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Mastercam 2022 Solids Tutorial

Software: Mastercam 2022

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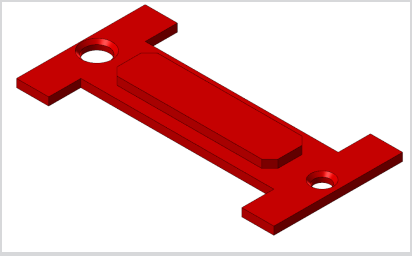
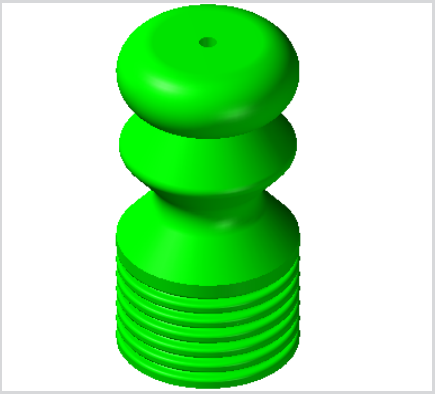
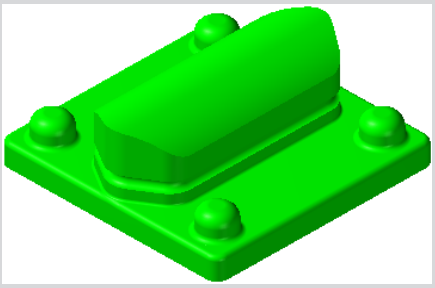
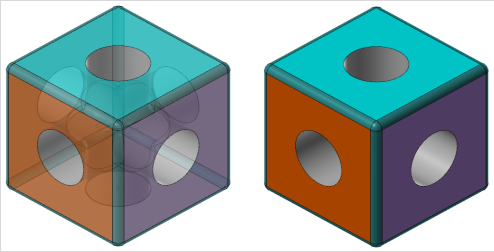
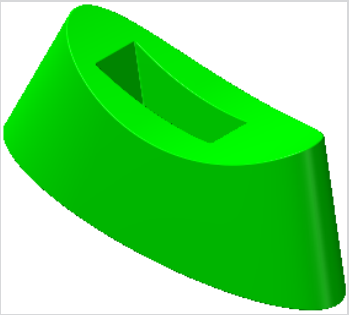
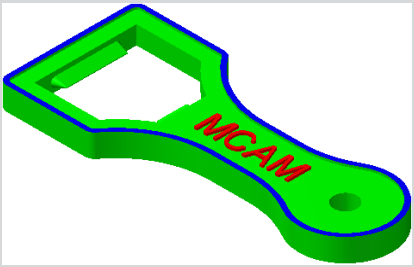
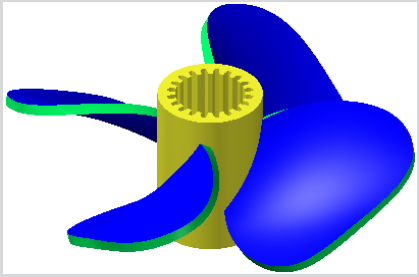
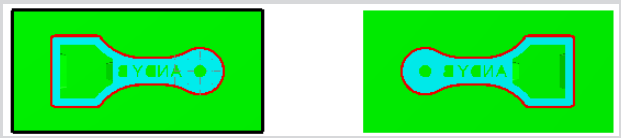
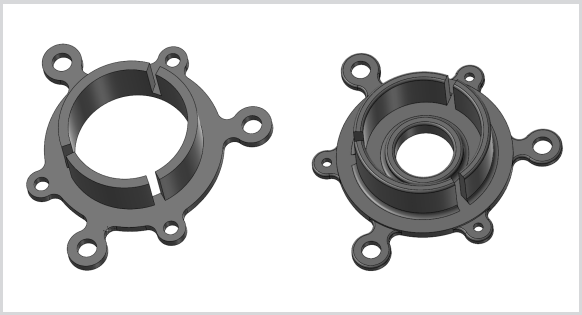
Table Of Content

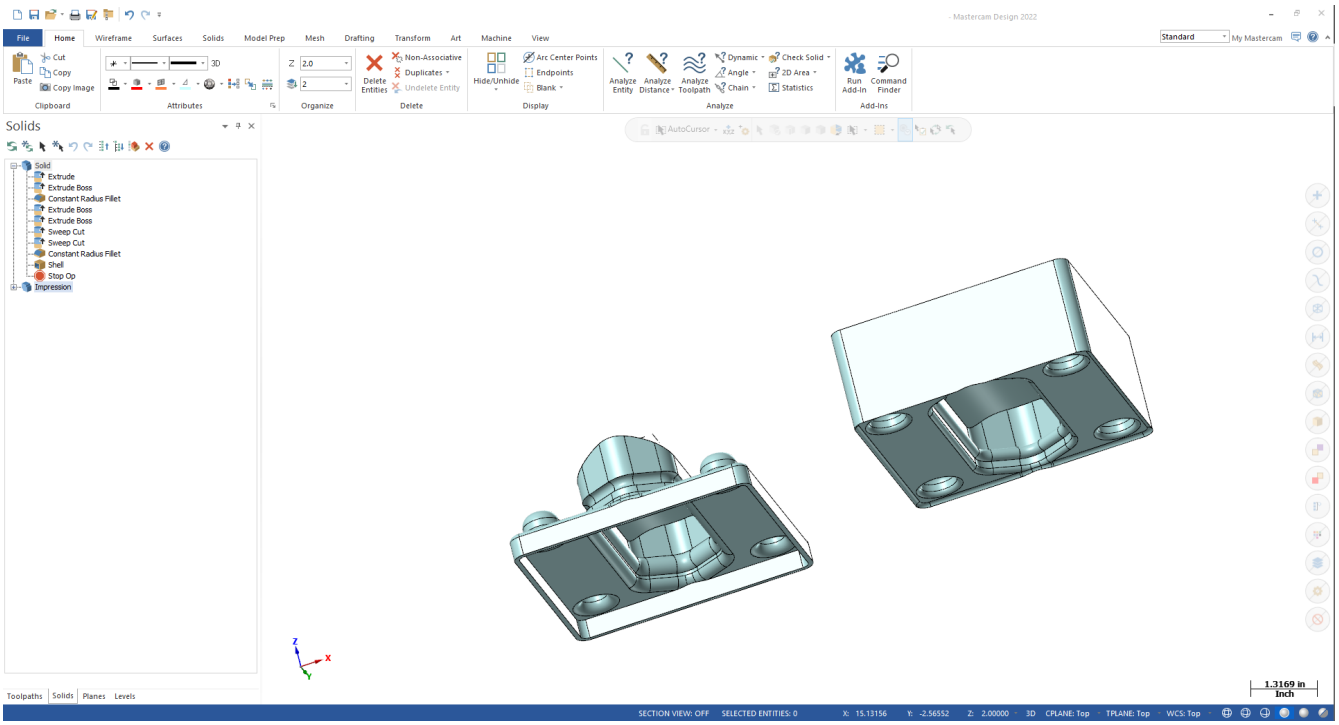
Solids Projects

Tutorial	Geometry Functions
#1 	Create Rectangle. Chamfer Outside Profile. Solid Extrude Create Body. Solid Extrude Add Boss. Solid Hole. Constant Radius Fillet. One Distance Chamfer.
#2 	Create Geometry in Front Plane. Create Rectangle. Create Parallel Lines. Create Tangent Arcs. Create Lines. Translate Geometry. Create Fillets. Solid Revolve Create Body. Solid Extrude Cut Body.
#3 	Create Rectangle. Create Geometry in Front Plane. Create Fillets. Create Circle Center Point. Create Rectangular Array. Solid Extrude Create Body. Solid Extrude Add Bosses. Constant Fillet Radius. Solid Sweep Cut Body. Make Changes to The Solid. Solid Shell.

Tutorial	Geometry Functions
#4 	Create Circles Primitive Solid Block Constant Fillet Radius Set Solid Feature Color Solid Extrude Boolean Add Boolean Remove
#5 	Create Ellipses. Create Rectangles. Create an Arc in Front Plane. Create Lines. Create Solid Body Using Loft. Solid Loft Cut. Solid Extrude Cut. Move Solid to Another Level. Fillet All Edges. Set Feature Color.
#6 	Top Construction Plane. Create Circle Center Point. Create Rectangle. Create Horizontal and Parallel Lines. Create Arc Tangent. Create Arc Endpoints. Create Fillet. Transform Mirror The Geometry. Transform Offset. Trim Geometry. Create Rectangular Shapes. Create Letters. Transform Dynamic. Solid Extrude Create Body. Solid Extrude Add Bosses. Solid Extrude Add Bosses with Draft Angle. Solid Extrude Cut Body. Remove Solid History.

Tutorial	Geometry Functions
#7 	Create Rectangle. Create Circle Center Point. Create Arc Polar. Transform Rotate. Create Line Parallel. Create Points. Create a Spline. Create Net Surface. Create Ruled Surface. Solids from Surfaces. Solid Extrude. Solid Circular Pattern. Create Curves On All Edges
#8 	Open File From Previously Saved File. Create Rectangle. Extrude Solid Body. Boolean Remove. Trim Solid by Plane. Transform Dynamic.
#9 	Open an existing file. Model Prep Remove All Solid History Operations. Model Prep Split Solid Face - Projection option. Model Prep Pull-Push. Model Prep Move. Model Prep Split Solid Face - Flowline option.

Getting Started



OBJECTIVES

- Starting Mastercam
- The student will learn about the Graphical User Interface.
- The student will learn how to navigate through Mastercam.

STEP 1: STARTING MASTERCAM

1.1 For Windows 7

- Select the **Start** button.
- Select **All Programs** and click on Mastercam 2022.

