



## **MILL 2D**

# **COURSE OBJECTIVES**

**By Matthew Manton and Duane Weidinger**

**camInstructor**



### Mill 2D Lesson 1 Objectives

You will create the geometry for Mill-Lesson-1. You will be working through the process to machine parts in later Lessons; Mill-Lesson-1 will just cover geometry creation. This Lesson covers the following topics:

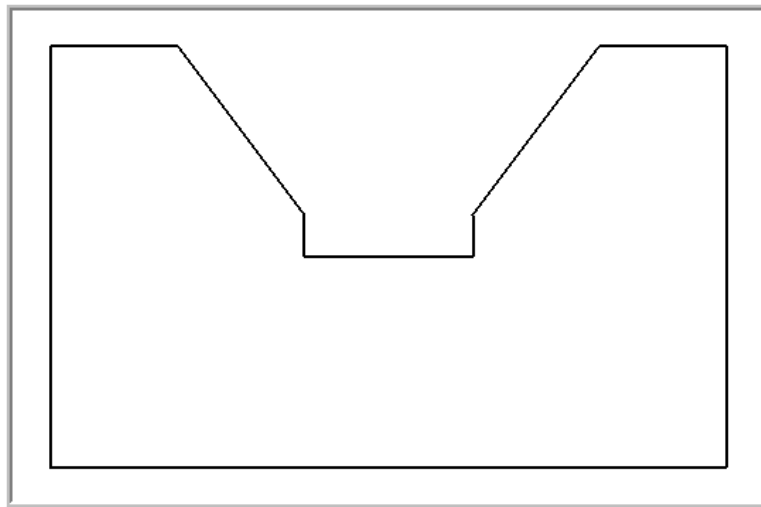
➤ **Create a 2-dimensional drawing by:**

Creating lines using line endpoints.

Using the AutoCursor to snap to endpoints of lines when creating lines.

Using the zoom functions to change the view of entities in the graphics window.

Saving the file.



### Mill 2D Lesson 2 Objectives

You will create the geometry for Mill-Lesson-3, and then generate a toolpath to machine the part on a CNC vertical milling machine. This Lesson covers the following topics:

➤ **Create a 2-dimensional drawing by:**

Creating lines.  
Creating arcs.  
Using Xform Translate to copy entities.  
Using Xform Rotate to copy entities.

➤ **Establish Stock Setup settings:**

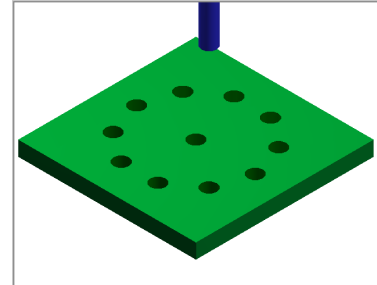
Stock size.  
Material for the part.  
Feed calculation.

➤ **Generate a 2-dimensional milling toolpath consisting of:**

Drill toolpath.

➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

Launching the Verify function to machine the part on the screen.  
Using Backplot to identify the correctness of the toolpaths.  
Generating the NC- code.



### **Mill 2D Lesson 3 Objectives**

You will create the geometry for Mill-Lesson-2. You will be working through the process to machine parts in later Lessons; Lesson #2 will just cover geometry creation. This Lesson covers the following topics:

➤ **Create a 2-dimensional drawing by:**

Creating lines using line endpoints.

Using the AutoCursor when creating lines to snap to endpoints of lines.

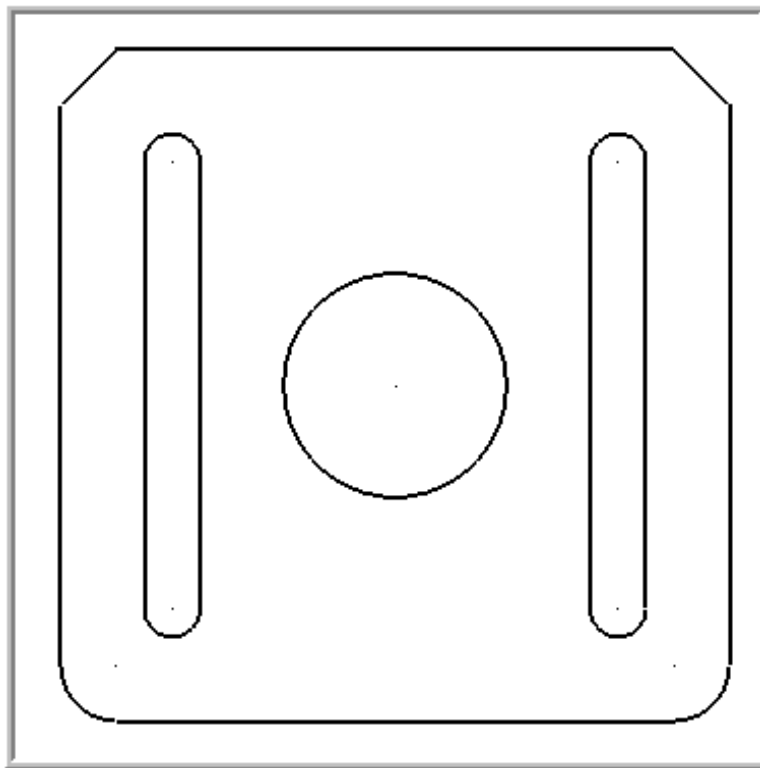
Using the zoom functions to change the view of entities in the graphics window.

Creating Chamfers.

Creating Fillets.

Constructing Arcs and Circles.

Saving the file.



### Mill 2D Lesson 4 Objectives

You will create the geometry for Mill-Lesson-4, and then generate a toolpath to machine the part on a CNC vertical milling machine. This lesson covers the following topics:

➤ **Create a 2-dimensional drawing by:**

Creating rectangles.  
Creating arcs.

➤ **Establish Stock Setup settings:**

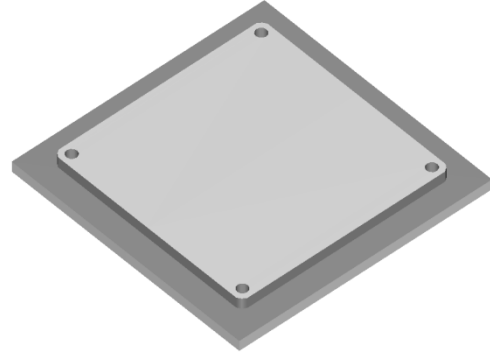
Stock size.  
Material for the part.  
Feed calculation.

➤ **Generate a 2-dimensional milling toolpath consisting of:**

Contour toolpath.  
Drill toolpath.

➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

Launching the Verify function to machine the part on the screen.  
Using Backplot to identify the correctness of the toolpaths.  
Generating the NC- code.



### Mill 2D Lesson 5 Objectives

You will create the geometry for Mill-Lesson-5, and then generate a toolpath to machine the part on a CNC vertical milling machine. This Lesson covers the following topics:

➤ **Create a 2-dimensional drawing by:**

Creating lines.  
Creating arcs.  
Using Xform Mirror to copy entities.  
Trimming geometry using Divide.

➤ **Establish Stock Setup settings:**

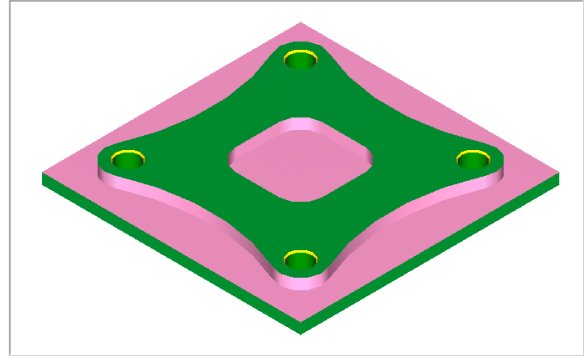
Stock size.  
Material for the part.  
Feed calculation.

➤ **Generate a 2-dimensional milling toolpath consisting of:**

Drill toolpath.  
Contour toolpath.  
Pocket toolpath.

➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

Launching the Verify function to machine the part on the screen.  
Generating the NC- code.

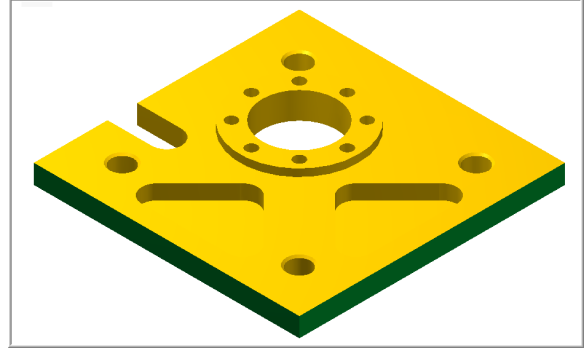


### Mill 2D Lesson 6 Objectives

You will create the geometry for Mill-Lesson-6. In Mill-Lesson-6 you create the geometry and in Mill-Lesson-7 you will create the Toolpath operations.

This Lesson covers the following topics:

- Create a 2-dimensional drawing by:
  - Creating lines.
  - Creating arcs.
  - Using Bolt circle.
  - Using Xform Translate to copy and move entities.
  - Trimming geometry using Divide/Delete.





### Mill 2D Lesson 7 Objectives

Previously in Mill-Lesson-6 the geometry was completed. This lesson will complete all the toolpath operations.

You will generate the toolpaths for Mill-Lesson-7 to machine the part on a CNC vertical milling machine.

This Lesson covers the following topics:

➤ **Establish Stock Setup settings:**

Stock size.

Material for the part.

Feed calculation.

➤ **Generate a 2-dimensional milling toolpath consisting of:**

Drill toolpath.

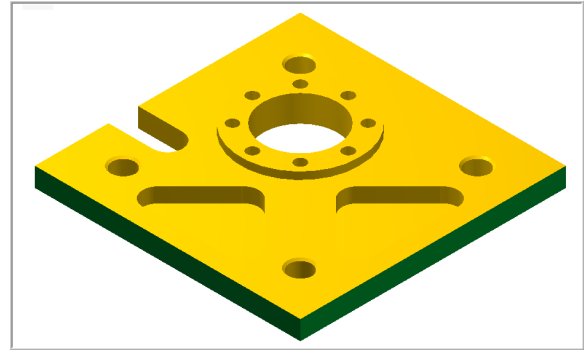
Tap toolpath.

Face toolpath.

Pocket face toolpath.

Pocket toolpath.

Contour toolpath.



➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

Launching the Verify function to machine the part on the screen.

Generating the NC- code.

### Mill 2D Lesson 8 Objectives

This lesson will be divided into two stages:

#### Part 1

The first stage will be to create the geometry, face, spot drill, drill and ream the part. The part will be held in a machine vise for this set of machining operations.

#### Part 2

The second stage will be to transfer the part machined in Part 1 and locate and fasten the part to a fixture to complete the remaining operations.

You will create the geometry for Mill-Lesson-8, and then generate the toolpaths to machine the part on a CNC vertical milling machine. This Lesson covers the following topics:

#### ➤ Create a 2-dimensional drawing by:

Creating lines.

Creating arcs.

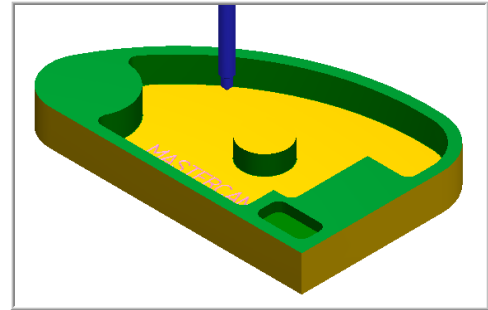
Trimming geometry using Divide/Delete.

#### ➤ Establish Stock Setup settings:

Stock size using Bounding Box.

Material for the part.

Feed calculation.



#### ➤ Generate a 2-dimensional milling toolpath consisting of:

Drill toolpath.

Contour toolpath.

Pocket toolpath.

Remachining.

Engrave toolpath.

#### ➤ Inspect the toolpath using Mastercam's Verify and Backplot by:

Launching the Verify function to machine the part on the screen.

Generating the NC- code.



## **MILL 3D**

# **COURSE OBJECTIVES**

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### Mill 3D Lesson 9 Objectives

You will create the geometry for Mill-Lesson-9, and then generate the toolpaths to machine the part on a CNC vertical milling machine. This Lesson covers the following topics:

➤ **Create a 3-dimensional drawing by:**

Creating lines.  
Creating arcs.  
Trimming geometry using Divide / Delete.  
Creating a revolved surface.

