UNIGRAPHICS

TURNING MANUFACTURING PROCESS

WORKBOOK

November 2002

MT11055 – Unigraphics NX

EDS Inc.

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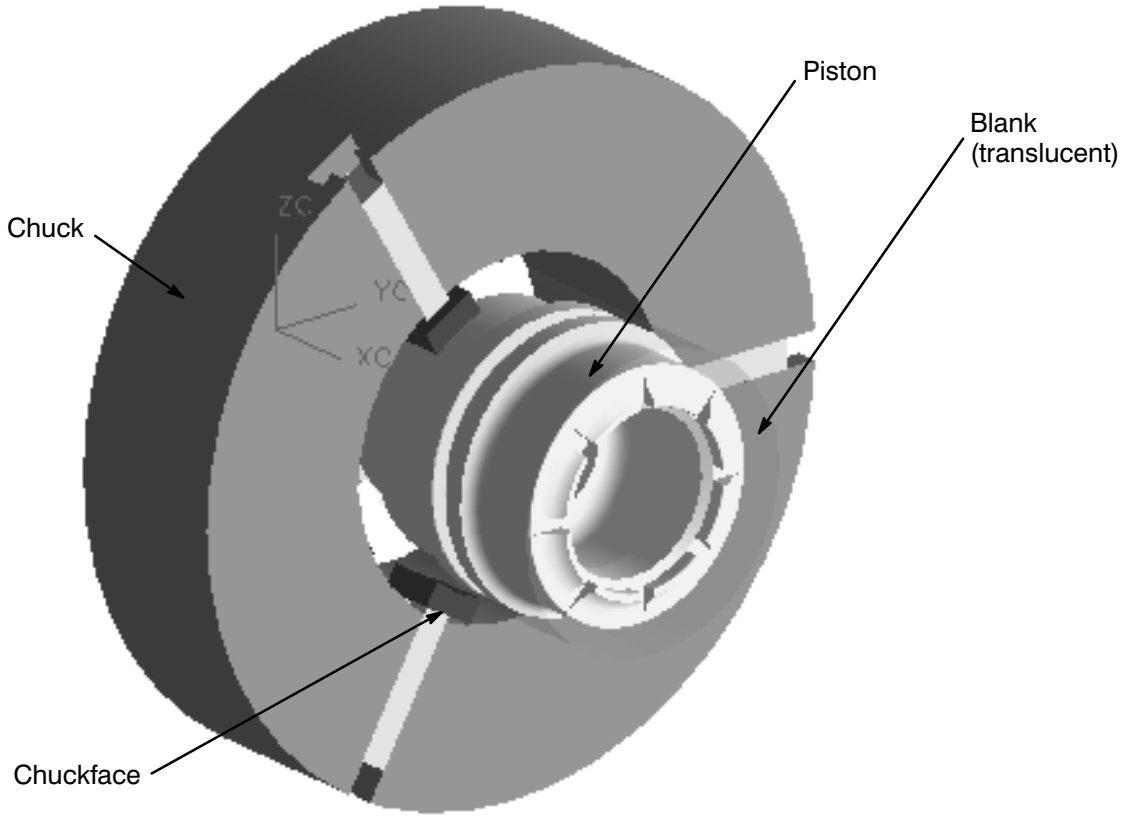
The Manufacturing Process

The workbook project allows you to practice many of the Turning concepts that you have learned in the Student Manual.

The part that you will program is an assembly part consisting of the Piston part, blank, and components used to hold the Piston for machining. The Piston is considered the *Master Model* and the chuck, chuckface, etc. are called component parts. In the first section of the workbook, you will take a closer look at the master model, assembly components, and determine the machining sequence.

The piston assembly, is shown in the following illustration.

