Mastercam®

Project Workbook

X9

Mastercam X3

Project Workbook Training Tutorials

Mastercam® Project Workbook X³
Date: October 2, 2008

Software: Mastercam X³ Mill & Lathe
ISBN: 978-1-926566-02-3

Notice

In-House Solutions Inc. reserves the right to make improvements to the CAD/CAM system described in this manual at any time and without notice.

Disclaimer Of All Warranties And Liability

In-House Solutions Inc. makes no warranties, either express or implied, with respect to this manual or with respect to the software described in this manual, its quality, performance, merchantability, or fitness for any particular purpose. In-House Solutions Inc. software is sold or licensed "as is." The entire risk as to its quality and performance is with the buyer. Should the CAD/CAM system prove defective following its purchase, the buyer (and not In-House Solutions Inc., its distributor, or its retailer) assumes the entire cost of all necessary servicing, repair, of correction and any incidental or consequential damages. In no event will In-House Solutions Inc. be liable for direct, indirect, or consequential damages resulting from any defect in the software, even if In-House Solutions Inc. has been advised of the possibility of such damages. Some jurisdictions do not allow the exclusion or limitation of implied warranties or liability for incidental or consequential damages, so the above limitation or exclusion may not apply to you.

Copyrights

Trademarks

Mastercam is a registered trademark of CNC Software, Inc.
Microsoft, the Microsoft logo, MS, and MS-DOS are registered trademarks of Microsoft Corporation; N-See is a registered trademark of Microcompatibles, Inc.; Windows 95, Windows2000, and Windows NT are registered trademarks of Microsoft Corporation.

Acknowledgments

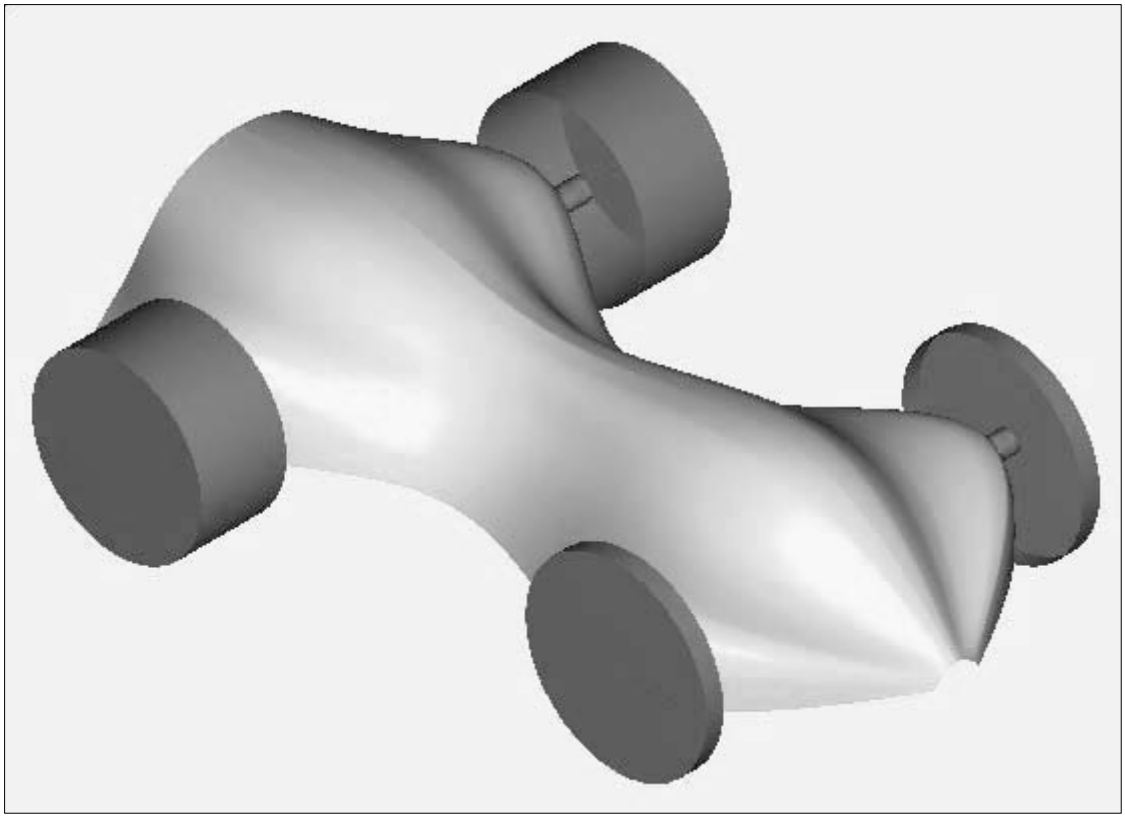
We would like to thank Jim Howie and Jeff Jordan for their contributions on this book.

Table of Contents

PROJECT 8

Mastercam X3

CONCEPT CAR PROJECT



Mill Level 2 - Surfaces & Flowline Toolpaths

Objectives

The student will use a template to create 3D geometry splines that will represent the body of a car. The student will then create a surface (skin) for the car which will be used to create a 3D toolpath to machine the shape of the car on a CNC machine. This tutorial covers the following topics:

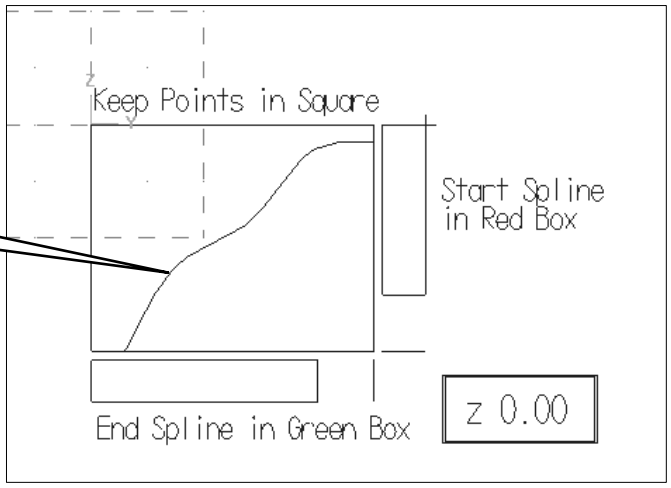
- Navigation of the Mastercam menus
- Creation of splines and 3D surfaces
- Shading and surface manipulation
- Constructing 3 dimensional geometry
- Surface selection methods
- Surface Rough Pocket toolpath
- Parameters for Surface Rough Pocket toolpath
- Surface Finish Flowline toolpath
- Parameters for Surface Finish Flowline toolpath
- Verification of the toolpath
- Posting of NC file

Definitions and Overview

In this next project you will create the following **Splines** and **Surfaces**.

Spline Definition

- A spline is a curve that passes through a series of points. In the following example you will create a spline by sketching a number of points.

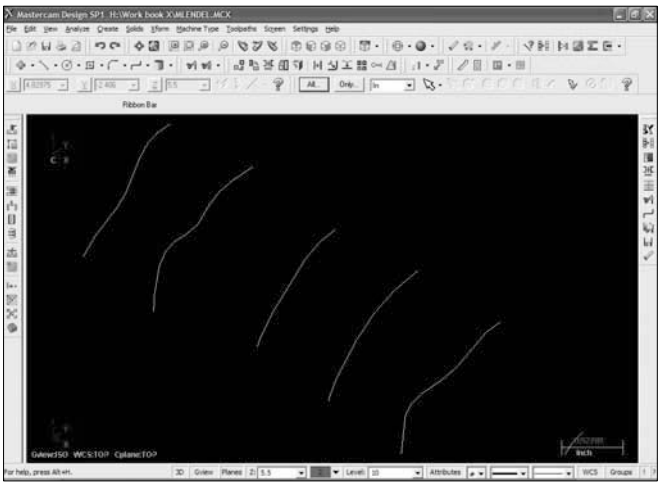


Here is an example of spline

Surface Definition

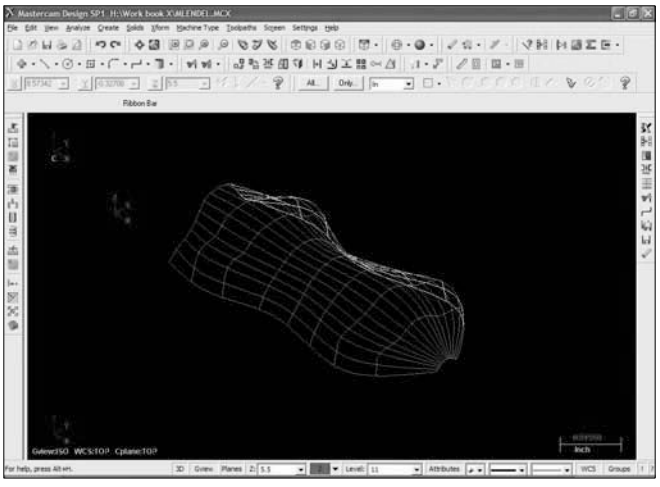
- "Surfaces are widely used to describe complex objects such as a car, ship and airline body, as well as their dies and molds."

- "A surface is the shape representation of a part's skin defined by mathematical equations. A surface normally consists of many sections of patches that are blended together to form an entity."



Overview

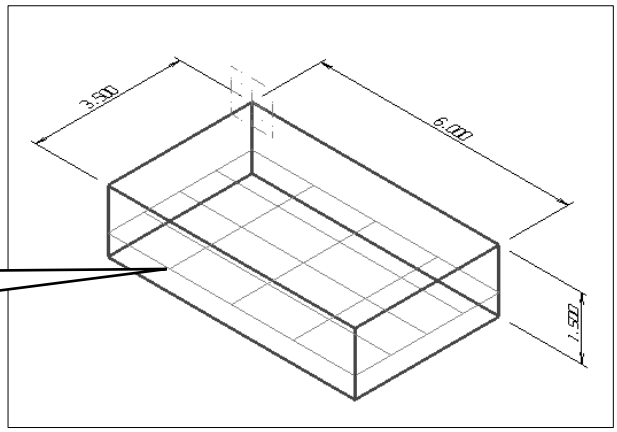
- **To create the body of the Concept Car the user will complete the following steps:**
  - Open a template file called **cartemp.MCX**. The template breaks the material into 6 cross sections.
  - Create 6 splines. The splines will represent the skeleton of the Car body.
  - Create a surface using the 6 splines.



GEOMETRY CREATION
Customizing the toolbars

- Before starting the geometry creation we should customize the toolbars to see the toolbars required to create the geometry and machine a 2D part. See **Getting started** page A-4
- **Toolpaths/Solids Manager** to the left of the screen can be hidden to gain more space in the graphic area for design. Press **Alt + O** to remove it.
- Before starting the geometry make sure that the **Grid** is enabled. It will show you at each moment where is the part origin. See **Getting started** page A-5 for details.

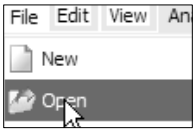
- Note: The stock size for this project is shown in the diagram on the right.



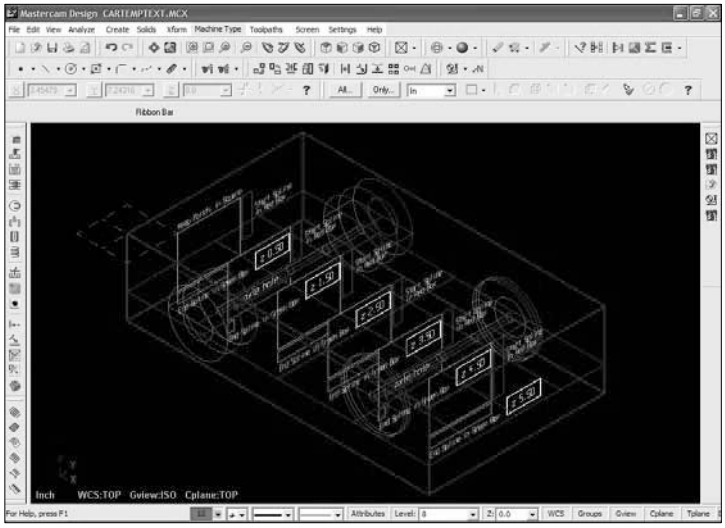
Be sure to draw in a flat boundry surface at Z = -1”

STEP 1:
OPEN THE CONCEPT CAR TEMPLATE.

