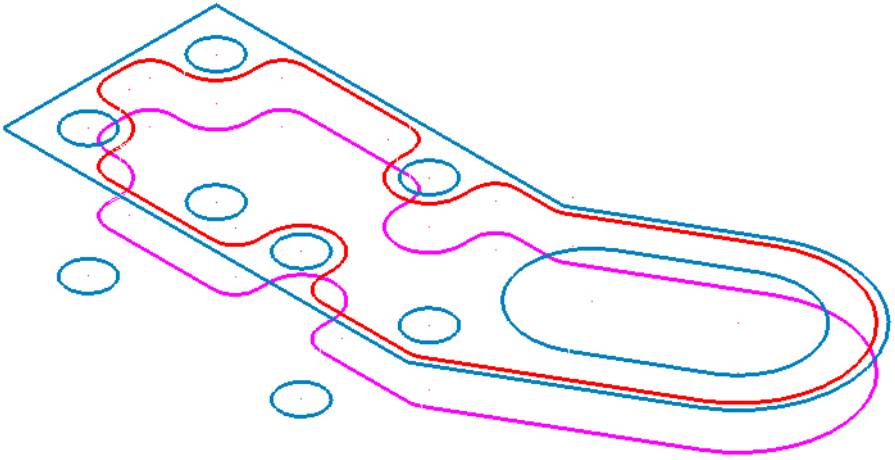
a Select **Copy**.

b Set **Y** to **-10**.

c Click **OK**.



Mastercam creates copies of the selected geometry 10 mm down the Y axis, as shown in the following picture.



5 On the toolbar, click **Clear Colors**.

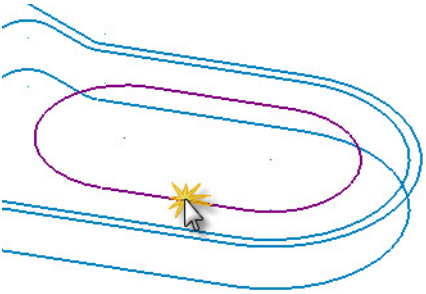
Mastercam removes the colors used to show the translation results.

Creating New Geometry for the Slot

1 From the MRU Function Bar, select **Xform Translate**.

2 Hold down [**Shift**], click the slot, as shown, and then choose **End Selection** on the ribbon bar.

Holding down [**Shift**] is another way to choose the chain selection mode.

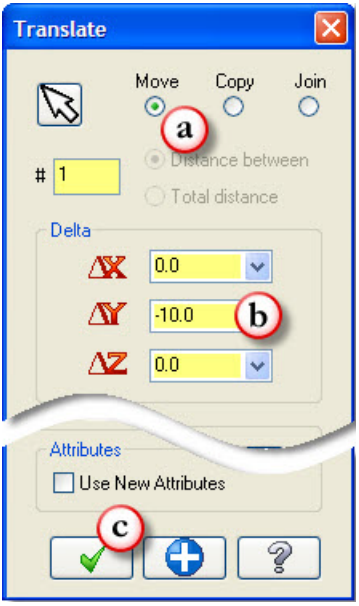


3 In the Translate dialog box, do the following:

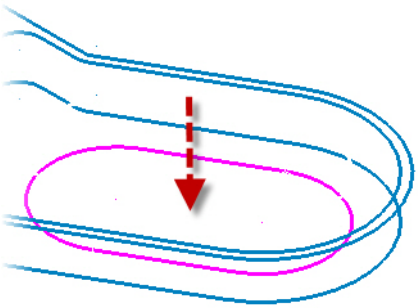
a Select **Move**.

b Set Y to **-10**.

c Click **OK**.



This time, Mastercam moves, rather than copies, the selected geometry down the Y axis by 10 mm.



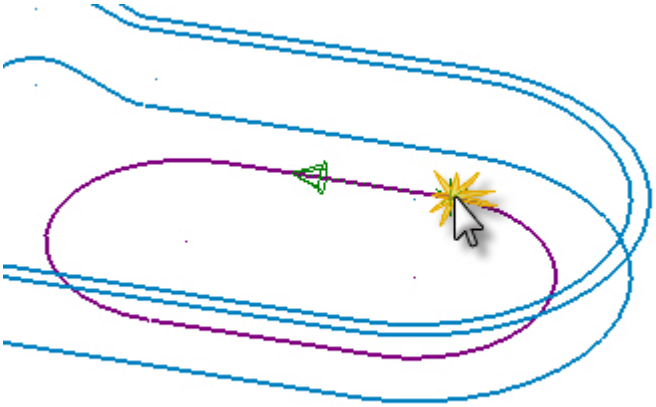
4 On the status bar, select **Planes, Top (WCS)**.

Mastercam sets the Cplane to Top.

5 From Mastercam's menu, select **Xform, Offset Contour**.

The Chaining dialog box opens.

6 Click the slot where shown to chain it counterclockwise, and then click **OK** in the Chaining dialog box.



The Offset Contour dialog box opens.

TIP: If you click in the wrong place and Mastercam chains the geometry clockwise (as indicated by the arrow on the selected geometry), click the **Reverse** button in the Chaining dialog box. Mastercam then reverses the chaining direction.

7 In the Offset Contour dialog box, do the following:

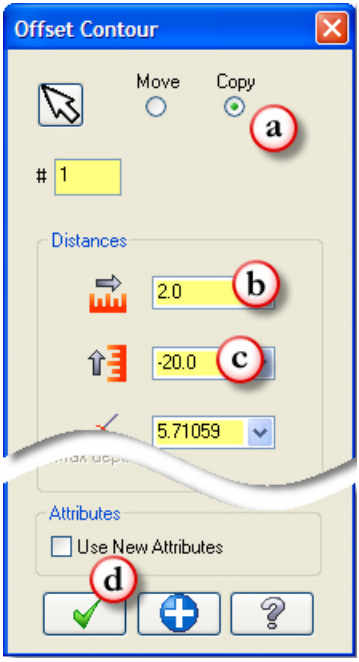
a Select **Copy**.

b Set **Distance** to **2.**

c Set **Height** to **-20**.

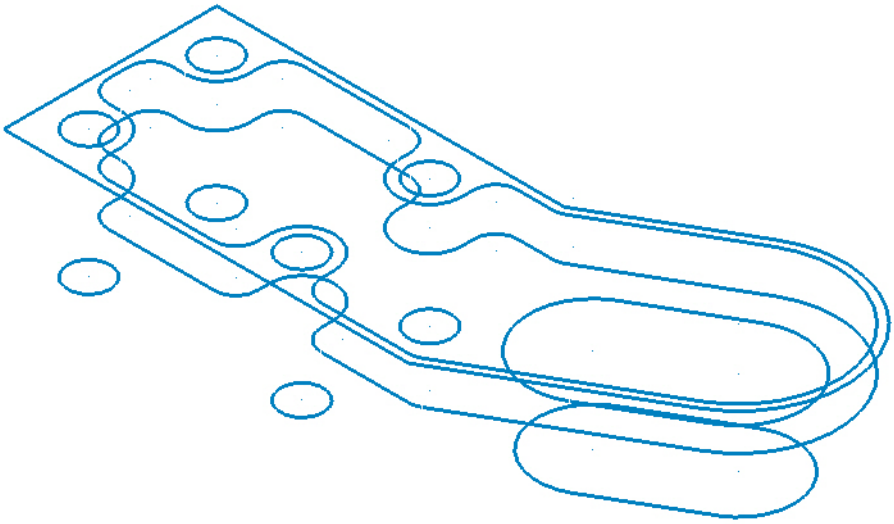
d Click **OK**.

Mastercam first creates a copy of the selected loop and offsets it 2 mm from the original. Mastercam then translates the copy 20 mm down the Z axis.



8 On the toolbar, click **Clear Colors**.

The following image shows the part at this point.



9 Choose **File, Save** to save your work.

Exercise 4: Creating the 3D Outside Perimeter

In this exercise, you create the connector's 3D outer faces. You can continue with the file you worked on in Exercise 3, or you can start this exercise by loading `CONNECTOR_L01EX03.MCX-6`. If you choose to load `CONNECTOR_L01EX03.MCX-6`, be sure to save it under a new name, so that you do not overwrite the original file.

1 Select **Xform Translate**.

2 Hold down [**Shift**] while clicking the part's outside perimeter, and then click **End Selection** in the ribbon bar.

The Translate dialog box opens.

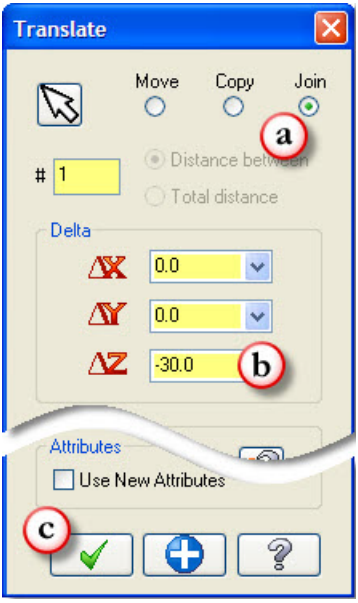
3 In the Translate dialog box, do the following:

a Select **Join**.

b Set **Z** to **-30**.

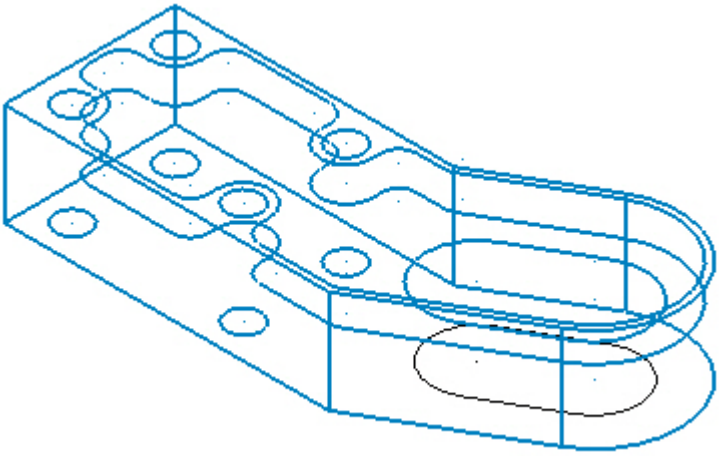
c Click **OK**.

Mastercam not only creates a copy of the geometry 30 mm down the Z axis, but also connects the copy with the original, forming a 3D shape.



4 Click **Clear Colors**.

The part now looks like the following image.



5 Choose **File, Save** to save your work.

Exercise 5: Completing the Wireframe Model

The final feature to create on the connector part is a small hole on the Front plane. As you create the hole, you learn how the status bar's 2D/3D button affects drawing functions. You can continue with the file you worked on Exercise 4, or you can start this exercise by loading `CONNECTOR_L01EX04.MCX-6`. If you choose to load `CONNECTOR_L01EX04.MCX-6`, be sure to save it under a new name.

▶ Draw the Interior hole

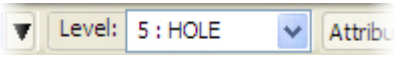
1 Select **Planes, Front (WCS)** from the status bar

Although the part view in the graphics window is unchanged, your construction plane is now aligned with the part's front view.

2 On the status bar, toggle the 2D/3D button to **3D**.

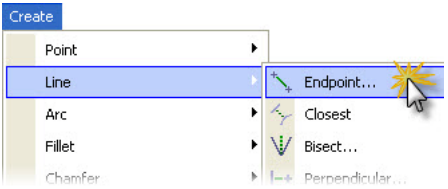
In 3D mode, you can work unconstrained by the current Cplane and Z depth.

3 Set the level to **5:HOLE**.

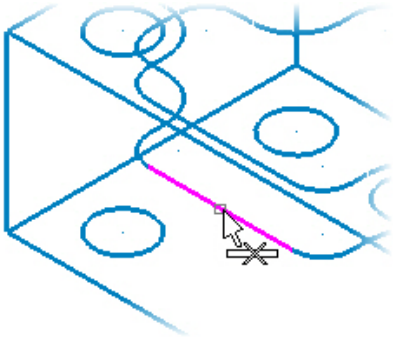


Mastercam will now place new geometry onto level 5.

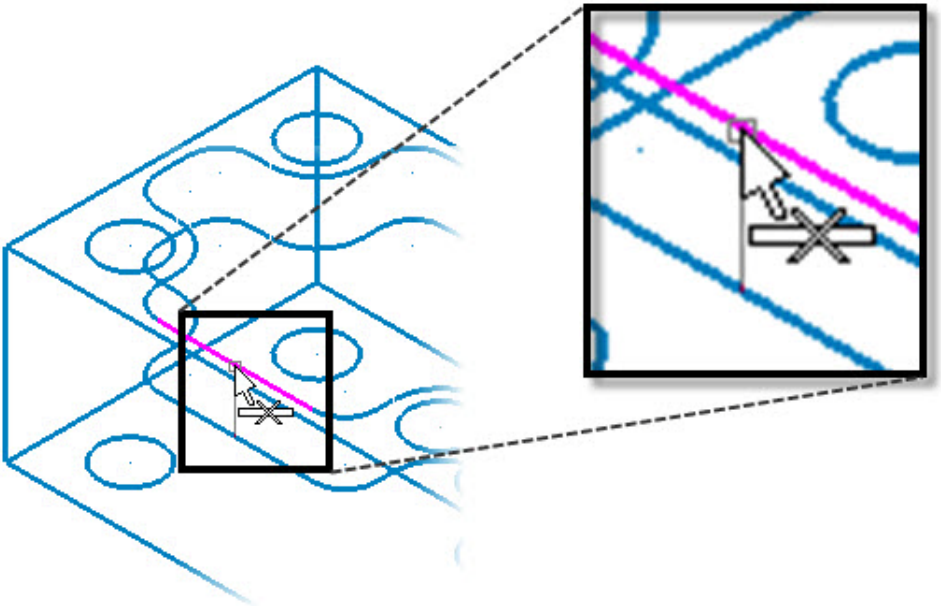
4 From Mastercam's menu, select **Create, Line, Endpoint**.



5 Click the lower pocket contour where shown, on the line's midpoint.



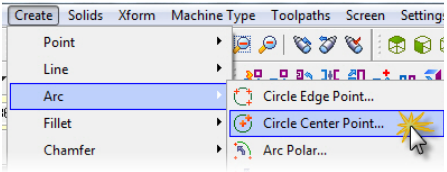
6 Click the upper pocket contour on the line's midpoint, as shown in the following picture.



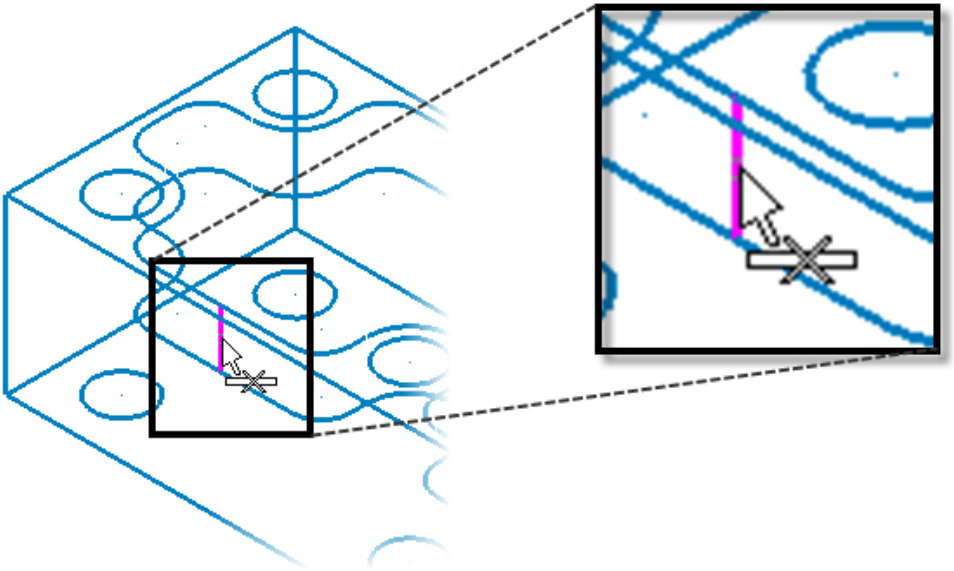
Mastercam draws a line between the two midpoints.

7 Click **OK** on the ribbon bar

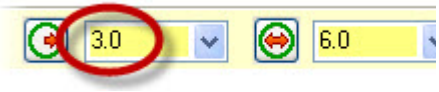
8 From Mastercam's menu, select **Create, Arc, Circle Center Point**.



9 Click the midpoint of the new line, as shown in the picture below.

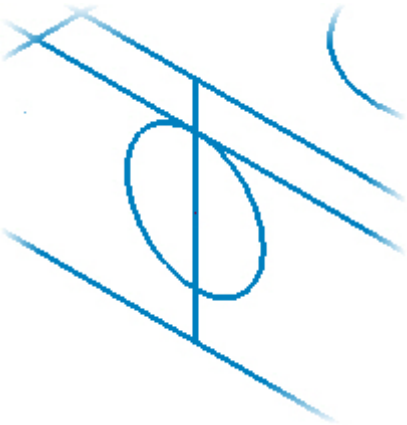


10 On the ribbon bar, set **Radius** to **3.**



11 Click the ribbon bar's **OK** and **Apply** buttons.

Mastercam creates a 6 mm circle that is centered on the line.