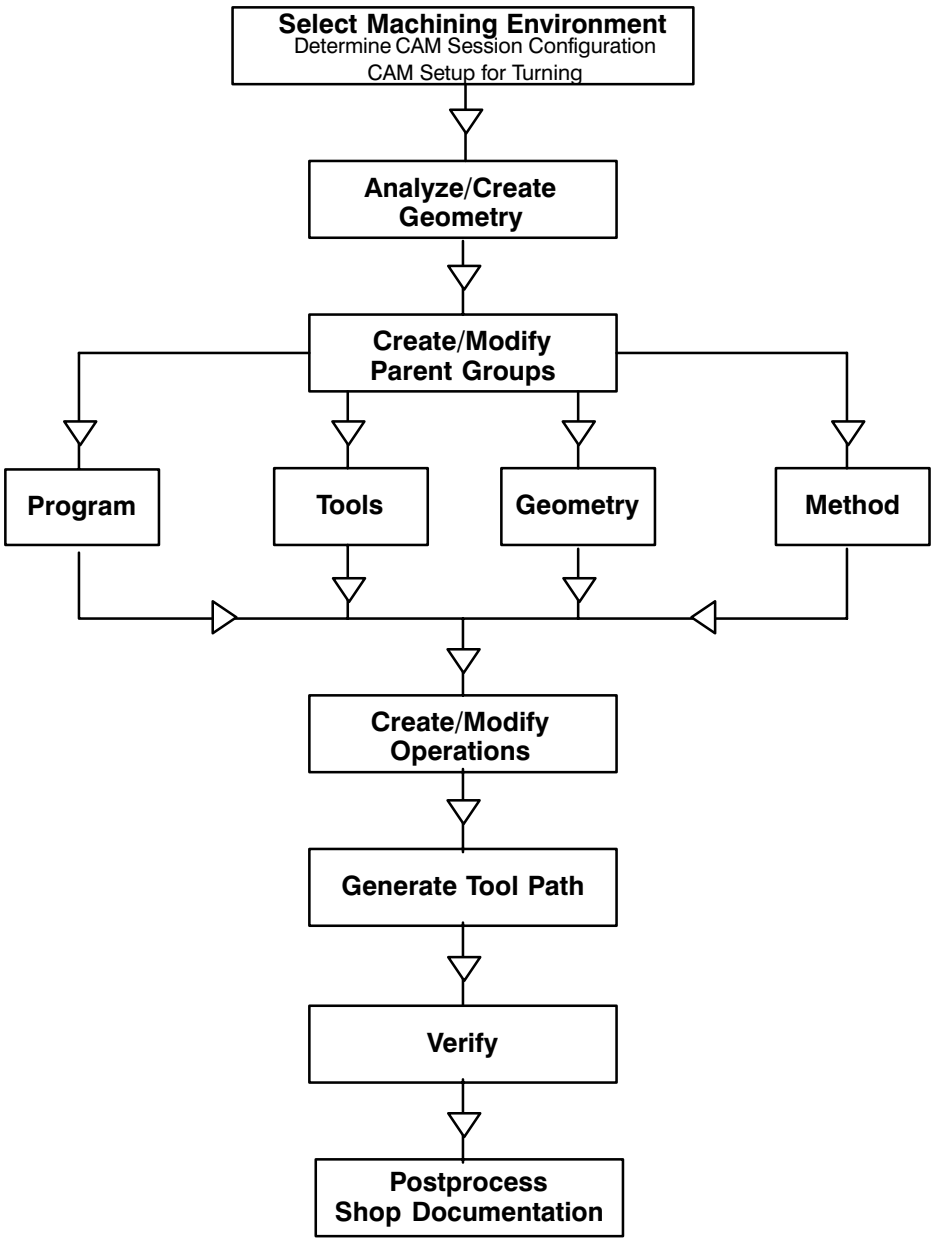


The manufacturing processes or methods that you will use in this workbook, may or may not be the same approach, in order or content, that you would use at your company. The importance of this project is to allow you to gain an understanding of the Turning application. You can then create programs, operations and tool paths in a way that is familiar to you and your company.

The flow chart below shows you the typical Manufacturing process when using the Unigraphics Manufacturing software. As you progress through this workbook a flow chart will be presented to show you were your are in this process.