1.2 For Windows 8

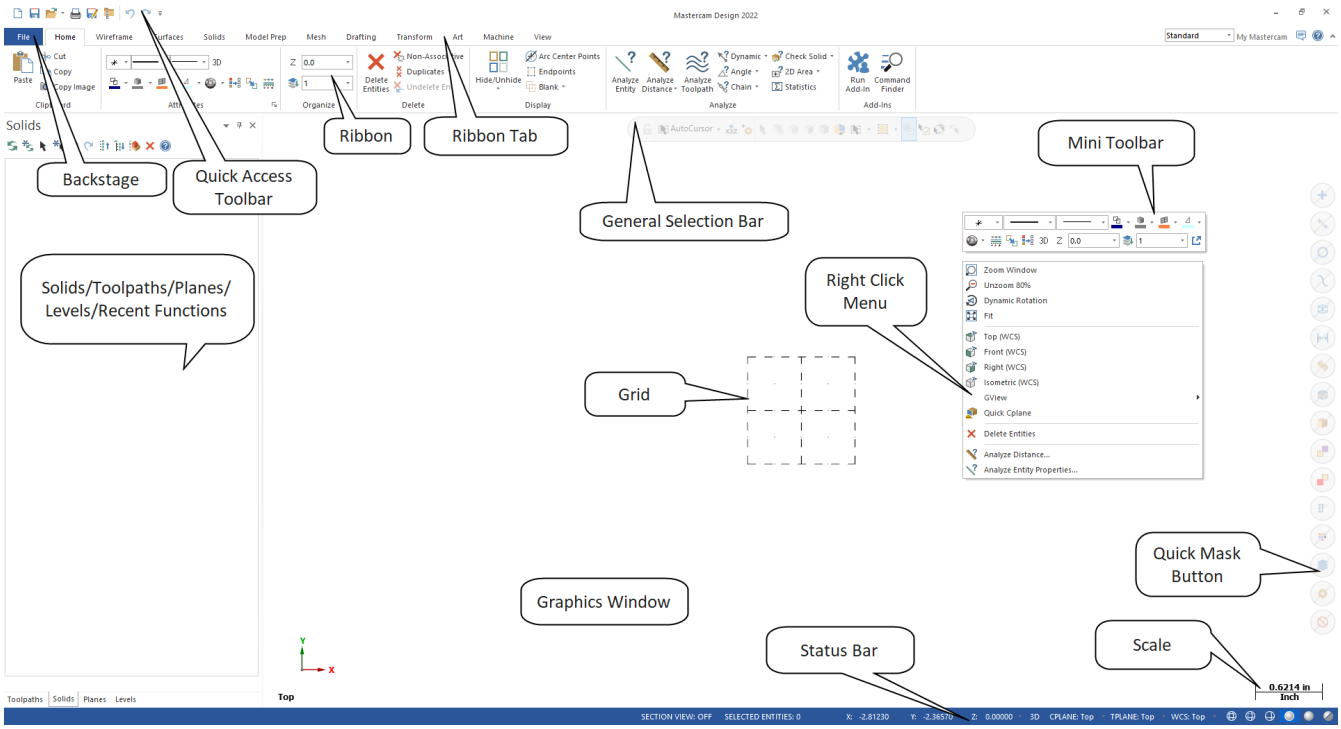
- Select the **Start** button.
- Click on the drop down arrow to open Apps.
- Find and click on Mastercam 2022.

1.3 For Windows 10

- Select the **Start** button.
- Click on the drop down arrow to open Apps.
- Find and click on Mastercam 2022.

- To start the software, from **Desktop**, click on the shortcut icon.

STEP 2: GUI - GRAPHICAL USER INTERFACE



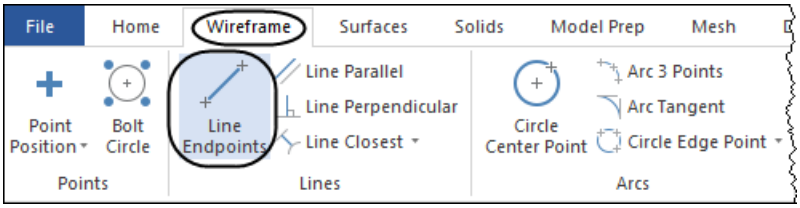
Quick Access Toolbar	**QAT** contains a fully customizable set of functions that can be quickly accessed by the user.
Backstage (File)	Allows you to manage files. You can insert information about files, start a new file, open an existing one or merge files together. You can also save, convert or print files as well as access the help resources.
Tabs	Contain all the functionality within Mastercam.
Ribbon	Displays the commands available for a selected Tab.
Selection Bar	Allows you to set the **AutoCursor** modes and to switch between wireframe or solid selections.
Quick Mask Buttons	Let you select all entities of a specific type. Clicking on the left side of the button or right side of the button toggles between select all or only.
Right Click Menu	Right click menu allows quick access to functions such as zoom, graphic views or recent functions used. A mini toolbar will also appear that allows you to quickly change the attributes.
Toolpaths/Solids/Planes Manager	Lists the history of the toolpath operations and solids.
Graphics Window	Workspace area in Mastercam where the geometry is displayed.
Scale	Shows you a scale of the object on the screen.
WCS: TOP T/Cplane:	Displays the current **WCS** and **T/Cplane** information.

STEP 3: NAVIGATE THROUGH MASTERCAM

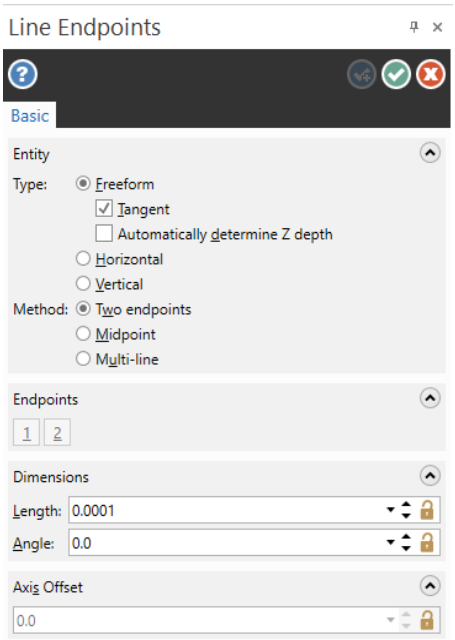
In this step, you will learn how to use the menu functions in Mastercam to create geometry.

3.1 Using the Wireframe tab to select the command to create Line Endpoints

- Left click on **Wireframe**.
- Left click on the **Line Endpoints** icon as shown.



- Once you select Line Endpoints, the Line Endpoints panel appears on the screen as shown.



3.2 Sketching a line

- To sketch a line, left click on two locations on the screen.

3.3 Creating a line knowing the endpoint coordinates

- To make a line knowing the two endpoint coordinates, select the **AutoCursor Fast Point** icon from the **General Selection** toolbar.

- In the coordinates field that opens in the upper left corner enter the coordinates of the first endpoint as shown.

- Press **Enter** to continue.

- Select the **AutoCursor Fast Point** icon again and enter in the coordinates of the second endpoint and then press **Enter**.

3.4 Creating a line knowing an endpoint, the length, and the angle

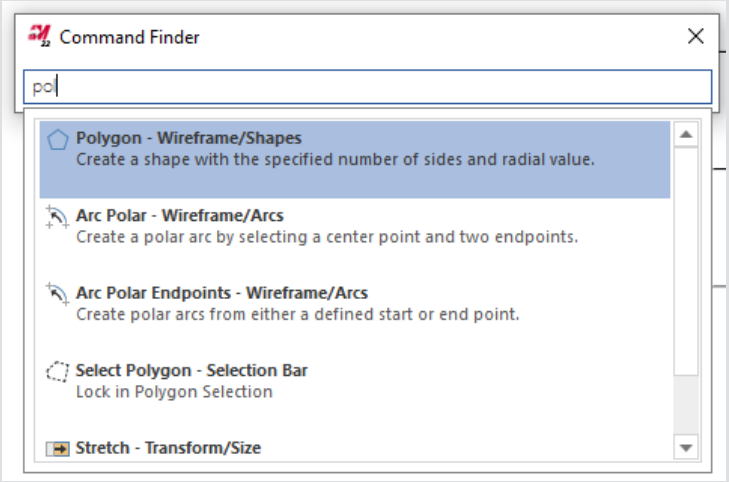
- You can also enter the coordinates of the first endpoint, then enter the **Length** and **Angle** if necessary.
- To continue making lines, choose the **OK** and **Create New Operation** button from the dialog box or press **Enter**. 
- To exit the current command, select the **OK** button or press the **Esc** button. 
- To undo the last command, from the **QAT** (**Q**uick **A**ccess **T**oolbar) select the **Undo** button. The Undo button can be used to go back to the beginning of geometry creation or to the last point of the saved file. Mastercam also has a **Redo** button for your convenience.

3.5 Function Prompt

Prompts the user to execute a command.

Example: this prompt is used in the **Line Endpoints** command. Specify the first endpoint

Note: To find a command, from the **Home** ribbon, select the **Command Finder** icon and type the function name in the field that opens up.
For example, to find the **Polygon** command type "polygon" in the text field. From the list, select the desired command.



STEP 4: SET THE ATTRIBUTES

Mastercam attributes are point style, line style, line thickness, color, and levels. Before starting to create geometry, you should set the attributes.

4.1 Attributes Group

Point Style	Displays and sets the system's point style.
Line Style	Displays and sets the system's line style.
Line Width	Displays and sets the current system's line width.
Color	Assigns the current color to wireframe, solid and surface entities. To change the current color, click in the specific color field and select a color from the color pallet. To change an existing geometry color, select the geometry first and then click in the color field and select a color from the color pallet.
Clear Color	When performing a transform function (Xform), Mastercam creates a temporary group from the originals (red) and a result (purple) from the transformed entities. These system groups appear in the Groups dialog box. However, they stay in effect only until you use the **Clear Colors** function or perform another transform function.
2D / 3D Construction Mode	Toggles between 2D and 3D construction modes. In 2D mode, all geometry is created parallel to the current Cplane at the current system Z depth. In 3D mode, you can work freely in various Z depths, unconstrained by the current system Z depth and Cplane setting.

4.2 Organize Group

Z Depth	Sets the current construction depth. To set this, click the drop down arrow and pick one from the most recently used list or click the **Z**: label and pick a point in the graphics window to use the Z depth values based on the selected entity.
Level	Sets the main level you want to work with in the graphics window. To change the current working level, type the level number in the box.

4.3 Change the Wireframe Color

- Click on the drop down arrow next to the **Wireframe Color** field as shown.
- Select the desired color from the dialog box as shown.

Note: Any geometry on your screen will remain in the previous system color. This change will only affect the geometry you create going forward.
To change the color of existing geometry, select the entities first and then click on the drop down arrow next to the Wireframe Color and select the desired color. The same method can be applied for any other attribute that you want to set or change.

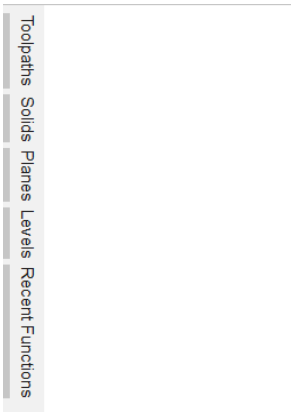
STEP 5: MANAGER PANELS

5.1 The Solid Manager

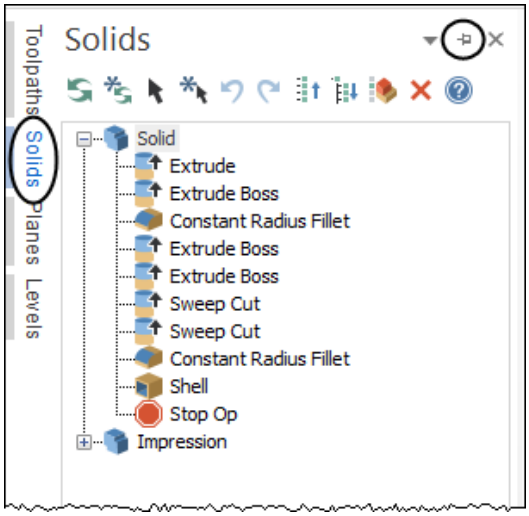
The **Solids Manager** allows you to view, manage, and edit solids and solid operations. The Solids Manager lists each solid in the current file, along with its operations history, and lets you edit the operations in various ways.