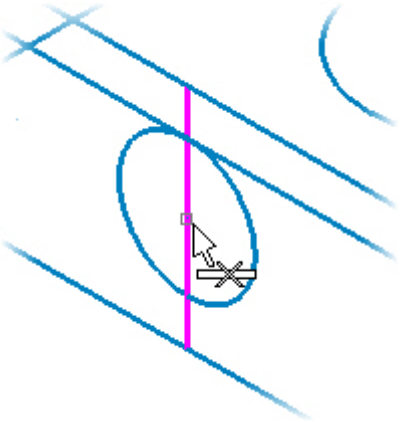


Draw the Exterior Hole

1 On the status bar, set the 2D/3D button to **2D**.

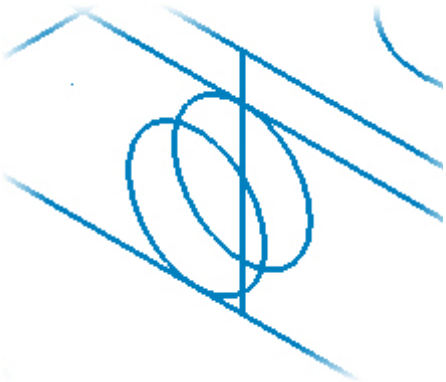
Mastercam now constrains geometry you create to the current Cplane and system Z depth (shown in the status bar).

2 Select the new line's midpoint again.

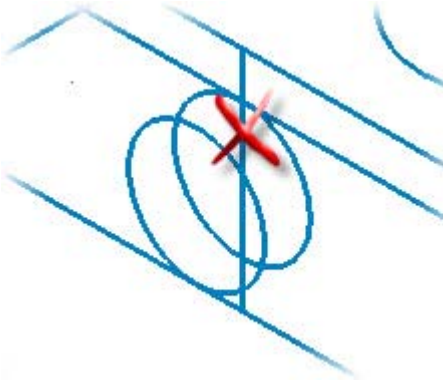


3 Set Radius to **3**, and click **OK twice**.

You should now have the circles shown to the right.

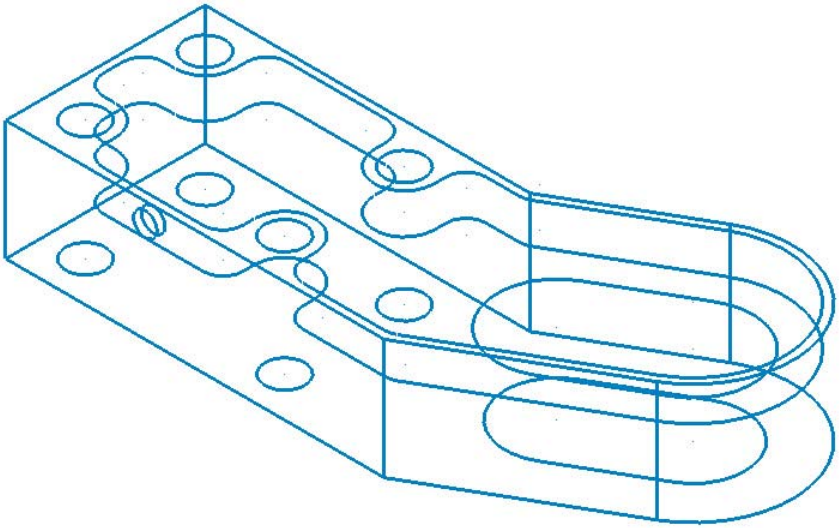


4 Delete the construction line using the **Delete Entities** tool.



5 Choose **File, Save** to save your work.

The following picture shows the connector part as it looks at this point. In the next lesson, you learn about Dynamic Planes as you place lettering on the part.



LESSON 2

Dynamic Planes

With Dynamic Planes, you use your mouse to visually specify views in Mastercam's graphics window. You learn to use Dynamic Planes in this lesson, as you add 3D lettering to the connector part.

This lesson includes the following files, which you can use as needed:

- CONNECTOR_L02EX01.MCX-6: The part file after the completion of Lesson 2, Exercise 1. You can use this file to start Exercise 2.
- CONNECTOR_L02EX02.MCX-6: The part file after the completion of Lesson 2, Exercise 2. You can use this file to start Exercise 3.
- CONNECTOR_L02EX03.MCX-6: The part file after the completion of Lesson 2, Exercise 3.

Lesson Goals

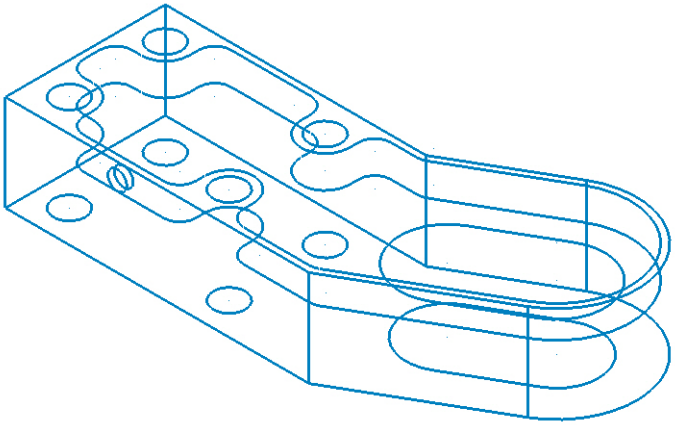
- Use Dynamic Planes to create custom views.
- Align geometry on custom views.
- Add 3D lettering to the part.

Exercise 1: Creating the Text Plane

In this exercise, you use Dynamic Planes to create a view that represents the correct orientation of the first set of letters. Creating such a view makes it easy to align your construction plane as needed.

Start with the part from your completedLesson 1. Alternatively, you can load Lesson 1's CONNECTOR_L01EX05.MCX-6 file, which is supplied with this tutorial. If you choose to load CONNECTOR_L01EX05.MCX-6, be sure to save it under a new name, so that you do not overwrite the original file.

The following picture shows the part in Mastercam's graphics window at the start of this lesson.



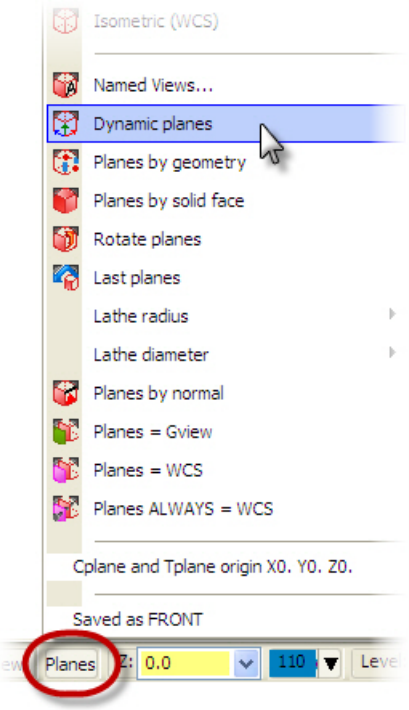
Defining the Custom View

1 Set the 2D/3D button to **3D**.

Mastercam now allows you to pick locations anywhere in the 3D coordinate system, without being constrained by the current plane and view.

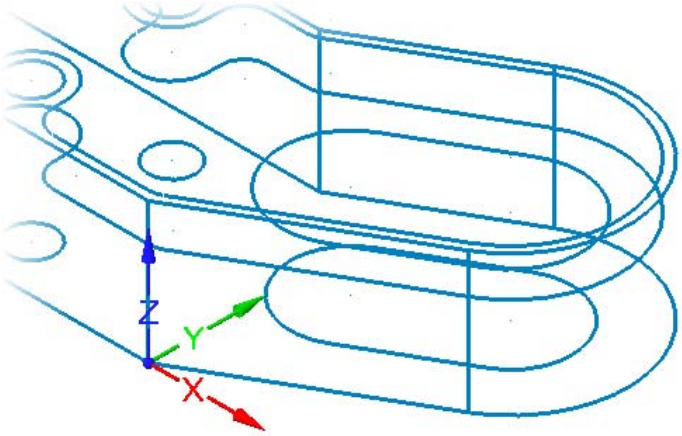
2 From the status bar, select **Planes, Dynamic Planes**.

The Dynamic Planes dialog box opens.



TIP: You can also use Dynamic Planes to manipulate the WCS. To do this, click **WCS** on the status bar, and then choose **Dynamic WCS** from the menu that opens. Please refer to Mastercam Help for more information about the WCS.

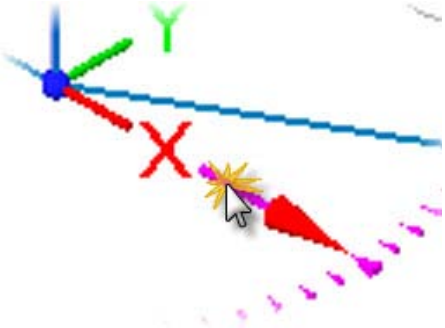
3 In the graphics window, place the origin of the Dynamic Planes icon on the line intersections shown in the following picture, and click.



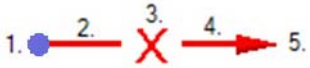
Mastercam anchors the gnomon where you clicked.

4 Click the gnomon's X leg between the X and the arrowhead, as shown.

Mastercam displays a scale for rotating the X axis around Z.



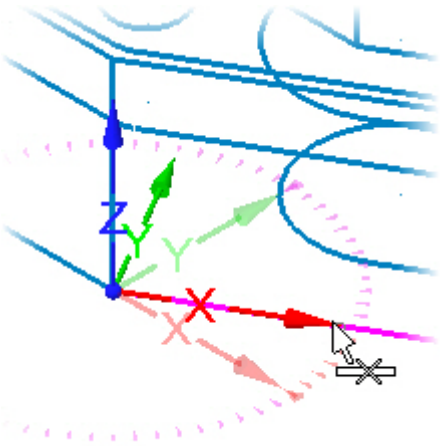
TIP: Where you click the Dynamic Planes gnomon determines how you can manipulate the axes. Each of the gnomon's "legs" has five clickable areas:



Please refer to Mastercam Help for more information.

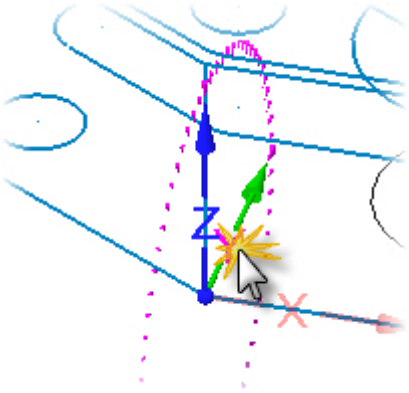
5 Click the line midpoint, where shown.

Mastercam positions the X axis on the selected line.



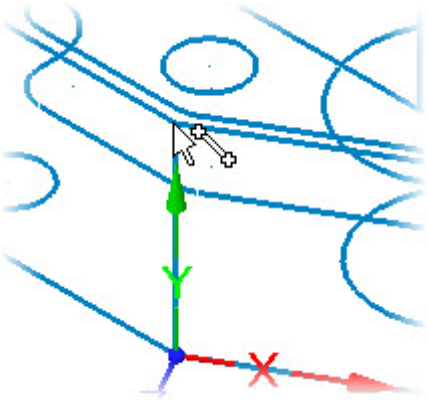
6 Click the gnomon's **Y** label.

A scale for rotating the Y axis around X appears.

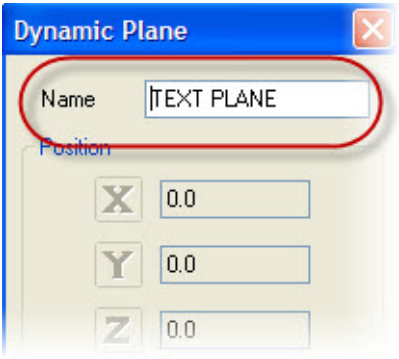


7 Select the upper endpoint of the vertical line, as shown.

Mastercam positions the Y axis on the selected line.



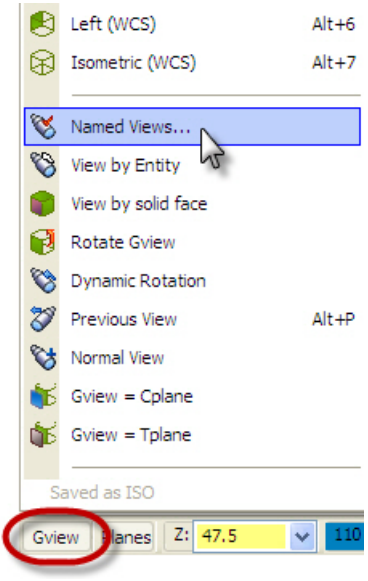
8 Change the view's name from **NEW VIEW (8)** to **TEXT PLANE**, and click **OK** to close the Dynamic Plane dialog box.



You have now used Dynamic Planes to create a new view named TEXT PLANE. In the following steps, you use the new TEXT PLANE view to position a line of text on the part.

Selecting the Custom View

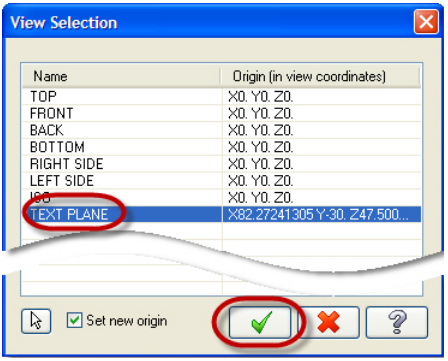
1 From the status bar, select **Gview, Named Views**.



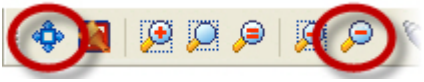
The View Selection dialog box opens.

2 In the View Selection dialog box, choose **TEXT PLANE**, and click **OK**.

Mastercam aligns the view in the Graphics window with the selected plane.



3 In Mastercam's toolbars, select **Fit** and **Un-zoom .8**.



The geometry in your graphics window should now look like the following picture.

4 Choose **File, Save** to save your work.

Exercise 2: Creating the First Set of Letters

The finished part has lettering on two of its surfaces. In this lesson, you create a set of letters that reads MASTERCAM. Continue with the part file you worked on in Exercise 1, or you can load `CONNECTOR_L02EX01.MCX-6`. If you choose to load `CONNECTOR_L02EX01.MCX-6`, make sure to save it under another name.

▶ Preparing for the Lettering

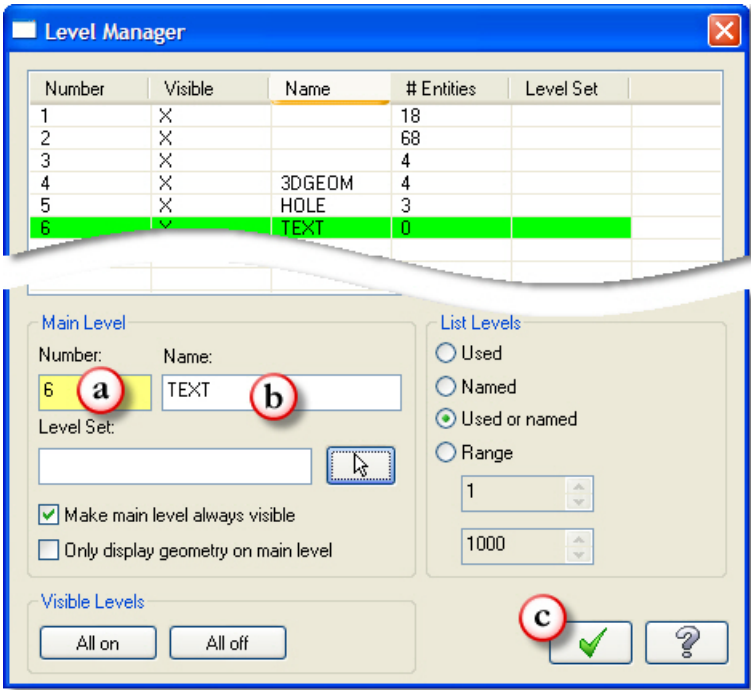
1 Set the 2D/3D button to **2D**.

2 Click the word **Level** on the status bar.

The Level Manager dialog box opens.

3 In the Level Manager, do the Following:

- **a** Set level **Number** to **6**.
- **b** Change the level's name to **TEXT**.
- **c** Click **OK**.



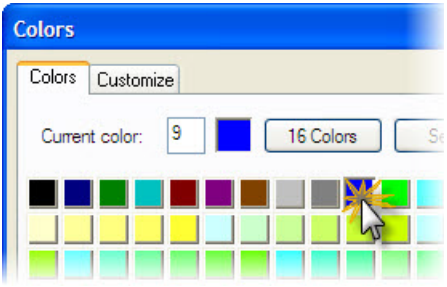
This is another way of starting a new level. Mastercam will now place the text that you create on the level named TEXT.