Unigraphics Manufacturing Process

Turning

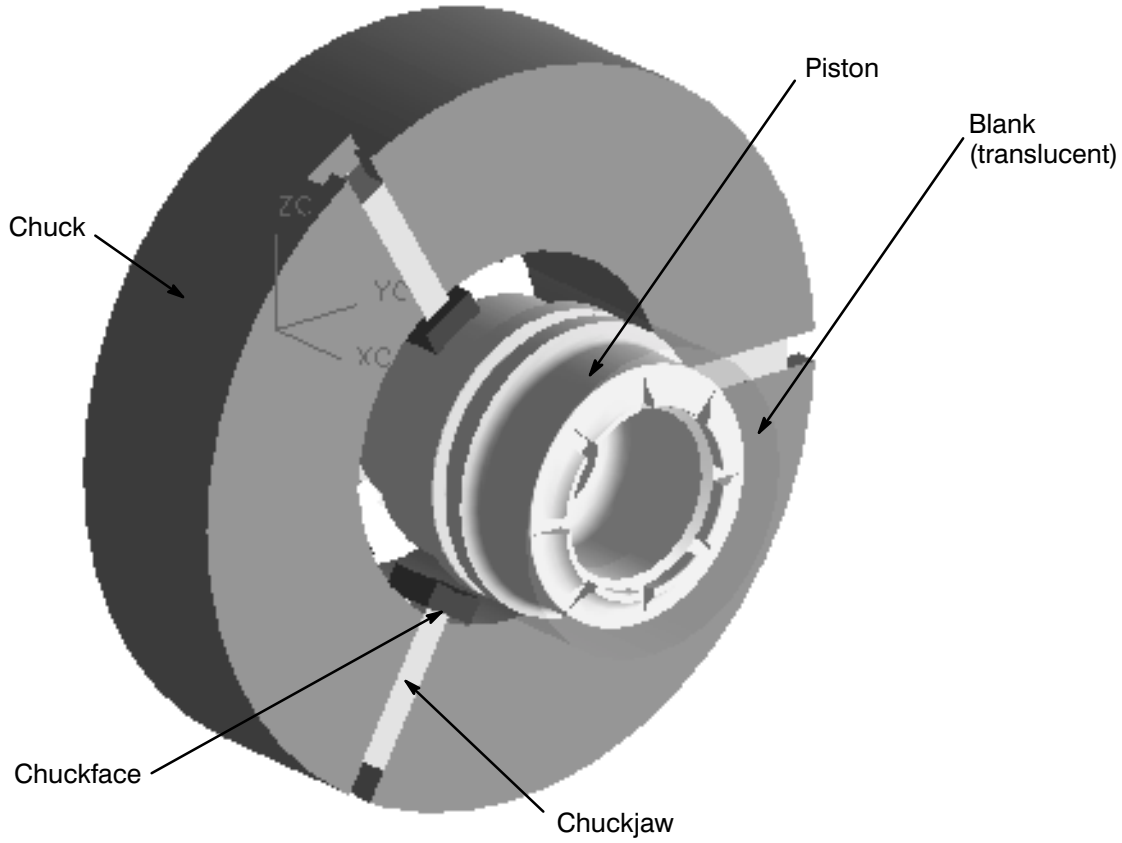


Examining the Project Part

Section 1

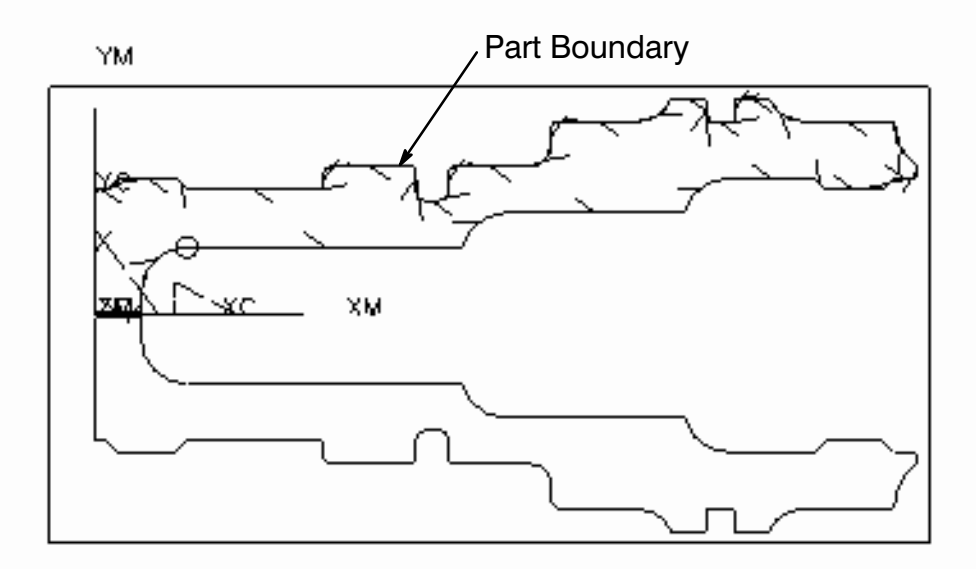
1

The piston (finished part), blank, and several components used to hold the piston for machining. are identified in the following illustration. The piston is considered the *Master Model* and the blank, chuck, chuckface and chuckjaw are called component parts.