➤ **Establish Stock Setup settings:**

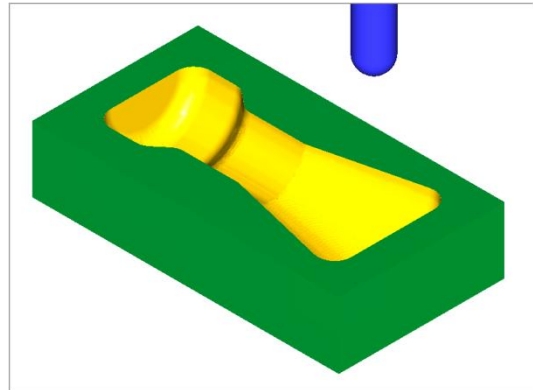
Stock size using Bounding Box.  
Material for the part.  
Feed calculation.

➤ **Generate a 3-dimensional milling toolpath consisting of:**

Surface Pocket.  
Surface High Speed Waterline.

➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

Launching the Verify function to machine the part on the screen.  
Generating the NC- code.



### Mill 3D Lesson 10 Objectives

You will create the geometry for Mill-Lesson-10, and then generate the toolpaths to machine the part on a CNC vertical milling machine. This Lesson covers the following topics:

➤ **Create a 3-dimensional drawing by:**

Creating lines.  
Creating arcs.  
Trimming geometry.  
Creating a lofted surface.

➤ **Establish Stock Setup settings:**

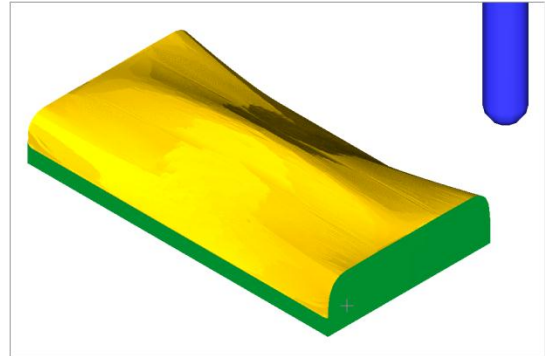
Stock size using Bounding Box.  
Material for the part.  
Feed calculation.

➤ **Generate a 3-dimensional milling toolpath consisting of:**

Rough and Finish Parallel Toolpaths.

➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

Launching the Verify function to machine the part on the screen.  
Generating the NC- code.



### Mill 3D Lesson 11 Objectives

You will create the geometry for Mill-Lesson-11, and then generate the toolpaths to machine the part on a CNC vertical milling machine. This Lesson covers the following topics:

**Create a 3-dimensional drawing by:**

- Creating lines.
- Creating arcs.
- Trimming geometry.
- Creating a net surface.
- Creating a Silhouette Boundary.

**Establish Stock Setup settings:**

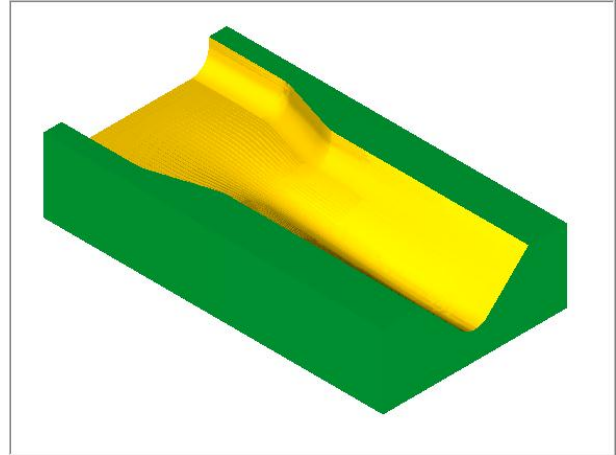
- Stock size using Bounding Box.
- Material for the part.
- Feed calculation.

**Generate a 3-dimensional milling toolpath consisting of:**

- Surface High Speed Area Clearance.
- Finish Flowline Toolpaths.

**Inspect the toolpath using Mastercam's Verify and Backplot by:**

- Launching the Verify function to machine the part on the screen.
- Generating the NC- code.



### Mill 3D Lesson 12 Objectives

You will create the geometry for Mill-Lesson-12, and then generate the toolpaths to machine the part on a CNC vertical milling machine. This Lesson covers the following topics:

➤ **Create a 3-dimensional drawing by:**

- Creating lines.
- Creating arcs.
- Trimming geometry.
- Creating a swept surface.
- Creating a flat boundary surface.
- Creating a filleted surface.

➤ **Establish Stock Setup settings:**

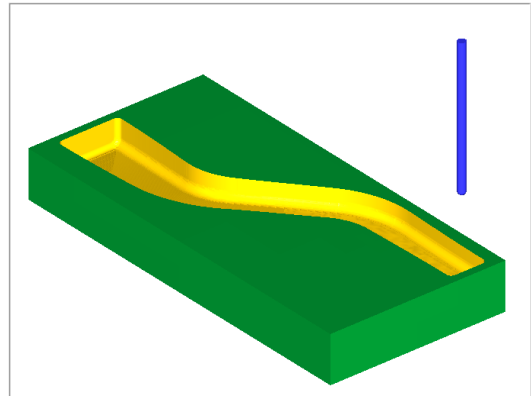
- Stock size using Bounding Box.
- Material for the part.
- Feed calculation.

➤ **Generate a 3-dimensional milling toolpath consisting of:**

- Surface Rough Pocket Toolpaths.
- Finish Surface High Speed (Waterline) Toolpaths.
- Finish Surface High Speed (Scallop) Toolpaths.
- Finish Surface High Speed (Waterline Rest Passes) Toolpaths.

➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

- Launching the Verify function to machine the part on the screen.
- Generating the NC- code.





### Mill 3D Lesson 13 Objectives

You will create the geometry for Mill-Lesson-13, and then generate the toolpaths to machine the part on a CNC vertical milling machine. This Lesson covers the following topics:

➤ **Create a 3-dimensional drawing by:**

- Creating lines.
- Creating arcs.
- Trimming geometry.
- Creating a ruled surface.

➤ **Establish Stock Setup settings:**

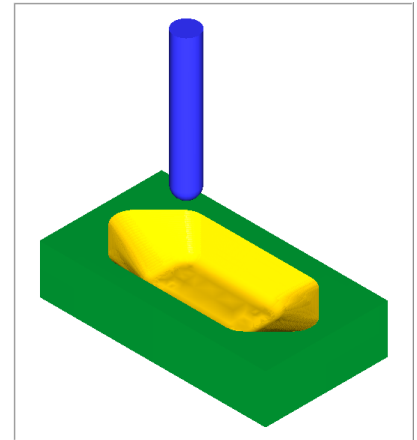
- Stock size using Bounding Box.
- Material for the part.
- Feed calculation.

➤ **Generate a 3-dimensional milling toolpath consisting of:**

- Surface rough plunge Toolpath.
- Surface finish contour Toolpath.
- Surface finish shallow Toolpath.

➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

- Launching the Verify function to machine the part on the screen.
- Generating the NC- code.

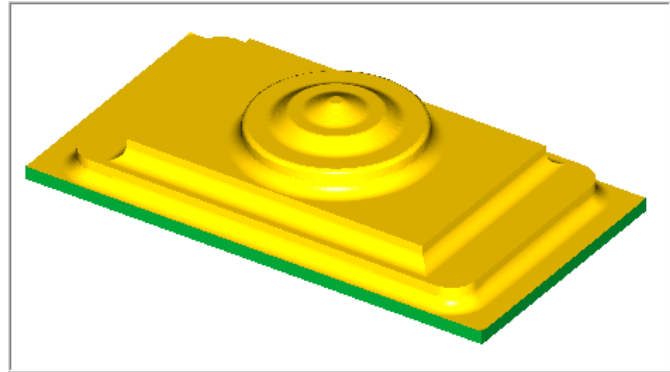


### Mill 3D Lesson 14 Objectives

You will create the geometry for Mill-Lesson-14, and then generate the toolpaths to machine the part on a CNC vertical milling machine. This Lesson covers the following topics:

➤ **Create a 3-dimensional drawing by:**

- Creating lines.
- Creating arcs.
- Trimming geometry.
- Analyze geometry.
- Creating solid bodies.
- Creating an extruded solid.
- Creating a revolved solid.
- Creating filleted solids.
- Creating Levels.



➤ **Establish Stock Setup settings:**

- Stock size using Bounding Box.
- Material for the part.
- Feed calculation.

➤ **Generate a 3-dimensional milling toolpath consisting of:**

- Surface rough pocket toolpaths.
- Surface finish contour Toolpath.

➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

- Launching the Verify function to machine the part on the screen.
- Creating a STL file.
- Generating the NC- code.

### Mill 3D Lesson 15 Objectives

You will use a provided model for Mill-Lesson-15, then generate the toolpaths to machine the part on a CNC vertical milling machine. This Lesson covers the following topics:

➤ **Establish Stock Setup settings:**

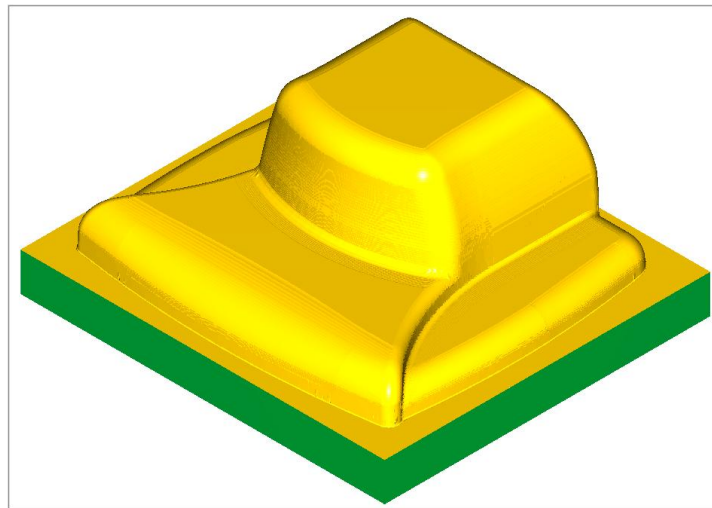
Stock size using Bounding Box.  
Material for the part.  
Feed calculation.

➤ **Generate 3-dimensional milling toolpaths consisting of:**

Core Roughing  
Waterline  
Surface Finish Leftover

➤ **Inspect the toolpath using Mastercam's Verify by:**

Launching the Verify function to machine the part on the screen.  
Comparing a verified part to the original stock stl file.  
Generating the NC- code.



### Mill 3D Lesson 16 Objectives

You will use a provided model for Mill-Lesson-16, and then generate the toolpaths to machine the part on a CNC vertical milling machine. This Lesson covers the following topics:

☞ **Establish Stock Setup settings:**

Stock size using Bounding Box.  
Material for the part.  
Feed calculation.

☞ **Prepare model for cutting by:**

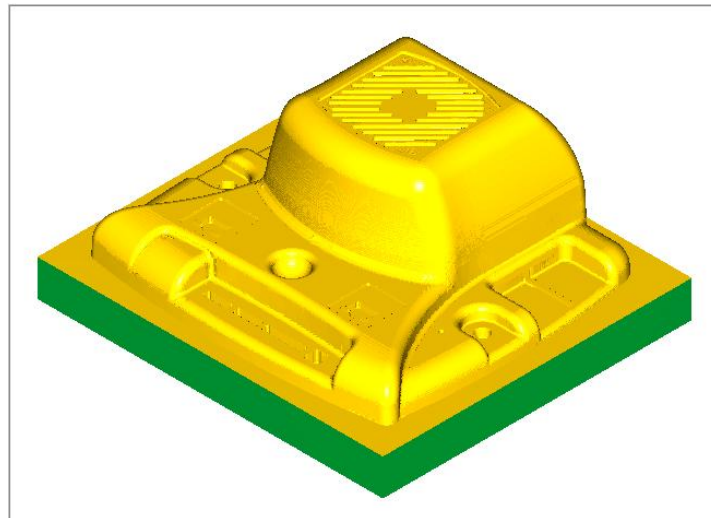
Creating surfaces from solid faces.  
Using Silhouette Boundary for containment boundaries.  
Creating flat boundary surfaces.

☞ **Generate 3-dimensional milling toolpaths consisting of:**

Importing toolpaths  
Rest Roughing  
Finishing Horizontal Area

☞ **Inspect the toolpath using Mastercam's Verify by:**

Launching the Verify function to machine the part on the screen.  
Comparing a verified part to the original stock stl file.  
Generating the NC- code.





# **LATHE**

## **COURSE OBJECTIVES**

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### Lathe Lesson 1 Objectives

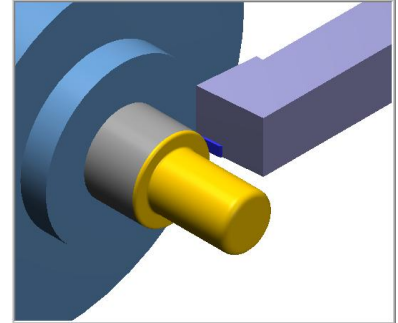
You will create the geometry for Lathe-Lesson-1, and then generate a toolpath to machine the part on a CNC lathe. This lesson covers the following topics:

➤ **Create a 2-dimensional drawing by:**

Creating lines.  
Creating fillets.