- The **Toolpaths Manager**, **Solids Manager**, or **Planes Manager** can be hidden to gain more space in the graphics area for creating geometry. Use **Auto Hide** icon to close all **Toolpaths**, **Solids**, **Planes**, and **Levels Manager** panels.

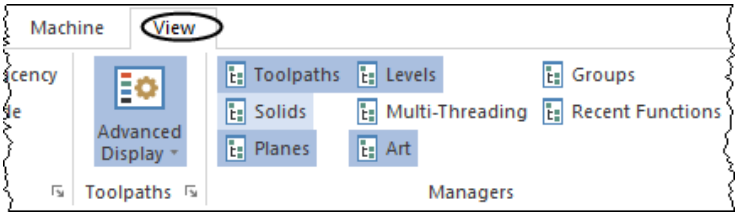
- The panels will be hidden to the left of the graphics window as shown.



- To un-hide them, click on one of the managers to open it and then click again on the Auto Hide icon as shown.



- Selecting the **X** (**Close** icon) instead of the **Auto Hide**, you will close the manager panel. To re-open them, from the **View** tab, select **Toolpaths**, **Solids**, **Planes**, or **Levels** as shown.



STEP 6: SETTING MASTERCAM TO IMPERIAL

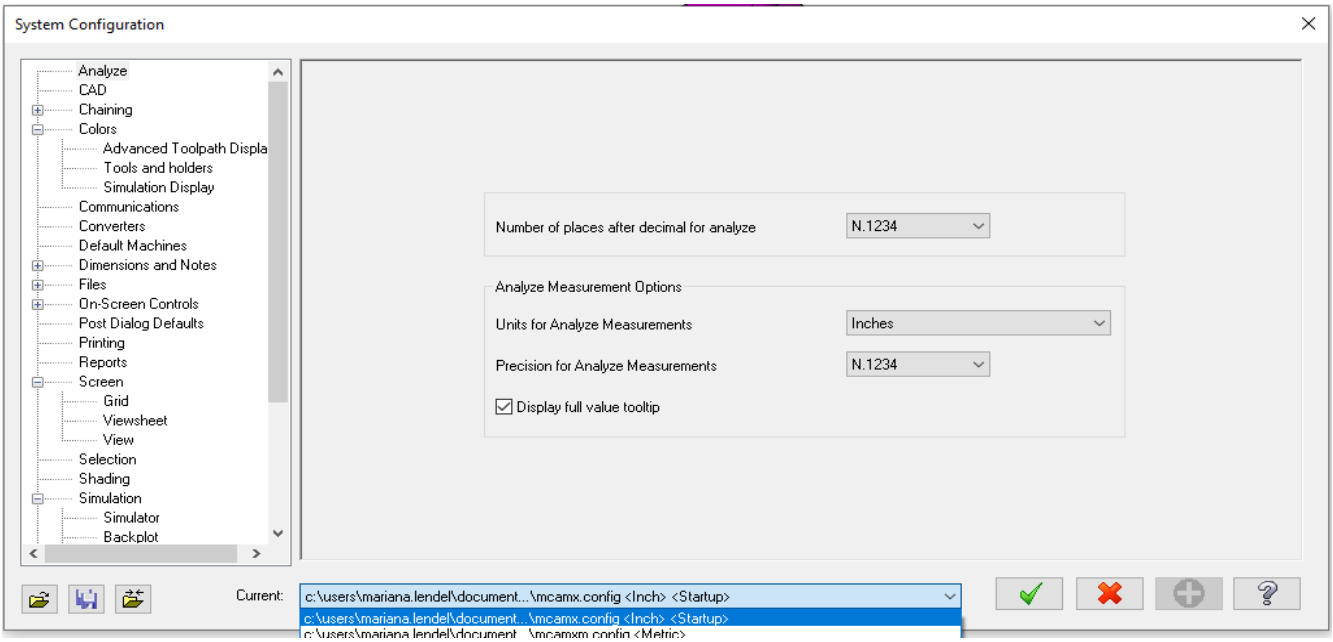
In this step you will learn how to set the imperial system as your default. You will have to select the **Backstage** options and select the system configuration.

6.1 Setting Mastercam to imperial for the current session only

Note: You may need to switch Mastercam to run in Imperial mode.

File

- **Configuration.**
  - Select the drop down arrow beside **Current** as shown.
  - Select **mcamx.config <Inch>** as shown. Check that **Units** for **Analyze Measurements** is set to Inches.



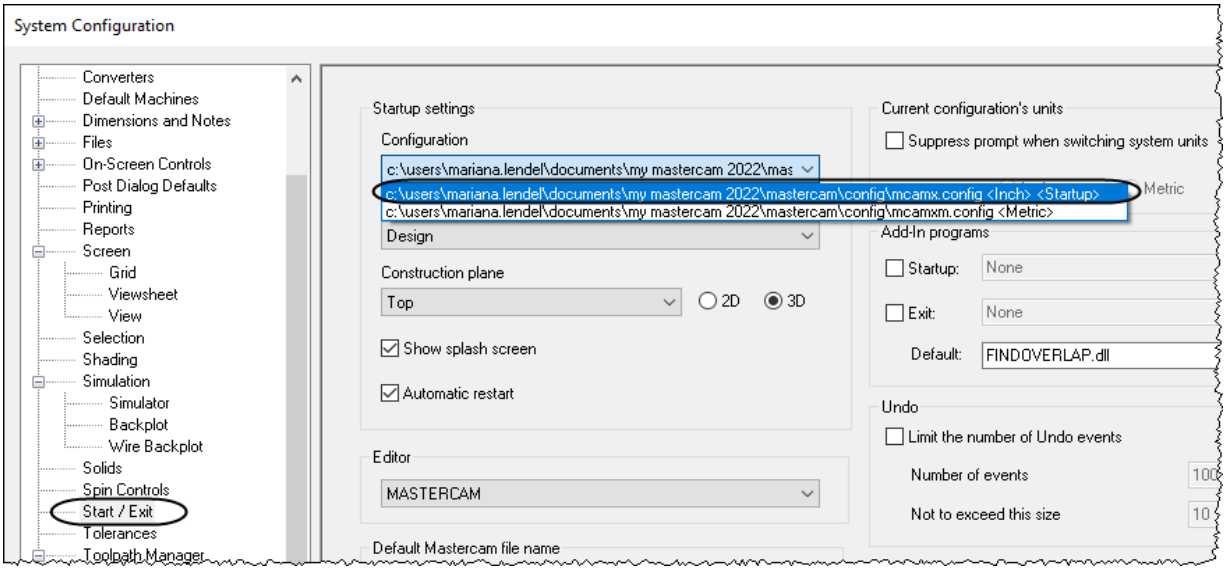
- Select the **OK** button to exit the **System Configuration** dialog box.

Note: If you have a drawing on the screen it may ask you to scale the current part to imperial. Choose Yes if you wish to do this.

6.2 Setting Mastercam to imperial as a default

File

- **Configuration.**
  - Select **Start/Exit** from the configuration topics.
  - Select the drop down arrow below **Configuration** in the **Startup** settings area as shown
  - Select **mcamx.config <Inch>** as shown.



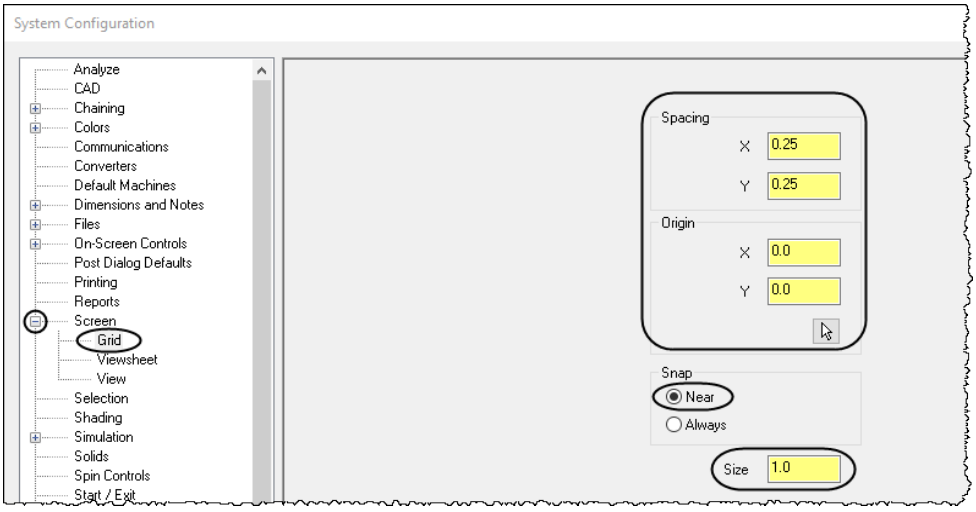
STEP 7: SET THE GRID

Before beginning to create geometry, it is highly recommended to enable the **Grid**. The grid will show you where the origin is and the orientation of the grid gives you a quick preview of the plane you are working in.

File

- **Configuration.**

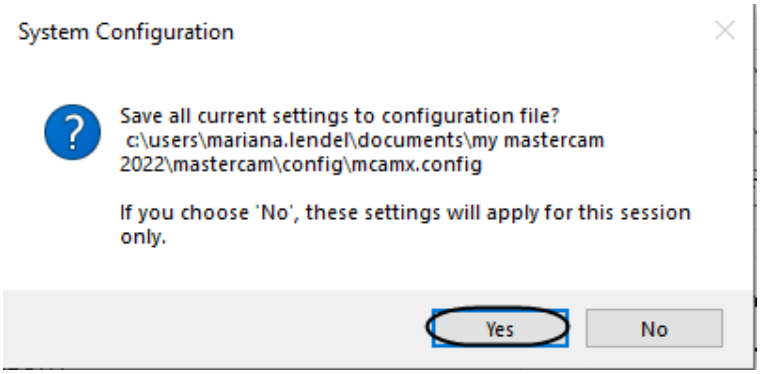
  - Select **Screen** from the configuration **Topics**.
  - Select the plus sign (**+**) beside **Screen** as shown.



- In **Grid**, change the **Spacing** to **X = 0.25** and **Y = 0.25**.
- Leave **Snap** as default
- Set the **Size** to **1.0**.