4 In the status bar, click the **System color** box.

a The Colors dialog box opens.

5 In the Colors dialog box, select color **9**, and click **OK**.

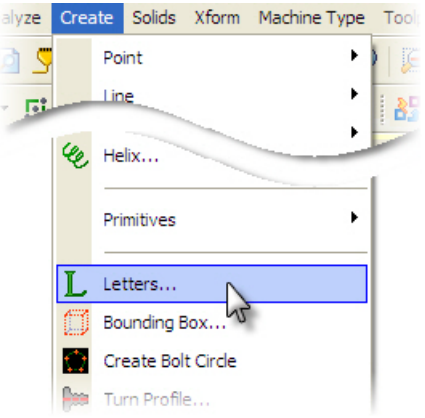
Mastercam will now use the selected color for the lettering that you create in the following steps.



Creating the Lettering

1 From Mastercam's menu bar, select **Create, Letters**.

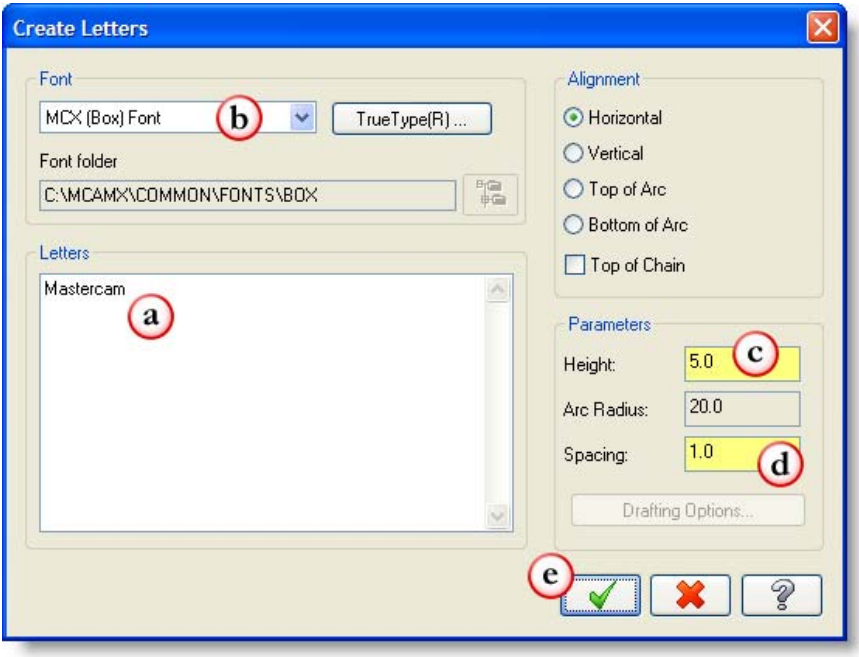
The Create Letters dialog box opens.



2 In the dialog box, do the following, as shown in the following picture.

- **a** Type **Mastercam** into the Letters box.
- **b** Set **Font** to **MCX (Box) Font**.
- **c** Set **Height** to **5.0**.
- **d** Set **Spacing** to **1.0**.

e Click **OK**.



3 Type **x6 y12 z0**, and then press [**Enter**] followed by [**Esc**].

Note: When you click **OK** *to dismiss the Create Letters dialog box, Mastercam waits for you to type the X, Y, and Z coordinates for the lettering. Be sure to type lowercase letters.*

Mastercam creates the lettering (in the color you selected in Step 5) and places it at the position you typed.

4 Choose **File, Save** to save your work.

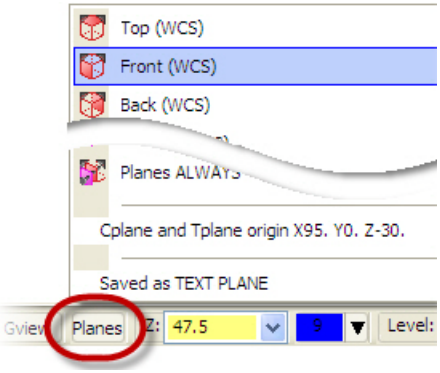
Exercise 3: Creating the Second Set of Letters

The second set of letters gets placed on the Front plane. Because Front is a standard Mastercam view, you do not need to create a custom view as you did for the first set of letters. In this exercise, you use the Front view to create the final lettering for the part.

Continue with the part file you worked on in Exercise 2, or you can load `CONNECTOR_L02EX02.MCX-6`. If you choose to load `CONNECTOR_L02EX02.MCX-6`, make sure to save it under another name.

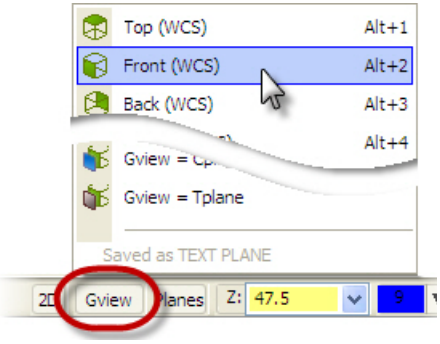
1 From the status bar, select **Planes, Front (WCS)**.

Mastercam sets the construction plane to the Front view.



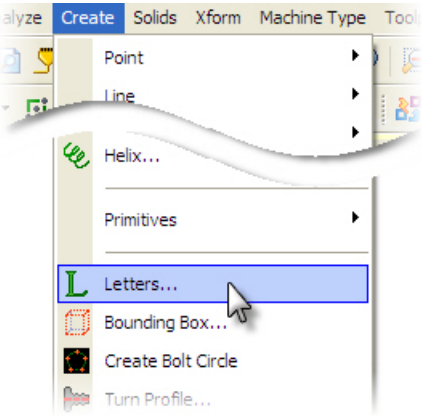
2 Select **Gview, Front (WCS)**.

Mastercam sets the graphics view to Front. You are now looking at the part in the same orientation that you set for the Cplane.



3 From Mastercam's menu bar, select **Create, Letters**.

The Create Letters dialog box opens.



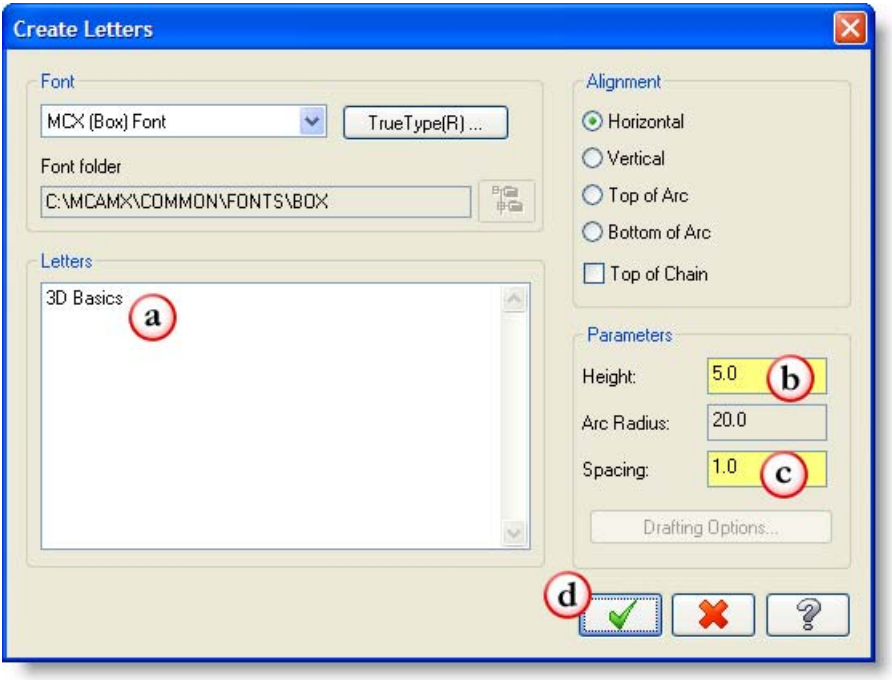
4 In the Create Letters dialog box, do the following:

a Type **3D Basics** into the Letters box.

b Ensure that Height is **5.0**.

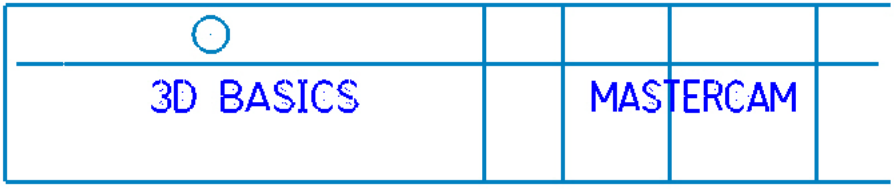
c Ensure that Spacing is **1.0**.

d Click **OK**.



5 Type **x25 y-18 z15**, and then press [**Enter**], followed by [**Esc**].

Mastercam places the second set of letters on the part, as shown in the following picture.



TIP: If you type the lettering incorrectly, you must delete the lettering geometry, and try again from Step 3.

6 Choose **File, Save** to save your work.

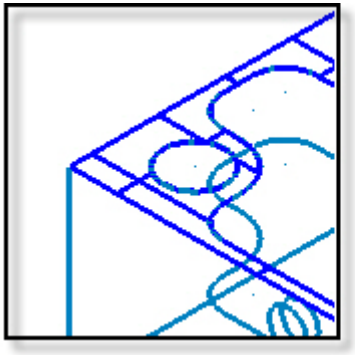
In the next lesson, you complete the part by creating various types of surfaces on the wireframe model.

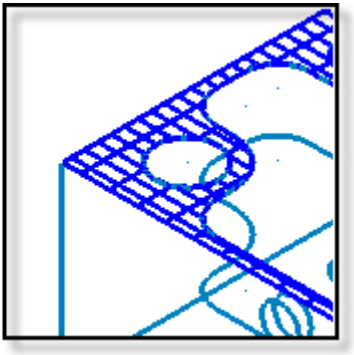
LESSON 3

Surface Creation

In this lesson, you complete the part by creating surfaces on the wireframe model. These surfaces form the part's top, bottom, and many side walls.

Note: As you work though this tutorial, your surfaces may display differently than those shown in the illustrations. In wireframe display mode, Mastercam draws surfaces with a set of lines. The number of lines drawn on a surface is determined by the Surface drawing density setting. The higher the drawing density setting, the more lines Mastercam uses to display a surface in wireframe mode. The picture on the left shows a surface with a drawing density of 2. The picture on the right shows the same surface with a drawing density of 10. To change surface drawing density, select **Settings, System Configuration**. *The surface drawing density setting is located on the CAD Settings page.*





This lesson includes the following files, which you can use as needed:

- `CONNECTOR_L03EX01.MCX-6`: The part file after the completion of Lesson 3, Exercise 1. You can use this file to start Exercise 2.
- `CONNECTOR_L03EX02.MCX-6`: The part file after the completion of Lesson 3, Exercise 2. You can use this file to start Exercise 3.
- `CONNECTOR_L03EX03.MCX-6`: The part file after the completion of Lesson 3, Exercise 3. You can use this file to start Exercise 4.

- CONNECTOR_L03EX04.MCX-6: The part file after the completion of Lesson 3, Exercise 4. You can use this file to start Exercise 5.
- CONNECTOR_L03EX05.MCX-6: The part file after the completion of Lesson 3, Exercise 5. You can use this file to start Lesson Exercise 6.
- CONNECTOR_L03EX06.MCX-6: The part file after the completion of Lesson 3, Exercise 6. You can use this file to start Exercise 7.
- CONNECTOR_L03EX07.MCX-6: The part file after the completion of Lesson 3, Exercise 7.

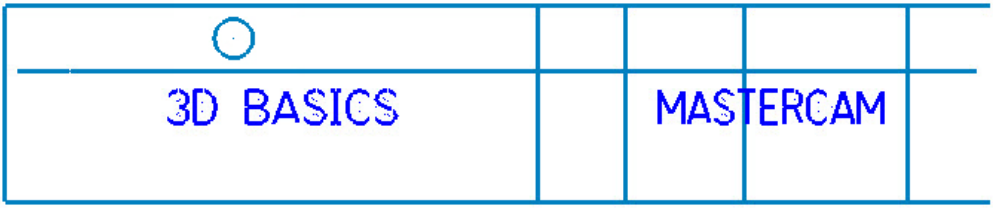
Lesson Goals

- Create Flat Boundary surfaces.
- Create Ruled surfaces.
- Create Lofted surfaces.
- Create Draft surfaces.
- Trim surfaces to curves and other surfaces.

Exercise 1: Preparing for Surface Creation

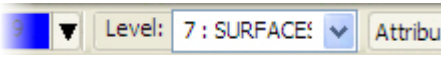
If necessary, load the part file from your completed Lesson 2. Alternatively, you can load Lesson 2's CONNECTOR_L02EX03.MCX-6 file, which is provided with this tutorial. If you choose to load CONNECTOR_L02EX03.MCX-6, remember to save it under a different file name so that you do not overwrite the original file.

The part should look like the one shown in the picture below.



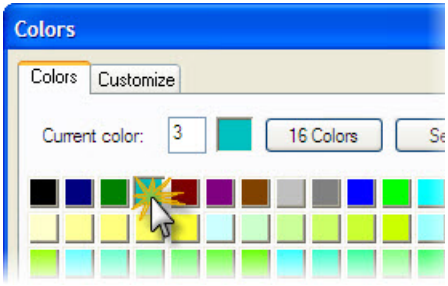
Note: If Mastercam opens a dialog box showing the message "Switching system units from English to Metric," just click **OK** *to accept the default settings.*

1 On the status bar, create a new level by typing **7:SURFACES** and pressing [**Enter**].



Mastercam will now place new geometry on level 7.

2 Also in the status bar, do the following:



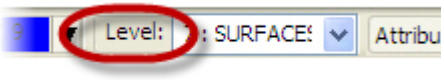
a Click the **System color** box.

b Select color 3 in the Colors dialog box.

c Click **OK**.

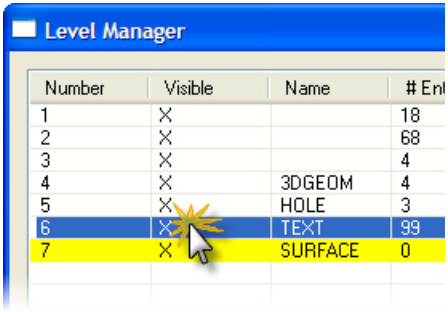
Mastercam will now use the selected color to display newly created geometry.

3 Click the **Level** label in the status bar.



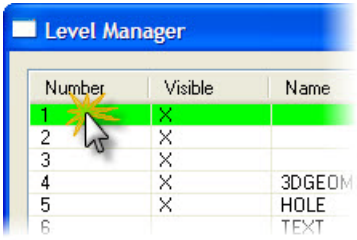
The Level Manager dialog box opens.

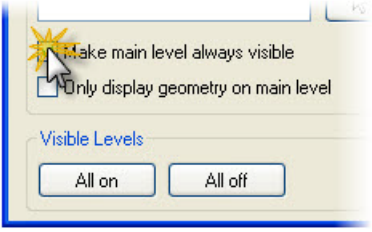
4 Click the **X** in level 6's Visible column, and then click **OK**.



Mastercam hides the lettering, keeping it out of the way of the geometry you will work with in the following steps.

TIP: If you can not turn off level 6, it is probably set as the main level. To proceed, click the **1** in the Number column, which makes level 1 the main level. You can now turn off level 6. Alternatively, turn off the **Make main level always visible** option, and then turn off level 6.





5 Choose **File, Save** to save your work.

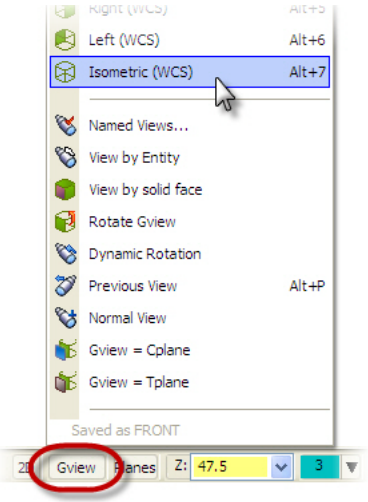
Exercise 2: Creating the Top Flat Boundary Surface

In this exercise, you create a Flat Boundary surface that forms the part's top. Flat Boundary surfaces are trimmed NURBS surfaces created within a boundary you select. The boundary is defined by a closed, planar chain. As you will see, when Mastercam creates the surface, it trims it to the boundaries of all of the chained entities

Continue with the part file from the previous exercise. Alternatively, you can load the file `CONNECTOR_L03EX01.MCX-6`, which is included with this tutorial. If you choose to load `CONNECTOR_L03EX01.MCX-6`, remember to save it under a different file name so that you do not overwrite the original file.