➤ **Establish Stock and Chuck settings:**

Stock size.  
Chuck Configuration.  
Material for the part.  
Feed calculation.



➤ **Generate a 2-dimensional lathe toolpath consisting of:**

Lathe Face.  
Lathe Rough.  
Lathe Finish.  
Lathe Cutoff.

➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

Launching the Verify function to machine the part on the screen.  
Using Backplot to identify the correctness of the toolpaths.  
Generating the NC- code.

### Lathe Lesson 2 Objectives

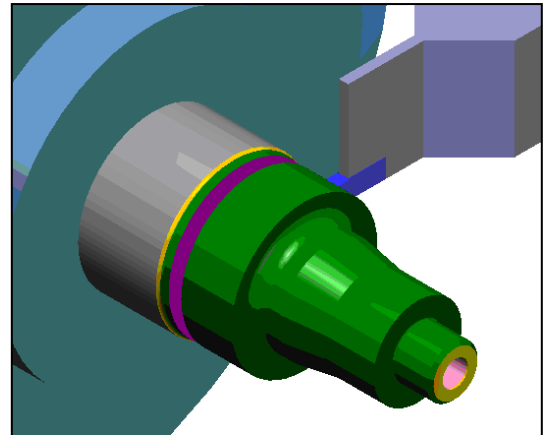
You will create the geometry for Lathe Lesson 2, and then generate a toolpath to machine the part on a CNC lathe. This lesson covers the following topics:

➤ **Create a 2-dimensional drawing by:**

- Creating lines.
- Creating fillets.
- Creating chamfers.

➤ **Establish Stock and Chuck Setup settings:**

- Stock size.
- Chuck Configuration.
- Material for the part.
- Feed calculation.



➤ **Generate a 2-dimensional lathe toolpath consisting of:**

- Lathe Face.
- Lathe Rough.
- Lathe Finish.
- Lathe Drill.
- Lathe Cutoff.

➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

- Launching the Verify function to machine the part on the screen.
- Using Backplot to identify the accuracy of the toolpaths.
- Generating the NC- code.



### Lathe Lesson 3 Objectives

You will create the geometry for Lathe Lesson 3, and then generate a toolpath to machine the part on a CNC lathe. This lesson covers the following topics:

➤ **Create a 2-dimensional drawing by:**

- Creating lines.
- Creating fillets.
- Creating chamfers.

➤ **Establish Stock and Chuck Setup settings:**

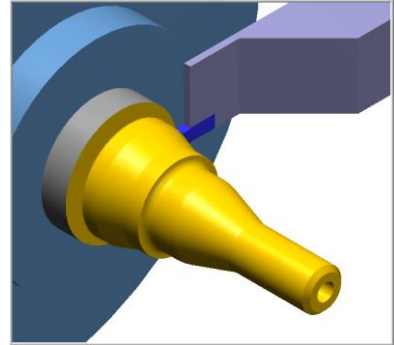
- Stock size.
- Chuck Configuration.
- Material for the part.
- Feed calculation.

➤ **Generate a 2-dimensional lathe toolpath consisting of:**

- Lathe Face.
- Lathe Rough.
- Lathe Finish.
- Lathe Drill and Thread.
- Lathe Cutoff.

➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

- Launching the Verify function to machine the part on the screen.
- Generating the NC- code.



### Lathe Lesson 4 Objectives

You will create the geometry for Lathe Lesson 2, and then generate a toolpath to machine the part on a CNC lathe. This lesson covers the following topics:

➤ **Create a 2-dimensional drawing by:**

Creating lines.  
Creating fillets.  
Creating chamfers.

➤ **Establish Stock and Chuck Setup settings:**

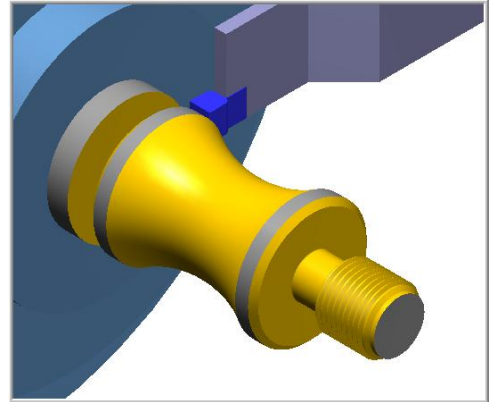
Stock size.  
Chuck Configuration.  
Material for the part.  
Feed calculation.

➤ **Generate a 2-dimensional lathe toolpath consisting of:**

Lathe Face.  
Lathe Rough.  
Lathe Finish.  
Lathe Groove.  
Lathe Thread.  
Lathe Cutoff.

➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

Launching the Verify function to machine the part on the screen.  
Generating the NC- code.



### **Lathe Lesson 5 Objectives**

You will create the geometry for Lathe Lesson 5, and then generate a toolpath to machine the part on a CNC lathe. This lesson covers the following topics:

➤ **Create a 2-dimensional drawing by:**

- Creating lines.
- Creating fillets.
- Creating chamfers.
- Trimming geometry.

➤ **Establish Stock and Chuck Setup settings:**

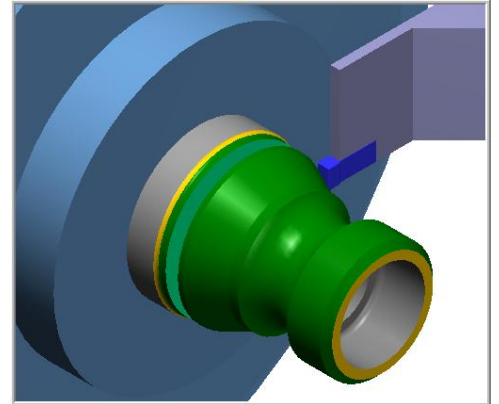
- Stock size.
- Chuck Configuration.
- Material for the part.
- Feed calculation.

➤ **Generate a 2-dimensional lathe toolpath consisting of:**

- Lathe Face.
- Lathe Rough.
- Lathe Finish.
- Lathe Drill.
- Lathe Cutoff.

➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

- Launching the Verify function to machine the part on the screen.
- Generating the NC- code.



### Lathe Lesson 6 Objectives

You will create the geometry for Lathe Lesson 6, and then generate a toolpath to machine the part on a CNC lathe. This lesson covers the following topics:

➤ **Create a 2-dimensional drawing by:**

- Creating lines.
- Creating fillets.
- Creating chamfers.
- Trimming geometry.

➤ **Establish Stock and Chuck Setup settings:**

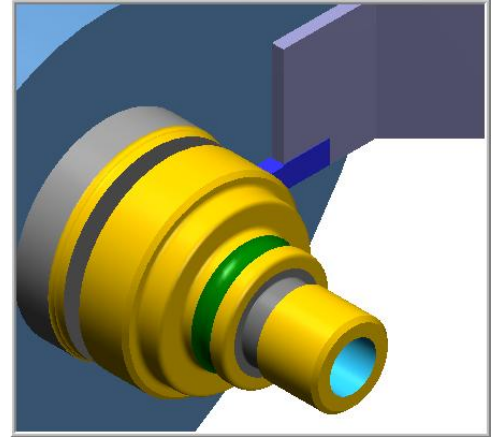
- Stock size.
- Chuck Configuration.
- Material for the part.
- Feed calculation.

➤ **Generate a 2-dimensional lathe toolpath consisting of:**

- Lathe Face.
- Lathe Quick Rough.
- Lathe Quick Finish.
- Lathe Finish.
- Lathe Drill.
- Lathe Groove.
- Lathe Cutoff.

➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

- Launching the Verify function to machine the part on the screen.
- Generating the NC- code.



### Lathe Lesson 7 Objectives

You will create the geometry for Lathe Lesson-7, and then generate a toolpath to machine the part on a CNC lathe. This lesson covers the following topics:

➤ **Create a 2-dimensional drawing by:**

- Creating lines.
- Creating fillets.
- Creating chamfers.
- Trimming geometry.

➤ **Establish Stock and Chuck Setup settings:**

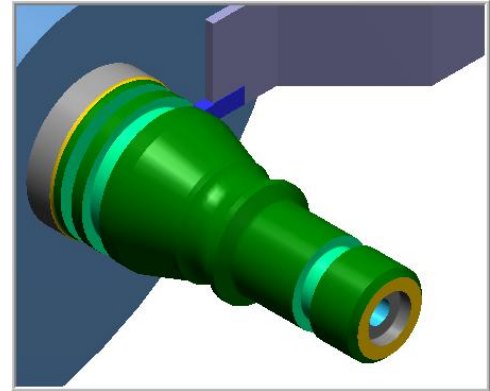
- Stock size.
- Chuck Configuration.
- Material for the part.
- Feed calculation.

➤ **Generate a 2-dimensional lathe toolpath consisting of:**

- Lathe Face.
- Lathe Quick Rough.
- Lathe Quick Finish.
- Lathe Finish.
- Lathe Drill.
- Lathe Groove.
- Lathe Cutoff.

➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

- Launching the Verify function to machine the part on the screen.
- Generating the NC- code.



### **Lathe Lesson 8 Objectives**

You will open an existing file: Lathe Lesson 1 and create the geometry for Lathe-Lesson-8. If you do not have the Mastercam file for Lathe Lesson 1 it is available on the CD that came with this textbook in the folder **Sample-Files**. The geometry creation for this part will involve the creation of a series of points that will be used to machine the four holes using the C-Axis.

You will then generate a toolpath to machine the part on a CNC lathe. This lesson covers the following topics:

➤ **Create a 2-dimensional drawing by:**

Creating points.

➤ **Establish Stock and Chuck settings:**

Stock size.

Chuck Configuration.

Material for the part.

Feed calculation.

➤ **Generate a C-Axis lathe toolpath consisting of:**

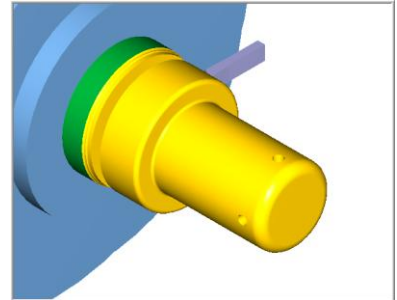
C-Axis Drill.

➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

Launching the Verify function to machine the part on the screen.

Using Backplot to identify the correctness of the toolpaths.

Generating the NC- code.



### **Lathe Lesson 9 Objectives**

You will create the geometry for Lathe-Lesson-9, and then generate a toolpath to machine the part on a CNC lathe. This lesson covers the following topics:

➤ **Create a 2-dimensional drawing by:**

Creating lines.

Creating fillets.

Creating lines rotated about the diameter.

➤ **Establish Stock and Chuck settings:**

Stock size.

Chuck Configuration.

Material for the part.

Feed calculation.

➤ **Generate a C-Axis lathe toolpath consisting of:**

Lathe Face.

Lathe Rough.

Lathe Finish.

Lathe Drill.

Lathe Bore.

C-Axis Cross Contour.

Lathe Cutoff.

Modify geometry and update toolpath operations

➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

Launching the Verify function to machine the part on the screen.

Using Backplot to identify the correctness of the toolpaths.

Generating the NC- code.







## **4 AXIS**

# **COURSE OBJECTIVES**

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### Four Axis Lesson 1 Objectives

In **Four-Axis-Lesson-1** you will setup the part prior to completing the machining operations in **Four-Axis-Lesson-2**.

This lesson will involve the re-orientation of geometry from an existing file and assigning new Levels. You will also create new wireframe and solid geometry that will be used as an STL file to verify the completed machining operations in **Four-Axis-Lesson-2**.