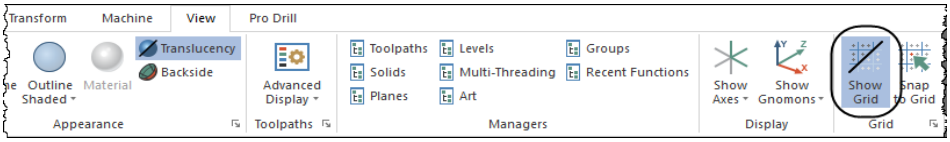
- Select the **OK** button to exit the **System Configuration** dialog box.

- Mastercam will then prompt you to save these settings to your current configuration file, select **Yes**.



- Select the **Yes** button to save the settings in the **System Configuration**.

- To see the **Grid** in the graphics window, from the **View** tab, enable **Show Grid** as shown.



- The grid should look as shown.

CONVENTIONS USED IN THIS BOOK:

We have attempted to make this manual as uncluttered as possible and provide you with reference information when it is appropriate. It is not intended to be a Reference Guide or all-encompassing user manual.

The Text Styles Used Are As Follows:

Standard Text - Represents normal wording needed to provide you the instruction.

Bold Text - Represents menu commands, dialog box settings or other similar items from the screen.

STEP 8: STEP TITLES

8.1 Sub step titles

Information about the current step or terms or parameter definitions describing the parameters and description.

Note: Represents information about the process/step that is important or may require an explanation.

- Bulleted text is step by step instructions that have to be followed.

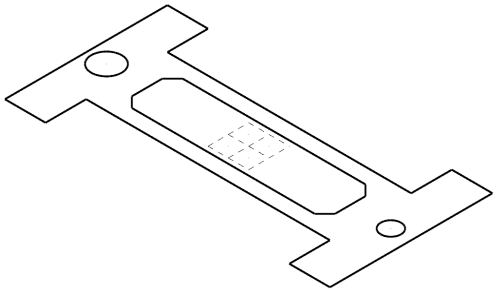
The files used in this book are available for download at http://www.emastercam.com/files/.

MASTERCAM® WORK FLOW

The process to create or import the wireframe and to create the solid using different operations will be repeated over and over through the tutorials in this book. You will find the process simple and straightforward once you have create a few solids. Following is an outline of the process we will follow to create the solids:

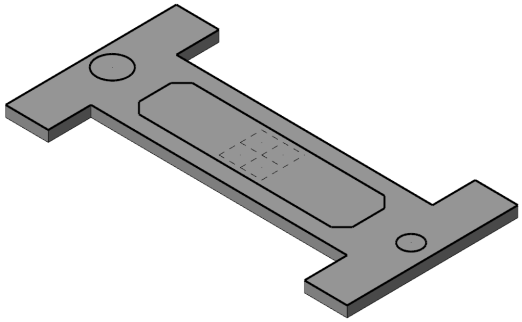
1. Set the Construction plane, the Z depth if needed and the geometry color.

2. Create or import the wireframe flat geometry in the Top plane.

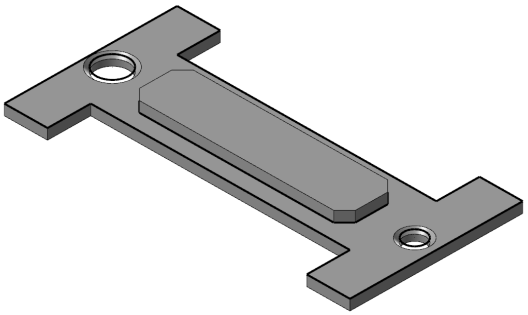


3. Set a new Active Level to create the solid.

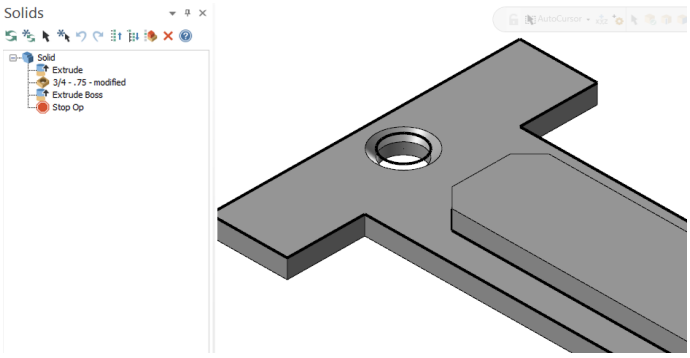
4. Create the solid base.



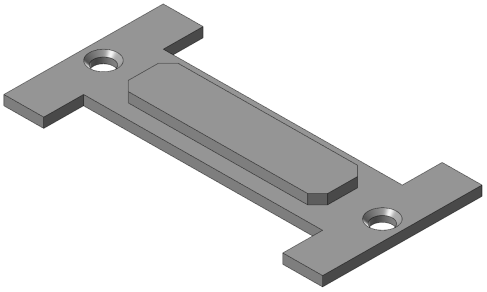
5. Create the rest of the operations.



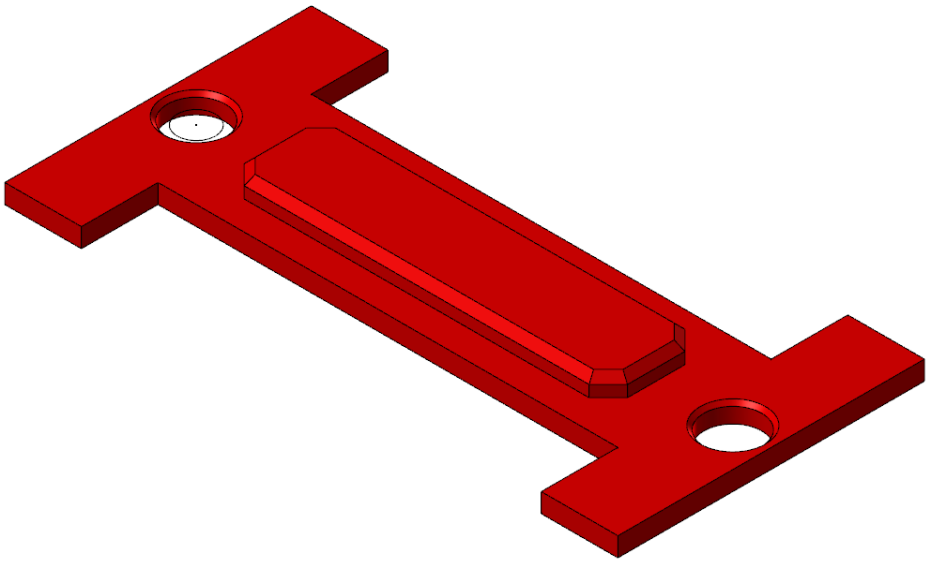
6. Optional: modifying the wireframe geometry or editing the solid parameters in the Solids Manager.



7. Save the solid and make the wireframe invisible.



Tutorial 1



OVERVIEW OF STEPS TAKEN TO CREATE THE PART GEOMETRY

From Drawing to CAD Model:

- The student should examine the drawing on the following page to understand what part is being created in the tutorial.
- From the drawing we can decide how to create the geometry in Mastercam.

Create the wireframe that will be used to create the solid:

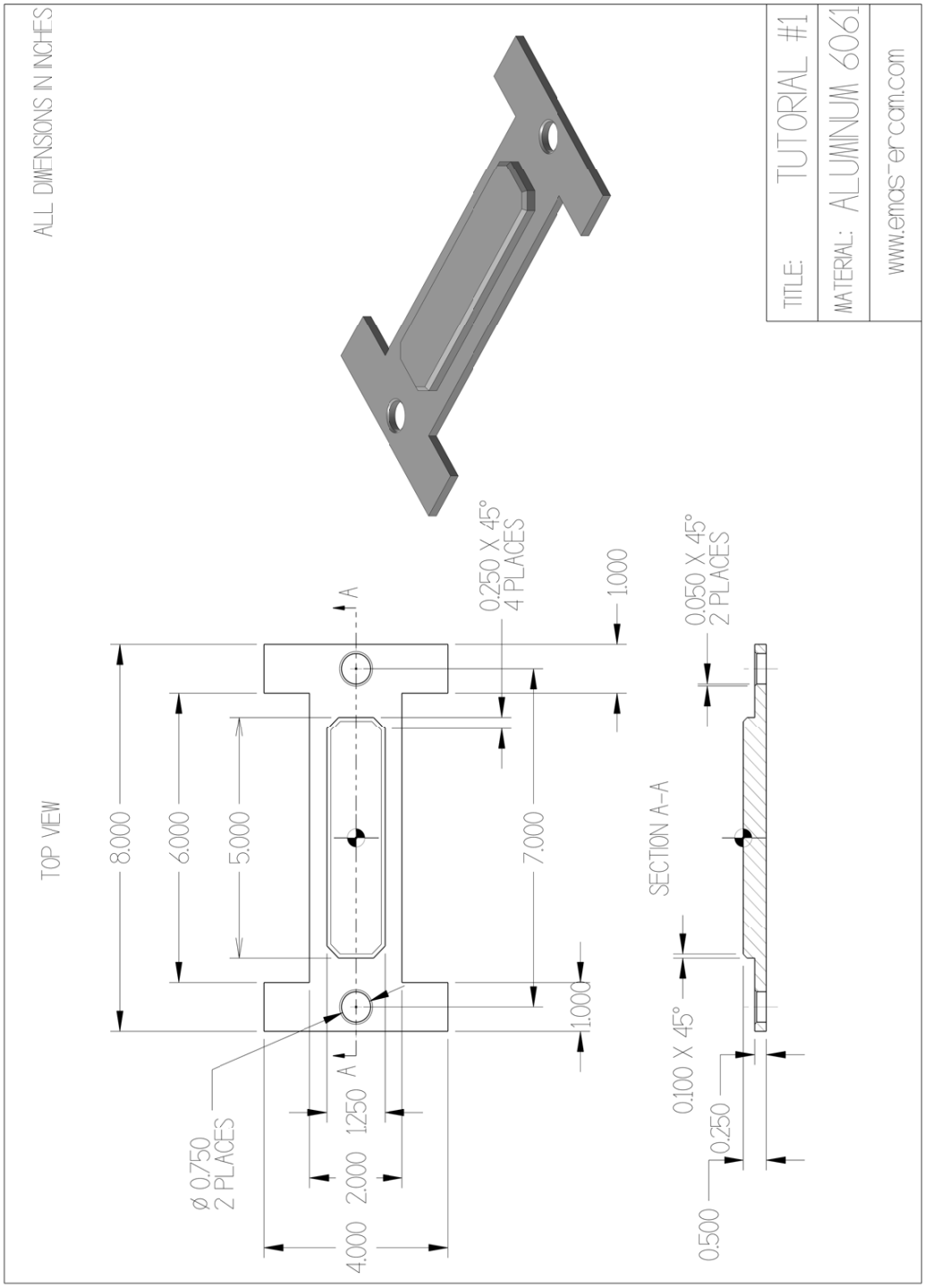
- The student will create flat geometry in the Top plane.
- Geometry with a Z-Depth of 0 will be created and used to extrude the solid later on.
- 2D Geometry commands such as Rectangle, Chamfer, Trim, and Divide will be used.