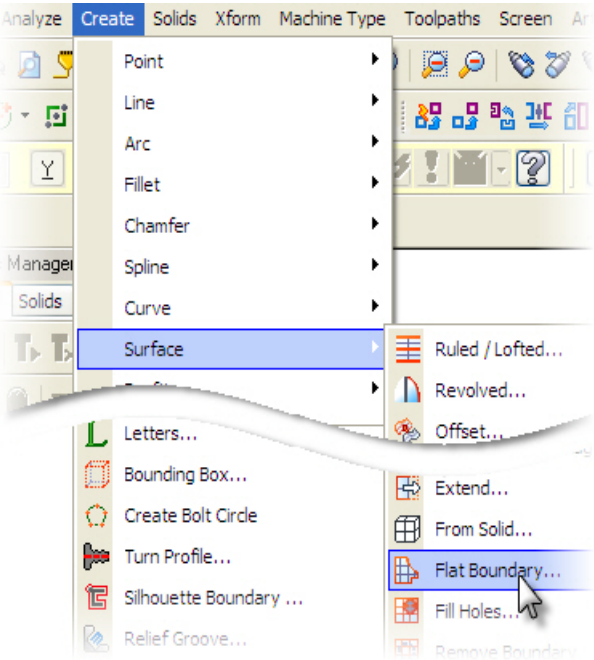
1 In the status bar, select **Gview, Isometric (WCS)**.

Mastercam displays the part in the isometric orientation.



2 From Mastercam's menu, select **Create, Surface, Flat Boundary**.

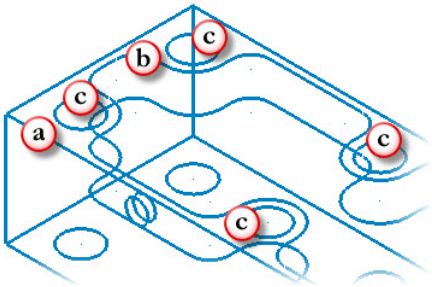
The Chaining dialog box opens.



3 In the Chaining dialog box, select **C-Plane**.

Mastercam now constrains chaining to entities that are parallel to the current construction plane and at the same Z depth as the first entity you chain.

4 Chain the following geometry. (The chaining order and direction is unimportant.)

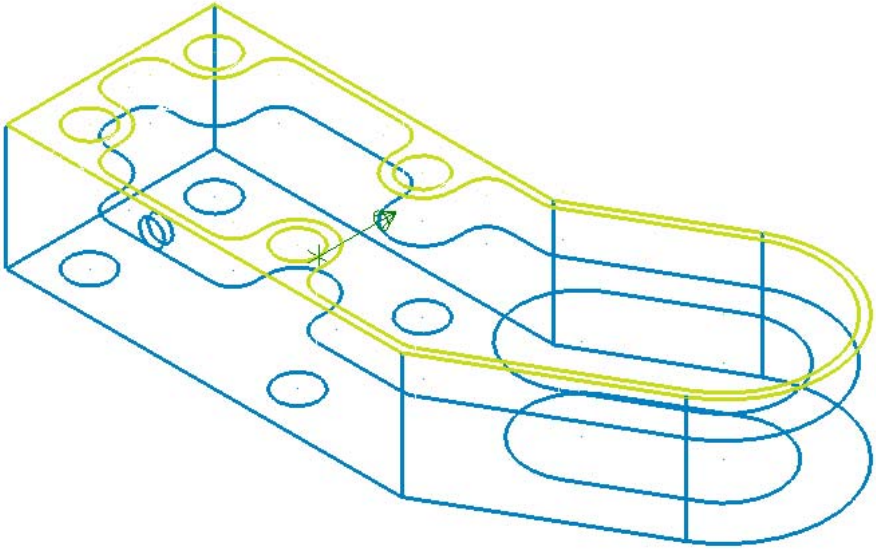


a The upper perimeter

b The upper, inner pocket

c The four upper circles

Your selected geometry should match the following picture.

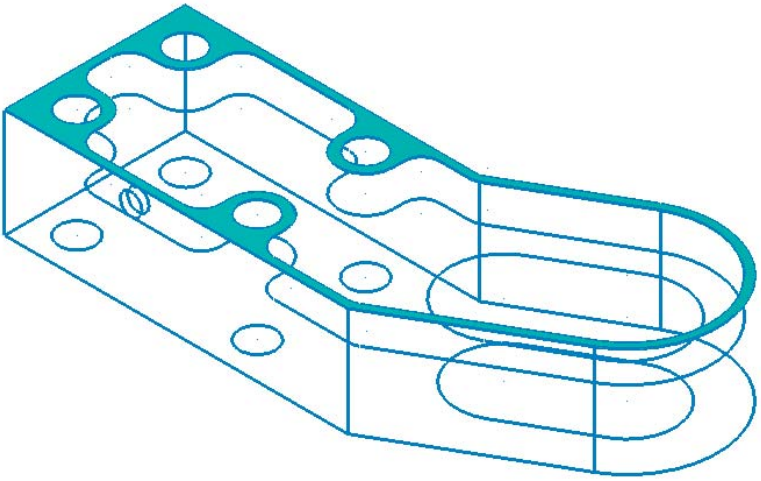


5 Click **OK** in the Chaining dialog box.

Mastercam creates a surface based on the selected geometry. Specifically, the upper perimeter you selected is the outer boundary of the surface. The selected circles are nested within this perimeter and so form holes in the flat boundary surface.

6 Click the **Shaded** button to better see your new surface.

Mastercam displays the part as a shaded model.



7 On the ribbon bar, click **OK**.

Exercise 3: Creating the Bottom Flat Boundary Surface

Continue with the part file from the previous exercise. Alternatively, you can load the file CONNECTOR_L03EX02.MCX-6, which is included with this tutorial. If you choose to load CONNECTOR_L03EX02.MCX-6, remember to save it under a different file name.

1 From Mastercam's menu, select **Create, Surface, Flat Boundary.**

The Chaining dialog box opens.

2 In the Chaining dialog box, select **C-Plane.**

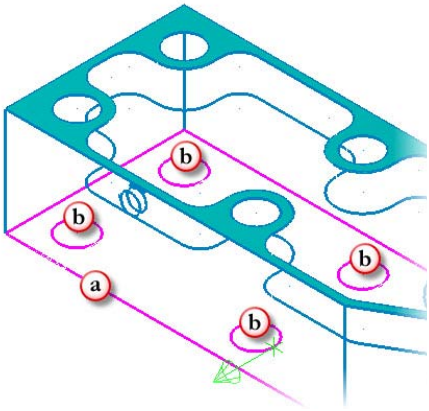
Mastercam constrains chaining to entities that are parallel to the current construction plane and at the same Z depth as the first entity you chain.

3 Chain the following geometry:

a The lower outside perimeter

b The lower four circles

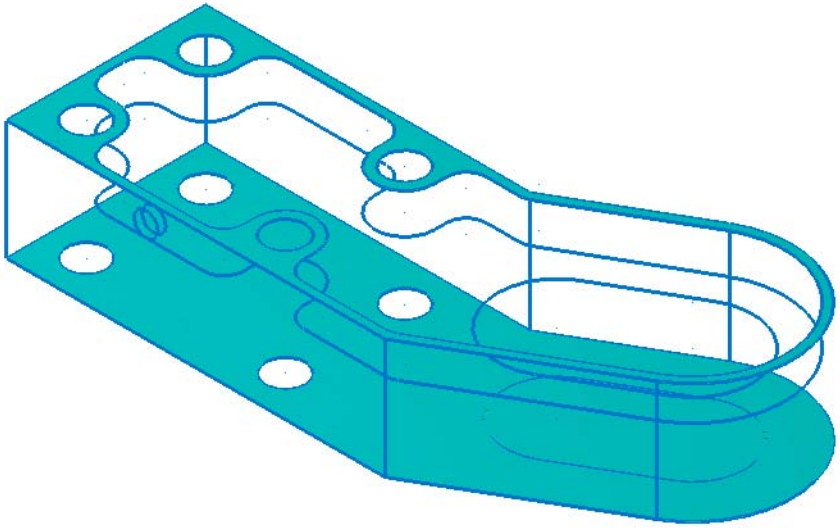
As you can see on one of the circles in the picture to the right, a chained entity displays a chaining arrow. The arrow remains on the entity only until you chain the next entity.



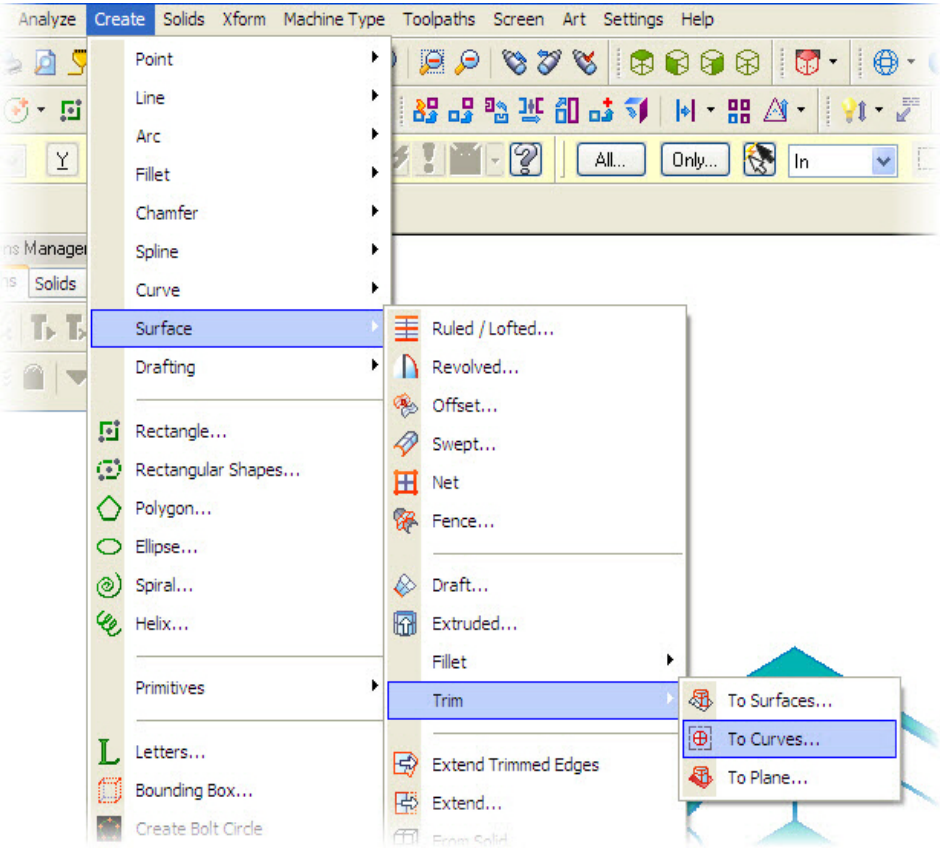
TIP: If clicking the outside perimeter results in an incomplete chain, and Mastercam tells you that a branch point has been reached, then you forgot to select the **C-plane** option in the Chaining dialog box. To fix your mistake, first click the **Unselect** button (in the Chaining dialog box) to remove the selected geometry from the chain. Then select the dialog box's **C-plane** option (C-plane), and try chaining again.

4 Click the **OK** button in the dialog box and the ribbon bar.

You now have a surface on the bottom of the part, as seen in the following picture.

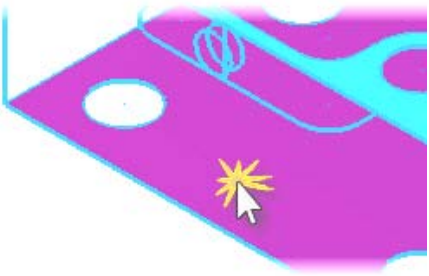


5 Select **Create, Surface, Trim, To Curves**.

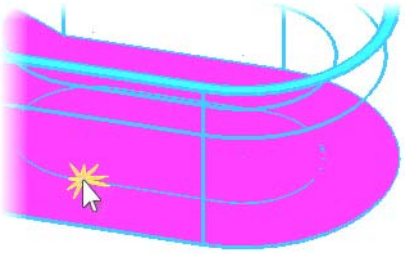


6 Click the lower surface, and press [**Enter**].

The Chaining dialog box opens.

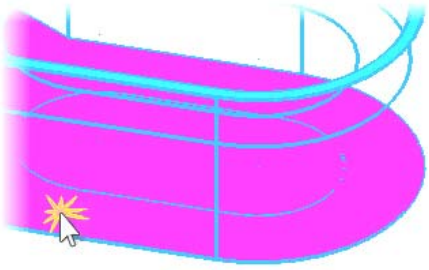


7 Click the lower slot contour as shown, and click **OK** in the Chaining dialog box.

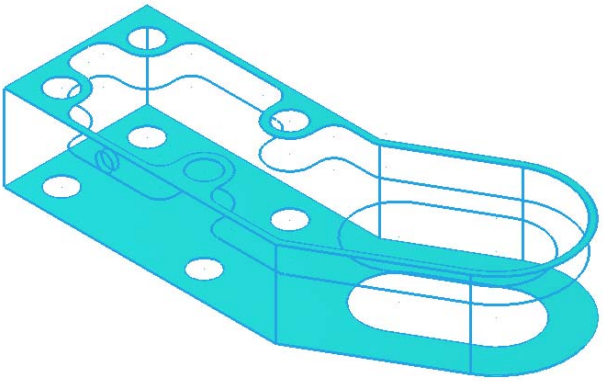


IMPORTANT: In the following step, you are instructed to click twice on a surface. *Do not move your mouse off of the surface between the two mouse clicks.* On the first click, an arrow indicating the surface normal appears. On the second click, the cursor returns to its default arrow. At that point, you can again move your mouse.

8 Click twice outside of the slot contour, as shown, and then click **OK** on the ribbon bar.



Mastercam trims the slot, leaving the geometry as it is shown in the following picture.



Note: You could have chained the lower slot with the other geometry in Step 3. This tutorial, however, left the slot to demonstrate the Trim to Curves function, which you used in Steps 5 through 8.

9 Choose **File, Save** to save your work.

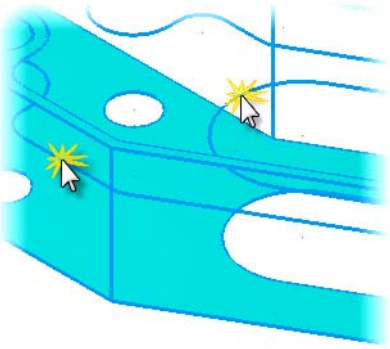
Exercise 4: Creating the Middle Flat Boundary Surface

Continue with the part file from the previous exercise. Alternatively, you can load the file `CONNECTOR_L03EX03.MCX-6`. If you choose to load `CONNECTOR_L03EX03.MCX-6`, be sure to save it under a different file name.

1 In the MRU Function Bar (shown undocked in the picture on the right), select **Create Flat Boundary Surface**.

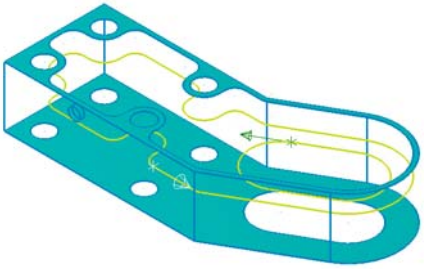
The Chaining dialog box opens.

2 Click the lower pocket contour and the upper slot boundary as shown.



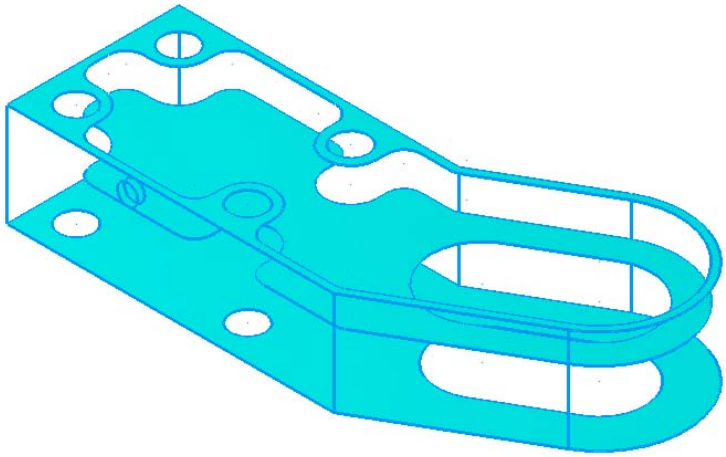
Note: In this case, the chaining direction does not matter. That is, the arrow on the chained geometry can point in either direction.

The picture to the right shows the properly chained geometry.



3 Click **OK** in the Chaining dialog box and the ribbon bar.

Mastercam creates a surface on the area between the selected chains, as shown in the following picture.



4 Choose **File, Save** to save your work.

Exercise 5: Creating Ruled/Lofted Surfaces

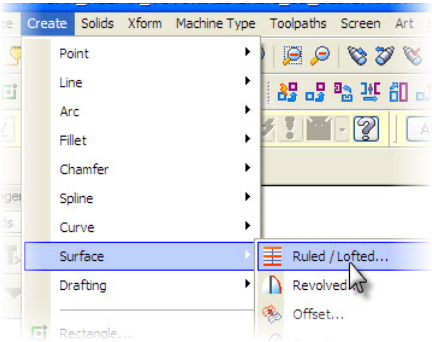
In this exercise, you create Ruled and Lofted surfaces to form walls on the part. Ruled and lofted surfaces blend a minimum of two curves or chains of curves. Although the two types of surfaces are similar, a ruled surface is a linear blending of the curves, whereas a lofted surface is a smooth blending of the curves.