1

The part geometry will be defined with a single closed part boundary.



The following process plan represents the manufacturing of the Piston. Included are the operation number, work center designation, operation description, operation name, and tool description. A definition of these items follows:

- **Operation Number** is the sequential order in which a process is performed.
- **Work Center** is the particular work area in which the operation is performed.
- **Description** is the detailed description of the operation that is to be performed.
- **Operation Name** is the actual name of the operation used to machine the specific feature or task.
- **Tool** is the description of the tool used to machine the specific feature.

Operation Number	Work Center	Description	Operation Name	Tool
		Piston		
100.00	**CNC Mill–Turn**	**Horizontal Mill–Turn, Side 1, Mach. No. 1450, Tape No. 12345_A**		
100.10		Rough face right end of part, leave stock	RGH_FACE	OD_80_L
100.20		Centerline drill to remove excess, leave stock on face	DRILL_2.750	DRILL_2.750
100.30		Centerline drill to remove excess material on bore face. Finish bore face	DRILL_1.00_ FLT_BOT	DRILL_1.00_FLT _BOT
100.40		Rough OD, leave stock	RGH_OD	OD_80_L
100.50		Rough bore ID, leave stock	RGH_ID	ID_80_L
100.53		Rough bore ID left side of thread relief, leave stock	RGH_RE-LIEF_LEFT	ID_55_L
100.57		Rough bore ID right side of thread relief, leave stock	RGH_RELIE F_RIGHT	BACK-BORE_55_L
100.60		Finish ID front	FIN_FRT_ID	ID_55_L
100.63		Finish ID complete	FIN_ID	ID_55_L
100.67		Finish right side of relief	FIN_RE-LIEF_RIGHT	BACK-BORE_35_L
100.70		Finish OD	FIN_OD	OD_55_L
100.80		Finish groove	FIN_GRV	OD_GROOVE_L
100.90		Thread ID	THRD_ID	ID_THREAD_L
200		Mill 8 slots X .500” wide (vertical machining center)	MILL_SLOTS	EM_.500_CAR-BIDE
300		**Horizontal Mill–Turn, Side 2, Mach. No. 1450, Tape No. 12345_B**		
300.10		Rough & finish face		
300.20		Rough OD		
300.30		Drill 1/8” hole on center		
300.40		Finish OD		