File
- **Open**



- Select **Cartemp.MCX** already downloaded from the www.emastercam.com/files/ or select it from the floppy disk. Check with your instructor if you are not sure of the location of the file.
- The representation of the template should be on screen, shown at right.



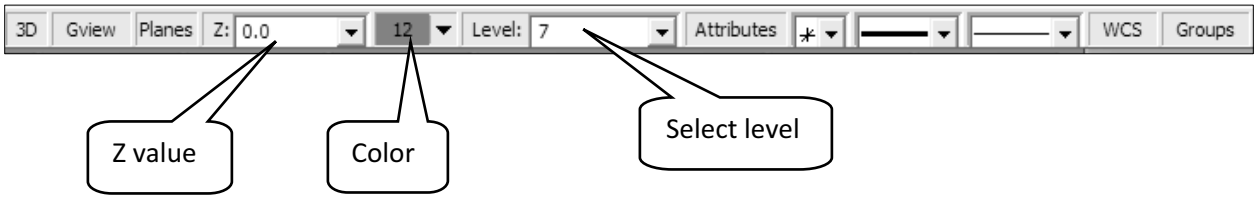
File
- **Save As**
  - Save the file under a different name. Use your initials followed by the first 4 letters of your last name.

STEP 2:

CREATE SPLINES.

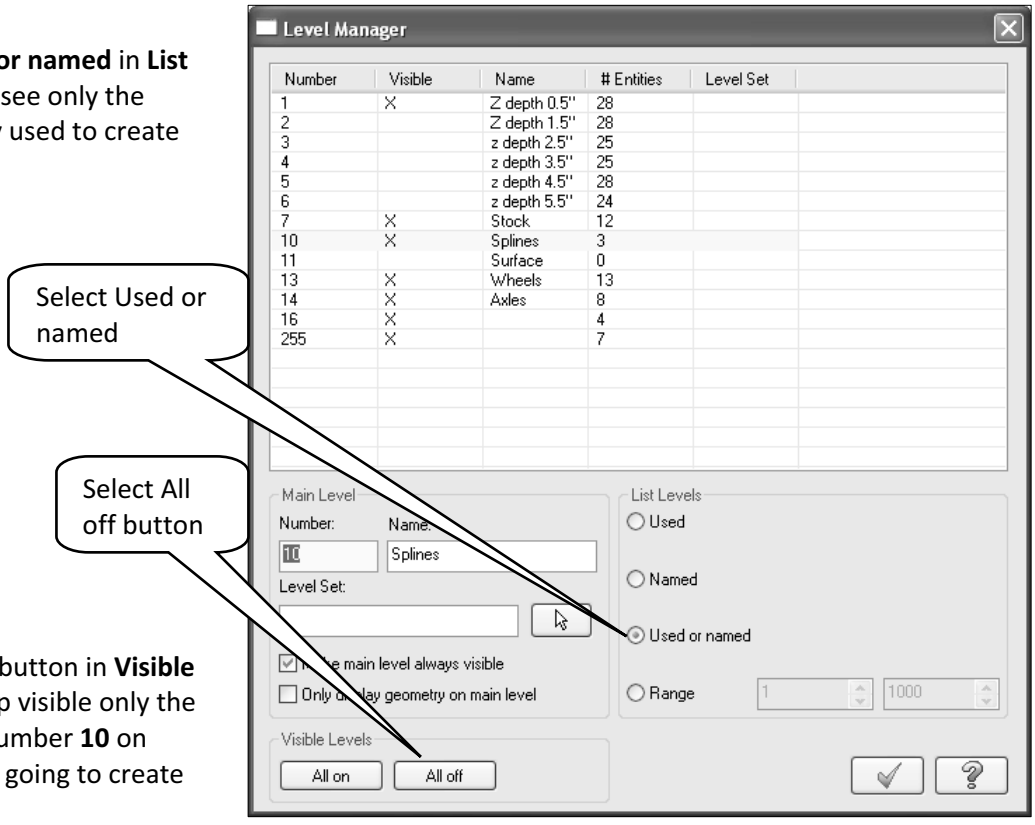
- During the geometry creation of this tutorial, if you make a mistake you can undo the last step using the **Undo** icon. You can undo as many steps as needed.
- If you delete or undo a step by mistake, just use the **Redo** icon.

Set up the attributes from the **Status bar**.



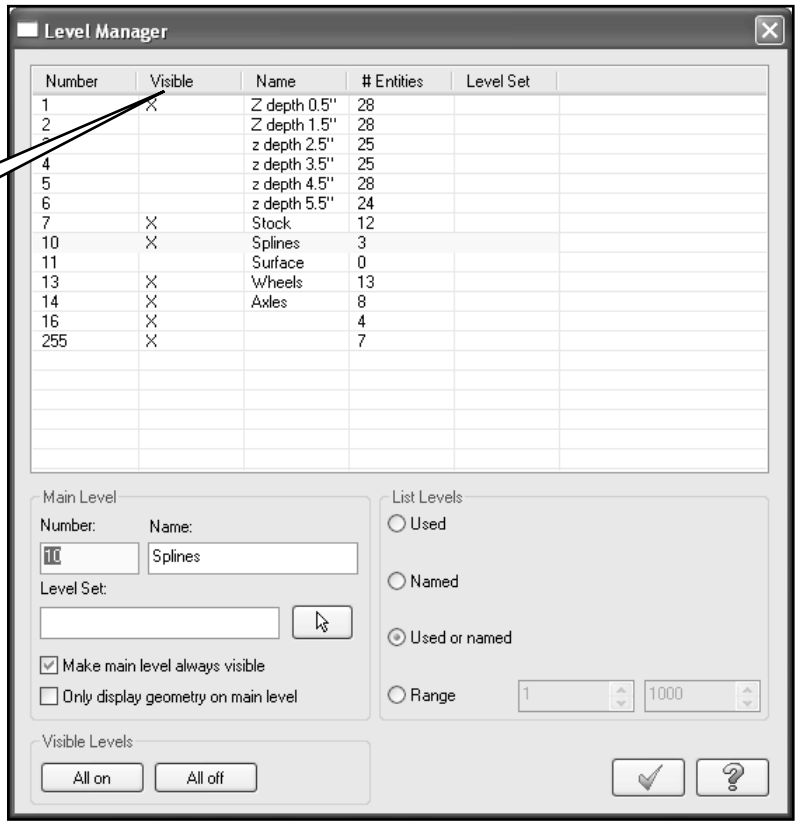
Select **Level** from the **Status Bar**.

Enable **Used or named** in **List Level** field to see only the levels already used to create the template.



Select **All off** button in **Visible Levels** to keep visible only the **Main Level** number **10** on which we are going to create the splines.

- Make **Level1** "Z depth 0.5" visible by selecting the Visible column as shown to the right.

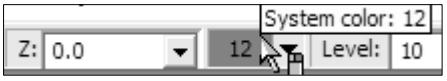


- **Select the OK button to exit.**

- Change the **View** to **Right Side**

- Use **Fit** icon to fit the geometry to the screen.

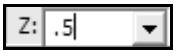
- Click on **Color** from the **Status Bar** and select white color no.15



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

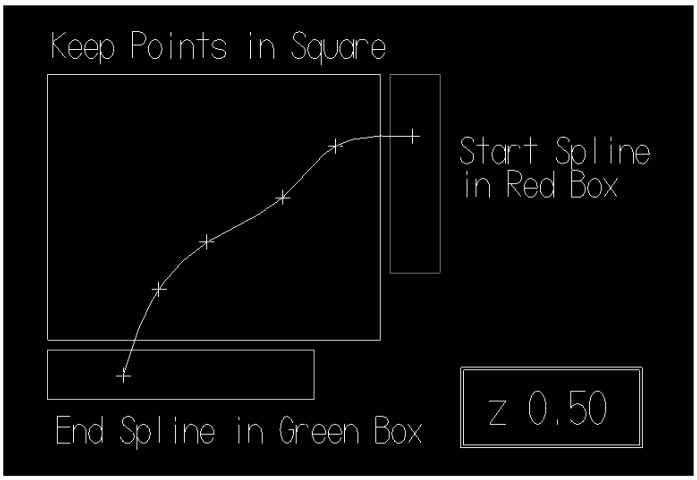
- Click on value next to **Z**: from the **Status Bar**

- Enter 0.5 (This sets the depth to 0.5)



Color white

STEP 2.1:
CREATE SPLINE 1 (BACK OF CAR)



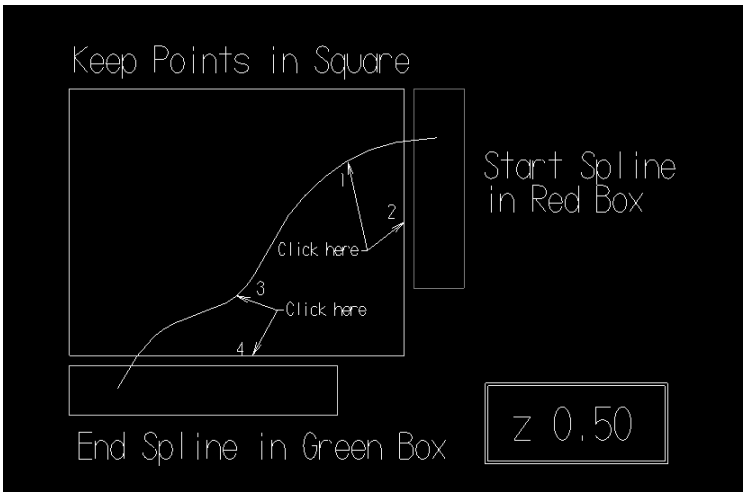
Create

- **Spline**
- **Manual spline**
  - Start the spline in the top right red box. Check points to form the spline within the blue box. Continue until you end up in the bottom green box.
  - Press [Enter] to create spline.

- At each moment you can undo the last command by using the **Undo** icon. You can undo as many steps as you need.
- To delete an entity, preselect it first and then select the **Delete** icon.

Edit

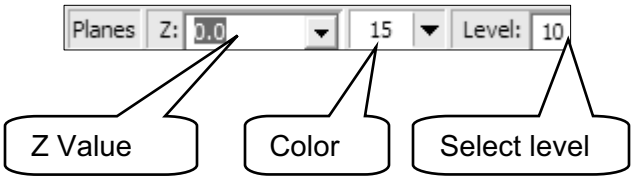
- **Trim/Break**
  - Select **Trim/Break**
  - Select **Trim 1 entity** icon from the ribbon bar
  - With the cursor, click on the part of the spline you want to keep (1), then the vertical blue line it intersects with (2).
  - With the cursor, click on the part of the spline you want to keep (3), then the horizontal blue line it intersects with (4).



- **OK**
  - Repaint the screen when necessary.