Continue with the part file from the previous exercise. Alternatively, you can load the file `CONNECTOR_L03EX04.MCX-6`, which is included with this tutorial. If you choose to load `CONNECTOR_L03EX04.MCX-6`, remember to save it under a different file name. If the part displays as a wireframe model, click the **Shaded** button to better see the part's surfaces, as shown in the picture for Step 3 in the previous exercise.

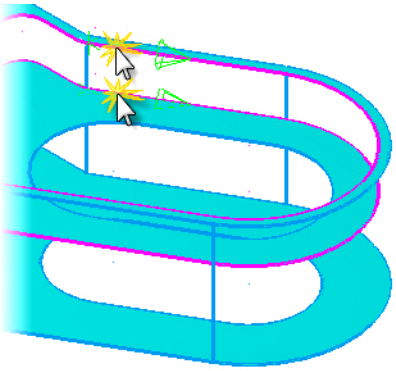
Creating the first side wall

1 Select **Create, Surface, Ruled/ Lofted**.

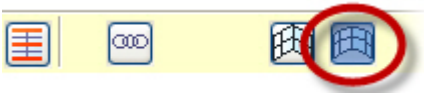
The Chaining dialog box opens.



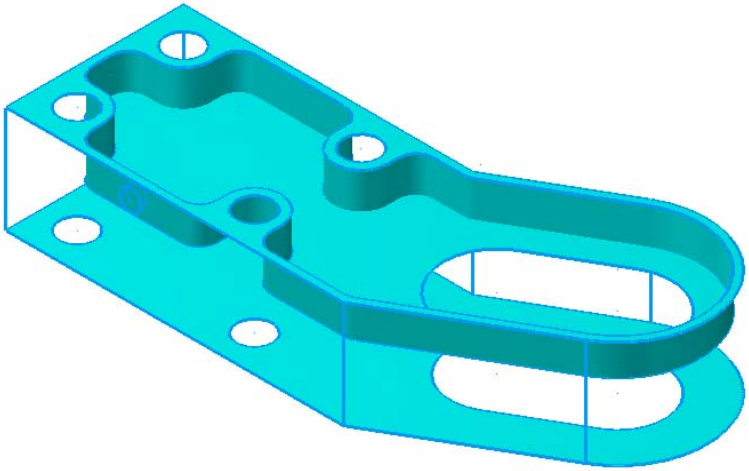
2 Click the upper and lower pocket contours where shown, and click **OK** in the chaining dialog box. (Make sure that both contours are chained in the same direction.)



3 In the ribbon bar, select the **Lofted** button, and then click **Apply**.



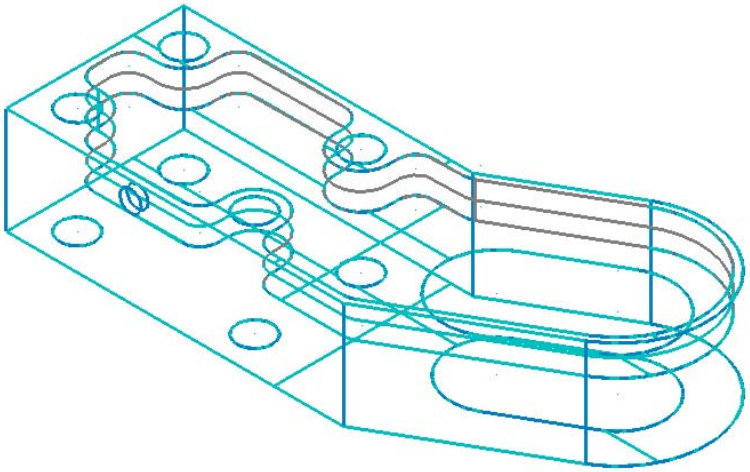
Mastercam creates a surface on the sidewall between the selected contours, as shown in the following picture.



Creating walls on the holes

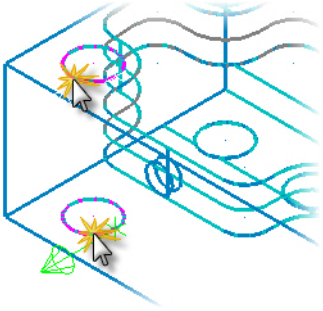
1 Click the **Wireframe** button.

Mastercam switches the display to wireframe, which better shows the drill-hole geometry. The following picture shows the wireframe model.



2 Select the first set of drill holes as shown, and click **OK** in the Chaining dialog box.

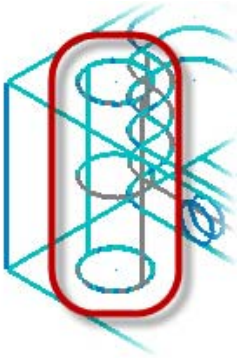
Make sure that you chain the holes in the same direction. Otherwise, your surface will be twisted.



TIP: To reverse a chain's direction, click the Reverse button in the Chaining dialog box.

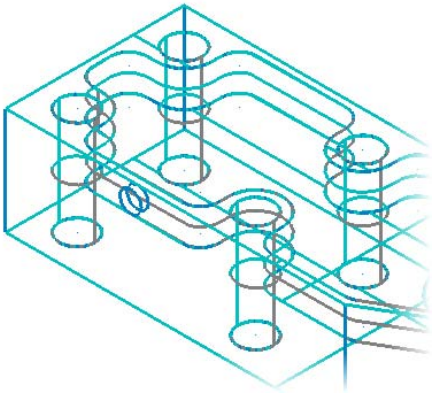
3 On the ribbon bar, click **Ruled** and then **Apply**.

Mastercam creates a wall with a Ruled Surface between the two selected circles. Then the Chaining dialog box reopens.



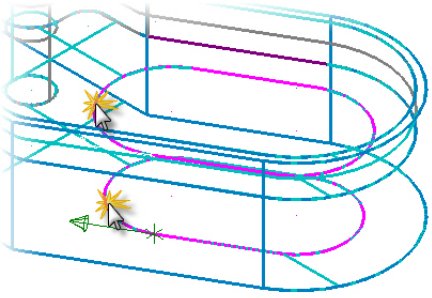
4 Use the same procedure to create surfaces on the other three sets of drill holes, always clicking **Apply** on the ribbon bar, rather than **OK**.

The picture to the right shows all four holes and their surfaces.

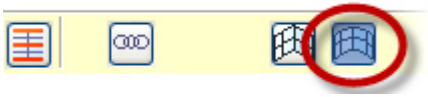


Creating walls on the slot

1 Select the upper and lower slot contours as shown, and click **OK** in the Chaining dialog box.



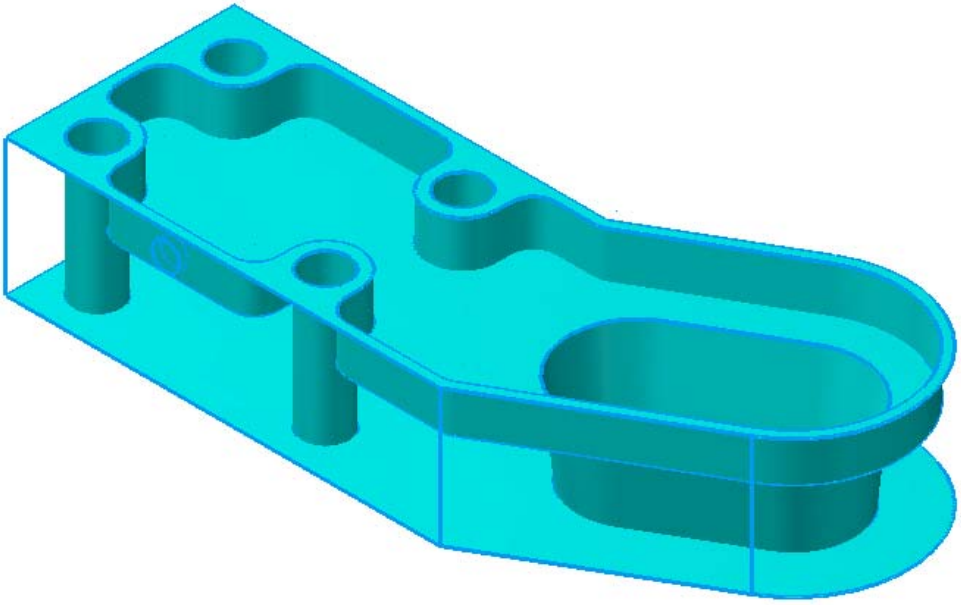
2 In the ribbon bar, click **Lofted** and then **OK**.



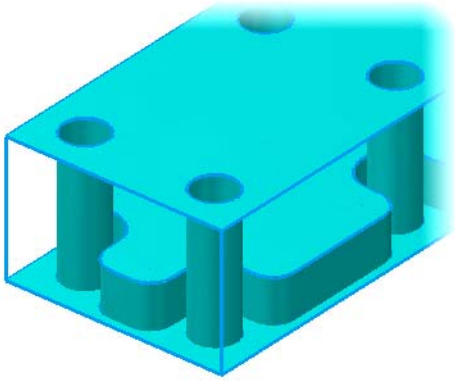
Mastercam creates a sidewall with a Lofted Surface between the selected contours.

3 Click the **Shaded** button to better examine the new surfaces.

The following picture shows the part at this point.



TIP: Use Dynamic Rotation ( ) to examine the holes on the back of the part. Then set your view back to isometric. You can also rotate the part by moving your mouse while holding down the middle button.



4 Choose **File, Save** to save your work.

Exercise 6: Creating Draft Surfaces

In this exercise, you create a Draft Surface that defines the wall of the part's side drill hole. A Draft Surface is an angled, extruded surface or a tapered wall formed from one or more chains of curves. The amount of taper is specified by the surface's Angle setting. In the following steps, however, you create a Draft Surface with an angle of 0, which results in no tapering.

Continue with the part file from the previous exercise. Alternatively, you can load the file `CONNECTOR_L03EX05.MCX-6`. If you choose to load `CONNECTOR_L03EX05.MCX-6`, remember to save it under a different file name.

▶ Creating the surface

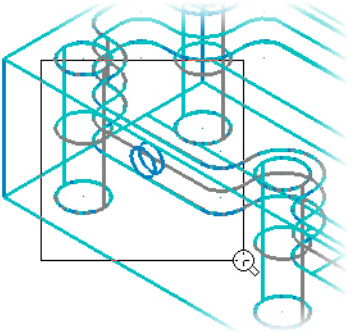
1 Click the **Wireframe** button.

In wireframe display mode, you can better see the geometry you work with in the following steps.

2 In Mastercam's tool bars, click the **Zoom Window** button.

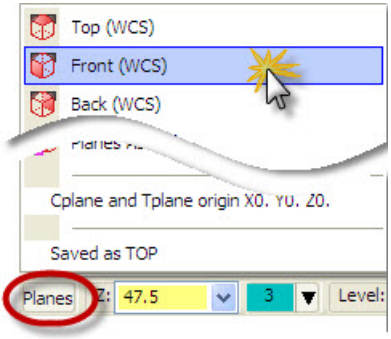
3 Click and drag around the area shown (the side hole), and then release the mouse button. Click a second time to set the opposite corner for the zoom window.

Mastercam magnifies the selected area.



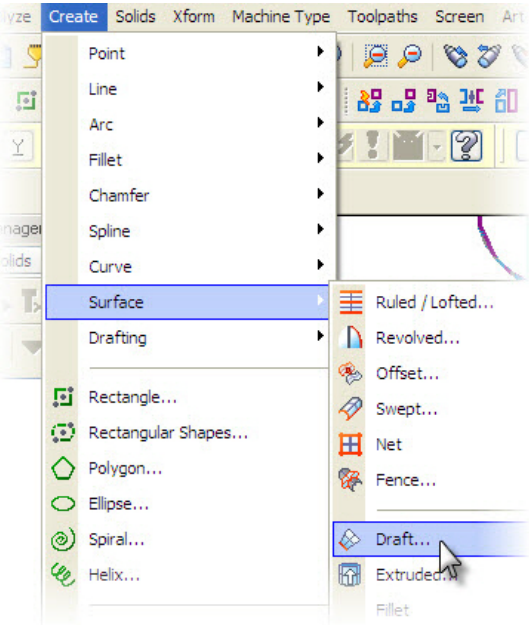
4 From the status bar, select **Planes, Front (WCS)**.

Mastercam aligns the construction plane with the Front view.



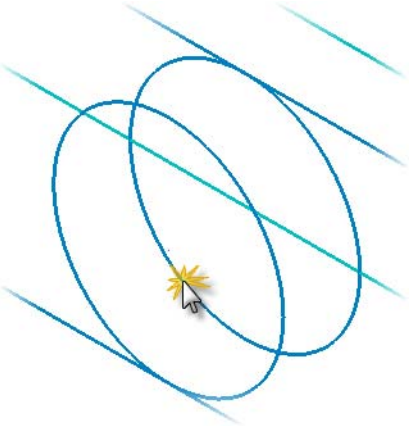
5 Select **Create, Surface, Draft**, as shown in the following picture.

The Chaining dialog box opens.

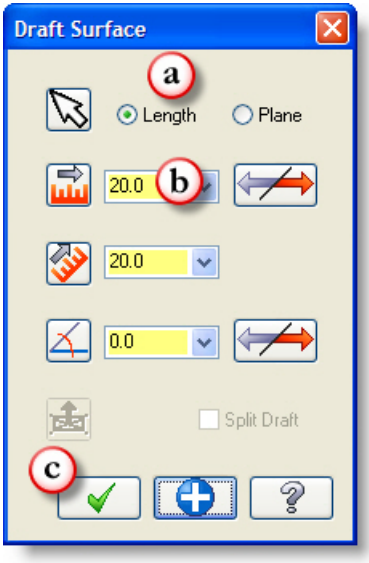


6 Select the inner hole, as shown, and click **OK** in the Chaining dialog box.

The Draft Surface dialog box opens.



7 In the dialog box, do the following:

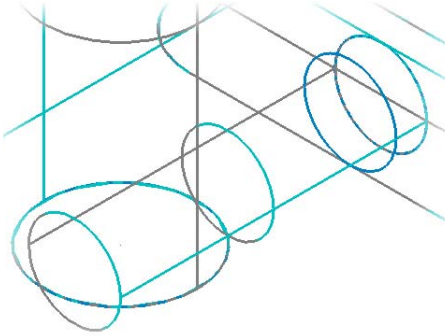


a Select the **Length** option.

b Set the length drop-down to **20.**

c Click **OK**.

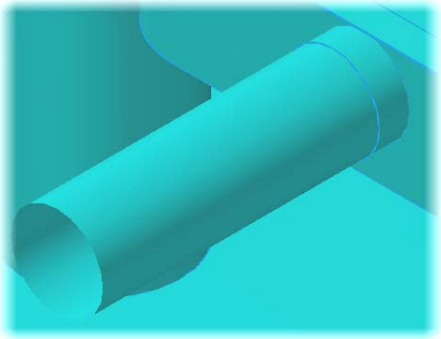
Mastercam creates a cylindrical surface that extends from the selected circle, as shown in the picture to the right.



Note: In this step, you created a draft surface. However, because its angle is 0, the surface does not taper.

8 Click the **Shaded** button.

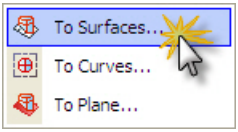
Mastercam applies shading to the wireframe model, which provides a better view of the surfaces, as shown to the right.



Note: This tutorial has you extend the surface by 20 mm to better demonstrate the Trim to Surfaces function in the following steps. Typically, you would not need to extend the surface this far.

Trimming the hole

1 From Mastercam's menu, select **Create, Surface, Trim, To Surfaces**.



2 Click the first surface where shown, and press [**Enter**].

This is the surface that Mastercam will trim.

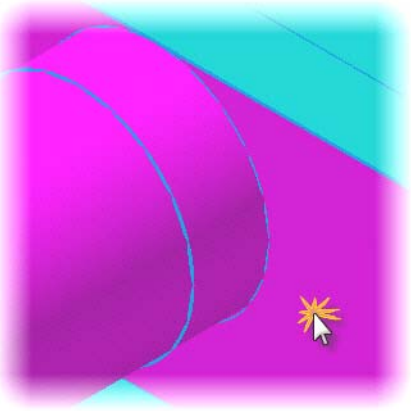
3 Click the second surface where shown, and press [**Enter**].

This is the surface to which the first surface will be trimmed.

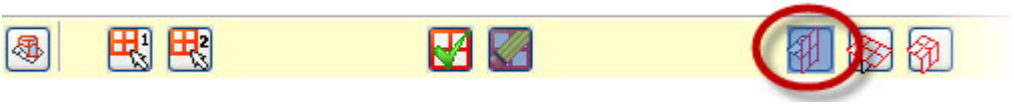
IMPORTANT: In the following step, you are instructed to click twice on a surface. *Do not move your mouse off of the surface between the two mouse clicks*. On the first click, an arrow indicating the surface normal appears. On the second click, the cursor returns to its default arrow. At that point, you can again move your mouse.