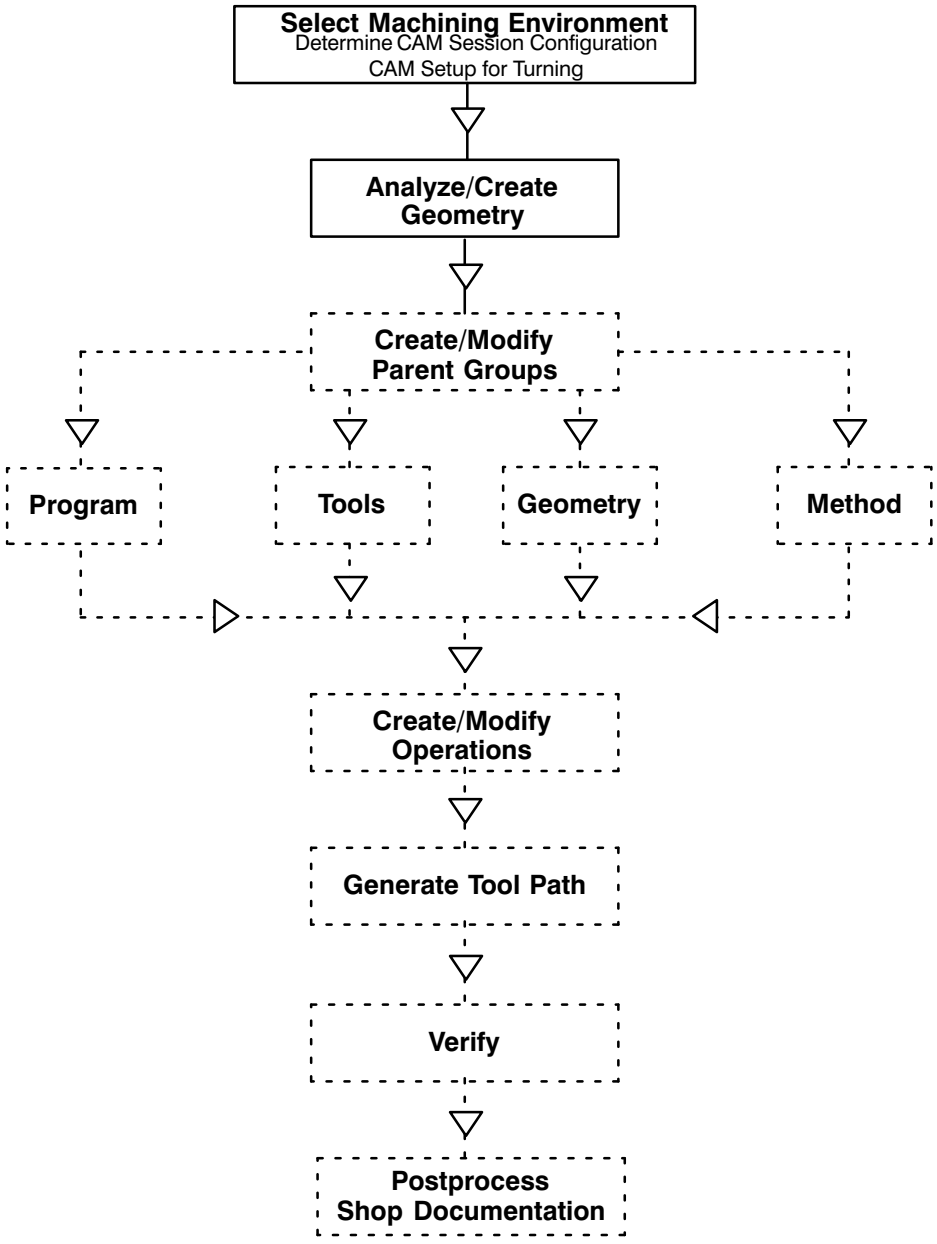
Operation Number	Work Center	Description	Operation Name	Tool
300.50		Finish groove		
300.60		Finish thread		
400	**Inspection**	**Inspect 1st article features machined in operation numbers 100 thru 1010**		
500	**Manual Deburr Clean**	**deburr and clean part per customer specifications**		
600	**Inspection**	**Final inspection of all features**		