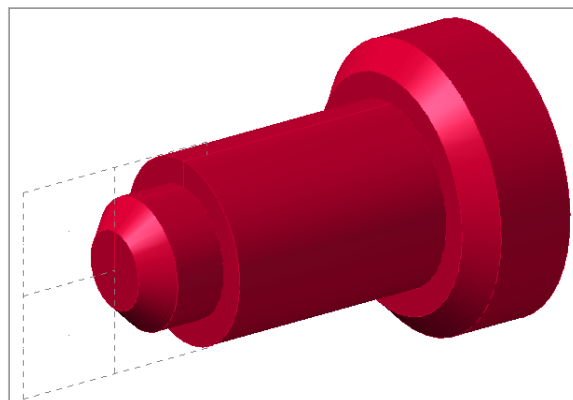
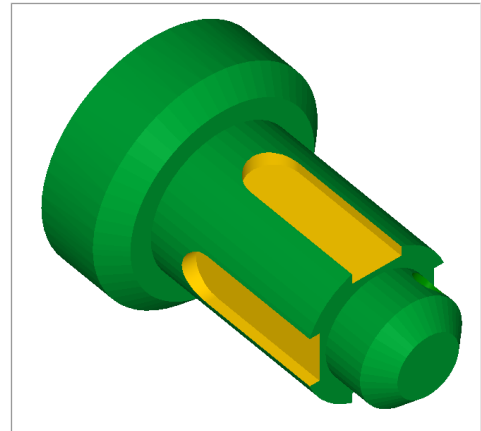
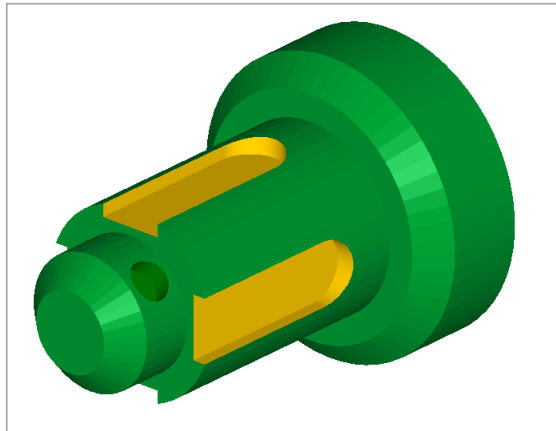
The part will be held in a rotary indexer as shown below. These types of indexes can utilise collets or a three-jaw chuck. This Lesson covers the following topics:

➤ **Open an existing file containing:**

The solid geometry for the part

➤ **Establish Stock Setup settings:**

Create a StereoLithography (STL) file to be used for toolpath verification  
Material for the part  
Feed calculation



**StereoLithography (STL) file to be used for toolpath verification**

## Four Axis Lesson 2 Objectives

In the previous lesson **Four-Axis-Lesson-1** you setup the part and created geometry. Working through this lesson you will use **Four-Axis-Lesson-1** to start off, make a duplicate of the file and then move onto toolpath creation using the part you created in **Four-Axis-Lesson-1**.

In **Four-Axis-Lesson-2** you will generate the toolpaths to machine the part on a CNC vertical milling machine with four-axis capability. The outside diameters have already been completed.

The part will be held in a rotary indexer as shown below. These types of indexes can utilise collets or a three-jaw chuck. This Lesson covers the following topics:

➤ **Open an existing file containing:**

The solid geometry for the part

➤ **Generate milling toolpath consisting of:**

Using the View Manager

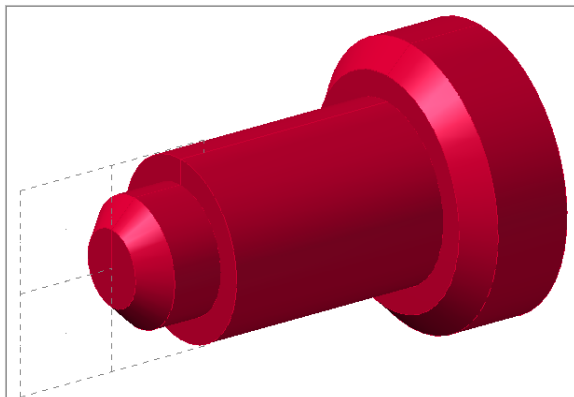
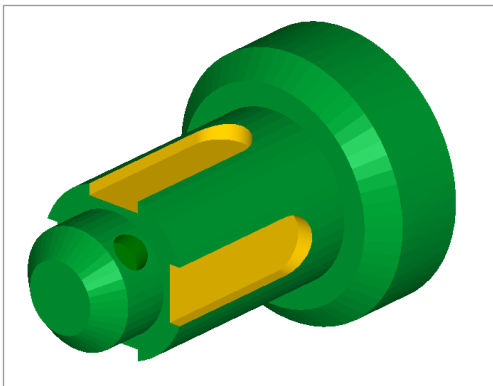
Using Views, Levels, Tool Planes and Construction Planes

Create Contour and Drill toolpaths

➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

Launching the Verify function to machine the part on the screen

Generating the NC- code



**StereoLithography (STL) file to be used for toolpath verification**

### ➤ **Getting Started**

Before working through these lessons you may find it useful to review the material in the **Tips and Techniques** section of the multimedia DVD that came with this text covering **Work Coordinate Systems (WCS)**.

If you are using the Online Course content the Work Coordinate Systems (WCS ) material is in the Tips and Techniques section of the main menu.

### Four Axis Lesson 3 Objectives

In **Four-Axis-Lesson-3** you will generate the toolpaths to machine the part on a CNC vertical milling machine with four-axis capability. The outside diameters have already been completed.

The part will be held in a rotary indexer as shown below. These types of indexes can utilise collets or a three-jaw chuck. This Lesson covers the following topics:

➤ **Open an existing file containing:**

The solid geometry for the part

➤ **Establish Stock Setup settings:**

Use a supplied StereoLithography (STL) file for toolpath verification  
Material for the part  
Feed calculation

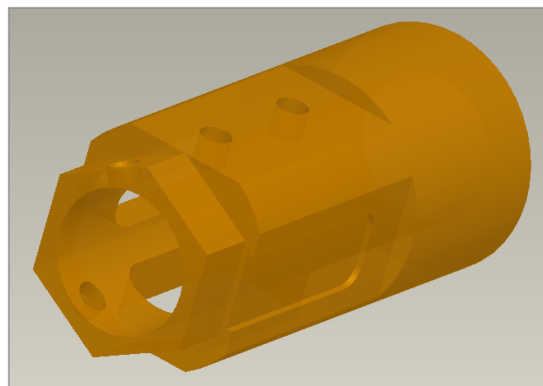


➤ **Generate milling toolpath consisting of:**

Using the View Manager  
Using Views, Levels, Tool Planes and Construction Planes  
Create Contour, Pocket and Drill toolpaths  
Using Toolpath Transform to rotate toolpaths

➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

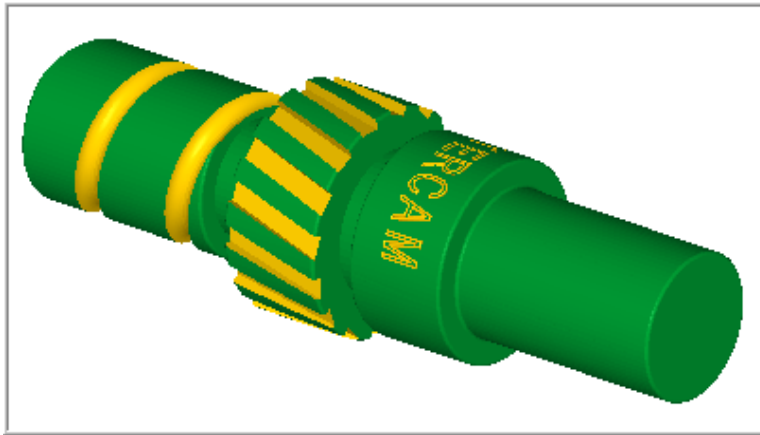
Launching the Verify function to machine the part on the screen  
Generating the NC- code



### Four Axis Lesson 4 Objectives

In **Four-Axis-Lesson-4** you will generate the toolpaths to machine the part on a CNC vertical milling machine with four-axis capability. The outside diameters have already been completed. The following features will be machined:

- **Gear slots**
- **Cylindrical Helix**
- **Mastercam Lettering**



The part will be held in a rotary indexer as shown below. These types of indexes can utilise collets or a three-jaw chuck. This Lesson covers the following topics:

- **Open an existing file containing:**

The solid geometry for the part

- **Establish Stock Setup settings:**

Use a supplied StereoLithography (STL) file for toolpath verification  
Material for the part  
Feed calculation



- **Generate milling toolpath consisting of:**

Using the View Manager  
Using Views, Levels, Tool Planes and Construction Planes  
Create Contour, Pocket and Drill toolpaths  
Using Toolpath Transform to rotate toolpaths

- **Inspect the toolpath using Mastercam's Verify and Backplot by:**

Launching the Verify function to machine the part on the screen  
Generating the NC- code

### Four Axis Lesson 5 Objectives

In **Four-Axis-Lesson-5** you will generate the toolpaths to machine the part on a CNC vertical milling machine with four-axis capability. The outside diameters have already been completed.

The part will be held in a rotary indexer as shown below. These types of indexes can utilise collets or a three-jaw chuck. This Lesson covers the following topics:

➤ **Open an existing file containing:**

The solid geometry for the part

➤ **Establish Stock Setup settings:**

Material for the part

Feed calculation

➤ **Generate milling toolpath consisting of:**

Using the View Manager

Using Views, Levels, Tool Planes and Construction Planes

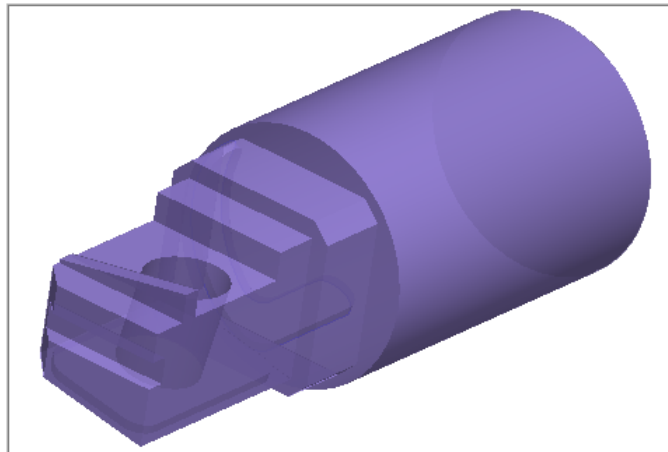
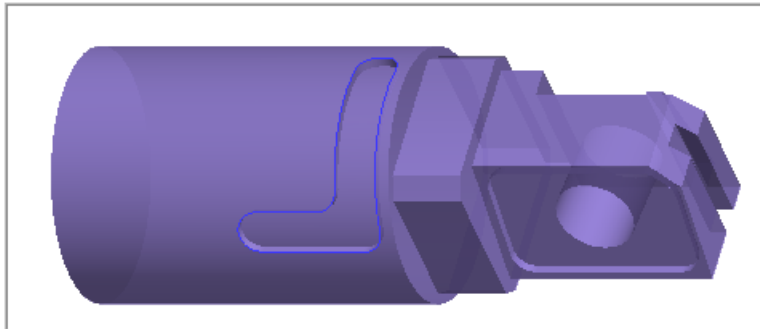
Create Contour, Pocket and Drill toolpaths

Using Toolpath Transform to rotate toolpaths

➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

Launching the Verify function to machine the part on the screen

Generating the NC- code





## **5 AXIS**

# **COURSE OBJECTIVES**

**By Matthew Manton and Duane Weidinger**

**camInstructor**





### Five Axis Lesson 1 Objectives

For **5-Axis Intro-Lesson-1** you will generate the toolpaths to machine the part on a CNC vertical milling machine with multi-axis capability. The part will be held in a machine vise and a Trunnion table as shown below will be utilised to machine the angled face and pocket. This Lesson covers the following topics:

➤ **Open an existing file containing:**

The solid geometry for the machine vise and  
Wireframe geometry for the part

➤ **Establish Stock Setup settings:**

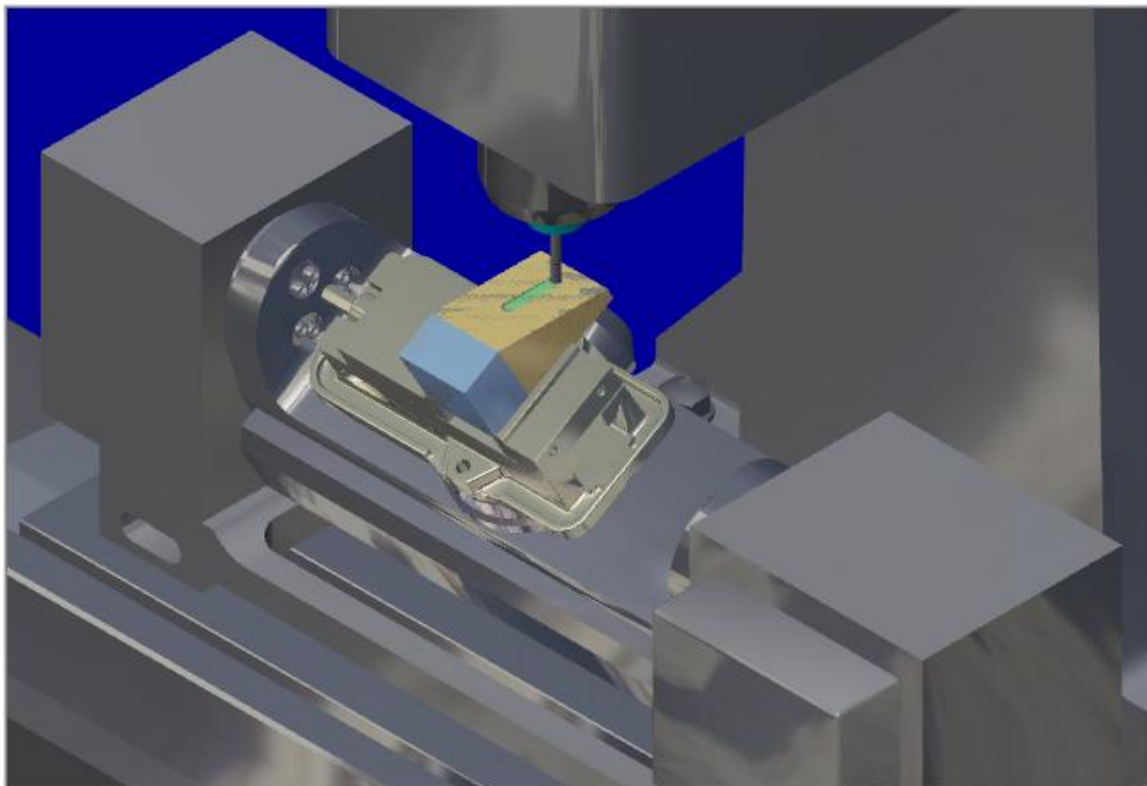
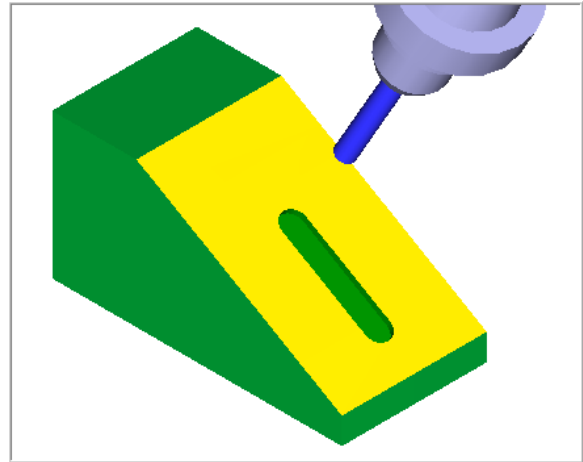
Stock size  
Create points to be used for Trim toolpath  
Material for the part  
Feed calculation