Create the solid model:

- The student will create a new level to separate the wireframe from the solid model so that the file can be better organized.
- The Extrude command will be used to create the main solid body of the part and the boss.
- The Hole command will be used to cut the holes through the part.
- The Extrude command will be used to add the boss at the top of the main solid.
- The top of the boss will be chamfered using the One Distance Chamfer command.

This tutorial takes approximately one hour to complete.

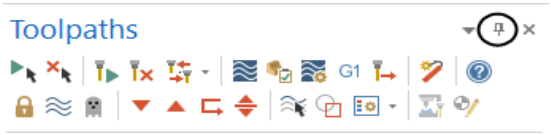
TUTORIAL #1 DRAWING



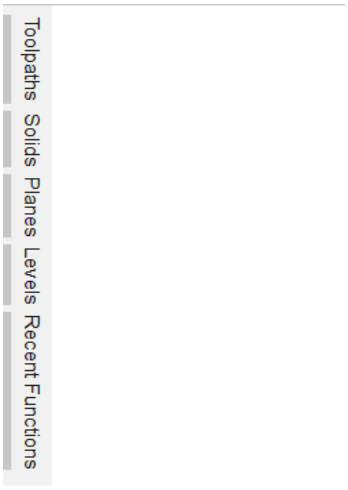
STEP 1: SETTING UP THE GRAPHICAL USER INTERFACE

Please refer to the **Getting Started** section for more info on how to set up the graphical user interface. In this step, you will learn how to hide the manager panels to gain more space in the graphics window.

- Use the **Auto Hide** icon to hide all **Manager** panels.

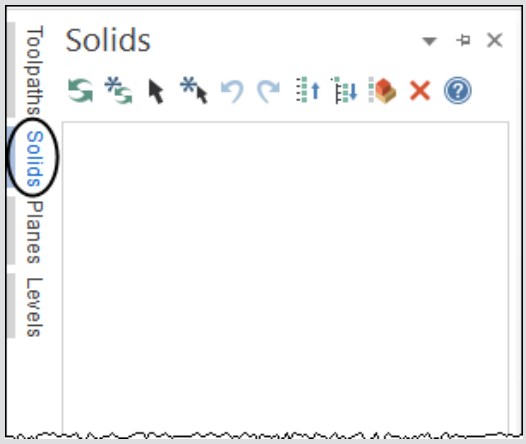


- The panels will be hidden to the left of the graphics window as shown.



Note: To un-hide them temporarily, you can click on one of the Managers to open it as shown.

While creating the geometry, keep the Manager panels hidden. This ensures more space in the graphics window for the geometry.

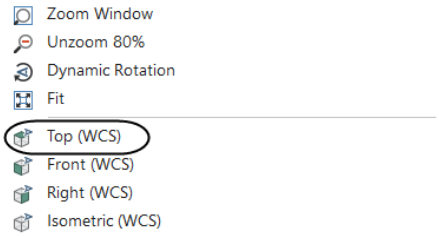


STEP 2: SET THE CONSTRUCTION PLANE AND WIREFRAME ATTRIBUTES

In this step you will learn how to set the Construction Plane to create the flat geometry. By setting the Graphic View to Top the Construction Plane will be automatically set to Top too.

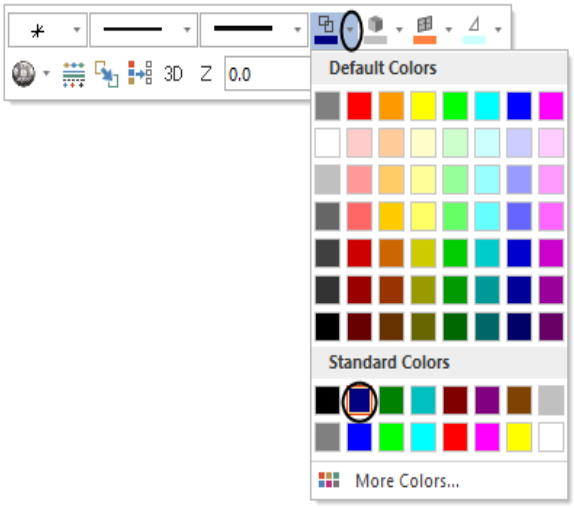
Mastercam considers attributes the line style, line width and color as well as levels. In this step you will set the color and the line width.

- Right mouse click in the graphics window and select the Top (WCS) icon as shown.

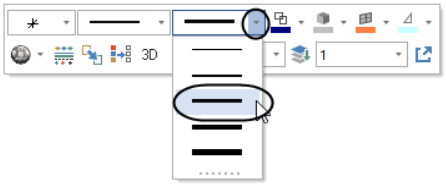


Note: You may skip this step if the wireframe color is already set to dark blue.
For printing reasons, the wireframe in the book is done in black.

- Right mouse click in the graphics window and from the **Mini Toolbar**, left click on the arrow next to the **Wireframe Color** icon and select the dark blue color as shown.



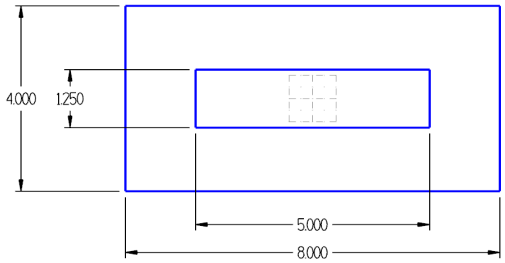
- Right mouse click in the graphics window and from the **Mini Toolbar**, left click on the arrow next to the **Line Width** icon and select the third one as shown.



STEP 3: CREATE RECTANGLES GIVEN THE SIZE AND ANCHOR POINT

In this step you will learn how to create two rectangles given the width, height, and anchor point.

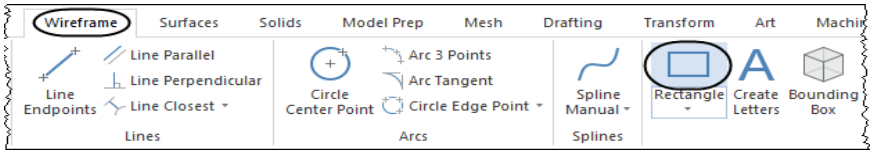
Step Preview:



3.1 Create the 8.0" X 4.0" Rectangle

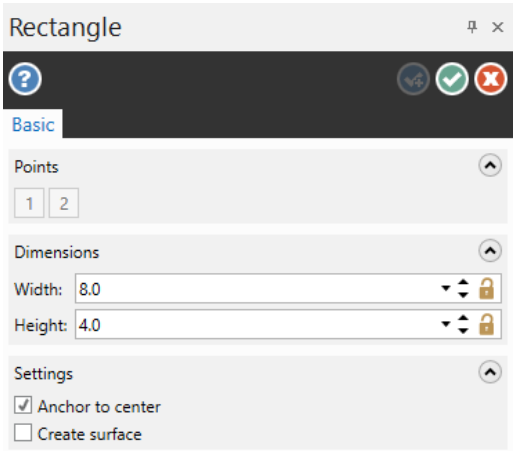
Wireframe

- From the **Shapes** group, select **Rectangle**.



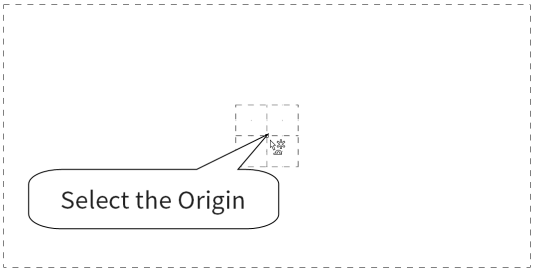
- In the **Rectangle** panel, enter the **Width** and **Height** and enable **Anchor to center** as shown.

Anchor to center sets the base point of the rectangle to its center and draws the rectangle outward from the center.
Create surface creates a surface inside of the rectangle. Surface creation and Surface toolpath are covered in Mill Advanced.
A **surface** can be described as the skin on the top of a 3D wireframe. If the Create surface option is on, in addition to the four lines of the rectangle, you will also see extra lines which represent the surface display while it is not shaded.



- Press **Enter** after typing the values to see a preview of the rectangle.

- [Select position of base point]: Select the Origin as shown.



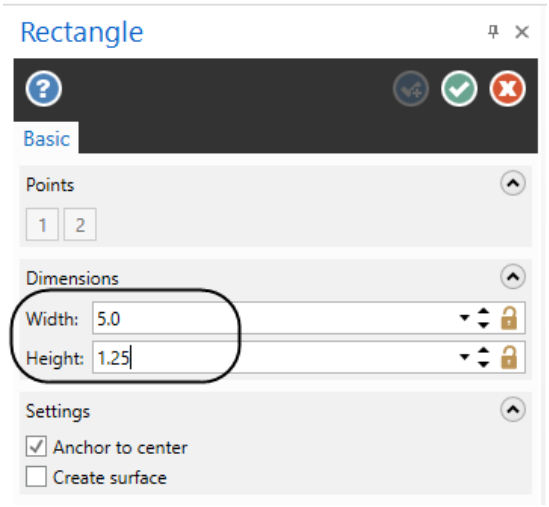
- Make sure that when selecting the origin, the visual cue of the cursor changes as shown. 
- Select the **OK and Create New Operation** button to stay in the same command. 
- To fit the drawing to the screen, press **Alt + F1**.

Note: While creating geometry for this tutorial, if you make a mistake, you can undo the last step using the **Undo** icon.  You can undo as many steps as needed. If you delete or undo a step by mistake, just use the **Redo** icon.  To delete unwanted geometry, select the geometry first and then press **Delete** from the keyboard. To zoom or un-zoom, move the cursor in the center of the geometry and scroll up or down the mouse wheel.

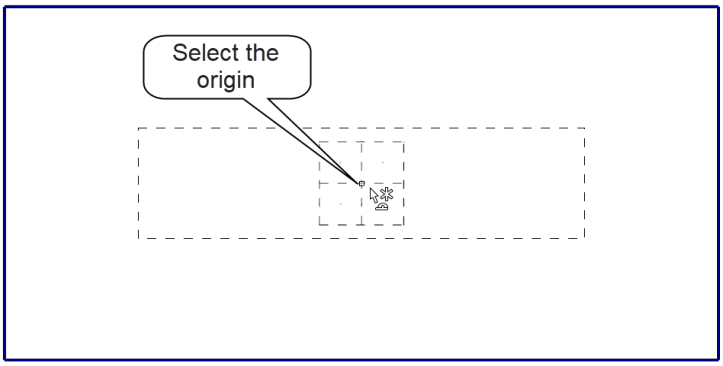
- To zoom in/out, hover the cursor approximately above the center of the part and scroll the mouse wheel up /down.

3.2 Create the 5.0" X 1.25" Rectangle

- Enter the **Width**, the **Height** and leave **Anchor to center** enabled as shown.
- Make sure that the **Create surface** button is not selected.