Machining Environment and Creating Lathe Cross Sections

Section 2

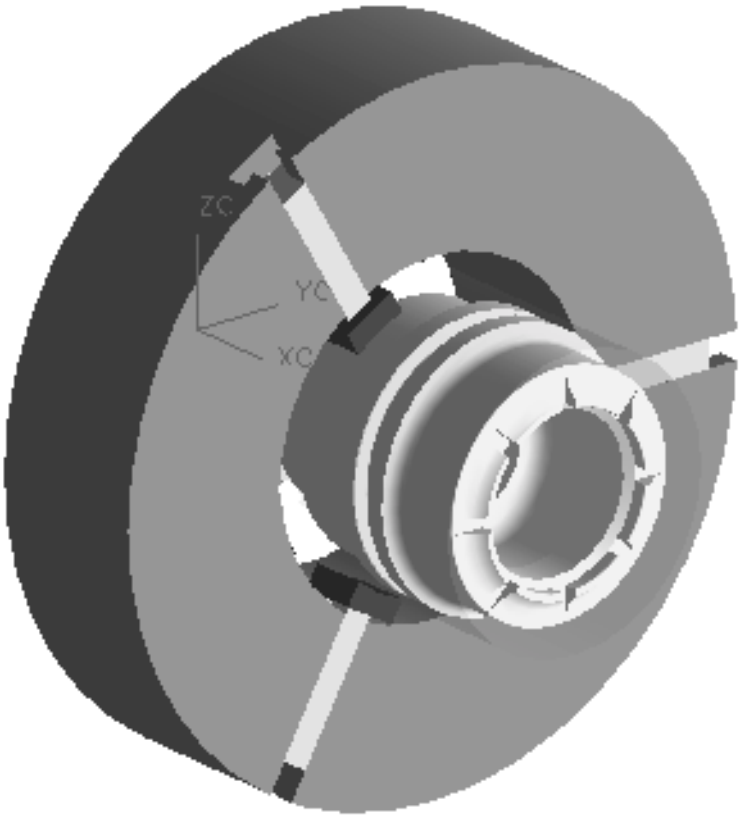
Unigraphics Manufacturing Process

Turning



Before you start to create operations and generate tool paths, the Machining Environment must be defined. You must also create cross sections of the solid model in order to obtain the 2D geometry needed to create and generate operations.

Piston, Right side, in the chuck assembly



Step 1 Open the part, **tmp_piston_mfg_asmb_1.prt**, from the workbook_parts directory.

Step 2 Rename the part ***_piston_mfg_asmb_1**.

Step 3 Choose the CAM Session Configuration and Setup, and then initialize the part file.

The "Why" Remember, the Configuration and Setup determine which templates and libraries are loaded into this part when you perform the initialization.

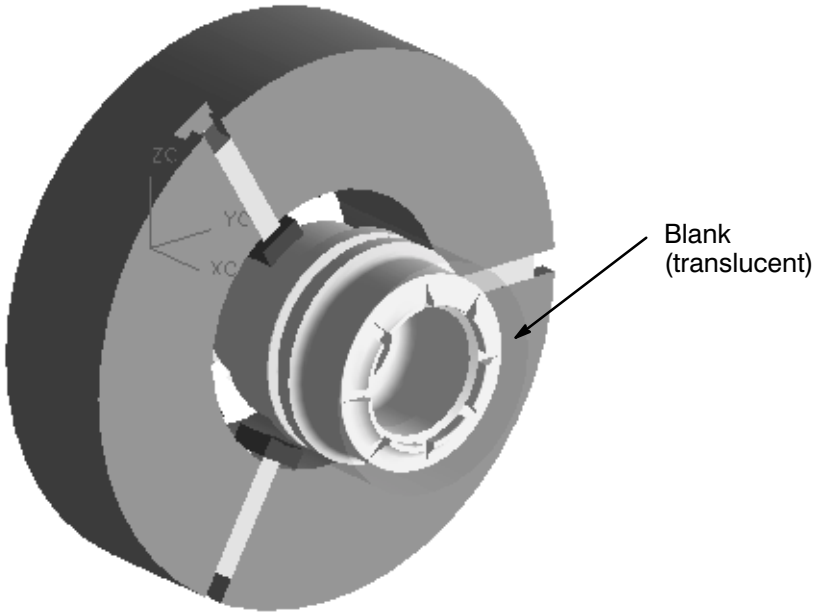
HINT Does the part require any Milling?

Step 4 Examine the layer settings.

Step 5 Make the layers containing the chuck and chuckjaw invisible so that only the part and the blank are visible.

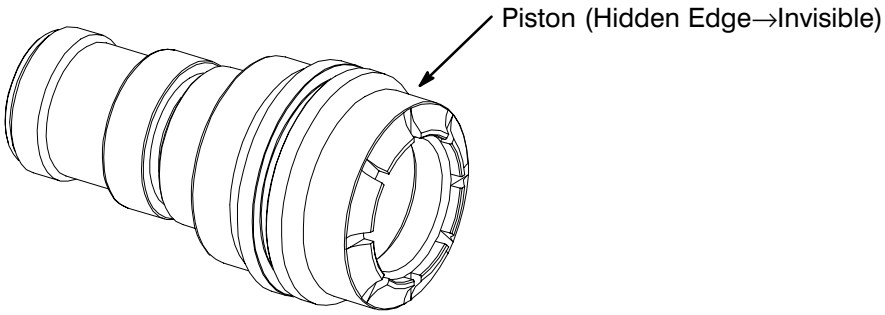
Step 6 Create the cross section curves of the Blank on their own layer.