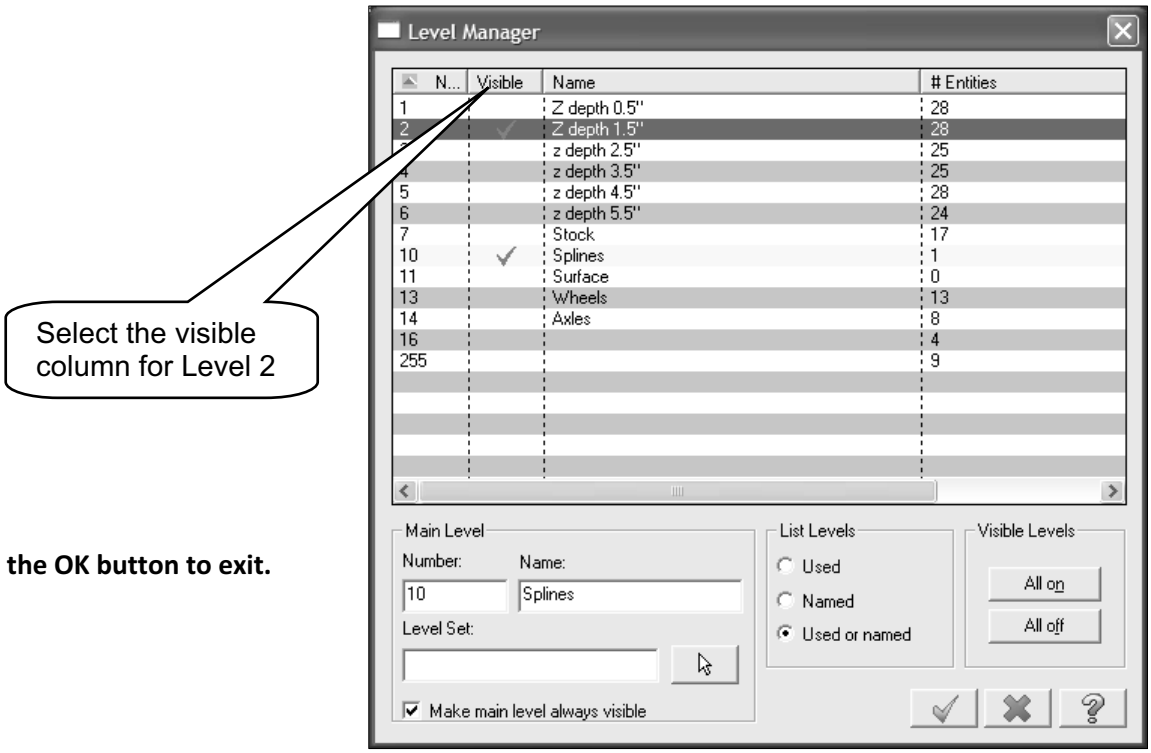
STEP 2.2:
CREATE SPLINE 2 (1.5“ FROM BACK OF STOCK)

- Set up the attributes from the **Status bar**.



- Select **Level** from the **Status Bar**.

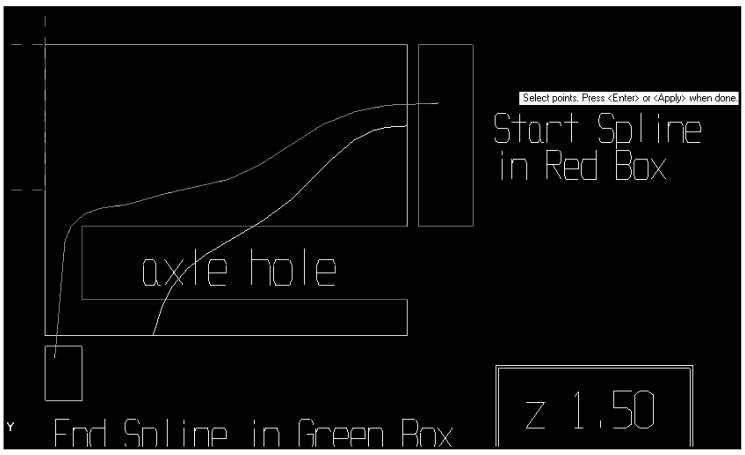
- Make **Level 1** “Z depth 0.5” invisible by selecting the check mark in the **Visible** column.(The check mark will be removed).
- Make **Level 2** “Z depth 1.5” visible by selecting the **Visible** column as shown to the right.



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

- Click on the color from the **Status Bar** and select purple color no.13

- Select the **OK** button to exit.
- Click on value next to **Z**: from the **Status Bar** Z: .5
- Enter 1.5 (This sets the depth to 1.5) Z: 1.5
- Select the **Manual** spline icon.
- Start the spline in the top right red box and click points until you end up in the bottom green box. Be sure to stay out of the axle hole area and stay in the blue lines.
- Press [Enter] to create the spline.

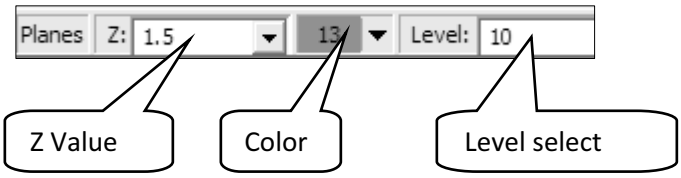


- Select the **Trim/Break** icon.
- Select **Trim 1** entity icon.

- With the cursor, click on the part of the spline you want to keep , then the vertical blue line it intersects with.
- With the cursor, click on the part of the spline you want to keep , then the horizontal blue line it intersects with.
- **OK**

STEP 2.3:
CREATE SPLINE 3 (2.5” FROM BACK).

- Set up the attributes from the **Status Bar** as shown in the previous steps.
- Select **Level** from the **Status Bar**.



- Make **Level 2** “Z depth 1.5” invisible by selecting the check mark in the **Visible** column.
- Make **Level 3** “Z depth 2.5” visible by selecting the **Visible** column.

- Click on **Color** from the **Status Bar** and select light blue color no.11
- Click on value next to **Z**: from the **Status Bar**
- Enter 2.5 (This sets the depth to 2.5)

- Select the **Manual** spline icon. 
- Start the spline in the top right red box and click points until you end up in the bottom green box. Press [Enter] to create the spline.
- Select the **Trim/Break** icon. 
- Select **Trim 1 entity** icon. 
- With the cursor, click on the part of the spline you want to keep , then the vertical blue line it intersects with.
- With the cursor, click on the part of the spline you want to keep , then the horizontal blue line it intersects with.
- **OK** 

STEP 2.4:
CREATE SPLINE 4 (3.5” FROM BACK)

- Set up the attributes from the **Status bar** as shown in the previous steps.
- Select **Level** from the **Status Bar**.
- Make **Level 3** “Z depth 2.5” invisible by selecting the check mark in the **Visible** column.
- Make **Level 4** “Z depth 3.5” visible by selecting the **Visible** column.

- Click on **Color** from the **Status Bar** and select blue color no.94

- Click on value next to **Z:** from the **Status Bar**
- Enter 3.5 (This sets the depth to 3.5)

- Select the **Manual** spline icon. 
- Start the spline in the top right red box and click points until you end up in the bottom green box. Press [Enter] to create the spline.
- Select the **Trim/Break** icon. 
- Select **Trim 1 entity** icon. 
- With the cursor, click on the part of the spline you want to keep , then the vertical blue line it intersects with.
- With the cursor, click on the part of the spline you want to keep , then the horizontal blue line it intersects with.
- **OK** 

STEP 2.5:
CREATE SPLINE 5 (4.5" FROM BACK)

- Set up the attributes from the **Status Bar** as shown in the previous steps.
- Select **Level** from the **Status Bar**.

- Make **Level 4** "Z depth 3.5" invisible by selecting the check mark in the **Visible** column.
- Make **Level 5** "Z depth 4.5" visible by selecting the **Visible** column.

- Click on **Color** from the **Status Bar** and select green color no.10.

- Click on value next to **Z:** from the **Status Bar**
- Enter 4.5 (This sets the depth to 4.5)

- Select the **Manual** spline icon. 

- Start the spline in the top right red box and click points until you end up in the bottom green box. Be sure to stay out of the axle hole area and stay in the blue lines.
- Press [Enter] to create the spline.
- Select the **Trim/Break** icon. 
- Select **Trim 1 entity** icon. 
- With the cursor, click on the part of the spline you want to keep , then the vertical blue line it intersects with.
- With the cursor, click on the part of the spline you want to keep , then the horizontal blue line it intersects with.
- **OK** 

STEP 2.6:
CREATE SPLINE 6 (5.5" FROM BACK).

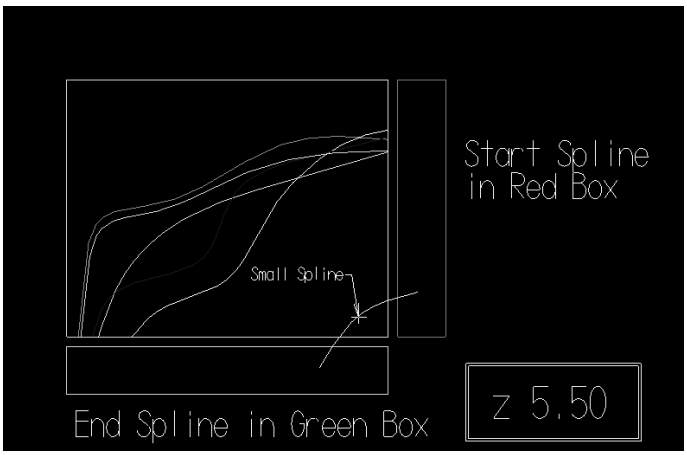
- Select **Level** from the **Status Bar**.

- Make **Level 5** "Z depth 4.5" invisible by selecting the check mark in the **Visible** column.
- Make **Level 6** "Z depth 5.5" visible by selecting the **Visible** column.

- Click on **Color** from the **Status Bar** and select royal blue color no. 9.

- Click on value next to **Z:** from the **Status Bar.**
- Enter 5.5 (This sets the depth to 5.5).

- Select the **Manual** spline icon.



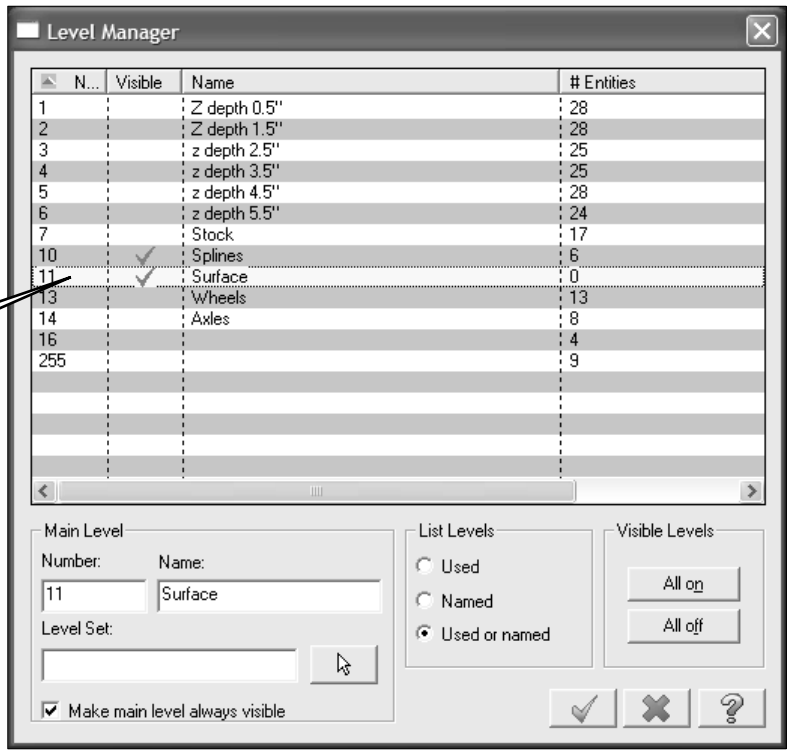
- Make a small spline as shown in the picture. Start the spline in the right red box and click points until you end up in the bottom green box. Press [Enter] to create the spline.

- Select the **Trim/Break** icon.
- Select **Trim 1 entity** icon.

- With the cursor, click on the part of the spline you want to keep , then the vertical blue line it intersects with.
- With the cursor, click on the part of the spline you want to keep , then the horizontal blue line it intersects with.
- **OK**

SURFACE CREATION
STEP 3:
CREATING THE SURFACE.