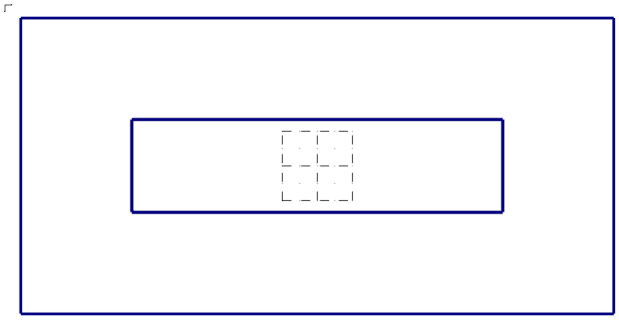


- [Select position of base point]: Select the **Origin** as shown.



- Select the **OK** button to exit the same command. 

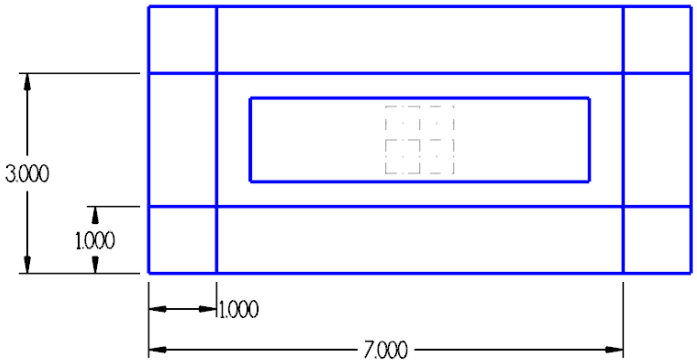
- The drawing should look as shown.



STEP 4: CREATE THE PARALLEL LINES

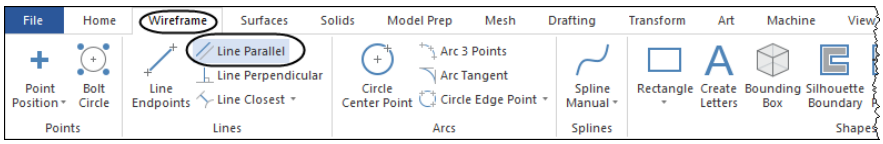
In this step you will learn how to create parallel lines to existing lines given the distance between the lines. We are creating the lines to use them as part of the geometry as well as construction lines.

Step Preview:

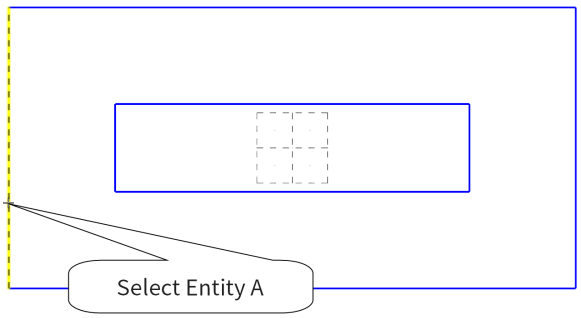


Wireframe

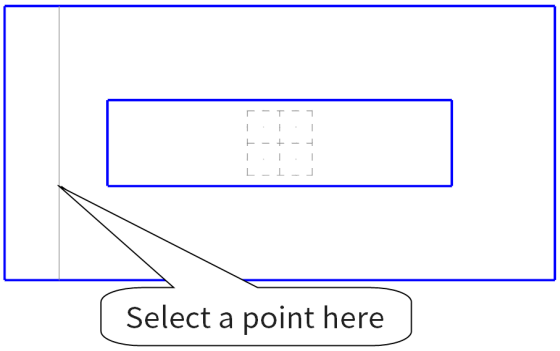
- From the **Lines** group, select **Line Parallel** as shown.



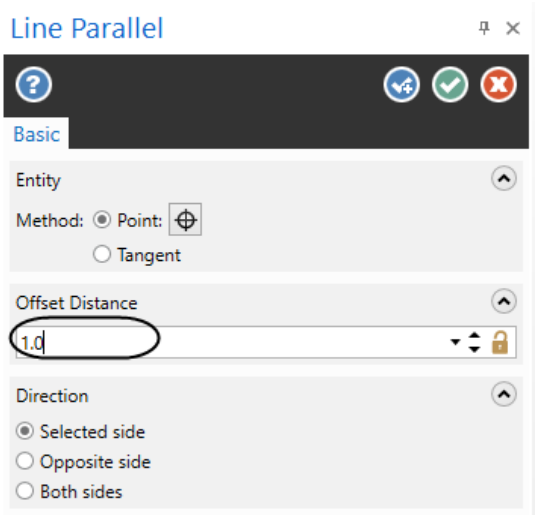
- [Select a line]: Select Entity A as shown.



- [Select the point to place a parallel line through]: Click to the right of the selected line.



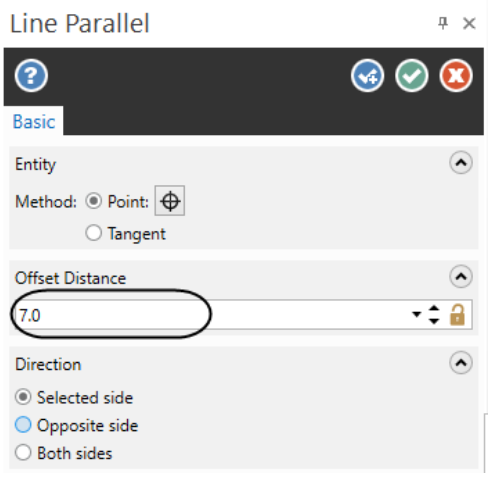
- In the **Line Parallel** panel, enter an **Offset Distance** of **1.0"** as shown.
- Press **Enter** to update the position of the line.



- Press **Enter** again or select the **OK and Create New Operation** button to stay within the command.

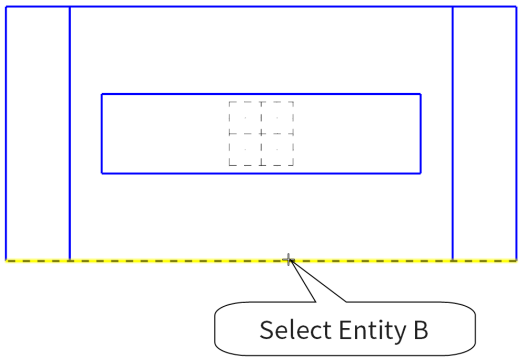
- [Select a line]: Select Entity A again.
- [Select the point to place a parallel line through]: Select a point to the right of the selected line.

- In the **Line Parallel** panel, enter an **Offset Distance** of **7.0"** as shown.
- Press **Enter** to update the position of the line.



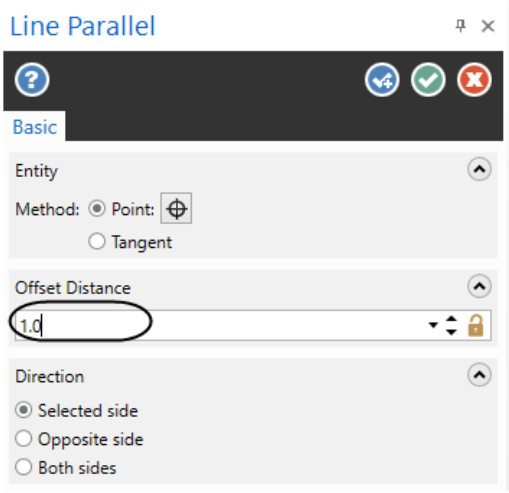
- Press **Enter** to stay within the command.

- [Select a line]: Select Entity B as shown.



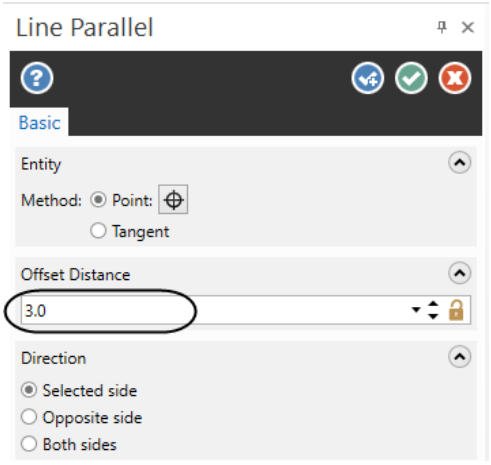
- [Select the point to place a parallel line through]: Select a point above the selected line.

- In the **Line Parallel** panel, enter an **Offset Distance** of **1.0"** as shown.
- Press **Enter** twice to position the line and to stay within the command.



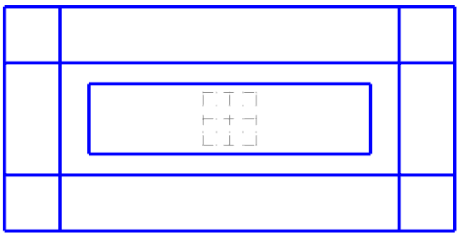
- [Select a line]: Select Entity B again.
- [Select the point to place a parallel line through]: Select a point above the selected line.

- In the **Line Parallel** panel, enter an **Offset Distance** of **3.0"** as shown.
- Press **Enter** to position the line.



- Select the **OK** button to exit the command. 

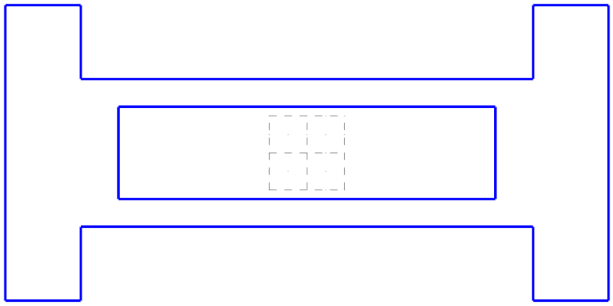
- The geometry should look as shown.



STEP 5: TRIM THE GEOMETRY USING DIVIDE

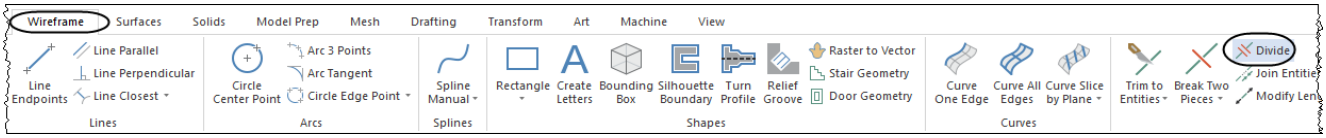
Divide function allows you to trim a line, arc, or spline into two disjointed segments by removing the segment that lies between two dividing intersections or a single intersection and an endpoint. Divide can also be used to delete entities with no intersections.