4 Click twice where shown to select the portion of the surface to keep.

Now Mastercam will trim only the portion of the side wall surface that blocks the hole.



5 In the ribbon bar, select the **1** button (not to be confused with the First Surface button, which has a "1" on it).



Mastercam is now set up to trim only the side wall surface.

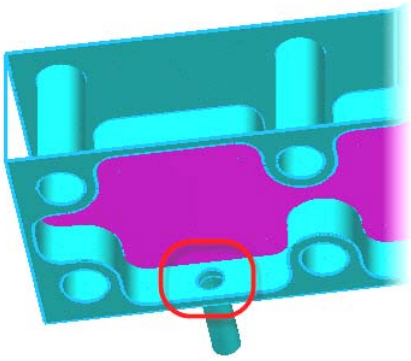
6 Click the ribbon bar's **OK** button.

Mastercam performs the trim function. However, you can not yet see the trimmed area.

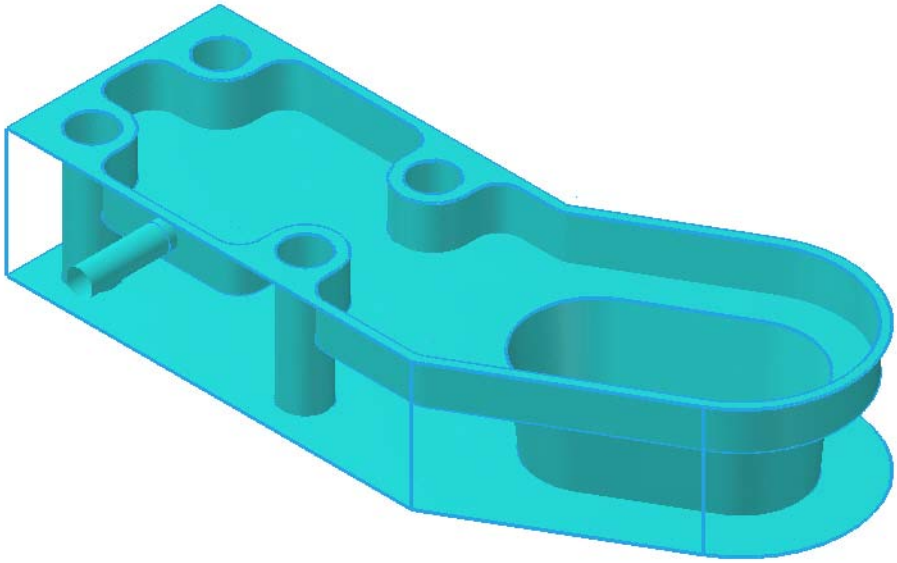
7 On Mastercam's toolbar, click the **Fit** button.

Mastercam resizes the part so that it fits on the screen.

8 Use your mouse to rotate the part to see the completed hole.



The following picture shows the part so far.



9 Use the **Isometric (WCS)**, **Fit**, and **Un-zoom .8** commands to reposition the part on the screen.

10 Save your work.

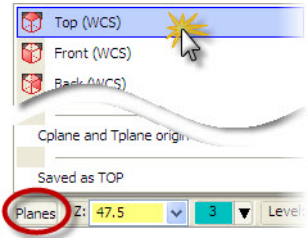
Exercise 7: Creating the Final Ruled/Lofted surface

Continue with the part file from the previous exercise. Alternatively, you can load the file `CONNECTOR_L03EX06.MCX-6`, which is included with this tutorial. If you choose to load `CONNECTOR_L03EX06.MCX-6`, remember to save it under a different file name so that you do not overwrite the original file.

Creating the surface

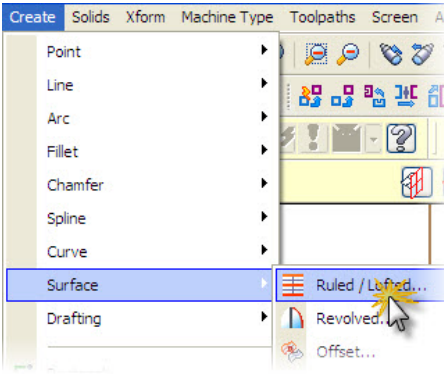
1 From the status bar, click **Planes, Top (WCS)**.

Mastercam aligns the construction plane with the Top view.



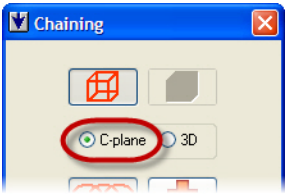
2 Select **Create, Surface, Ruled/ Lofted**.

The Chaining dialog box displays.

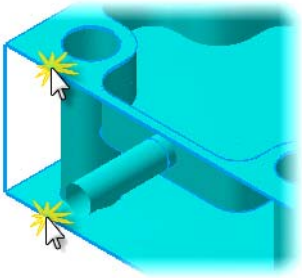


3 In the Chaining dialog box, select the **C-plane** option.

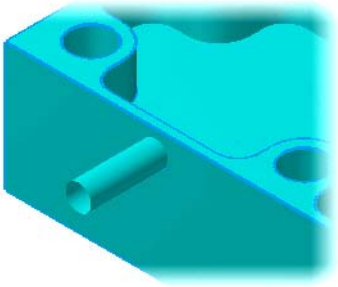
Mastercam now constrains chaining to entities that are parallel to the current construction plane and at the same Z depth as the first entity you chain.



4 Click the part's upper and lower outer perimeters as shown, and then click **OK** in the dialog box and in the ribbon bar.

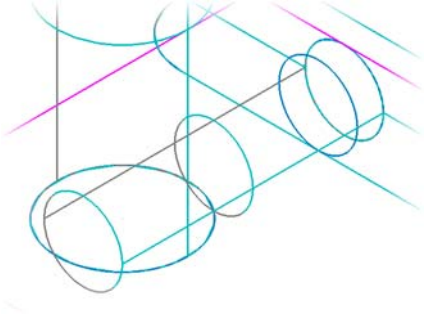


Mastercam creates a surface for the part's outer wall.

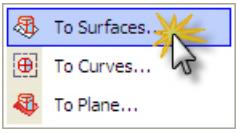


Trimming the drill hole surface

1 Click the **Wireframe** button, and then zoom to the side drill hole.

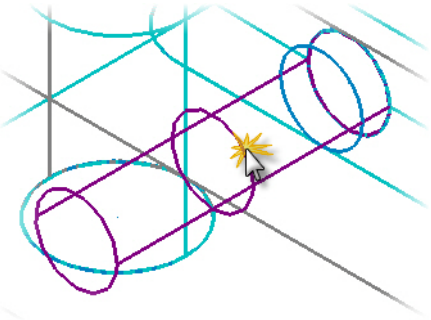


2 Select **Create, Surface, Trim, To Surfaces**.



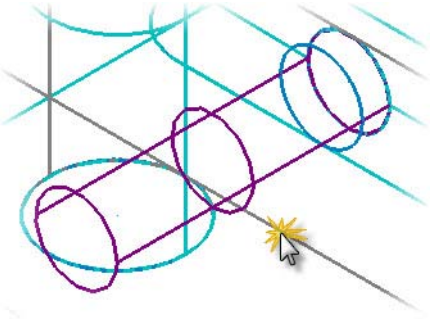
3 Click the side drill hole where shown in the picture to the right, and press [**Enter**].

You have now selected the first surface to trim



4 Click the outer surface where shown, and press [**Enter**].

You have now selected the second surface. to trim.



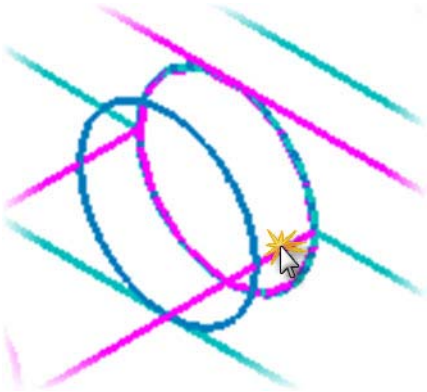
5 On the ribbon bar, click the **Both** button.

Mastercam is now set up to trim both the cylindrical and side-wall surfaces.

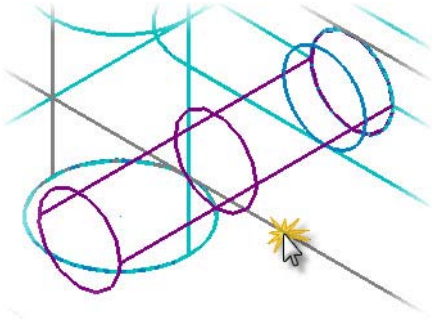
IMPORTANT: In the following two steps, you are instructed to click twice on a line. *Do not move your mouse between the two mouse clicks*. On the first click, an arrow indicating the surface normal appears. On the second click, the cursor returns to its default arrow. At that point, you can again move your mouse.

6 Click twice on the line between the circles on the part's wall, as shown in the picture.

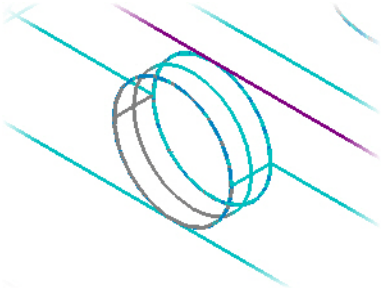
You have now selected the portion of the cylindrical surface to keep after trimming.



7 Click twice on the same line you clicked in Step 4.

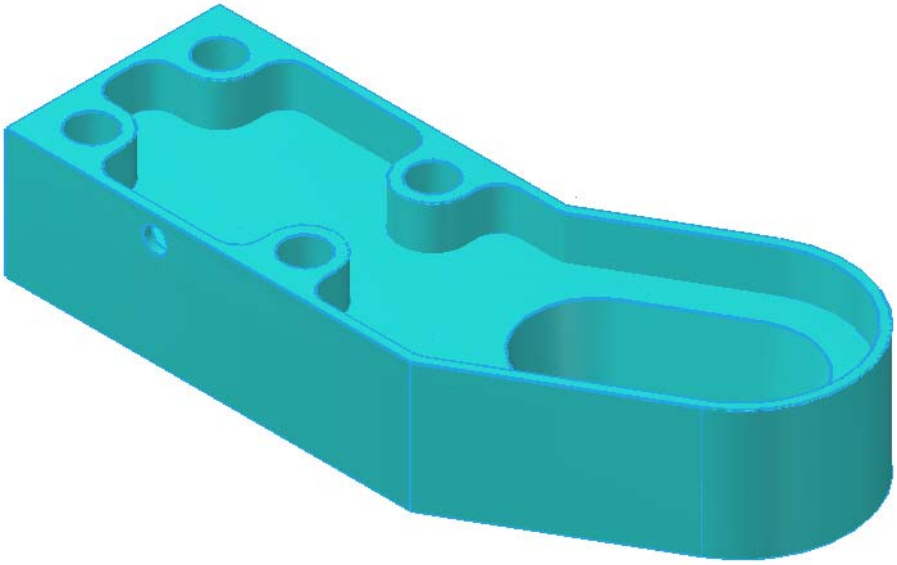


Mastercam trims the surfaces to leave behind the side drill hole.



8 Click **OK** in the ribbon bar, resize the part to fit, and turn on shading.

The following picture shows the completed part.



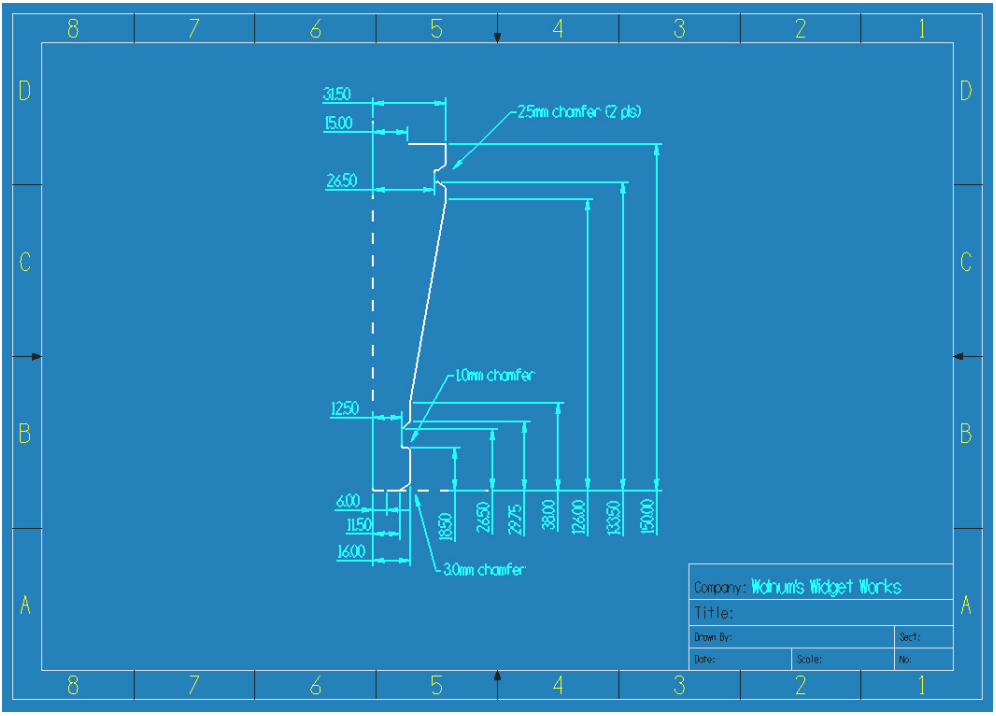
9 Save your work.

You have now completed the connector part. (The tutorial book titled *Basic 3D Machining* shows how to prepare the connector for machining by creating various types of toolpaths on the part.) The next lesson in this tutorial demonstrates other 3D drawing techniques, as you create a tool holder part.

LESSON 4

Creating the Tool Holder Part

In this lesson, you draw the tool holder shown in the following blueprint. Along the way, you discover powerful drawing techniques, such as using construction lines and offsetting geometry. In the tutorial book titled *Basic 3D Machining*, you learn to create toolpaths for this part.



This lesson includes the following files, which you can use as needed:

- `TOOLPATH01.MCX-6`: The part file after the completion of Lesson 4, Exercise 1. You can use this file to start Exercise 2.
- `TOOLPATH02.MCX-6`: The part file after the completion of Lesson 4, Exercise 2. You can use this file to start Exercise 3.

- TOOLPATH03.MCX-6: The part file after the completion of Lesson 4, Exercise 3. You can use this file to start Exercise 4.
- TOOLPATH04.MCX-6: The part file after the completion of Lesson 4, Exercise 4. You can use this file to start Exercise 5.
- TOOLPATH05.MCX-6: The part file after the completion of Lesson 4, Exercise 5. You can use this file to start Exercise 6.
- TOOLPATH06.MCX-6: The part file after the completion of Lesson 4, Exercise 6.

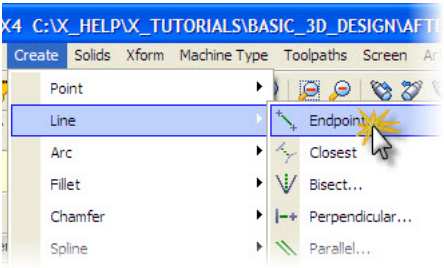
Lesson Goals

- Use construction lines as reference geometry.
- Offset lines from reference geometry to create part geometry.
- Trim geometry to clean up your part.
- Use rotation to form 3D geometry.
- Create Net surfaces on wireframe geometry.

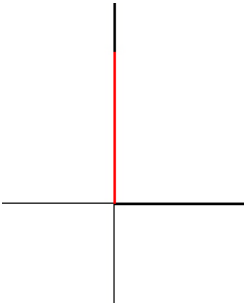
Exercise 1: Drawing the Tool Holder, Part 1

Most of the geometry you draw in this lesson is relative to a set of temporary construction lines. You delete such construction lines when they are no longer needed. In this exercise, you draw the vertical and horizontal construction lines on which most of the geometry is based.

1. Start Mastercam in metric mode.
2. Press [**F9**] to display the axes in the graphics window.
3. Choose **Create, Line, Endpoint**.

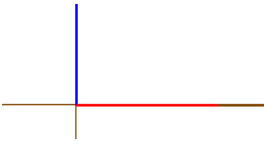


4 Draw any length vertical line upward from the origin. (Do not click **Apply** or **OK** yet.)



5 In the ribbon bar, while the line is still live, set the line's length to **150** mm, its angle to **90**, and click **Apply**.

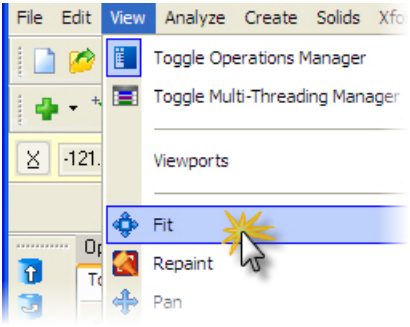
6 Similarly, draw a Horizontal line from the origin to the right.