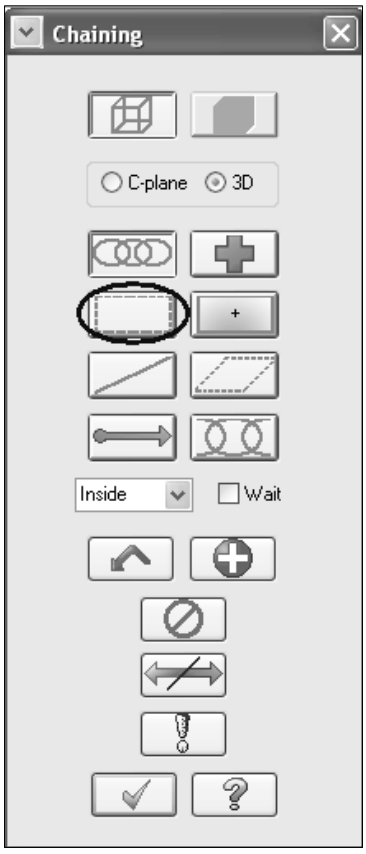
- Select **Level** from the **Status Bar**.
- Make **Level 6** "Z depth 5.5" invisible by selecting the check mark in the **Visible** column to remove it.
- Make **Level 11** "Surface" **Visible** and the **Main Level**. Select number **11** in the **Number** column as shown.



Click on no. 11

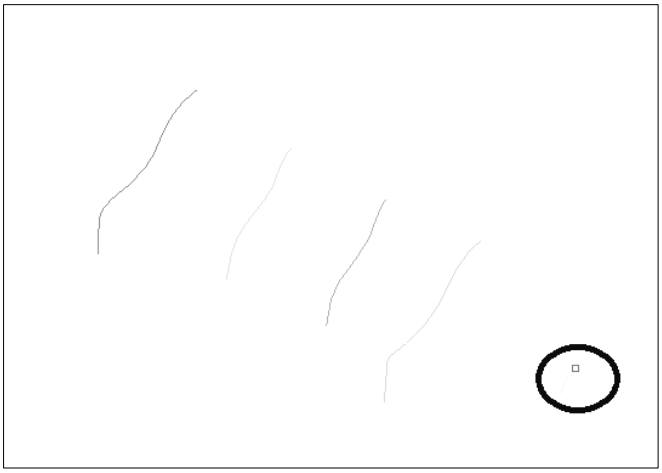
- Click on **Color** from the **Status Bar** and select green color no. **2**.

- Select **Graphic View Isometric**. 
- Use **Fit** icon to fit the geometry to the screen. 



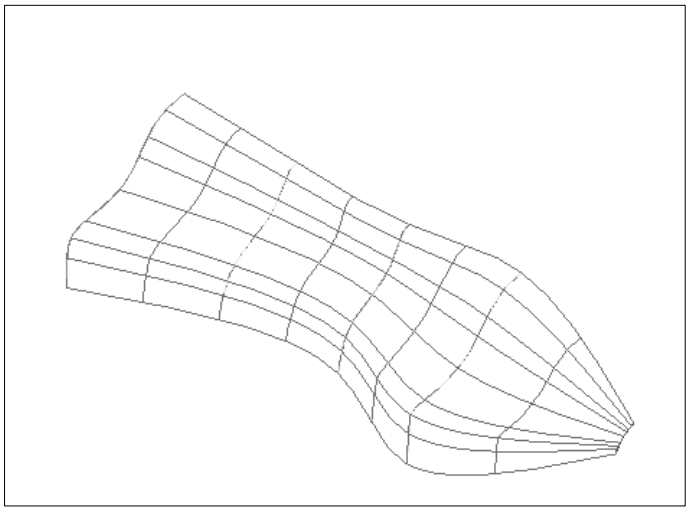
Create
- **Surface**
- **Ruled / Lofted**

- Select **Window** button in the **Chaining** dialog box.
  - While the chaining dialog box is open it can be moved by selecting the title bar and dragging it to a desired location.
- Select a window around all splines.
- Select the smallest line at the top corner, they will then all be highlighted in Yellow.



- Select the **OK** button to exit **Chaining** dialog box. 
- Select the **OK** button from the ribbon bar. 

- A wireframe representation of the surface should appear around the splines.



STEP 4:
VIEW THE SURFACE AS A SOLID IMAGE.

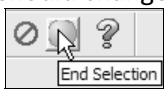
Shading allows you to view surfaces. However, it takes a lot of computing power and will slow down the performance.

- To turn the shading feature on select the **Shaded** button. or Alt +S
- To turn the shading feature off select the **Wireframe** button. or Alt +S
- If you like what you see, continue. If not, go back and re-create the splines. Be sure to delete the surface and the splines before you go back and create new ones.

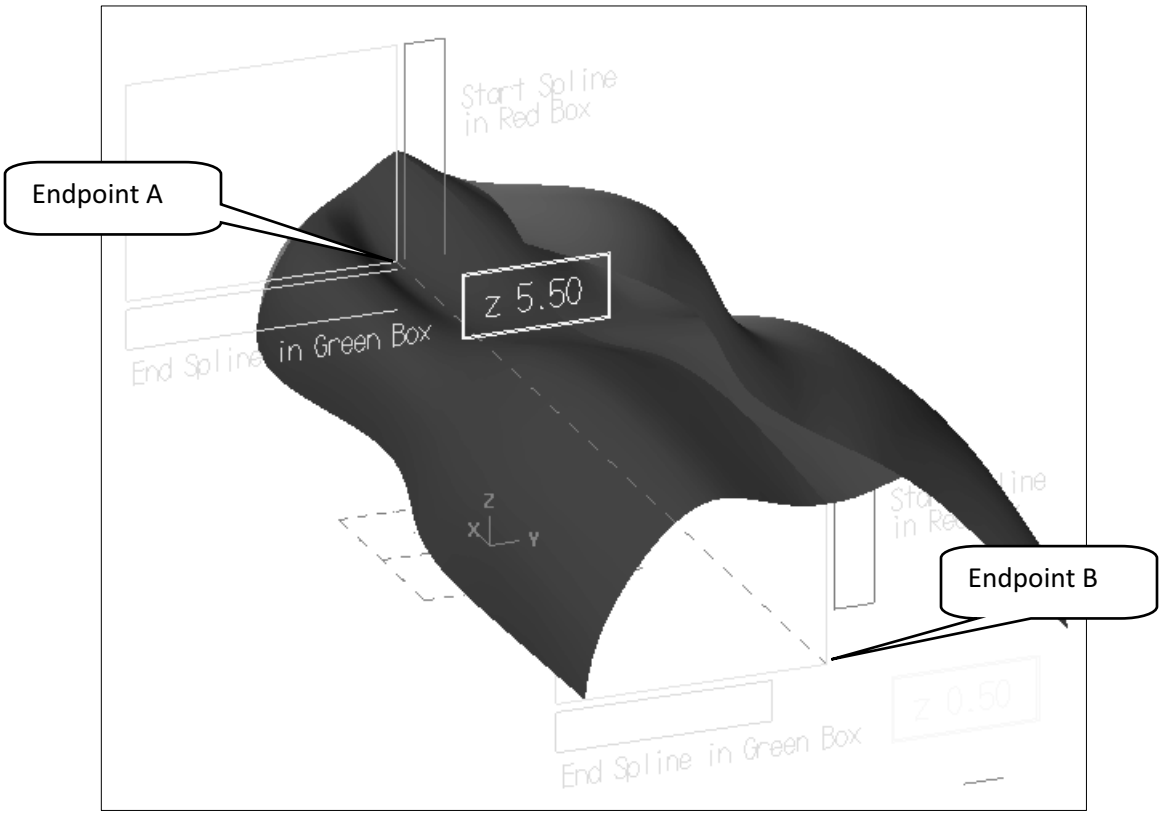
STEP 5:
MIRROR THE SURFACE.

Xform

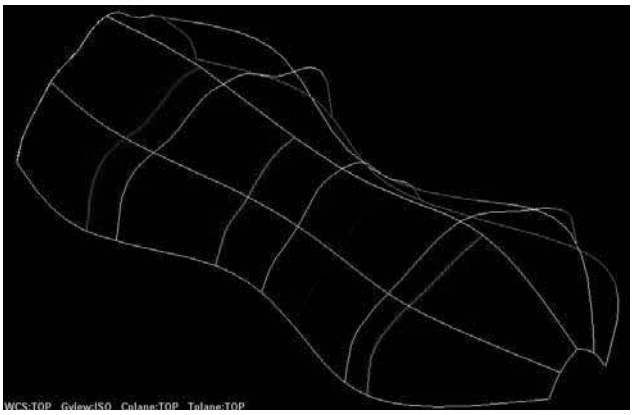
- **Mirror**
  - [Select entities to mirror]:Click on the surface (it should change color).
  - Select **End Selection** button from the ribbon bar.
  - Make sure that **Copy** is enabled.
  - Enable **Preview** and **Fit** to be able to see the final result of mirror.
  - Select two points button.



- The system brings you into the graphic area where you can select the two points as shown in the following picture.
- [Select first point of mirror line]: Select Endpoint A (Make sure that you select an endpoint as shown in the picture)
- [Select second point of mirror line]: Select Endpoint B



- The preview should look as shown.



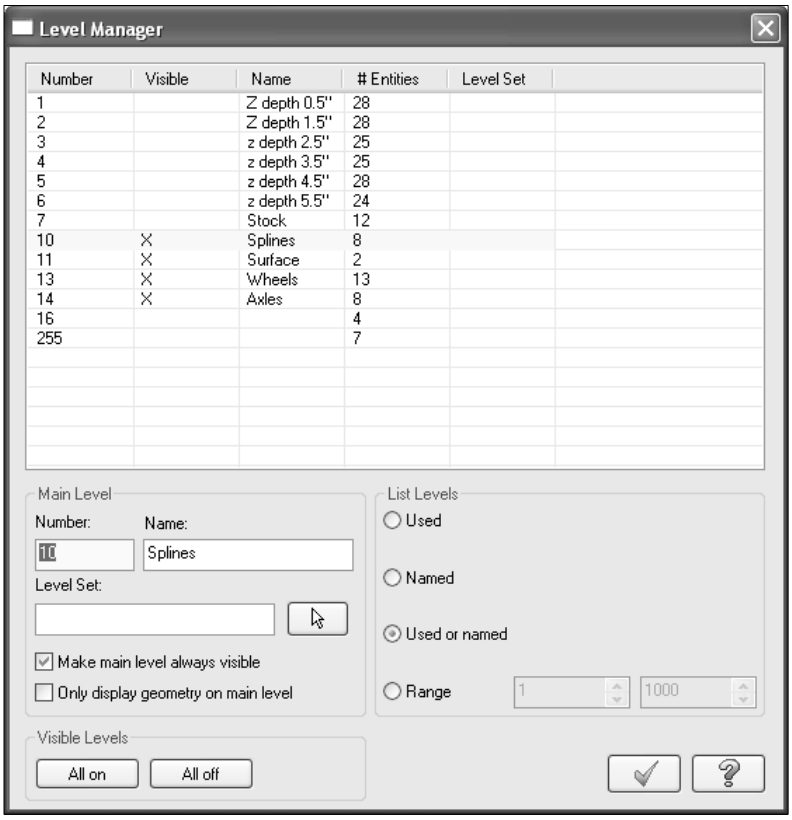
- **Select the OK button to exit.**

Screen

- **Clear colors**

- Use **Dynamic Rotation** icon to move the image around.
- Click on the screen to stop rotating the part.