➤ **Generate milling toolpath consisting of:**

Using the View Manager  
Using Views, Tool Planes and Construction Planes  
Create Face and Pocket toolpaths

➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

Launching the Verify function to machine the part on the screen  
Generating the NC- code



### Five Axis Lesson 1 Objectives

For **5-Axis-Lesson-2** you will generate the toolpaths to machine the part on a CNC vertical milling machine with multi-axis capability. The part will be held in a machine vise and a Trunnion table as shown below will be utilised to machine the angled face, end radii and drill all the holes

This Lesson covers the following topics:

➤ **Open an existing file containing:**

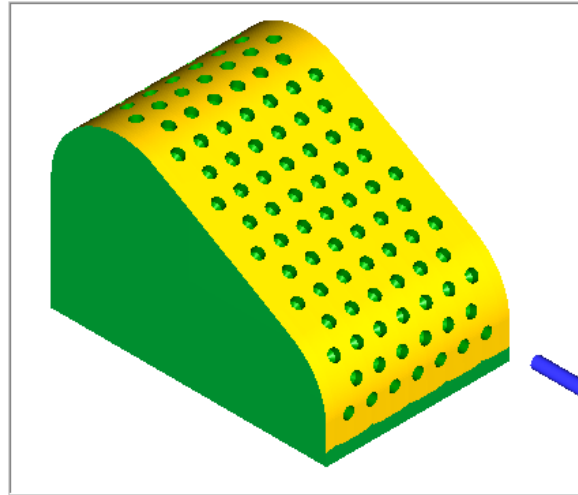
The solid geometry for the machine vise  
Solid geometry for the part

➤ **Establish Stock Setup settings:**

Stock size  
Material for the part  
Feed calculation

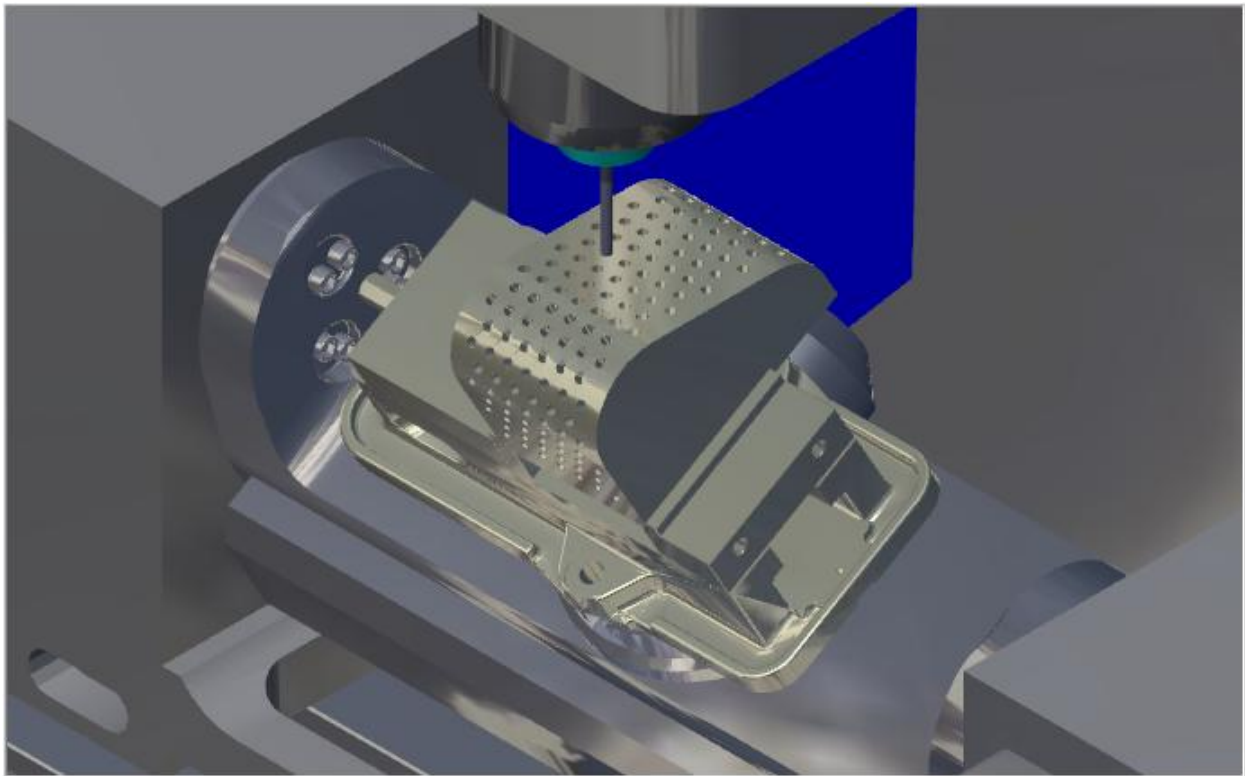
➤ **Generate toolpaths consisting of:**

Flow 5 Axis toolpath  
Drill 5 Axis toolpath



➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

Launching the Verify function to machine the part on the screen  
Generating the NC- code



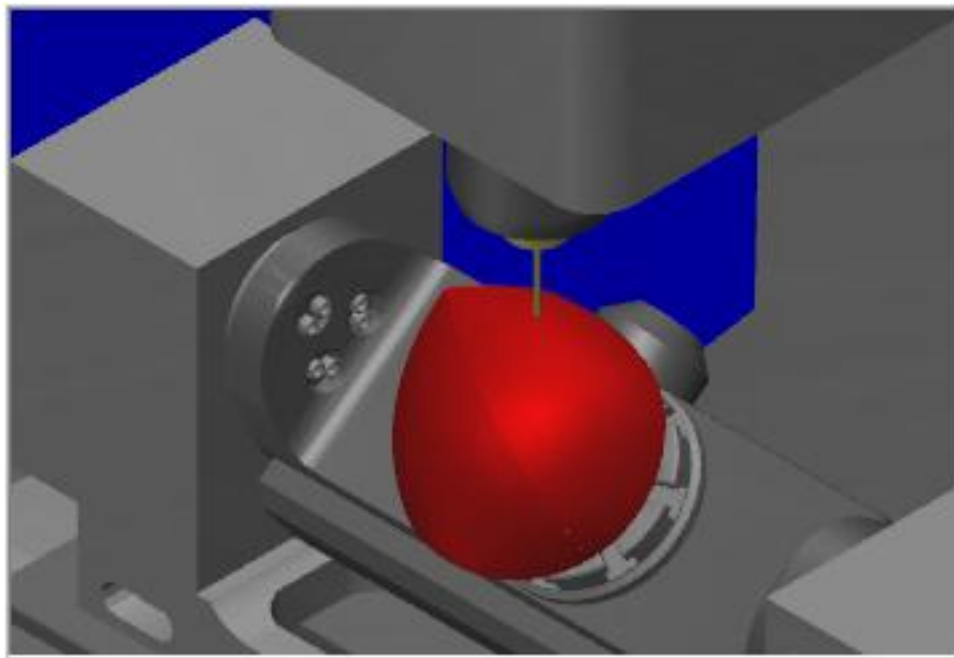
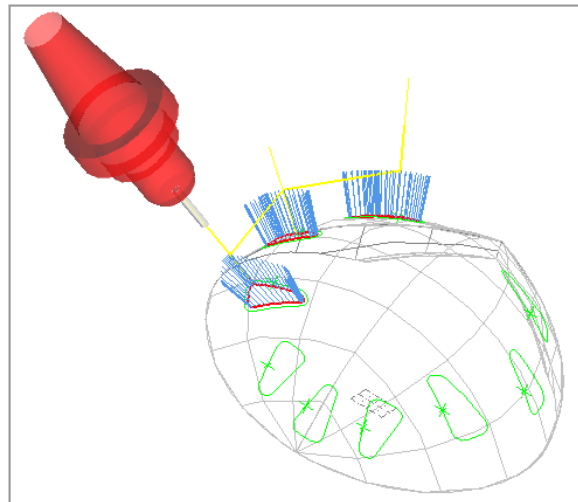
### Five Axis Lesson 3 Objectives

For **5-Axis-Lesson-3** you will generate the toolpaths to machine the Helmet part on a CNC vertical milling machine with multi-axis capability. The Curve 5-Axis toolpath is used to machine out the air vents on this expanded polystyrene helmet. The part is in Metric units. The part will be held on a vacuum fixture located on a Trunnion table.

For more info on vacuum fixtures visit” [www.bettervacuumcups.com](http://www.bettervacuumcups.com)

This Lesson covers the following topics:

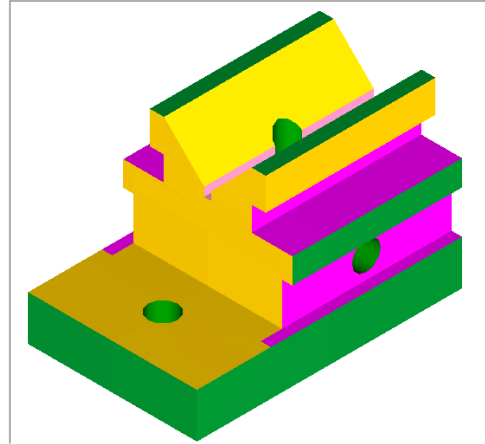
- **Open an existing file containing:**  
Solid geometry for the part
- **Generate toolpaths consisting of:**  
Curve 5 Axis toolpath
- **Inspect the toolpath using Mastercam’s Backplot by:**  
Launching the Backplot function to machine the part on the screen  
Generating the NC- code



### Five Axis Lesson 4 Objectives

For **5-Axis-Lesson-4** you will generate the toolpaths to machine the Vee-block part on a CNC vertical milling machine with multi-axis capability. The part is in Metric units. The part will be held in a machine vise and a Trunnion table as shown below will be utilised to machine the part and drill all the holes.

Typically this part would be machined, heat treated and then ground to size. The faces of the part held in the vise have already been machined. At the end of this lesson you will find a drawing of the Vee-block dimensioned in inches, use this drawing if you would like to machine the Vee-block for yourself.