7 Set this line's length to **35**, its angle to **0**, and click **OK**.

8 Choose **View, Fit**, and then **View, Un-Zoom Previous** / **.5**.

Now the geometry is conveniently sized and positioned on the screen.



9 Save your part as `ToolHolder01_WORK.MCX-6`.

Exercise 2: Drawing the Tool Holder, Part 2

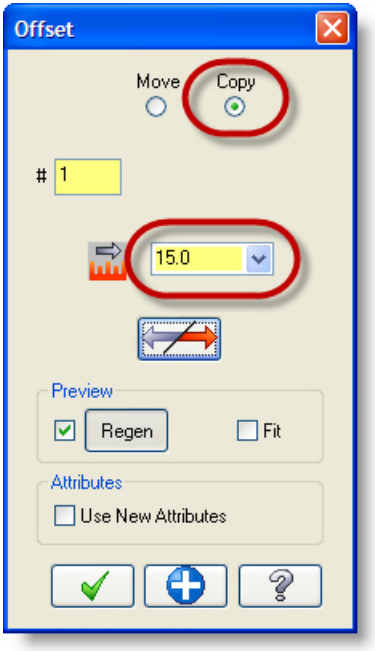
Start this exercise with the part you worked on in the previous exercise, or you can load `Toolholder01.MCX-6`, which is supplied with this tutorial. If you choose to load `Toolholder01.MCX-6`, be sure to save it under another file name so that you do not overwrite the original file.

Creating the New Geometry

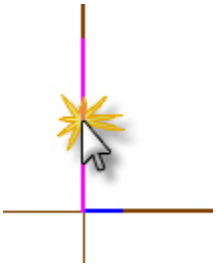
1 Choose **Xform, Offset**.

The Offset dialog box opens.

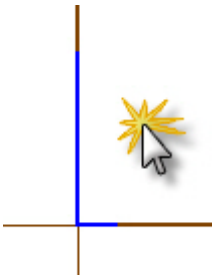
2 Choose the **Copy** option, and set the offset to **15**.



3 Click the vertical construction line (VCL) to select it.

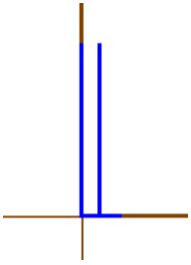


4 Click to the right of the VCL to specify the offset direction, and click **Apply** in the dialog box.



IMPORTANT: Make sure that you click **Apply** and not **OK**. (If you do click **OK**, you must choose **Xform, Offset** again to redisplay the Offset dialog box.)

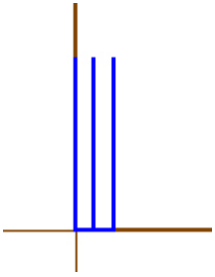
A copy of the line appears, offset to the right of the VCL by 15 mm, as shown in the picture to the right.



5 In the Offset dialog box, change the offset to **31.5**.

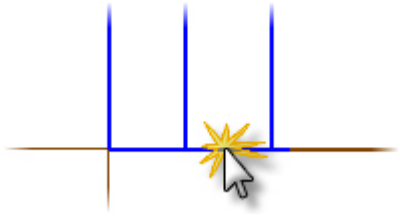
6 Repeat Step 3 and Step 4 to create another offset line.

The picture to the right shows the result.

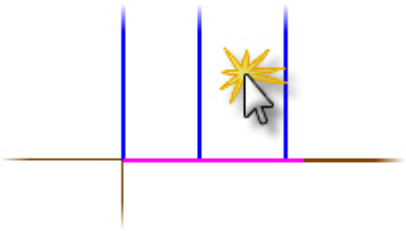


7 In the Offset dialog box, change the offset to **150**.

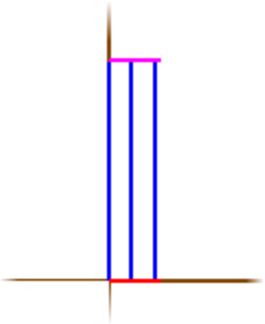
8 Click the horizontal construction line (HCL) to select it.



9 Click above the HCL to specify the offset direction.



A copy of the line appears, 150 mm above the HCL, as shown in the picture to the right.



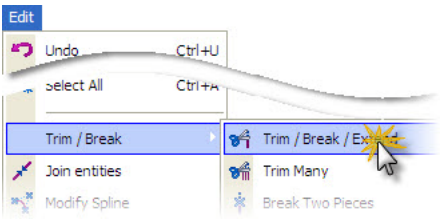
10 Click **OK** to apply your last offset and to dismiss the Offset dialog box.

Note: For the remainder of this lesson, when you are instructed to offset a line, use the same procedure you used in the previous steps, as reviewed below. Remember to click **Apply** *or* **OK** *after each offset operation.*

1. *Open the Offset dialog box.*
2. *Set the* **Copy** *option.*
3. *Set the offset length.*
4. *Click the line to copy.*
5. *Click in the graphics window to choose the offset direction*

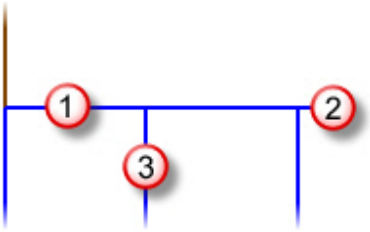
Trimming the New Geometry

1 Select **Edit, Trim/Break, Trim/Break/Extend**.

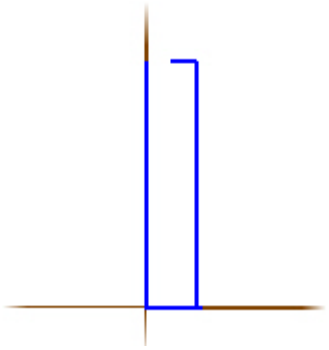


2 In the ribbon bar, select the **Divide/Delete** option.

3 Click the three locations shown in the picture to the right, and then click **OK** on the ribbon bar.



Mastercam deletes the selected line segments, leaving the geometry shown in the picture to the right.



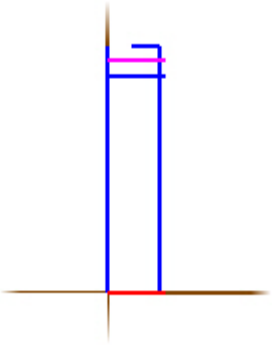
4 Save your part as `ToolHolder02_WORK.MCX-6`.

Exercise 3: Drawing the Tool Holder, Part 3

Start with the part you worked on in the previous exercise, or you can load `Toolholder02.MCX-6`. If you choose to load `Toolholder02.MCX-6`, be sure to save it under another file name.

TIP: Use the MRU Function Bar to easily access commands that you use often in these exercises. The MRU Function Bar is located on the right edge of Mastercam's window, but for even faster access to the bar's commands, drag and drop it onto the graphics window, close to the geometry you are working on.

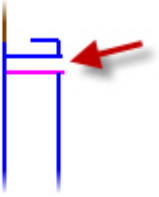
1 Offset the HCL twice upward by 141 mm and 131 mm.



2 Choose **Trim/Break/Extend** and make sure that the **Divide/Delete** button is still selected.

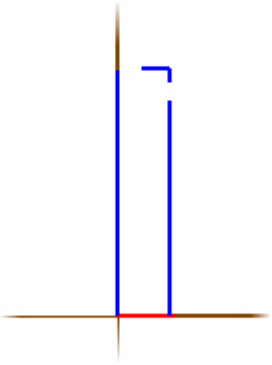
3 Click the right-hand vertical line between the two new HCLs, and then click the ribbon bar's **OK** button.

Mastercam removes the selected line segment from the geometry, as shown in the picture.

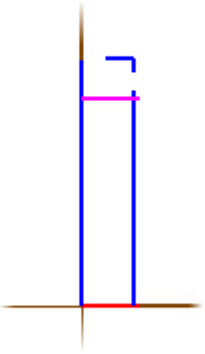


4 Click both of the HCLs you created in Step 1, and press [**Delete**].

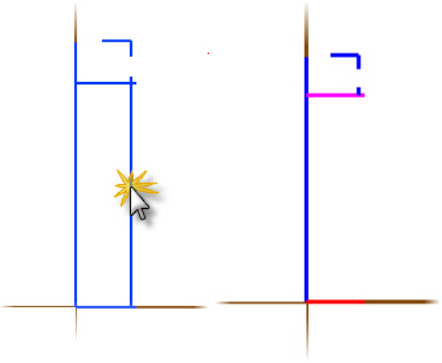
Mastercam deletes both lines from the geometry.



5 Offset a copy of the original HCL upward 126 mm.



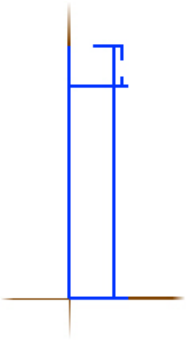
6 Use **Trim/Break/Extend**, **Divide/Delete** to delete the right-hand vertical line below the new HCL.



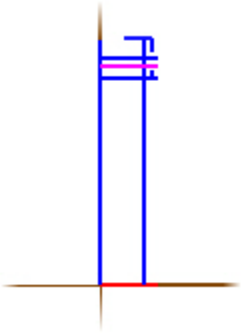
Note: From now on, exercise steps describe Trim operations by showing the trim command to use, followed by the name of the ribbon bar button to select, as seen in Step 6. To perform the Trim operation, do the following:

1. *Select the command.*
2. *Click the ribbon bar button.*
3. *Click the geometry indicated in the step.*
4. *Click the ribbon bar's* **OK** *button to end the Trim operation.*

7 Use **Xform Offset** to copy the VCL 26.5 mm to the right.

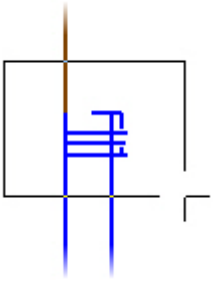


8 Xform Offset two copies of the HCL 138.5 mm and 133.5 mm upward.

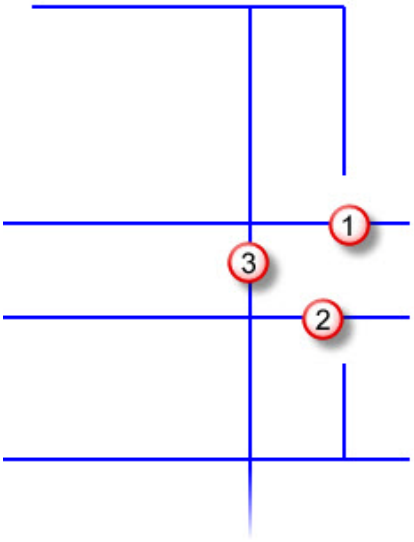


9 Choose **View, Zoom Window** (or just press [**F1**]), and draw a rectangle around the lines at the top of the part.

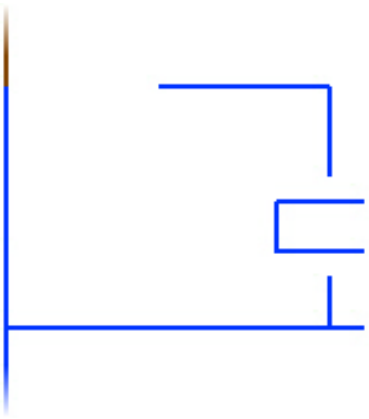
Mastercam magnifies the selected area, so that you can better see the details.



10 Select **Trim/Break/Extend**, **Trim 3 entity** and click the three lines in the order shown in the picture.



The picture to the right shows the upper geometry so far.

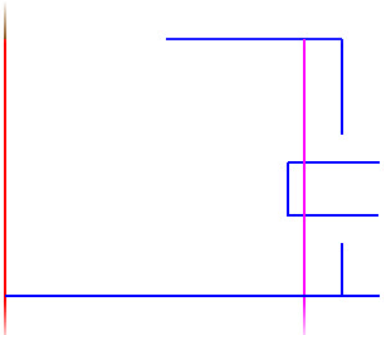


11 Save your part as `ToolHolder03_work.MCX-6`.

Exercise 4: Drawing the Tool Holder, Part 4

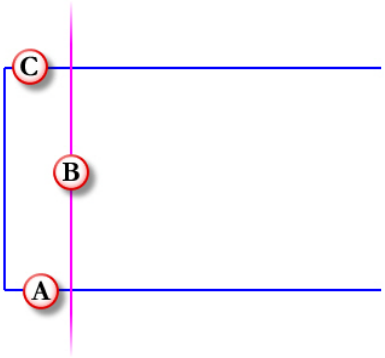
Start with the part you worked on in the previous exercise, or you can load `Toolholder03.MCX-6`. If you choose to load `Toolholder03.MCX-6`, be sure to save it under another file name.

1 Offset the original VCL to the right by 28 mm.

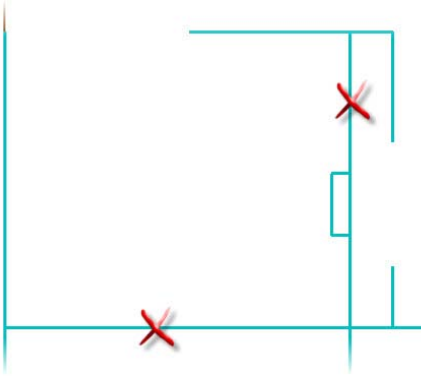


2 Select **Trim/Break/Extend**, **Trim 1 entity**, and click lines A, B, and C (see picture) in the order A, B, C, B.

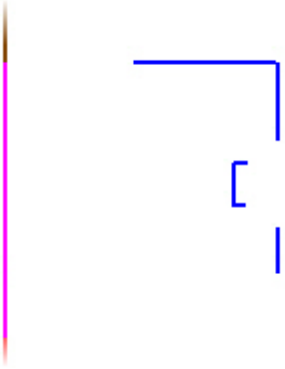
Mastercam trims lines A and C to the single entity, line B.



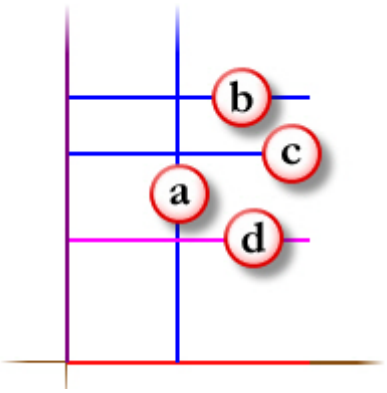
3 Delete the offset line you created in Step 1, as well as the longer horizontal construction line.



Your part's upper geometry now looks like the picture to the right.

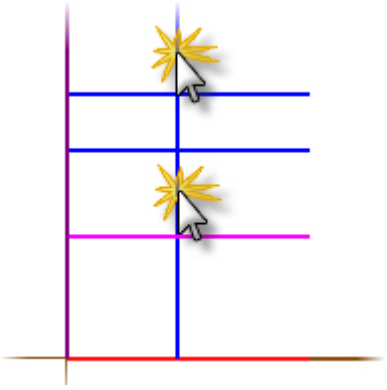


4 Zoom in on the lower portion of the part, and create the following offset lines:



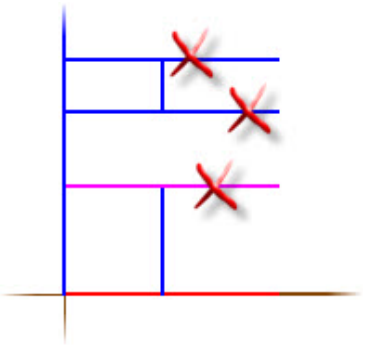
- **a** Offset the VCL to the right by 16 mm.
- **b** Offset the HCL upward by 38 mm.
- **c** Offset the HCL upward by 29.75 mm.
- **d** Offset the HCL upward by 17.5 mm.

5 Select **Trim/Break/Extend**, **Divide/Delete**, and then click the lines shown, followed by **OK** in the ribbon bar.

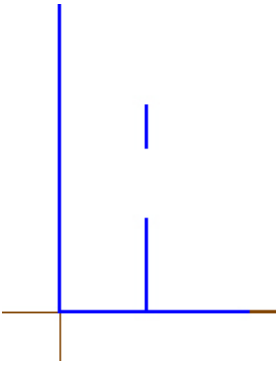


Mastercam removes the selected line segments.

6 Delete the three horizontal construction lines you created in Step 4.

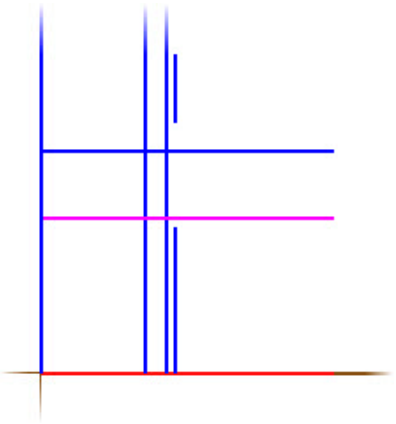


You now have the lower geometry shown to the right.