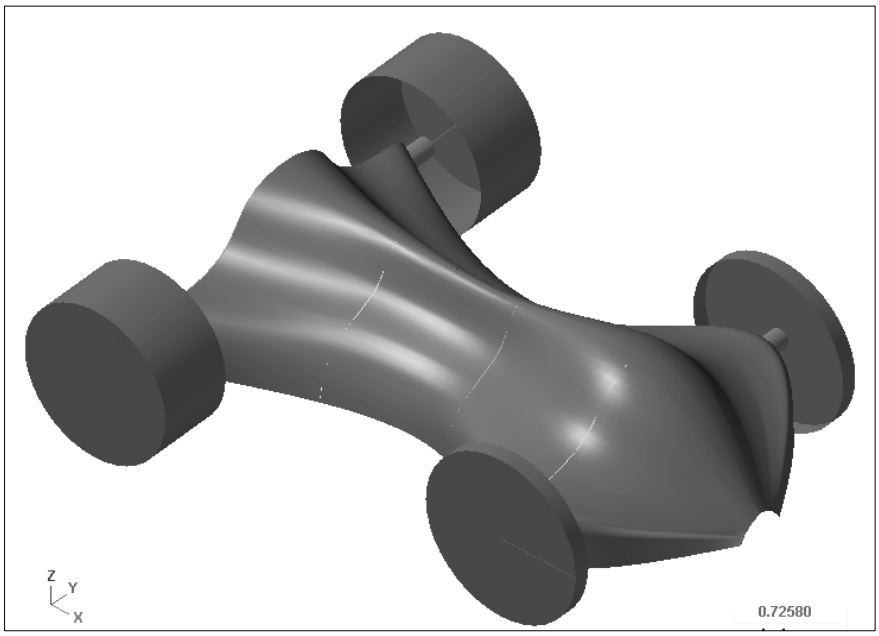
STEP 6:
TO CHECK THE SHAPE OF THE CAR.



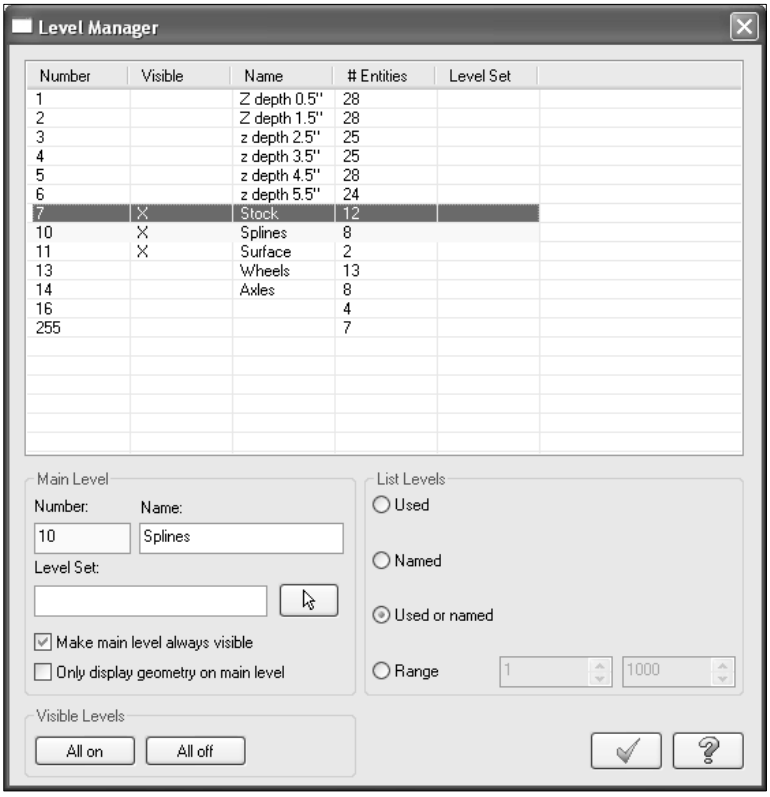
- Select Level from the Status bar.
- In the Visible column;
- Turn on “surface”
- Turn on “wheels”
- Turn on “axles”
- Select the **OK** button to exit.

- Shade the part.(Alt +S)

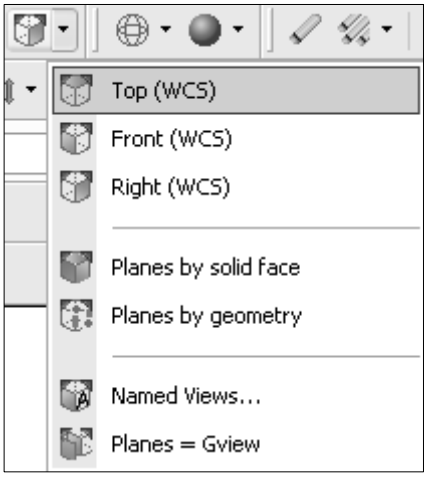
- Unshade the part. (Alt +S)



- Select **Level** from the **Status bar**.
- In the **Visible** column;
- Turn off “wheels”
- Turn off “axles”
- Leave on “surface”
- Leave on “Splines”
- Turn on **Level 7** “Stock”
- Select the **OK** button to exit.



- Set planes to **Top**.



- Select **Graphic View Isometric**.

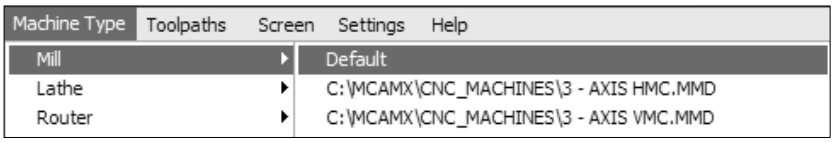
- Use **Fit** icon to fit the geometry to the screen.

STEP 7
SAVE THE GEOMETRY

- Select **Save As**
- Type “LastName_8” in the filename spot.
-

TOOLPATH CREATION
STEP 8:
SET THE MACHINE TYPE.

- Before defining the stock check in the **Toolpath Manager** for an existing Machine Group, if there is one use it instead of adding another one



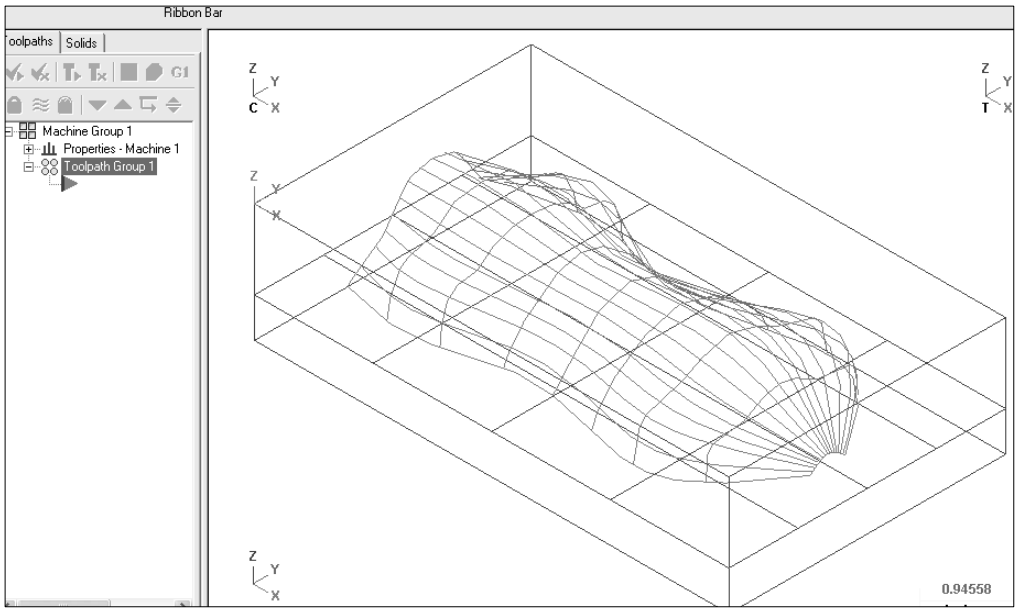
Machine type

Select Mill

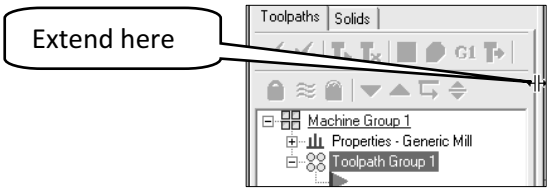
Select **Default**

- For the exercise purpose we are using the default machine. Please check with your instructor to select the proper machine and post attached.

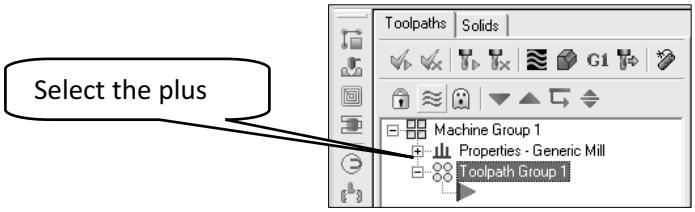
To display the **Toolpaths Manager** press **Alt + O.**



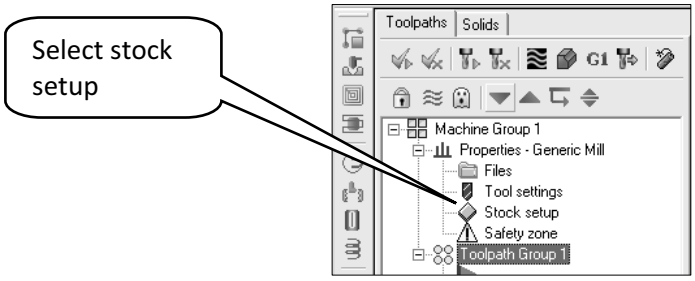
STEP 9:
SET UP THE STOCK TO BE MACHINED.



- Select the plus in front of **Properties** to expand the Machine **Group Properties**

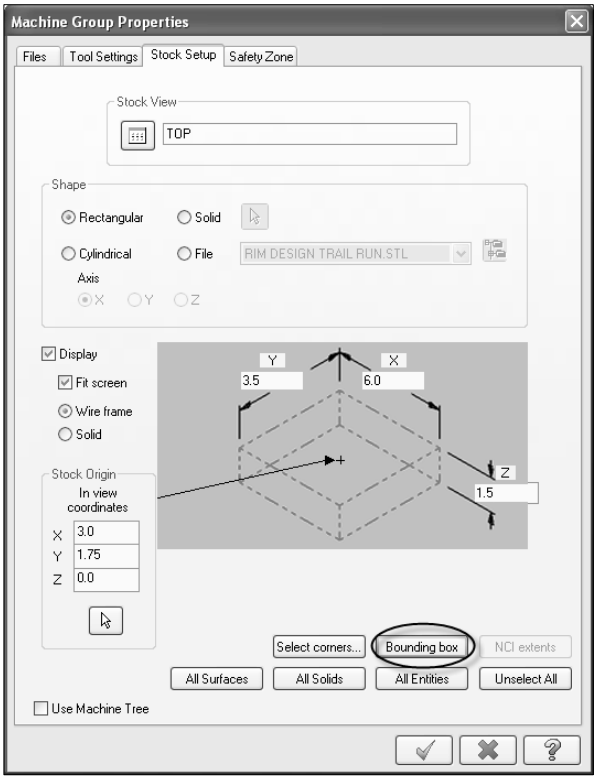


- Select **Stock setup**

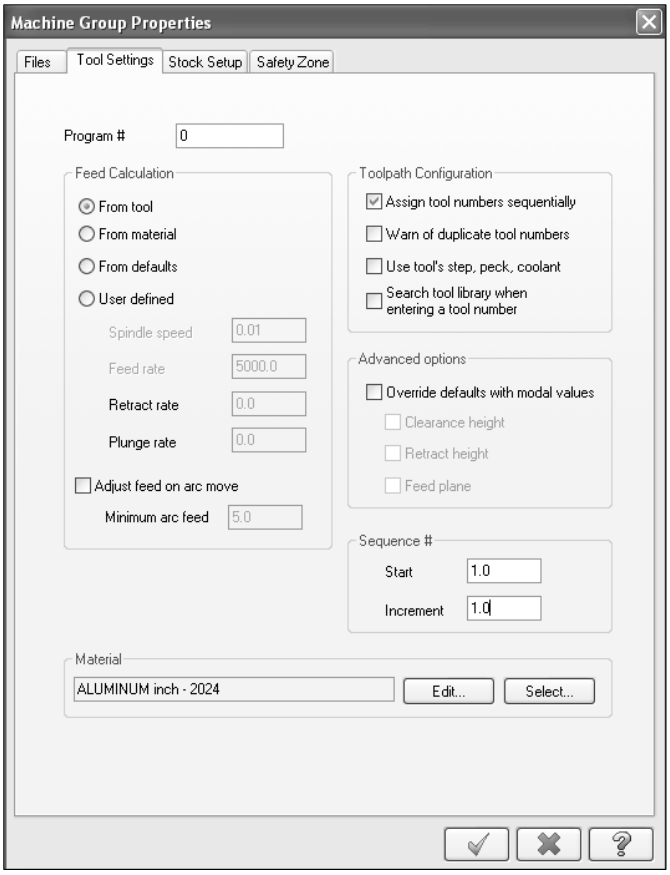


- Change the parameters to match the following screenshot.