This Lesson covers the following topics:

➤ **Open an existing file containing:**

The solid geometry for the machine vise  
Solid geometry for the part

➤ **Establish Stock Setup settings:**

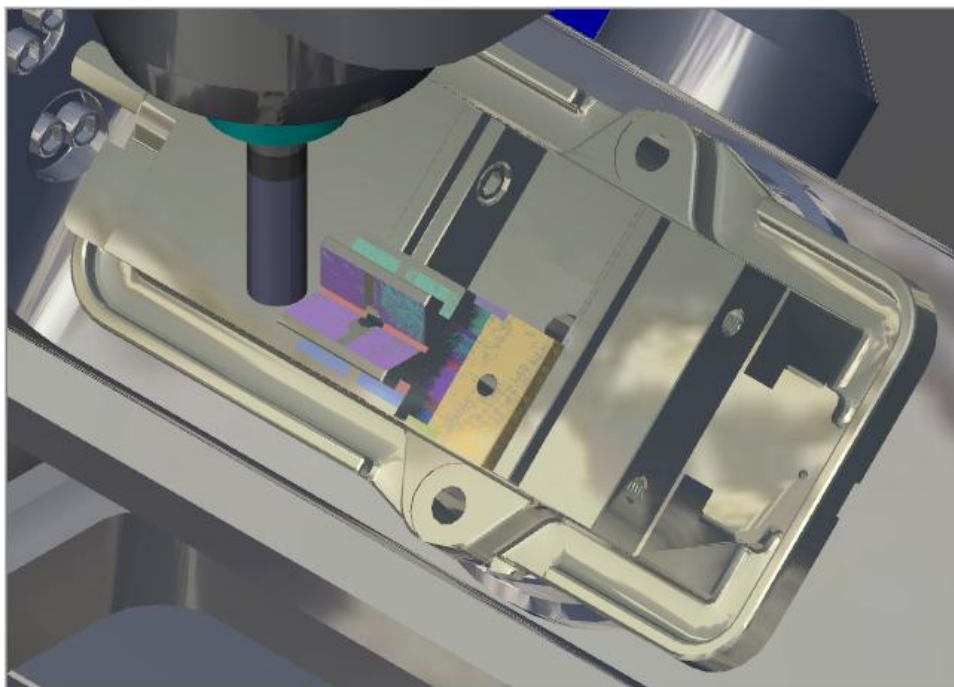
Stock size  
Material for the part  
Feed calculation

➤ **Generate toolpaths consisting of:**

Contour toolpath  
Drill toolpath

➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

Launching the Verify function to machine the part on the screen  
Generating the NC-code



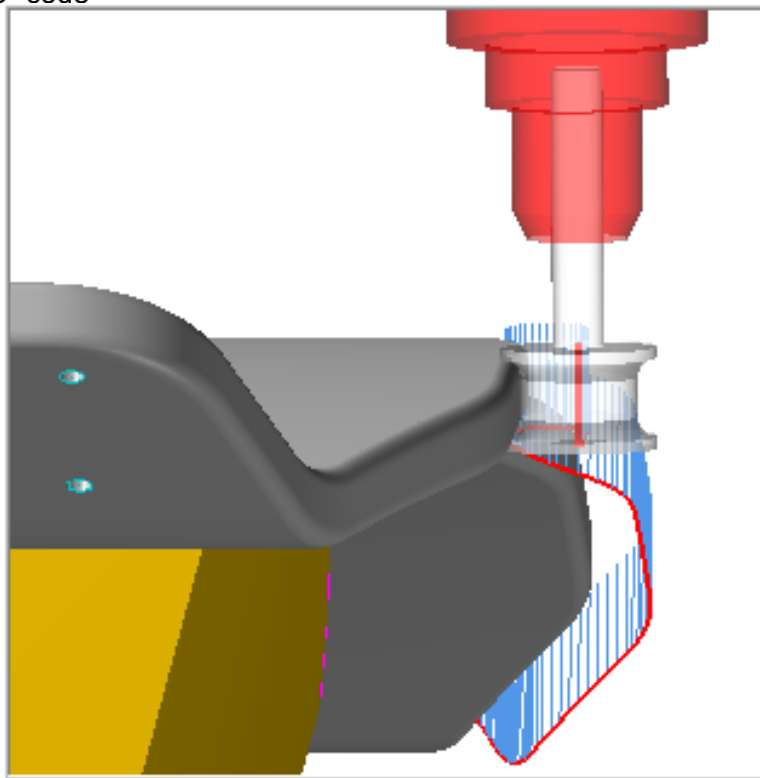
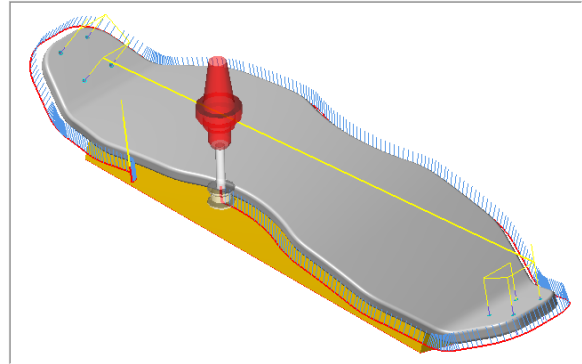
### Five Axis Lesson 5 Objectives

For **5-Axis-Lesson-5** you will generate the toolpaths to machine the skateboard part on a CNC vertical milling machine with multi-axis capability. The Drill 5-Axis toolpath is used to drill the holes in the end of the part and the Swarf 5-Axis toolpath is used to machine the contour. The part is in inch units. The part will be held on a vacuum fixture located on a Trunnion table. The contour will be machined using a custom tool so radii will be created on the bottom and top edges of the skateboard. The tool is similar to the image below right.

For more info on Vacuum Fixtures and Vacuum Cups go to: [www.bettervacuumcups.com](http://www.bettervacuumcups.com)

This Lesson covers the following topics:

- **Open an existing file containing:**  
Solid geometry for the part
- **Generate toolpaths consisting of:**  
Drill 5 Axis toolpath  
Curve 5 Axis toolpath
- **Inspect the toolpath using Mastercam's Backplot by:**  
Launching the Backplot function to machine the part on the screen  
Generating the NC- code



### Five Axis Lesson 6 Objectives

For **5-Axis-Lesson-6** you will generate the toolpaths to machine the part shown below on a CNC vertical milling machine with multi-axis capability. The part will be roughed out using Contour and Pocket toolpaths. To finish machine Swarf 5-Axis toolpath is used to machine the contour and the inside of the pockets. The part is in inch units. The part will be held on a fixture using socket head cap screws through the two outside holes. This setup will be located on a Trunnion table.

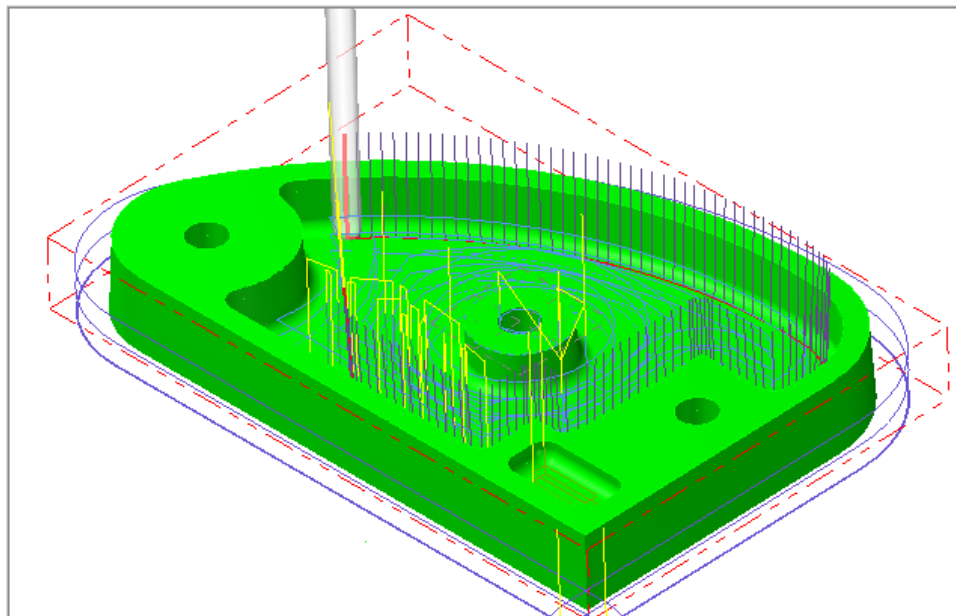
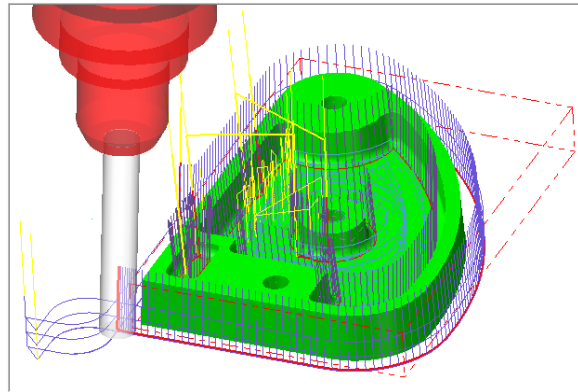
This Lesson covers the following topics:

➤ **Open an existing file containing:**  
Solid geometry for the part

➤ **Generate toolpaths consisting of:**  
Contour toolpath.  
Pocket toolpath.  
Swarf 5 Axis toolpath

➤ **Inspect the toolpath using Mastercam's Backplot by:**

Launching the Backplot function to machine the part on the screen  
Generating the NC- code





### Five Axis Lesson 7 Objectives

For **5-Axis-Lesson-7** you will generate the toolpaths to machine the propeller part shown below on a CNC vertical milling machine with multi-axis capability. The raw material for the propeller is a casting. The part will be initially machined using the Flow 5-axis toolpath. Following this the Parallel to multiple curves toolpath will be used to finish machine. Finally the Toolpath Transform feature will be used to copy the toolpaths to and machine the remaining two vanes of the propeller. The part is in inch units. The part will be held on a fixture using a socket head cap screw through the centre hole. This setup will be located on a Trunnion table.

This Lesson covers the following topics:

➤ **Open an existing file containing:**

Solid geometry for the part

➤ **Generate toolpaths consisting of:**

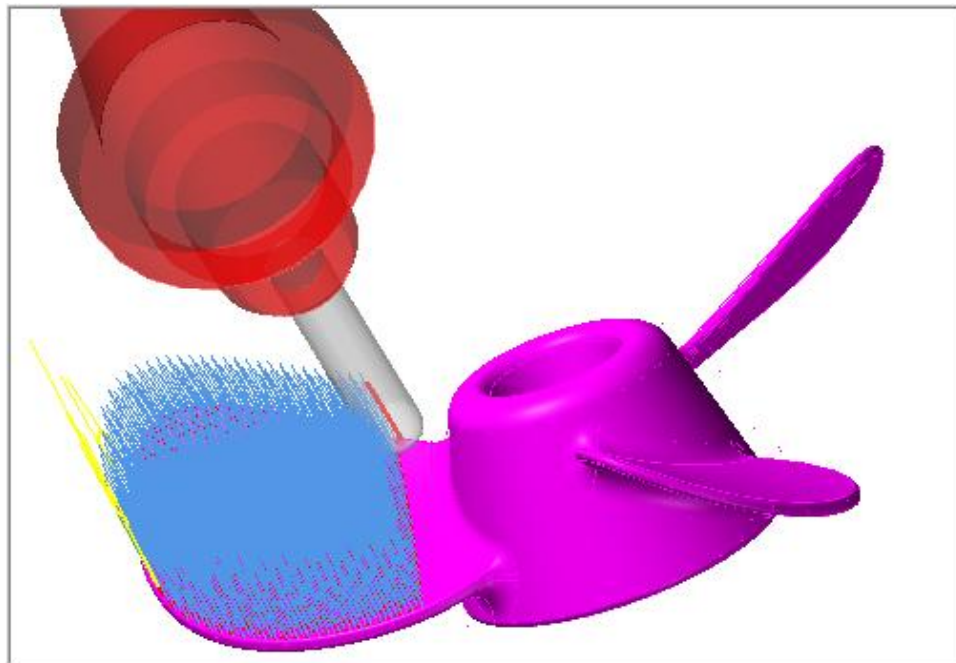
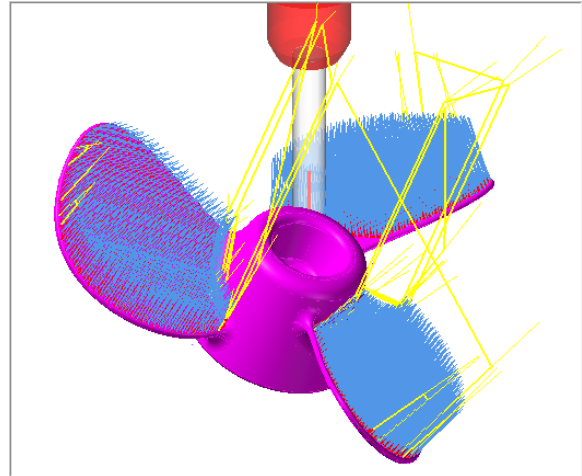
Flow 5-axis toolpath

Parallel to multiple curves toolpath

➤ **Inspect the toolpath using Mastercam's Backplot by:**

Launching the Backplot function to machine the part on the screen

Generating the NC- code



### Five Axis Lesson 8 Objectives

For **5-Axis-Lesson-8** you will generate the toolpaths to machine the impeller part shown below on a CNC vertical milling machine with multi-axis capability. The raw material for the impeller is round stock. The part will be initially rough machined using the High Speed Surface toolpath. Following this the **Advanced Multiaxis** option toolpaths will be used to finish machine. Finally the Toolpath Transform feature will be used to copy the toolpaths and machine the remaining vanes of the impeller. The part is in metric units. The part will be held on a fixture using a socket head cap screw through pre-drilled holes in the part. This setup will be located on a Trunnion table.