Step Preview:

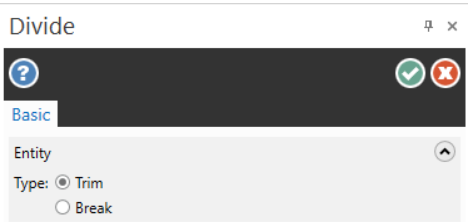


Wireframe

- From the **Modify** group, select the **Divide** icon as shown.

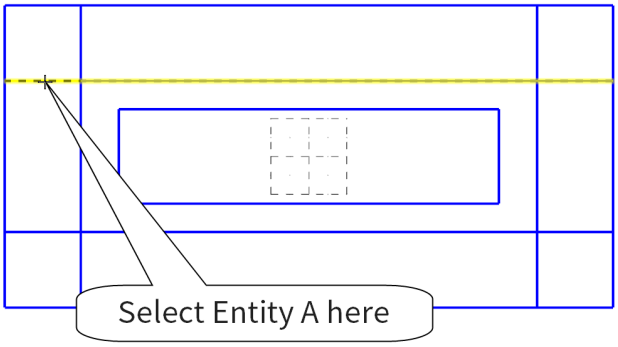


- In the **Divide** panel, enable the **Trim** as shown.

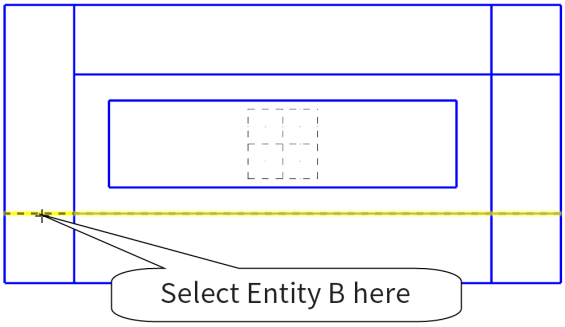


- [Select the curve to divide / delete]: Select Entity A as shown.

Note: When using divide command you should select the segment of the entity that has to be removed.

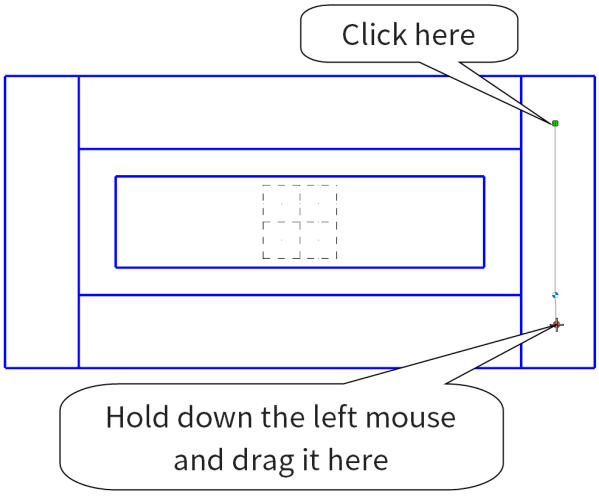


- [Select the curve to divide / delete]: Select Entity B as shown.

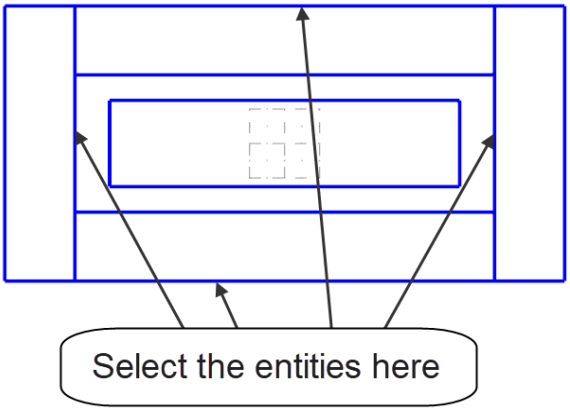


Note: Another way to remove the segments is to hold down the left mouse button and dragging the cursor across the entity.

- [Select the curve to divide / delete]: Left click about the line segment as shown.
- Holding down the left mouse, drag it down to include the other segment that has to be removed as shown.
- The drawing will appear as shown.

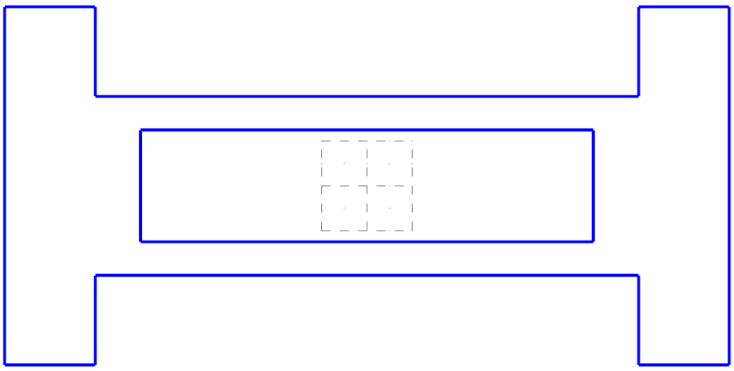


- [Select the curve to divide / delete]: To remove the rest of the segments, select the lines as shown.



- Select the **OK** button to finish the command.

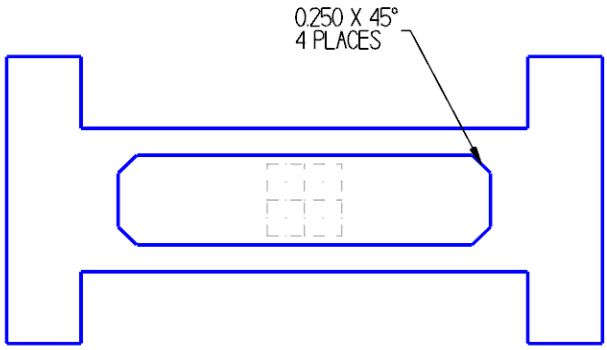
- The geometry will appear as shown.



STEP 6: CHAMFER THE INSIDE RECTANGLE

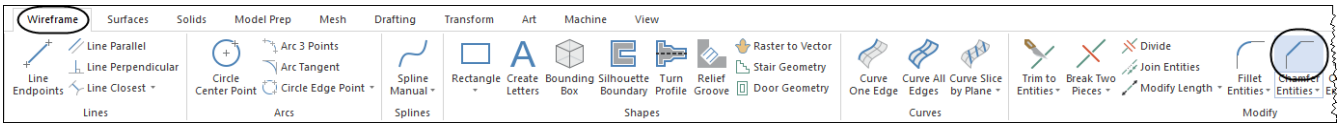
In this step we will use the **Chamfer Entities** command to apply chamfers to the corners of the outside profile.

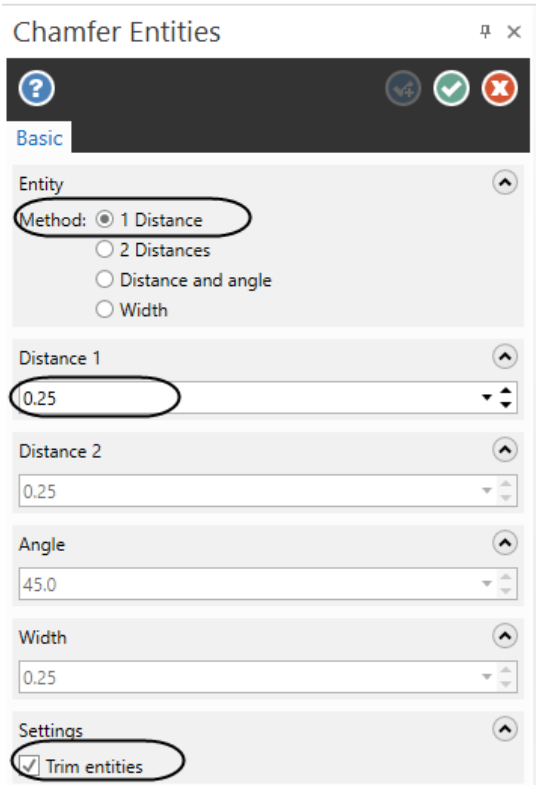
Step Preview:



Wireframe

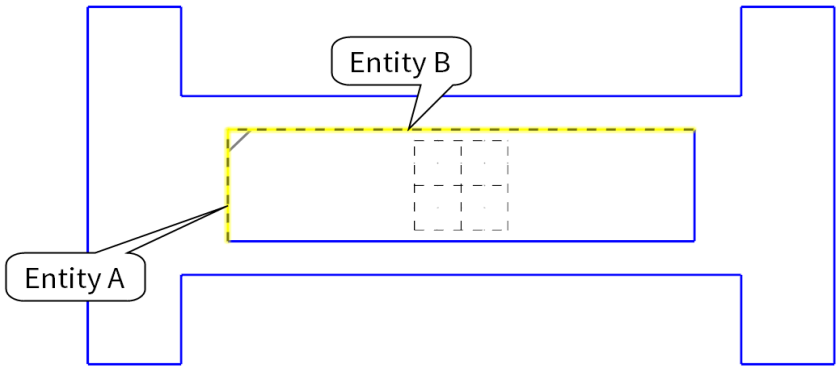
- From the **Modify** group, select **Chamfer Entities**.



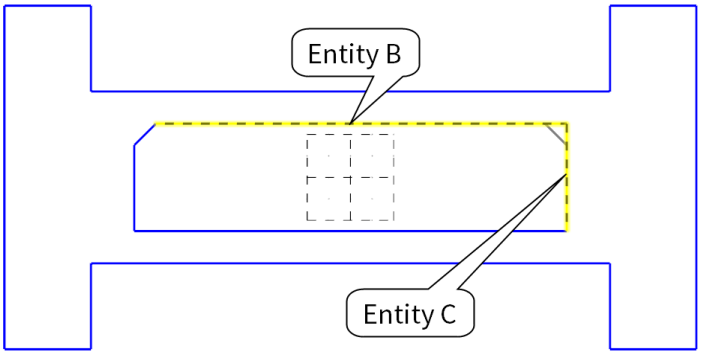


- Select **1 Distance** and enable **Trim entities** in the panel as shown.
- Enter a distance of **0.25** as shown.

- [Select line or arc]: Select Entity A as shown.
- [Select line or arc]: Select Entity B as shown.

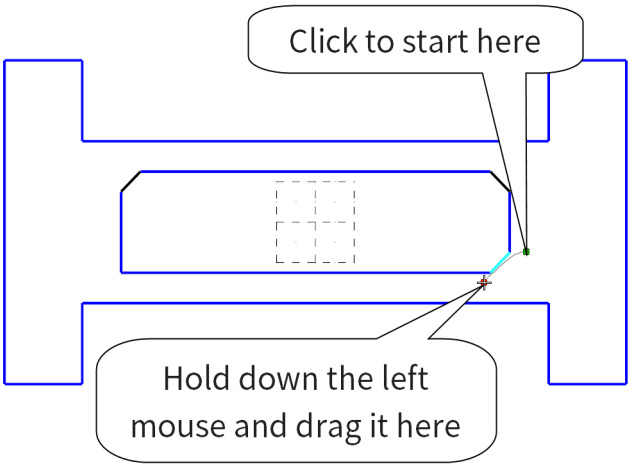


- [Select line or arc]: Select Entity B as shown.
- [Select line or arc]: Select Entity C as shown.