- The stock shape should be set to **Rectangular**.
- Select **Bounding box** for the system to automatically find the part overall dimensions.
- Select OK on the **Bounding Box** dialog box.
- Enable **Display stock** as **Wireframe** and enable **Fit screen** to the stock.

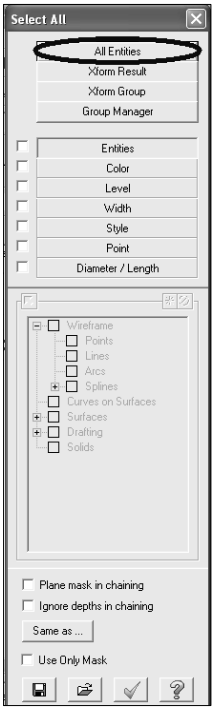


- Select the **Tool Settings** tab to set the tool parameters and the part material.
- Change the parameters to match the following screenshot.
- Enable **Assign tool numbers sequentially** to overwrite the tool number from the library with the next available tool number. (First operation tool number 1; Second operation tool number 2, etc)
- Enable **Warn of duplicate tool numbers** to get a warning if you enter two tools with the same number.
- Enable **Override defaults with modal values** for the system to keep the values that you enter.
- **Feed Calculation** set **From tool** uses feed rate, plunge rate, retract rate and spindle speed from the tool definition.



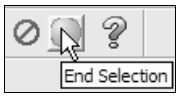
- **Select the OK button to exit Toolpath Group Properties.** 

STEP 10:
SURFACE ROUGH POCKET TOOLPATH.

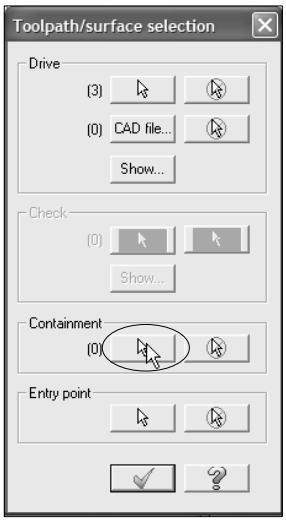


- Surface rough pocket requires a closed boundary to define and limit the machining area. Without the boundary selected the system will not generate the toolpath. We are going to chain the top rectangle of the stock.

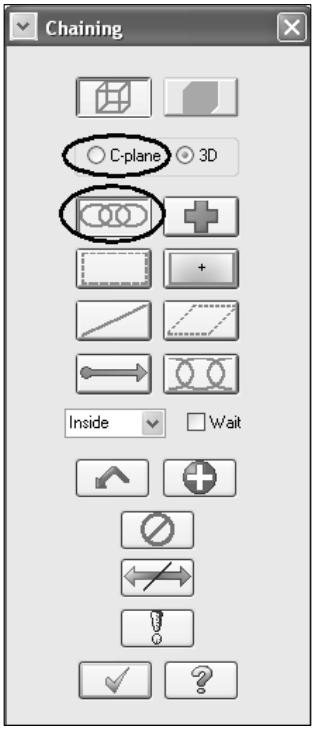
Toolpaths

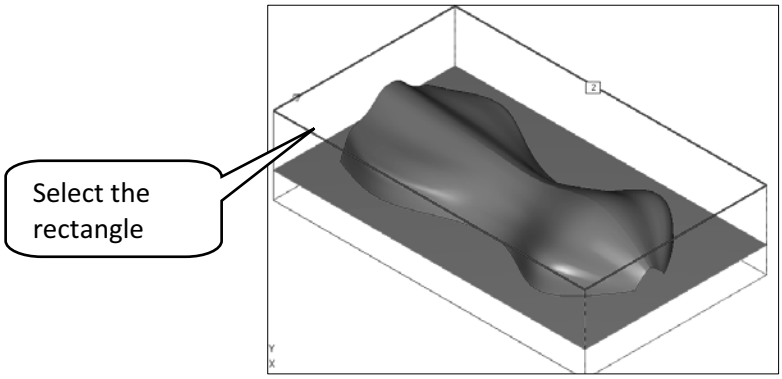
- **Surface Rough**
- **Pocket**
  - Click OK  to enter new NC name
  - [Select drive surface]: Select the **All** button. 
  - Select All Entities button
  - Select **End Selection** button in the **Ribbon bar** 

- Select **Containment** in the **Toolpath/surface selection**.



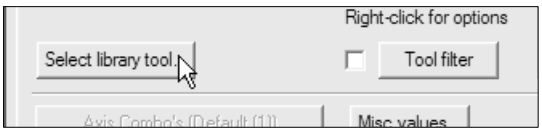
- Enable **C-plane** and **Chain** in the **Chaining** dialog box to allow chaining of only those entities in the same construction plane as the first entity you select.



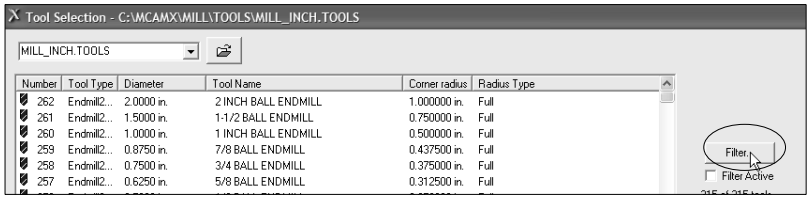


- Select the top rectangle.
- Select the **OK** button twice to exit **Chaining** and **Toolpath/surface selection**.

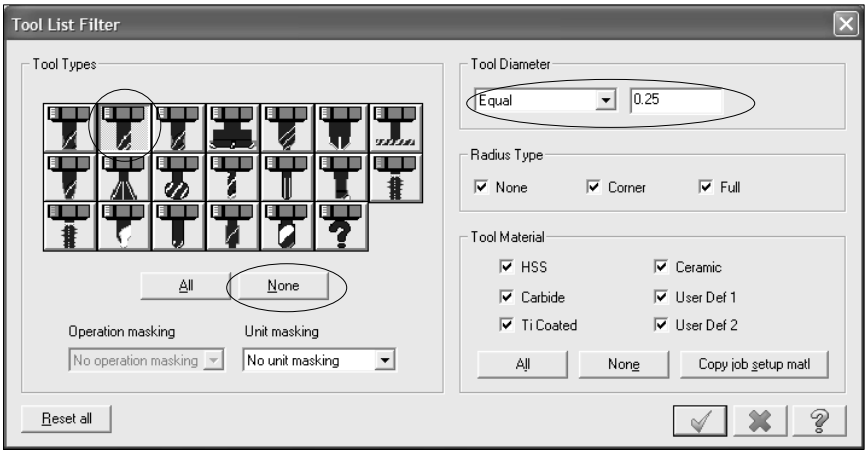
- Click on **Select library tool** in the **Toolpath parameters**



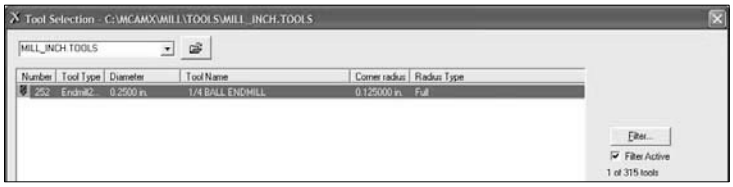
- Select **Filter** button.



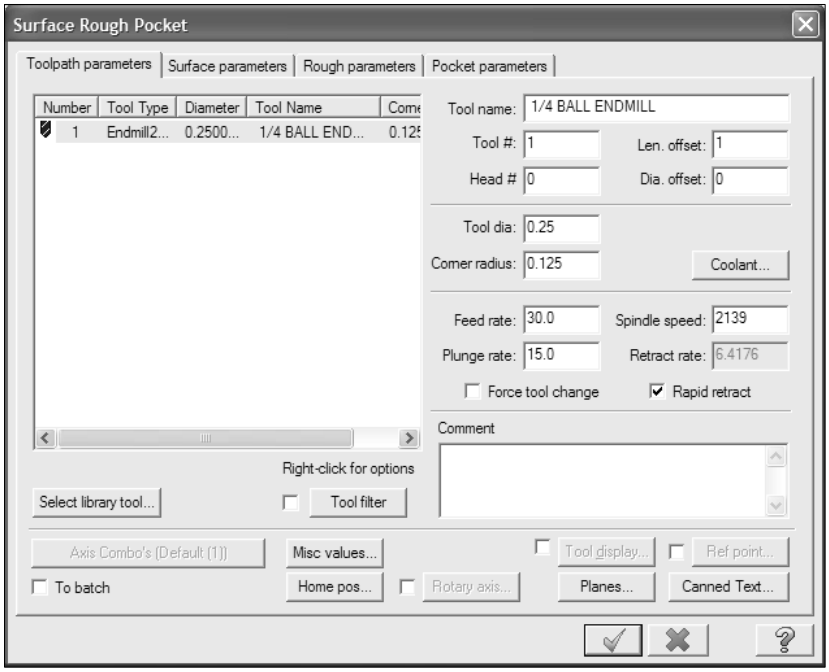
- In the **Tool Types** field select None button to disable all tools.
- Select the **Endmill Sphere** as shown (second from the upper right corner).
- In the **Tool Diameter** field click the pull down arrow and select **Equal**.
- Enter the tool diameter value (0.25).
- Select the **OK** button to exit **Tool List Filter**.



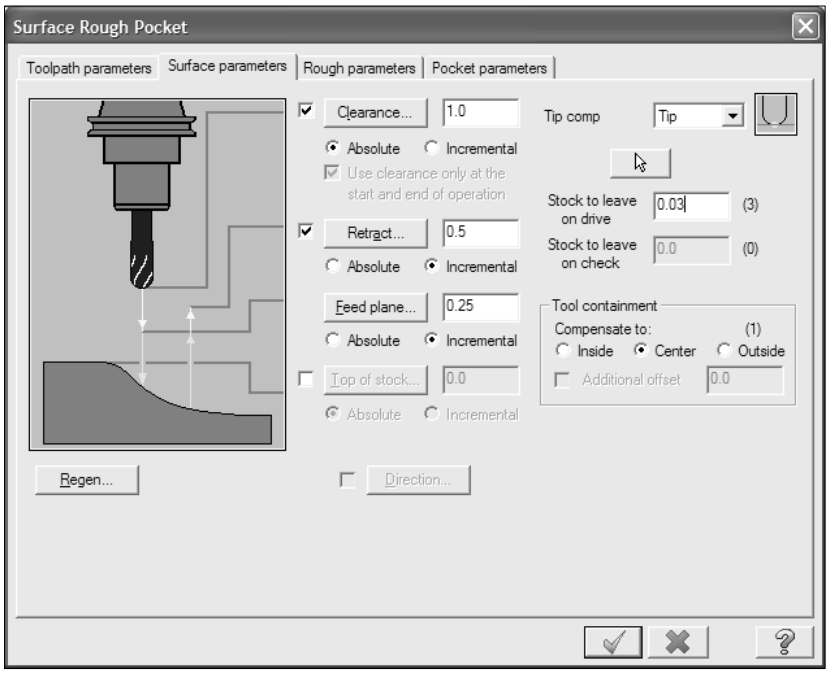
- Select the tool in the Tool Selection screen.