HINT You might also change the display to wireframe in order to see the blank.



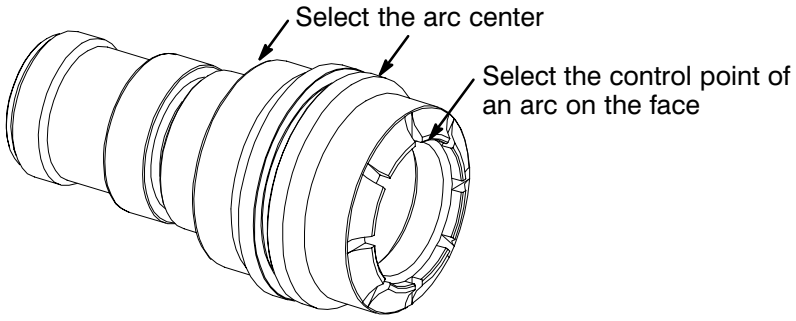
Step 7 Create the cross section curves of the piston on the same layer as the cross section curves of the blank.

HINT Dismiss the blank and blank cross section layers and change the display to **Hidden Edges→Invisible.** Also, make the layers with the cross sections visible and all other layers invisible.

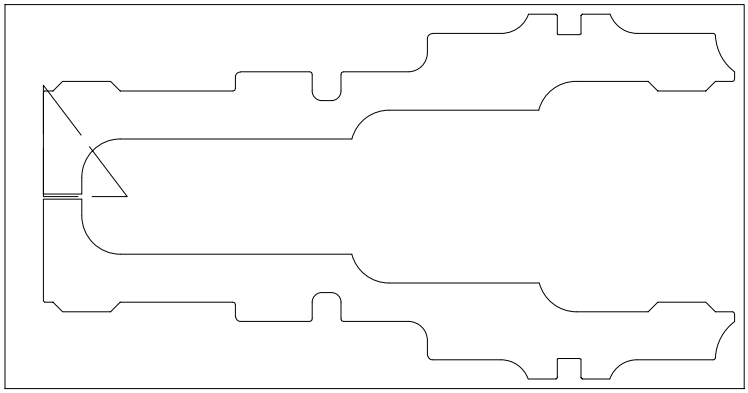


HINT The geometry on the right end of the piston is not symmetrical. It will require that you use the Complex cross section method.

HINT When creating the Section plane you can use the three points method. Use the arc centers for two of the points and use a control point of one of the arcs on the face of the part for the third point.



Step 8 Make the layers containing solid geometry invisible and change the layout to the Top view.



Step 9 Save the part file.