This Lesson covers the following topics:

**Open an existing file containing:**

Solid geometry for the part

**Generate toolpaths consisting of:**

High Speed Surface

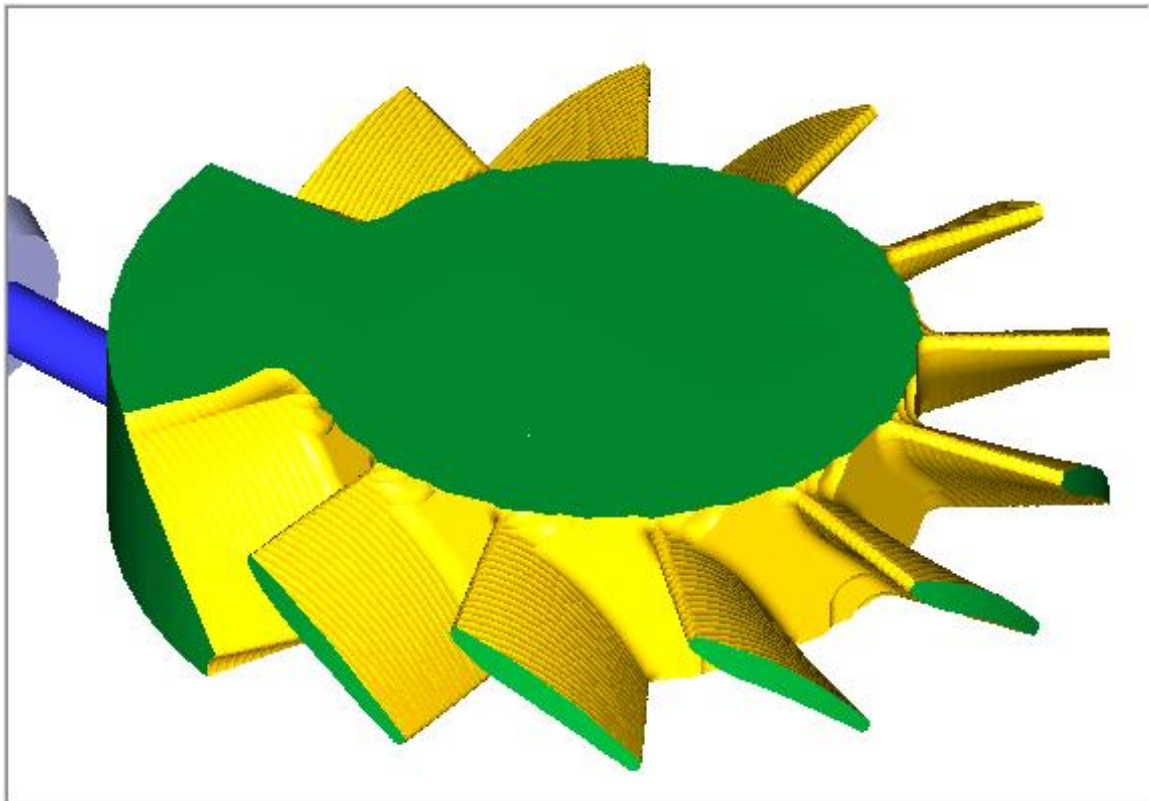
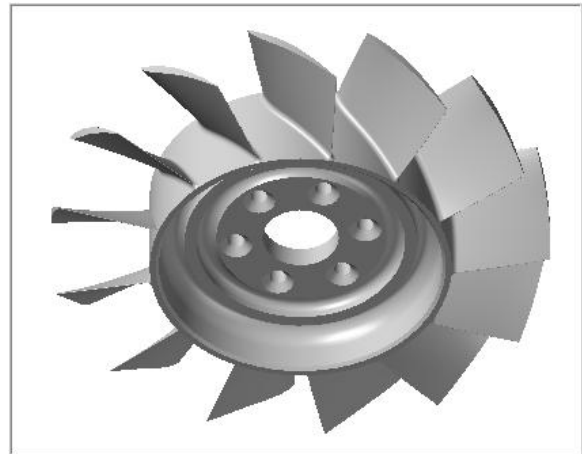
Advanced Multiaxis toolpath

**Inspect the toolpath using Mastercam's**

**Backplot by:**

Launching the Backplot function to machine the part on the screen

Generating the NC- code







## **SOLIDS**

# **COURSE OBJECTIVES**

**By Matthew Manton and Duane Weidinger**

**camInstructor**



### **Solids Lesson 1 Objectives**

You will create the geometry and Solid Model for Solids-Lesson-1. This Lesson covers the following topics:

➤ **Create a 2-dimensional drawing by:**

Creating lines using line endpoints.

Using the AutoCursor to snap to endpoints of lines when creating lines.

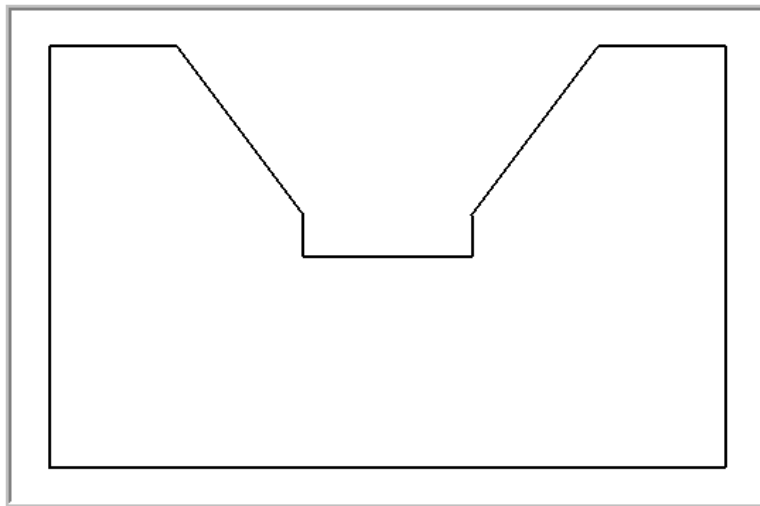
Using the zoom functions to change the view of entities in the graphics window.

Saving the file.

➤ **Create a Solid Model by:**

Extrude and Create Body

Extrude and Cut Body



### **Solids Lesson 2 Objectives**

You will create the geometry for Solids-Lesson-2. This Lesson covers the following topics:

➤ **Create a 2-dimensional drawing by:**

Creating lines using line endpoints.

Using the AutoCursor when creating lines to snap to endpoints of lines.

Using the zoom functions to change the view of entities in the graphics window.

Creating Chamfers.

Creating Fillets.

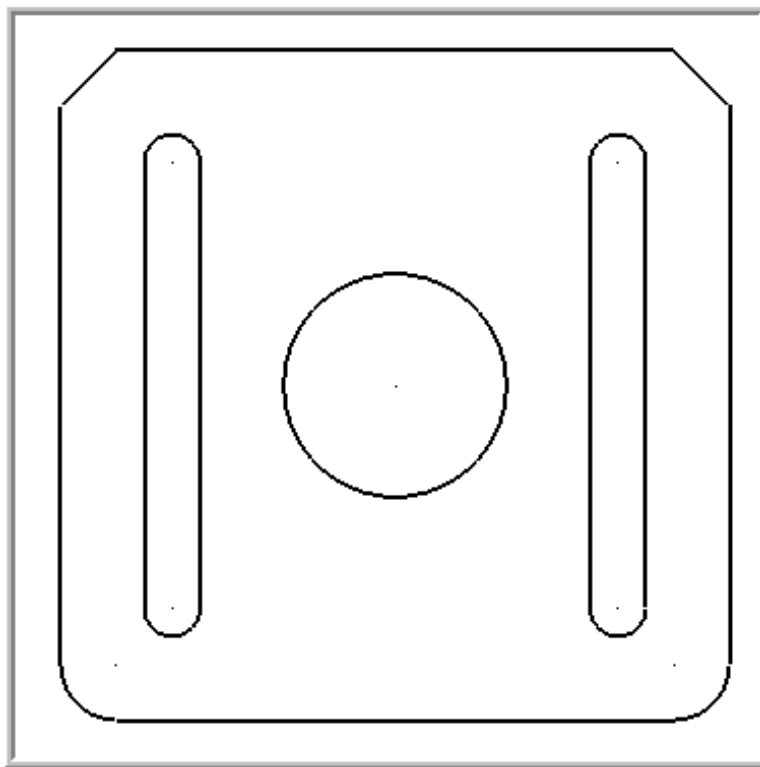
Constructing Arcs and Circles.

Saving the file.

➤ **Create a Solid Model by:**

Extrude and Create Body

Extrude and Cut Body



### Solids Lesson 3 Objectives

You will create the geometry for Solids-Lesson-3, and then create the solid body from the geometry. This Lesson covers the following topics:

➤ **Create a 2-dimensional drawing by:**

Creating lines.

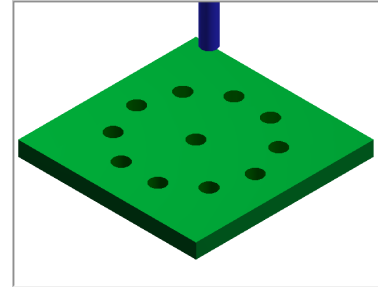
Creating arcs.

Using Xform Translate to copy entices.

Using Xform Rotate to copy entices.

➤ **Create a solid body by:**

Extruding multiple chains simultaneously.



### **Solids Lesson 4 Objectives**

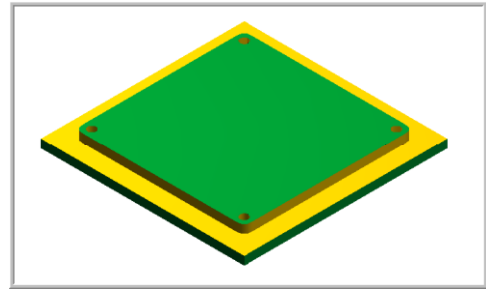
You will create the geometry and then generate a solid model of the part. This module covers the following topics:

➤ **Create a 2-dimensional drawing by:**

Creating rectangles  
Creating arcs.

➤ **Create a Solid Model:**

Extrude and Create Body  
Extrude and Cut Body



### Solids Lesson 5 Objectives

You will create the geometry for Solids-Lesson-5, and then create the solid part from that geometry. This Lesson covers the following topics:

➤ **Create a 2-dimensional drawing by:**

- Creating lines
- Creating arcs
- Using Xform Mirror to copy entities
- Trimming geometry using Divide

➤ **Create a Solid Model by:**

- Extrude and Create Body
- Boolean Addition
- Extrude and Cut Body



### Solids Lesson 6 Objectives

In this tutorial you create the geometry and then use the geometry to produce a solid body.  
This Lesson covers the following topics:

➤ **Create a 2-dimensional drawing by:**

Creating lines.

Creating arcs.

Using Bolt circle.

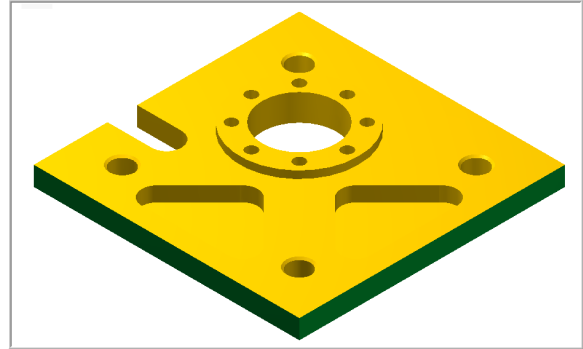
Using Xform Translate to copy and move entities.

Trimming geometry using Divide.

➤ **Create a Solid Body by:**

Extrude and Create Body

Extrude and Cut Body





### Solids Lesson 7 Objectives

You will create the geometry for Solids-Lesson-7, and then generate the solid from the geometry. This Lesson covers the following topics:

➤ **Create a 2-dimensional drawing by:**

Creating lines.

Creating arcs.

Trimming geometry using Divide.

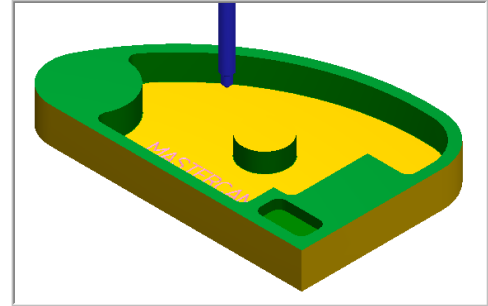
➤ **Create a Solid Model by:**

Extruding and Creating a solid body

Extruding and Cutting a solid body

Drafting solid faces

Filleting solid edges



### Solids Lesson 8 Objectives

You will create the geometry for Solids-Lesson-8, and then generate the solid model from the geometry. This Lesson covers the following topics:

➤ **Create a 3-dimensional drawing by:**

Creating lines.