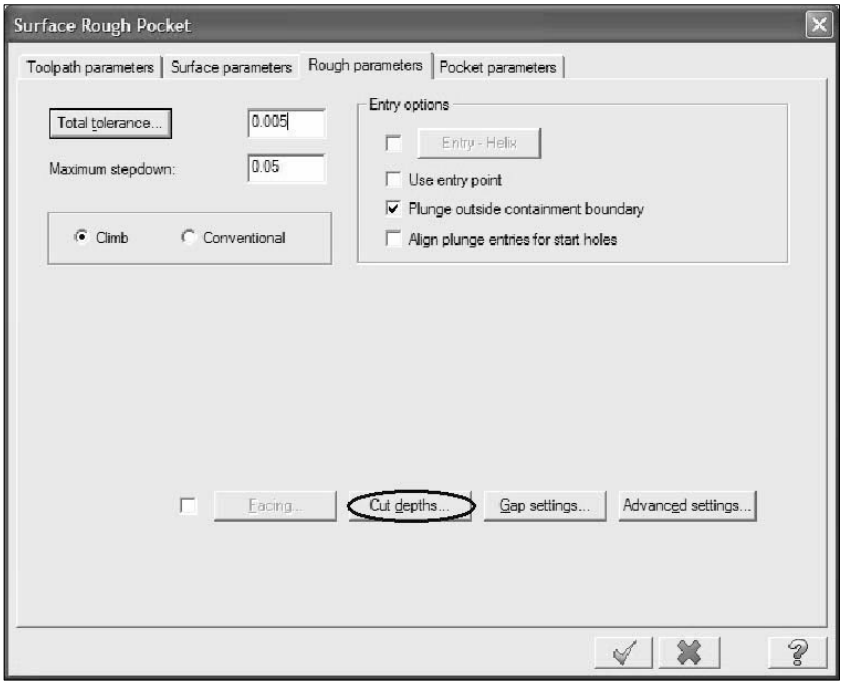
- The tool information should be displayed in the screen as shown.
- Check with your instructor to fill in the following information;
- Feed rate
- Plunge rate
- Spindle speed



- Make all the necessary changes as shown and select the **Surface parameter** page.

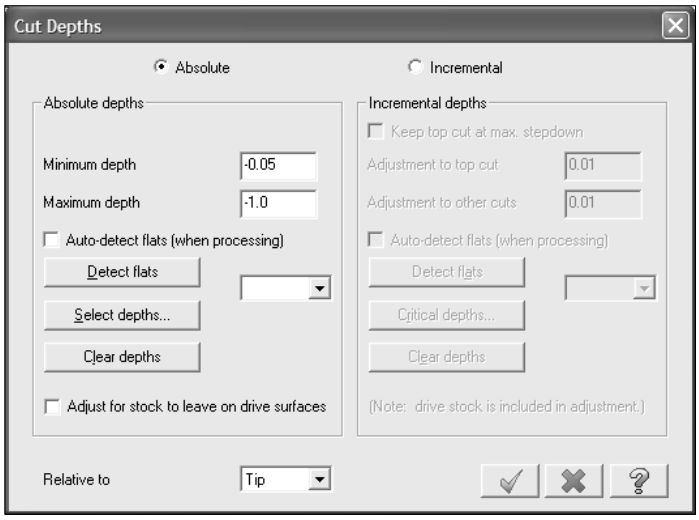


- Enable and enter the Clearance value to set the height at which the tools rapids to or from the part.
- Enter the Retract value to set the height at which the tools rapids/feed-rates up to, before the next step down.
- Enter the Feed plane as an incremental value to set the height at which the tools rapids to before changing to the plunge rate.
- Enter in the Stock to leave on drive surfaces amount.



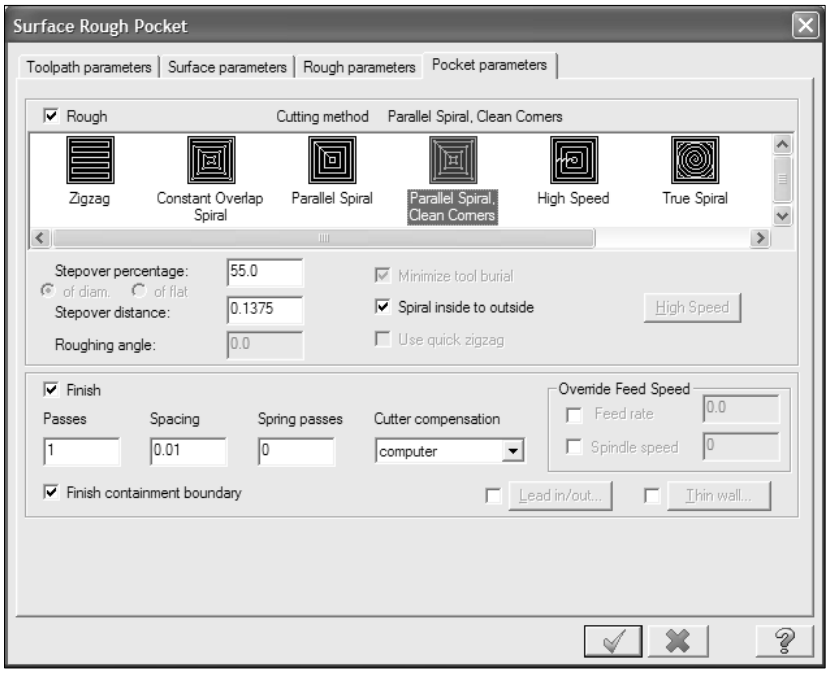
- Select **Rough parameters** page and set the Z **Maximum stepdown**, **Total tolerance**, Z **Cut depths,** and **Entry/exit options** for surface rough pockets.
- Enable **Plunge outside containment boundary** to place the starting points outside the chained boundary.
- Change the **Maximum stepdown** to 0.05 to set the maximum distance between adjacent cuts along z-axis in the surface toolpath.

- Select **Cut depths** button and change the **Minimum depth** and the **Maximum depth** to absolute values as shown in the following dialog box.



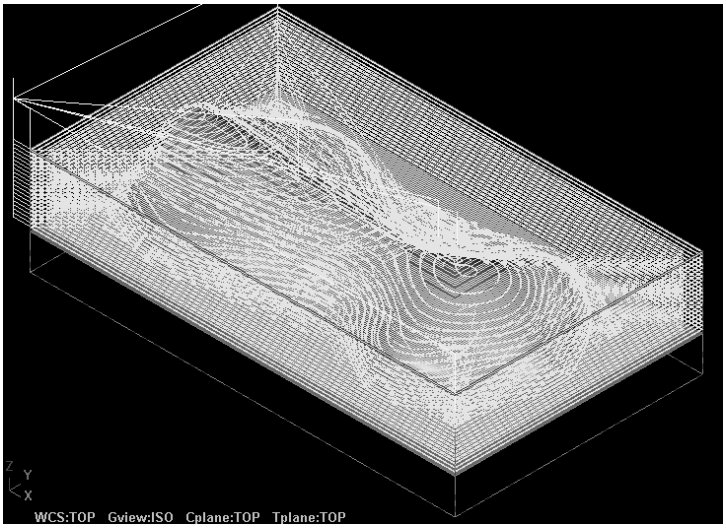
- **Select the OK button.**

- Select the **Pocket parameters** page and change the **Cutting method** to **Parallel Spiral** and the **Stepover percentage** to 50%.

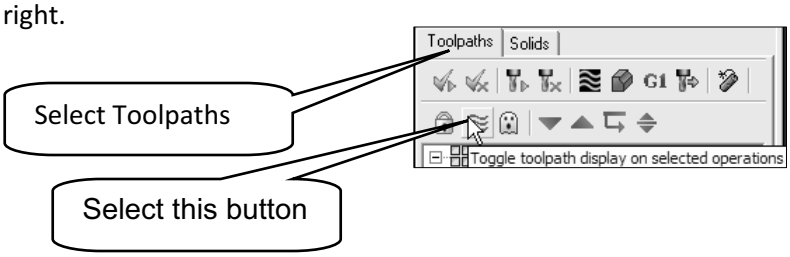


- Select the **OK** button to exit **Surface rough pocket** parameters.

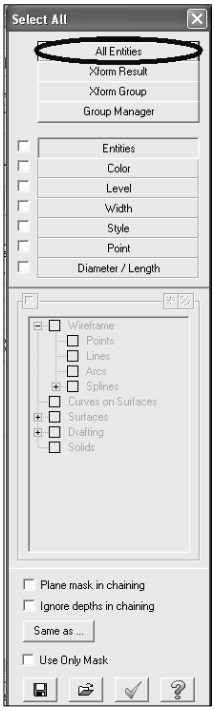
- To remove the toolpath display select **Toolpaths Manager.**



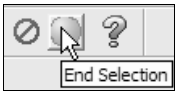
- Select the button as shown to the right.



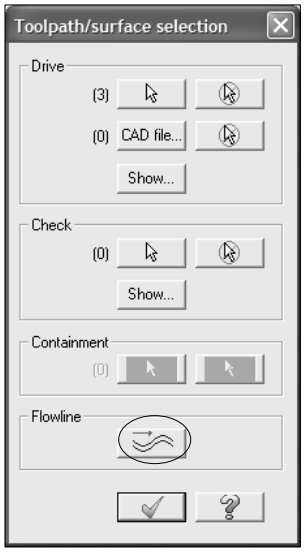
STEP 11:
SURFACE FINISH FLOWLINE TOOLPATH.



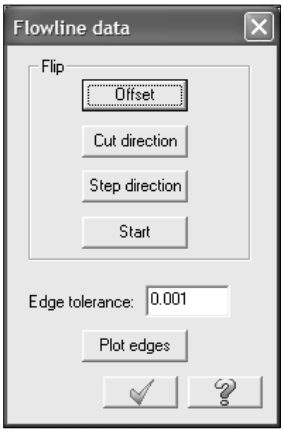
Toolpaths
- **Surface Finish**
- **Flowline**
  - [Select Drive Surfaces]: Select **All** button. 

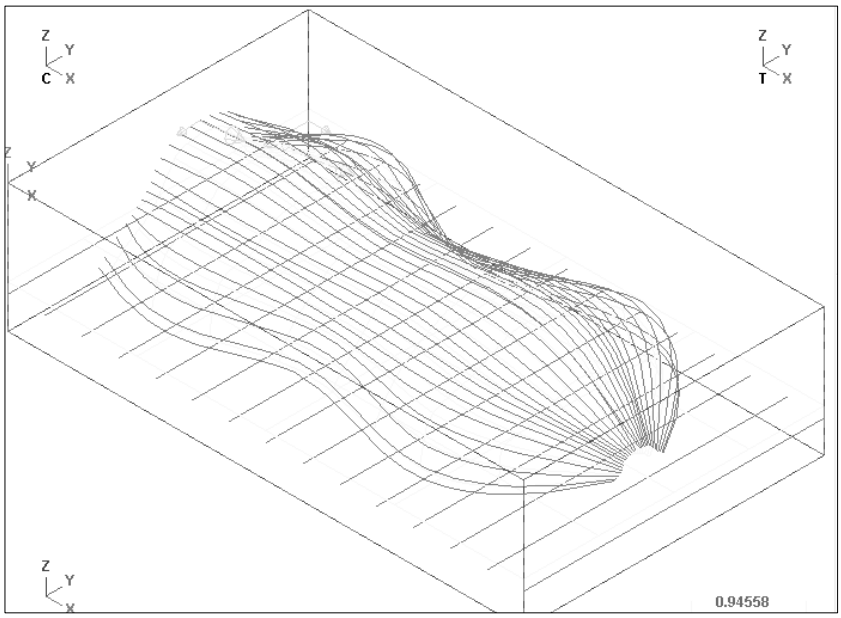
  - Select the **All Entities** button
  - Select **End Selection** button. 

- Select **Flowline** button in the **Toolpath/surface selection** screen.