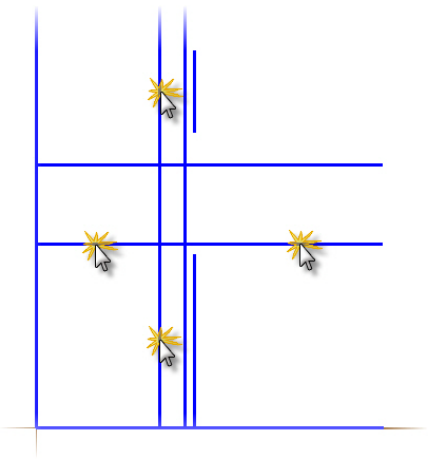


7 Create the following offset lines:

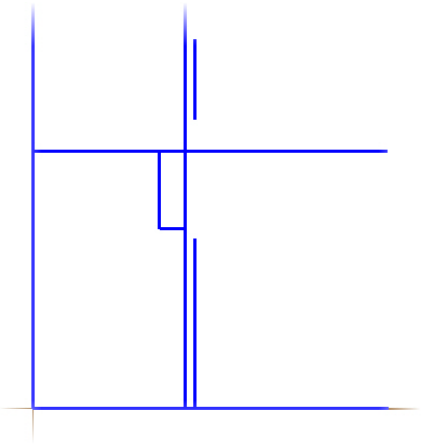
- **a** Offset the original VCL to the right by 12.5 mm.
- **b** Offset the original VCL to the right by 15 mm.
- **c** Offset the original HCL upward by 26.5 mm.
- **d** Offset the original HCL upward by 18.5 mm.



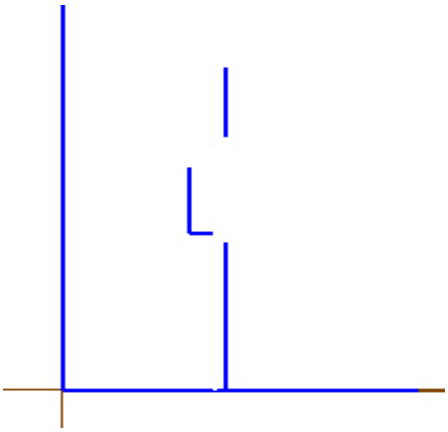
8 Select **Trim/Break/Extend**, **Divide/Delete**, and then click the lines shown, followed by **OK** in the ribbon bar.



Mastercam removes the selected line segments from the part.



9 Delete the VCL at X = 15 mm and the HCL at Y = 26.5 mm.



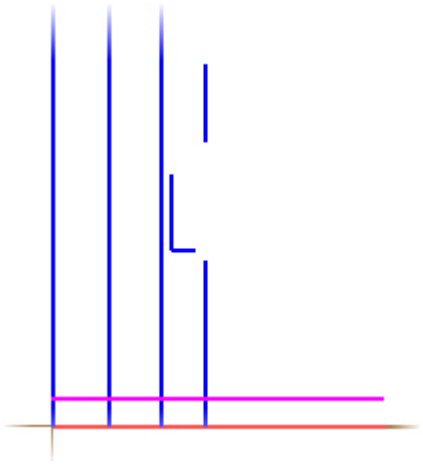
10 Save the part as `ToolHolder04_WORK.MCX-6`.

Exercise 5: Drawing the Tool Holder, Part 5

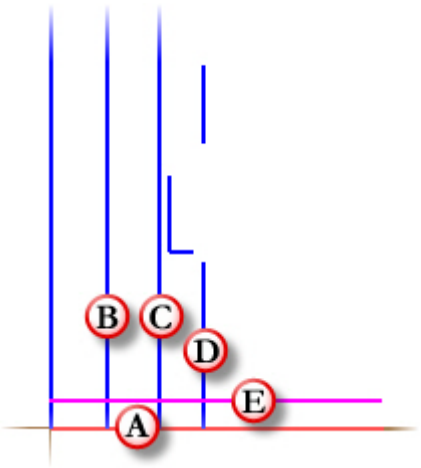
You can start with the part you worked on in the previous exercise, or you can load `Toolholder04.MCX-6`. If you choose to load `Toolholder04.MCX-6`, be sure to save it under another file name.

1 Create the following offset lines:

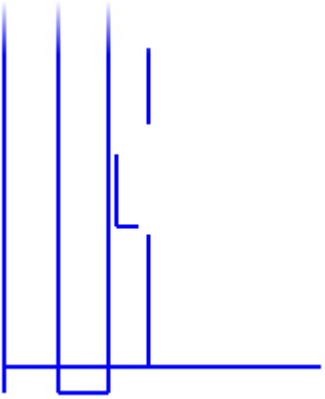
- **a** Offset the VCL to the right by 11.5 mm.
- **b** Offset the VCL to the right by 6 mm.
- **c** Offset the HCL upward by 3 mm.



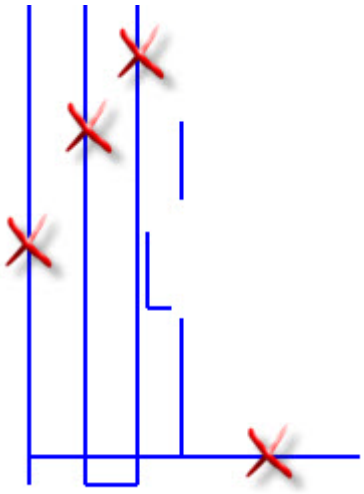
2 Select **Trim/Break/Extend**, **Trim 1 entity**, and then click the lines in the order A, B, A, C, D, E, followed by **OK** in the ribbon bar.



3 Press [**F9**] to turn off the axes, so that you can better see the changed geometry, shown in the picture to the right.



4 Delete the VCL at X = 6 mm, the VCL at X = 11.5, the HCL at Y = 3 mm, and the original VCL.

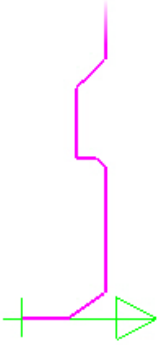


The picture to the right shows the resulting lower geometry.

5 Zoom out so that you can see the full geometry.

6 Use **Create, Line, Endpoint** to connect all of the line segments, as shown to the right.

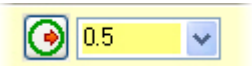
7 Select **Create, Fillet, Chains**, and chain from the bottom of the geometry as shown.



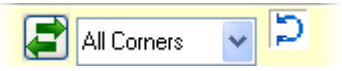
Note: When you click **OK** *to dismiss the Chaining dialog box, you may, depending on the Fillet Chain ribbon bar settings, get warnings. Just click* **OK** *to dismiss them. In the next step, you enter the settings that create the correct fillets.*

8 In the ribbon bar, set the following options, and then click **OK**:

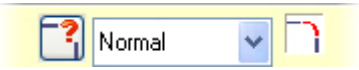
a **Radius** to **0.5**



b **Direction** to **All Corners**



c **Style** to **Normal**



d **Trim** button selected

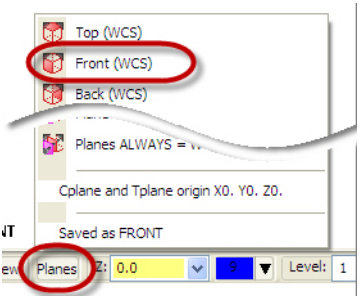
9 Save the file as `ToolHolder05_WORK.MCX-6`.

Exercise 6: Creating the Surface

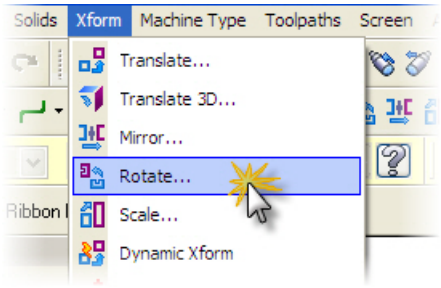
Start with the part you worked on in the previous exercise, or you can load `Toolholder05.MCX-6`. If you choose to load `Toolholder05.MCX-6`, be sure to save it under another file name.

▶ Rotating the Geometry

1 On the status bar, click **Planes**, and then select **Front (WCS)**.



2 From Mastercam's menu bar, select **Xform, Rotate**.



3 Select all of the geometry in the graphics window, and click **End Selection**.

The Rotate dialog box opens.

4 In the dialog box, do the following:

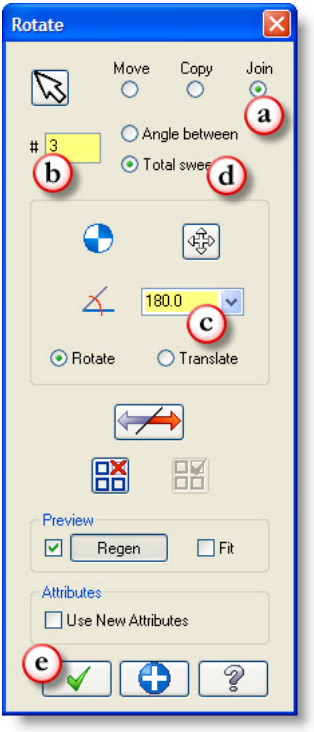
a Select **Join**.

b Set **#** to **3**.

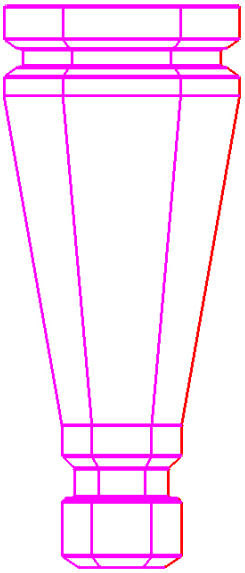
c Set **Angle** to **180**.

d Select **Total sweep**.

e Click **OK**.



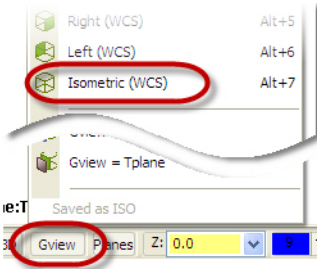
Mastercam rotates the geometry as specified in the dialog box, giving the result shown in the picture to the right.



5 In Mastercam's toolbars, click **Clear Colors**.

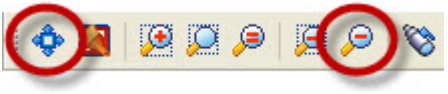
Mastercam redraws the part in the default colors.

6 In the status bar, click **Gview**, and then select **Isometric (WCS)**.



Mastercam displays the tool holder in isometric view.

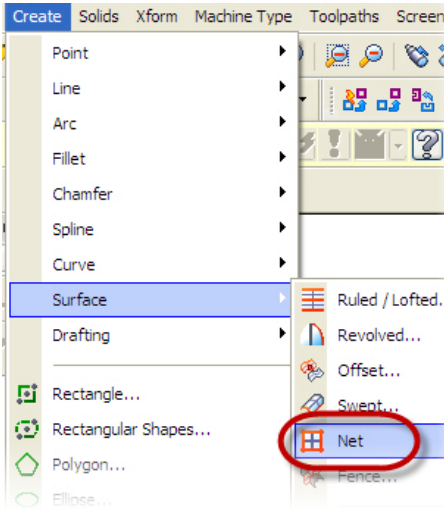
7 Use the **Fit** and **Un-Zoom .8** commands to fit the part to the screen.



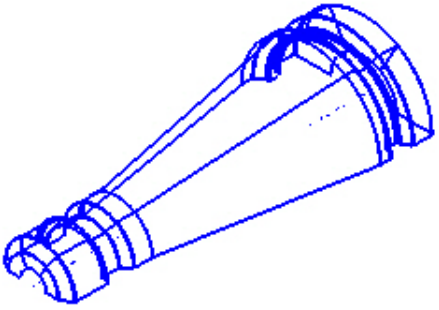
Creating the Net Surface

1 From Mastercam's menu bar, choose **Create, Surface, Net**.

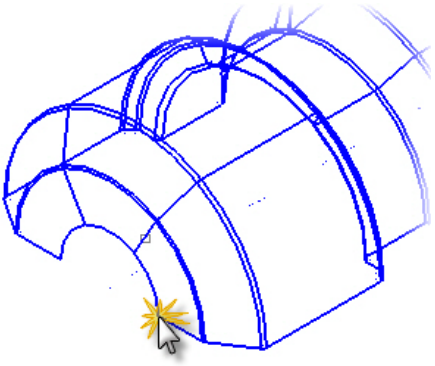
The Chaining dialog box opens.



2 In the dialog box, click the **Window** button, and then select all geometry in the graphics window.



3 Click the point shown in the picture.

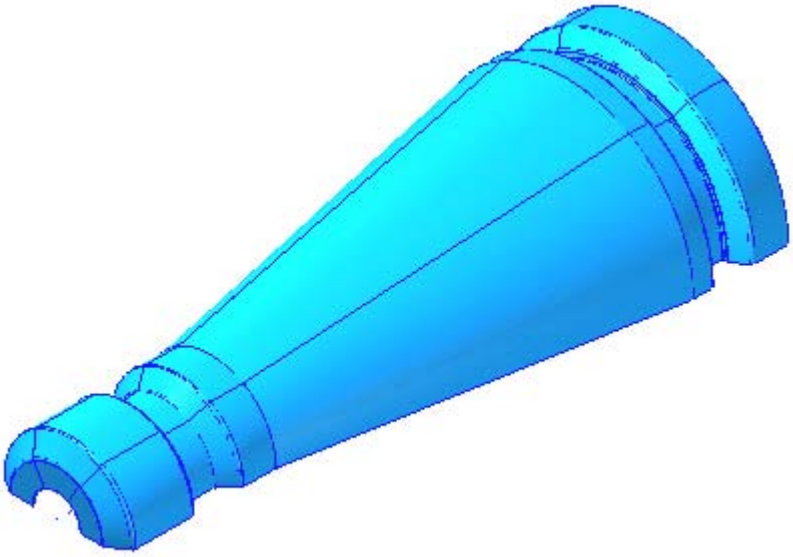


4 Click **OK** in the dialog box and **OK** on the ribbon bar.

Mastercam creates a Net surface on the selected geometry.

5 Press [**Alt+S**] to turn on shading.

Mastercam changes the part's display from wireframe to fully shaded, as seen in the following picture.



6 Save the part as `Toolholder06_WORK.MCX-6`.

You have now completed the tool holder part. The tutorial book titled *Basic 3D Machining* shows how to prepare the tool holder for machining by creating various types of toolpaths on the part.

Conclusion

Congratulations! You have completed the *Mastercam X6 Basic 3D Design* tutorial. Now that you have mastered the skills in this tutorial, explore Mastercam's other features and functions. Additional tutorials may be available in this or other series.

This is a module of the *Mastercam Getting Started* Tutorial Series. The series introduces general Mastercam functions and teaches basic skills for getting started with Mastercam. Other tutorial series include:

- *Focus Series*: Focuses on a specific Mastercam feature—for example, Setup Sheets or FBM Drill, and teaches basic and advanced skills.

- *Exploring Series:* Explores a single Mastercam product—for example Mastercam® for SolidWorks® or Mastercam Swiss Expert, and teaches in-depth skills for working with the product.

The Mastercam tutorial series is in continual development, and we will add modules as we complete them. For information and availability or for further training, please contact your local Mastercam Reseller.

Mastercam Resources

Enhance your Mastercam experience by using the following resources:

- *Mastercam Help*—Access Mastercam Help by selecting **Help, Contents** from Mastercam's menu bar or by pressing [**Alt+H**] on your keyboard. Also, most dialog boxes and ribbon bars feature a Help button that opens Mastercam Help directly to related information.
- *Mastercam Reseller*—Your local Mastercam Reseller can help with most questions about Mastercam.
- *Technical Support*—CNC Software's Technical Support department (860-875-5006 or support@mastercam.com) is open Monday through Friday from 8:00 a.m. to 5:30 p.m. USA Eastern Standard Time.
- *Mastercam University*—CNC Software sponsors Mastercam University, an affordable online learning platform that gives you 24/7 access to Mastercam training materials. Take advantage of more than 180 videos to master your skills at your own pace and help prepare yourself for Mastercam Certification. For more information on Mastercam University, please contact your Authorized Mastercam Reseller, visit www.mastercamu.com, or email training@mastercam.com.
- *Online communities*—You can search for information or ask questions on the Mastercam Web forum, located at www.emastercam.com. You can also find a wealth of information, including many videos, at www.mastercam.com and www.mastercamedu.com.

  For tech tips and the latest Mastercam news, you can join us on Facebook (www.facebook.com/mastercam), follow us on Twitter (www.twitter.com/mastercam), and subscribe to our blog, *Mastercam Xtras* (http://

blog.mastercam.com). Visit our YouTube channel to see Mastercam in action (www.youtube.com/user/MastercamCadCam)!

Mastercam Documentation

Mastercam installs the following documents in the `\Documentation` folder of your Mastercam installation:

- *Mastercam X6 Quick Start*
- *Mastercam X6 Administrator Guide*
- *Mastercam X6 Transition Guide*
- *Mastercam X6 Quick Reference Card*
- *Mastercam X6 File Location Card*
- *Mastercam X6 Post Debugger User's Guide*

Contact Us

For questions about this or other Mastercam documentation, contact the Technical Documentation department by email at techdocs@mastercam.com.

Attention! Updates may be available.
Go to Mastercam.com/Support for the latest downloads.

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