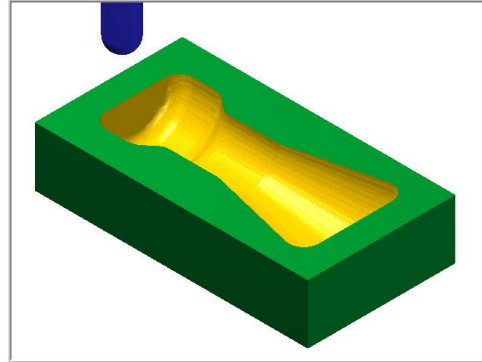
Creating arcs.

Trimming geometry using Divide.

➤ **Create the solid model**

Revolve and Create a solid body

Boolean subtract a solid body



### **Solids Lesson 9 Objectives**

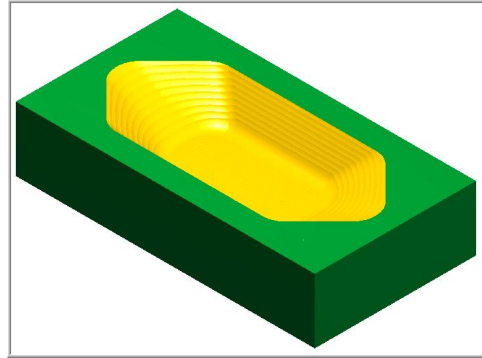
You will create the geometry for Solids-Lesson-9, and then generate solid body from the geometry. This Lesson covers the following topics:

➤ **Create a 3-dimensional drawing by:**

Creating lines.  
Creating arcs.  
Trimming geometry.

➤ **Create a Solid Model by:**

Creating a ruled solid body  
Extruding and Creating a solid body  
Boolean subtract of a solid body



### **Solids Lesson 10 Objectives**

You will create the geometry for Solids-Lesson-3, and then create the solid body from the geometry. This Lesson covers the following topics:

➤ **Create a 2-dimensional drawing by:**

Creating lines.

Creating arcs.

Creating new construction planes to work on

➤ **Create a solid body by:**

Extrude and Create a solid body

Extrude and Cut a solid body

### **Solids Lesson 11 Objectives**

You will create the geometry for Solids-Lesson-11, and then generate the solid from the geometry. This Lesson covers the following topics:

➤ **Create a 2-dimensional drawing by:**

Creating lines  
Trimming geometry  
Mirroring geometry

➤ **Create a solid model:**

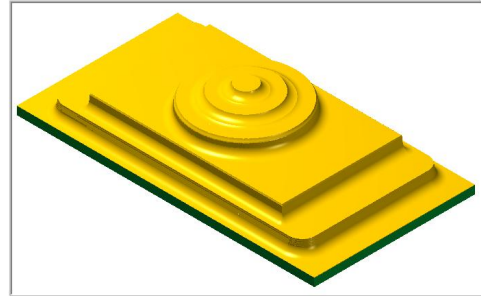
Extrude and Create a solid body  
Extrude and Cut a solid body

### Solids Lesson 12 Objectives

You will create the geometry for Solids-Lesson-14, and then create the solid from the geometry. This Lesson covers the following topics:

➤ **Create a 3-dimensional drawing by:**

- Creating lines.
- Creating arcs.
- Trimming geometry.
- Analyze geometry.
- Creating solid bodies.
- Creating an extruded solid.
- Creating a revolved solid.
- Creating filleted solids.
- Creating Levels.



### **Solids Lesson 13 Objectives**

You will create the geometry for Solids-Lesson-13, and then generate solid from that geometry. This Lesson covers the following topics:

➤ **Create a 3-dimensional drawing by:**

- Creating lines.
- Creating arcs.
- Trimming geometry.
- Creating a lofted solid









# **WIRE**

## **COURSE OBJECTIVES**

**By Matthew Manton and Duane Weidinger**

**camInstructor**

### Wire Lesson 1 Objectives

You will create the geometry for Wire-Lesson-1. You will be working through the process to machine parts in later Lessons; Wire-Lesson-1 will just cover geometry creation. This Lesson covers the following topics:

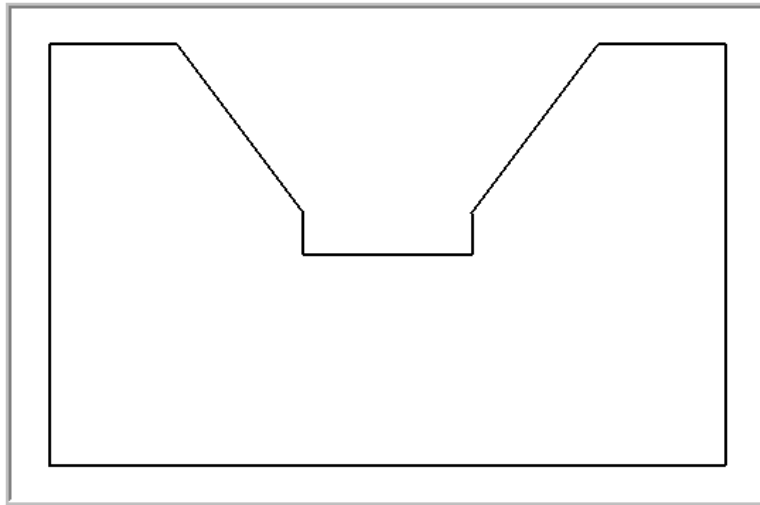
➤ **Create a 2-dimensional drawing by:**

Creating lines using line endpoints.

Using the AutoCursor to snap to endpoints of lines when creating lines.

Using the zoom functions to change the view of entities in the graphics window.

Saving the file.



### Wire Lesson 2 Objectives

You will create the geometry for Wire-Lesson-2. You will be working through the process to machine parts in later Lessons; Lesson #2 will just cover geometry creation. This Lesson covers the following topics:

➔ **Create a 2-dimensional drawing by:**

Creating lines using line>endpoint...

Using the AutoCursor when creating lines to snap to endpoints of lines.

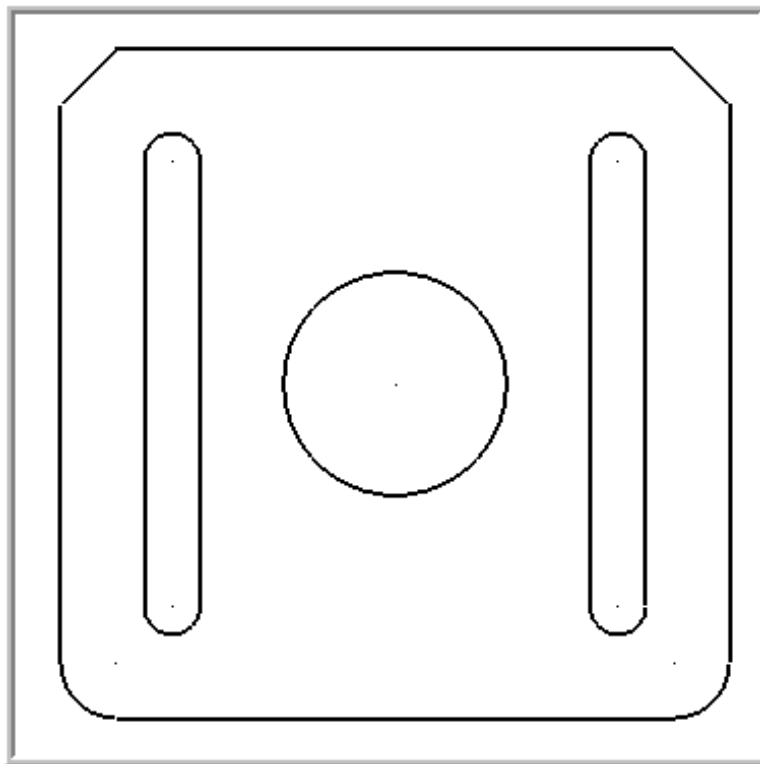
Using the zoom functions to change the view of entities in the graphics window.

Creating Chamfers.

Creating Fillets.

Constructing Arcs and Circles.

Saving the file.



### Wire Lesson 3 Objectives

You will create the geometry for Wire-Lesson-3, and then generate a toolpath to machine the part on a CNC Wire EDM machine. This Lesson covers the following topics:

➤ **Create a 2-dimensional drawing by:**

- Creating Rectangles
- Creating lines.
- Creating arcs.
- Creating a Thread point

➤ **Establish Stock Setup settings:**

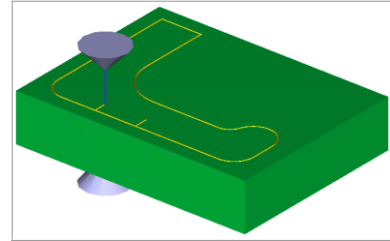
- Stock size.

➤ **Generate a 2-dimensional Wire toolpath consisting of:**

- Wire Contour toolpath.

➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

- Launching the Verify function to machine the part on the screen.
- Using Backplot to identify the correctness of the toolpaths.
- Generating the NC- code.



### Wire Lesson 4 Objectives

You will create the geometry for Wire-Lesson-4, and then generate a toolpath to machine the part on a CNC Wire EDM machine. This Lesson covers the following topics:

➤ **Create a 2-dimensional drawing by:**

- Creating a Rectangle
- Creating Lines
- Creating Arcs
- Transforming the geometry
- Creating a Thread point

➤ **Establish Stock Setup settings:**

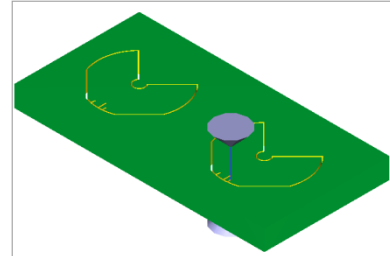
- Stock size

➤ **Generate a 2-dimensional Wire toolpath consisting of:**

- Wire Contour toolpath

➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

- Launching the Verify function to machine the part on the screen.
- Using Backplot to identify the correctness of the toolpaths.
- Generating the NC - code.

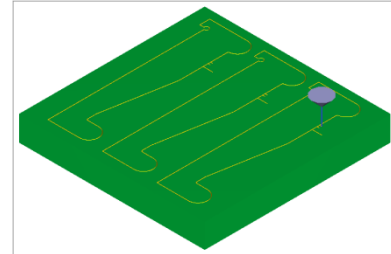


### Wire Lesson 5 Objectives

You will create the geometry for Wire-Lesson-5, and then generate a toolpath to machine the part on a CNC Wire EDM machine. This Lesson covers the following topics:

➤ **Create a 2-dimensional drawing by:**

- Creating a Rectangle
- Creating Arcs
- Creating Lines
- Creating a Thread point



➤ **Establish Stock Setup settings:**

- Stock size

➤ **Generate a 2-dimensional Wire toolpath consisting of:**

- Wire Contour toolpath

➤ **Transform Wire toolpath consisting of:**

- Transform Toolpath

➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

- Launching the Verify function to machine the part on the screen
- Using Backplot to identify the correctness of the toolpaths
- Generating the NC - code

### Wire Lesson 6 Objectives

You will create the geometry for Wire-Lesson-6, and then generate a toolpath to machine the part on a CNC Wire EDM machine. This Lesson covers the following topics:

➤ **Create a 2-dimensional drawing by:**

Creating a Rectangle  
Creating a Polygon  
Creating a Thread point

➤ **Establish Stock Setup settings:**

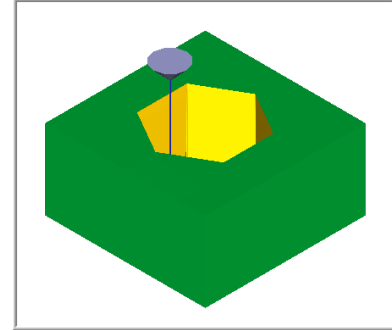
Stock size

➤ **Generate a 2-dimensional Wire toolpath consisting of:**

Wire Contour toolpath

➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

Launching the Verify function to machine the part on the screen.  
Using Backplot to identify the correctness of the toolpaths.  
Generating the NC - code.



### Wire Lesson 7 Objectives

You will create the geometry for Wire-Lesson-7, and then generate a toolpath to machine the part on a CNC Wire EDM machine. This Lesson covers the following topics:

➤ **Create a 3-dimensional drawing by:**

- Creating Circles
- Creating Fillets
- Creating Lines
- Creating a Thread point

➤ **Establish Stock Setup settings:**

- Stock size

➤ **Generate a 3-dimensional Wire toolpath consisting of:**

- Wire 4-Axis toolpath

➤ **Inspect the toolpath using Mastercam's Verify and Backplot by:**

- Launching the Verify function to machine the part on the screen
- Using Backplot to identify the correctness of the toolpaths
- Generating the NC - code