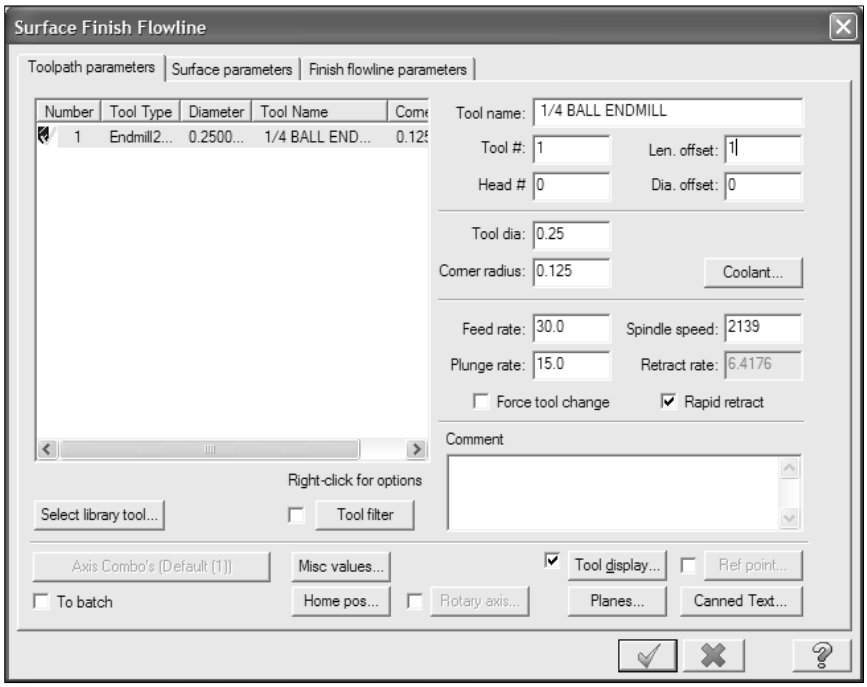
- Select the **Offset** button and the **Direction** button to have the flowlines above the part as shown below.
  - Selecting **Cut Direction** button automatically changes the cutting direction. Selecting **Step direction** button automatically changes the stepover direction. Selecting **Start button** automatically changes the start point of the toolpath.



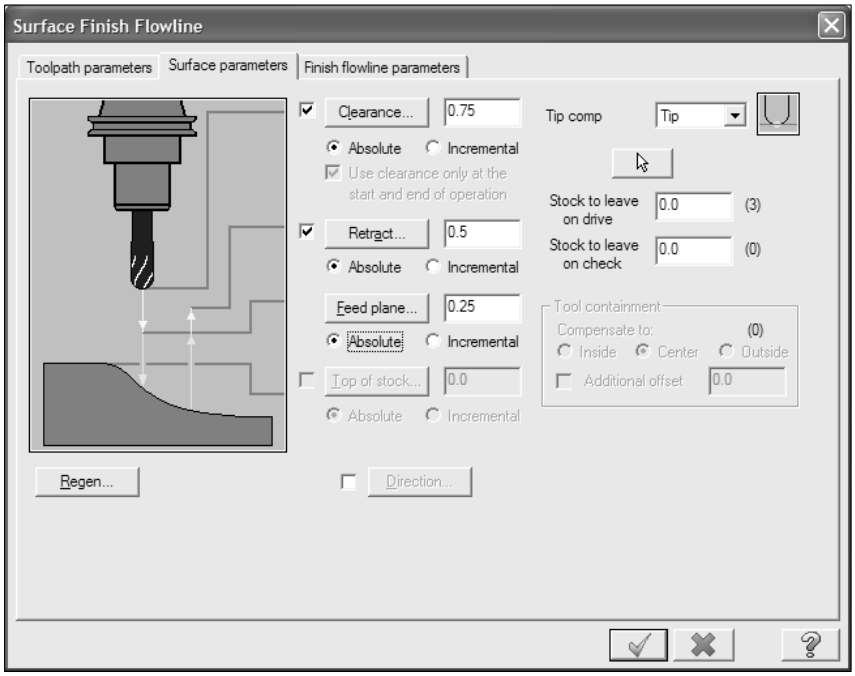


- Select the **OK** button twice to exit **Flowline Data** and **Toolpath/surface selection** screens.

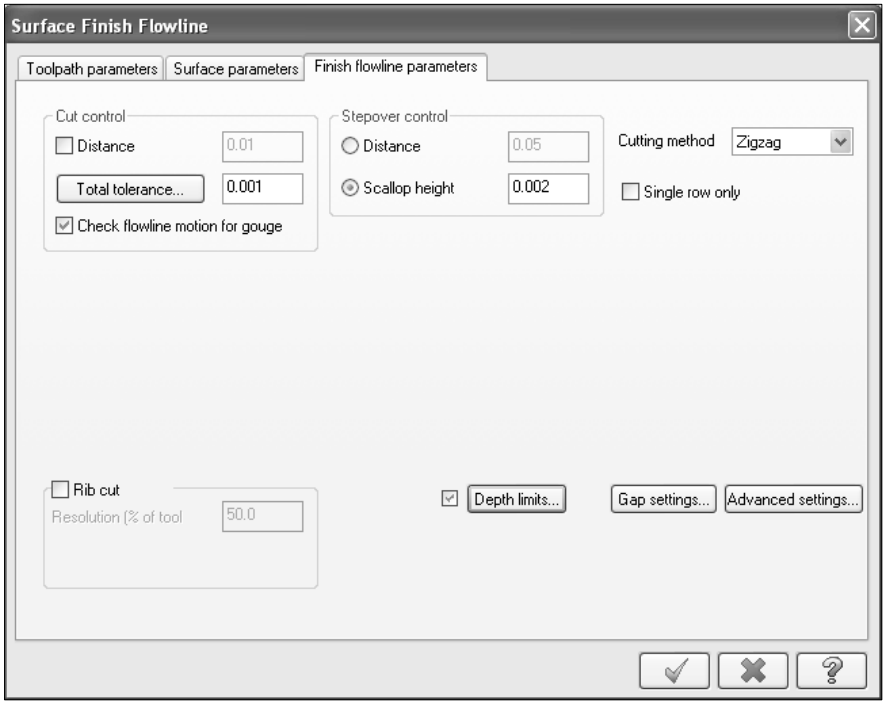
- Fill out the 3 parameter screens as shown in the following diagrams.



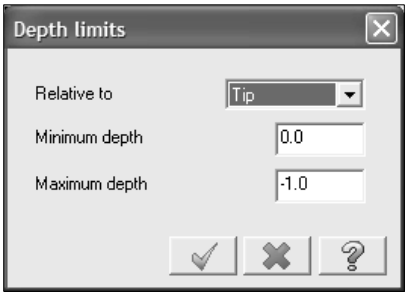
- Select the **Surface parameters** and set **Clearance, Retract** and **Feed plane** heights as shown.



- Select the **Finish flowline parameters** page and set the **Total tolerance**, the **Stepover** as a **Scallop height**, and enable **Depth limits.**

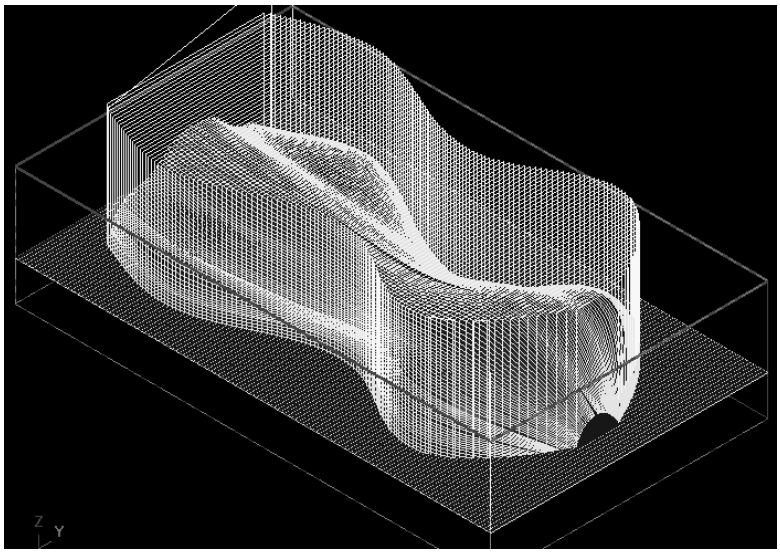


- Select the **Depth limits** button and change the parameters as shown in the following screenshot.



- Select the **OK** button to exit flowline parameters. 

- A toolpath should be shown on screen as shown to the right.

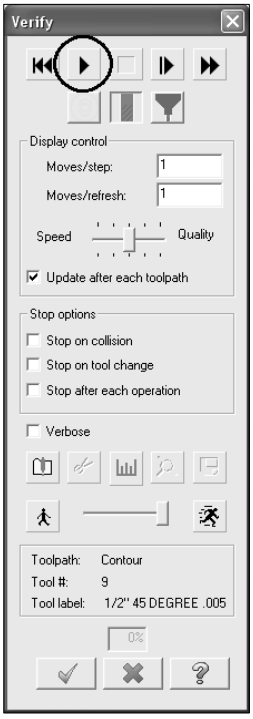


- If it does not ask the instructor for help.

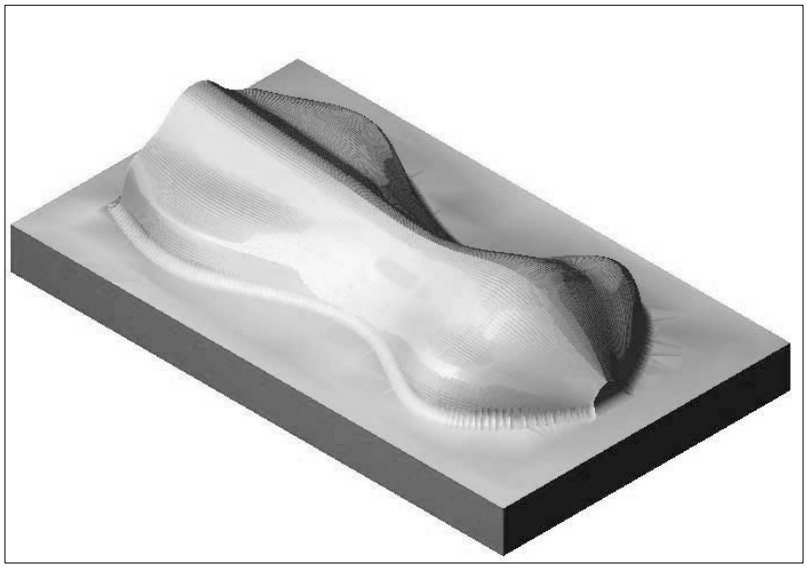
STEP 12:
CHECKING THE TOOLPATH USING VERIFY.

- In the **Toolpath Manager** select the **Verify** button as shown to the right.

- Click on the **Play** button as shown in the **Verify** screen;



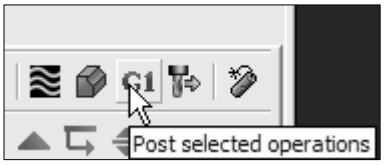
- Machine (the simulation may take a couple of minutes or more to finish).
- The finish part should appear as shown in the following picture.



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

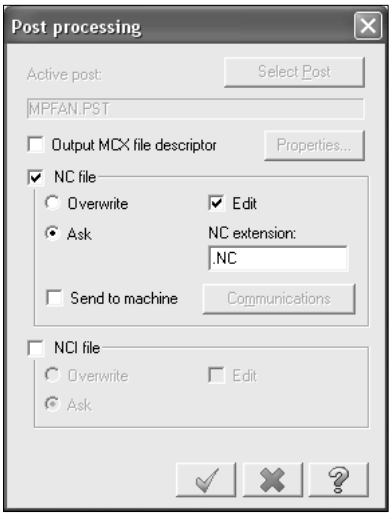
STEP 13:
POST THE FILE

- Note; Before continuing make sure the proper machine and post processor are installed on your computer. Check with your teacher.



- In the **Toolpath Manager.**
- Click on the **Post selected operations** button.

- Info item; A post is like a printer driver, it tells Mastercam how to execute the NC code.



- Make sure the check boxes for **NC file** and **Edit** are selected.
- **OK**

- The NC file will be displayed in a white window. Click on the **X** in the upper right corner to close the screen.

STEP 14:
SAVE THE MCX FILE.

File
- **Save**