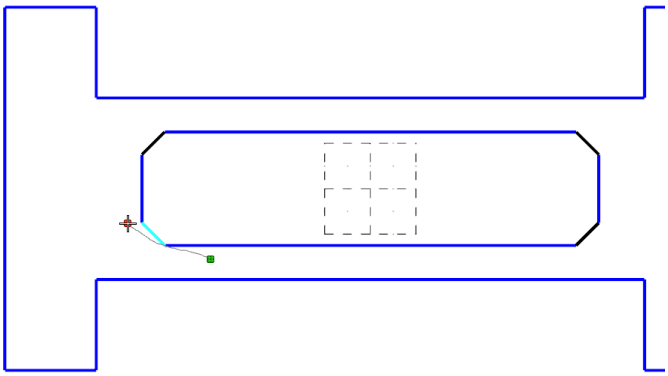


Note: Similar with divide you can also hold down the left mouse and drag it above the two entities at the corner that has to be chamfered.

- [Select line or arc]: Click to start as shown.
- [Select line or arc]: Hold down the left mouse and drag it as shown.

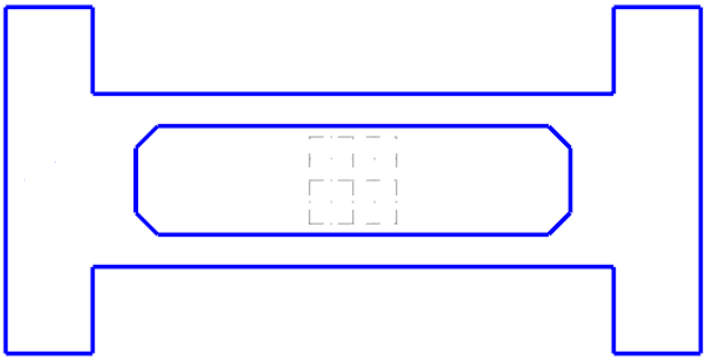


- Use one of the methods shown to chamfer the last corner.



- Select the **OK** button to exit the command. 

- The geometry should look as shown.



STEP 7: SAVE THE FILE

File

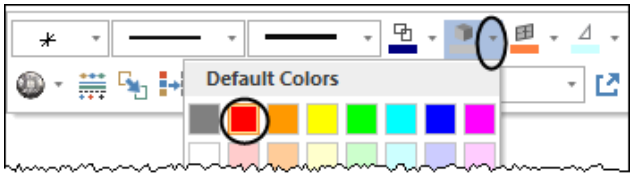
- **Save As.**
  - Click on the **Browse** icon as shown. 
  - Find a location on the computer to save your file.
  - File name: "Wireframe 1".
  - Click **Save**

Solid Creation

A **Solid** is a geometric entity that occupies a region of space and consists of one or more faces, which define the closed boundary of the solid. A solid operation requires closed boundary geometry.

STEP 8: CHANGE THE SOLID COLOR TO RED

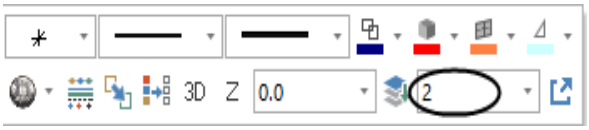
- Right mouse click in the graphics window and from the **Mini Toolbar**, left click on the arrow next to the **Solid Color** icon and select the color red as shown.



STEP 9: CHANGE THE MAIN LEVEL TO 2

Levels are a primary organizational tool in Mastercam. A Mastercam file can contain separate levels for wireframe, surfaces, drafting entities, solids, and toolpaths. By organizing your files into levels, you can easily control which areas of the drawing are visible at any time and which parts are selectable. By doing so, you will not inadvertently make changes to areas of the drawing you do not want to change.
In this step we will change the **Main Level** to **2** to create the solid on **Level 2**.

- Right mouse click in the graphics area and in the **Mini Toolbar**, change the **Level** number to **2** as shown.

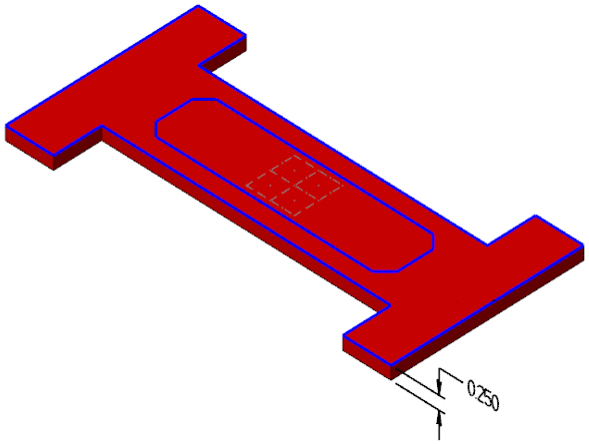


- Press the **Enter** key on your keyboard.

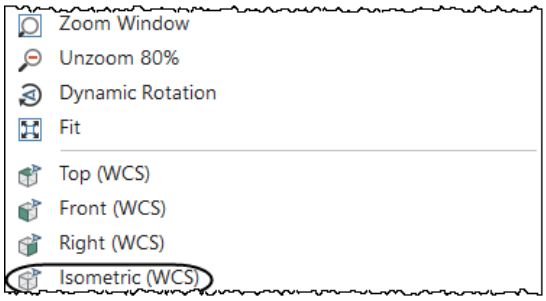
STEP 10: CREATE THE SOLID BODY

Solid Extrude performs an operation that results in the creation of one or more new solids. Mastercam extrudes entities by driving the shapes of the entity along a linear path using a specified direction, distance, and other parameters that further define the results.

Step Preview:



- Right mouse click in the graphics window and select **Isometric** view as shown.

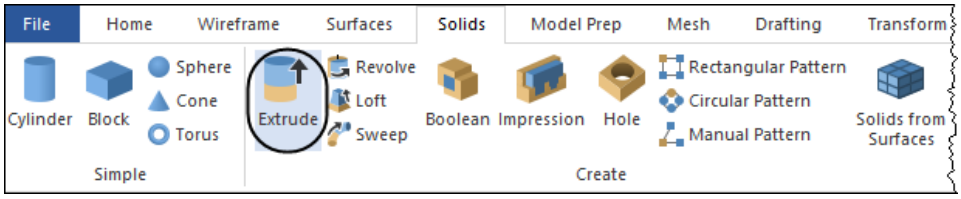


- Press **Alt + F1** to fit the geometry to the screen.

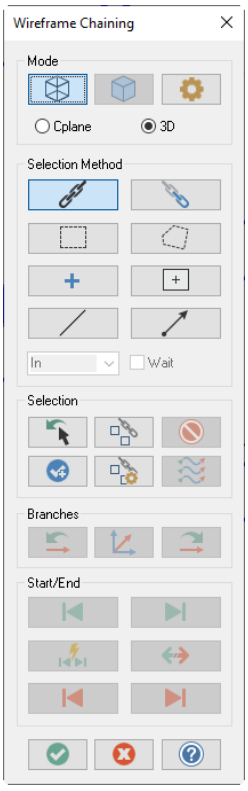
Note: The construction plane or the graphics view does not affect the way in which the solid is generated.

Solids

- Navigate to the **Solids** tab
- From the **Create** area, select **Extrude** as shown.



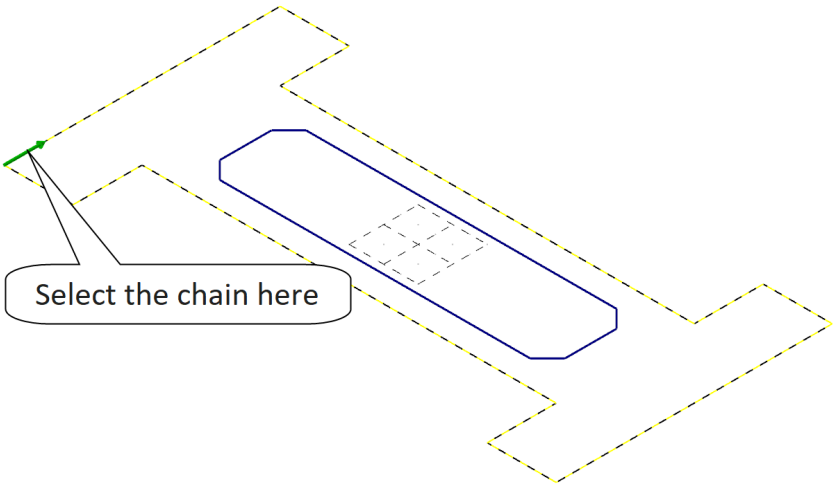
- Leave the default settings in the **Chaining** dialog box and select the outside rectangle as shown.



Chaining is the process of selecting and linking geometry entities such that they form the foundation of a toolpath, a surface, or a solid. When you chain the geometry, you can select one or more sets of curves (lines, arcs, and splines) that have adjoining endpoints.

Chaining differs from other selection methods because it assigns order and direction to the selected curves. Chaining order and direction determine how surfaces, solids, and toolpaths are generated.

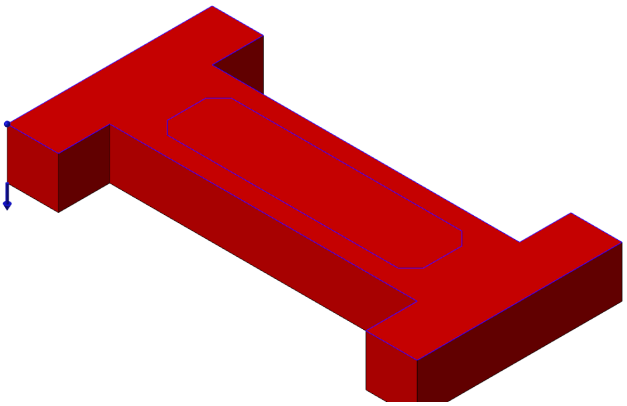
- [Select chain(s) to extrude 1]: Select the outer chain as shown.



Note: If you did not select the chain correctly, from the Chaining dialog box, click on the **Unselect** button to undo the previous selection. If you need to change the chain direction, click on the **Reverse** button.

- Select the **OK** button to exit the **Chaining** dialog box.
- Press **Alt + F1** to fit the geometry inside the graphics window if needed.

- The **Solid Extrude** panel will display. An arrow will appear on the geometry. This arrow indicates the direction of the extrusion. The arrow should point downwards.
- Otherwise, in the **Solid Extrude** panel, click on the **Reverse All** icon to flip the direction.



- Press **Alt + S** if needed to see the solid shaded as shown.

Note: The **Type** can only be set to **Create body** as this is the first solid operation**.**