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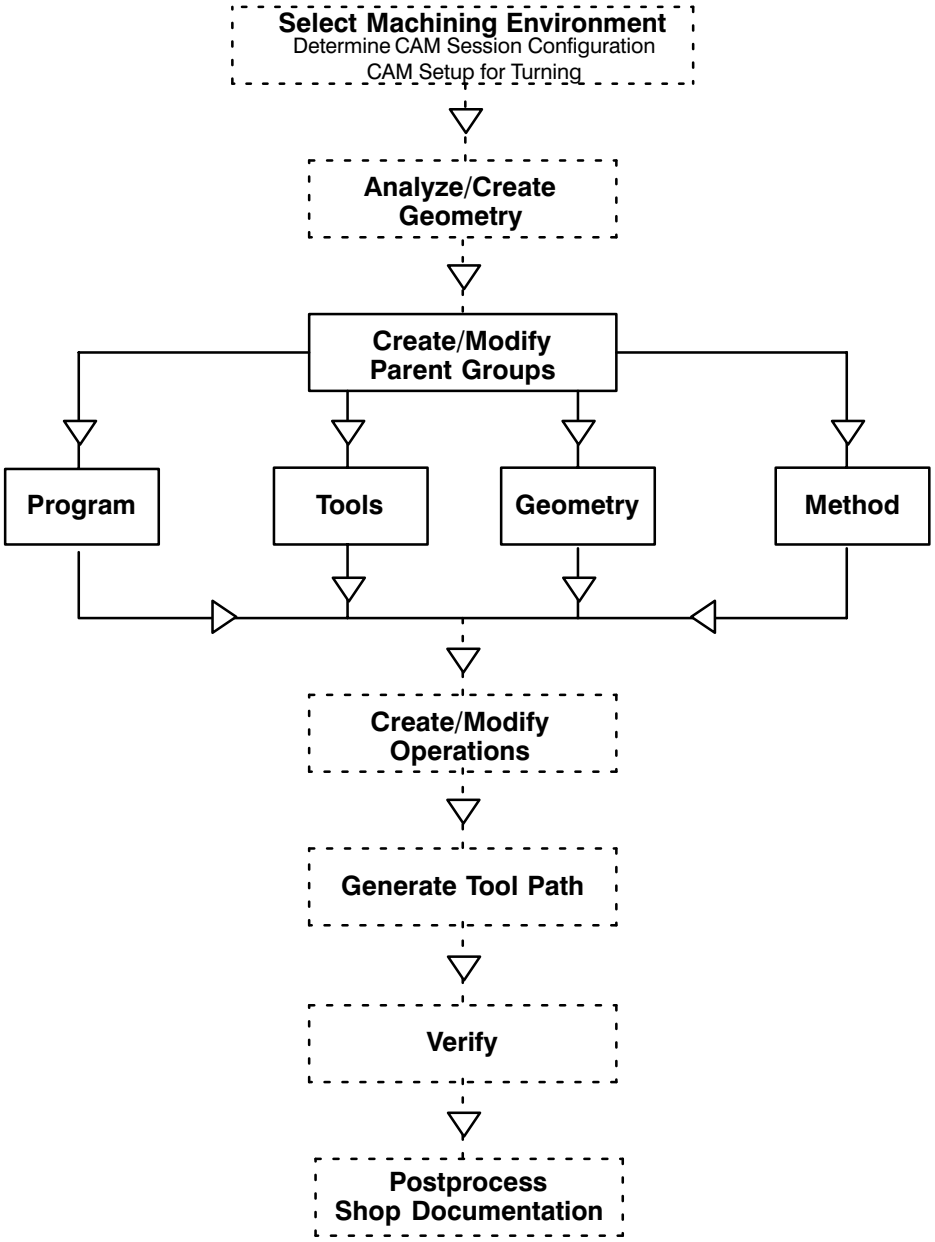
Defining Tools and Geometry

Section 3

Unigraphics Manufacturing Process

Turning



In this section of the workbook, you will define the tools and geometry necessary to create the operations to cut this part.

The "Why" Predefining the tools and geometry allows you to create operations and tool paths more efficiently.

Step 1 If necessary, open the part from the workbook_parts directory, ***_piston_mfg_asmb_1.prt**.

Step 2 Create the tools necessary to cut the part.

❑ The tools are identified in the Process Planning Sheet. To save time a list has been created for you. Create the following tools.

- Turning tools:

OD_80_L:

Nose Radius	.031
Orient Angle	5.00
Tool Number	1
Adjust Number	1

OD_55_L:

Nose Radius	.031
Orient Angle	17.5
Tool Number	2
Adjust Number	2

ID_80_L:

Nose Radius	.031
Orient Angle	275
Tool Number	3
Adjust Number	3

ID_55_L:

Nose Radius	.031
Orient Angle	282.5
Tool Number	4
Adjust Number	4

ID_35_L:

Nose Radius	.0312
Orient Angle	285
Tool Number	5
Adjust Number	5

BACKBORE_55_L:
Nose Radius .0468
Orient Angle 212.5
Tool Number 6
Adjust Number 6

BACKBORE_35_L:
Nose Radius .0468
Orient Angle 227.5
Tool Number 7
Adjust Number 7

ROUND (start with OD_80_L tool / change the insert type):
Diameter .162
Holder Width .162
Orient Angle 90

- Drilling tools:

DRILL_2.75 (Drilling Tool)**:**
Diameter 2.75
Length 20.00
Point Angle 118
Tool Number 8
Adjust Number 8

DRILL_1.00FLT_BOT (Drilling Tool)**:**
Diameter 1.00
Length 20.00
Point Angle 180
Tool Number 9
Adjust Number 9

- Grooving tools:

OD_GROOVE_L:
Insert Width .250
Radius .016
Tool Number 10
Adjust Number 10

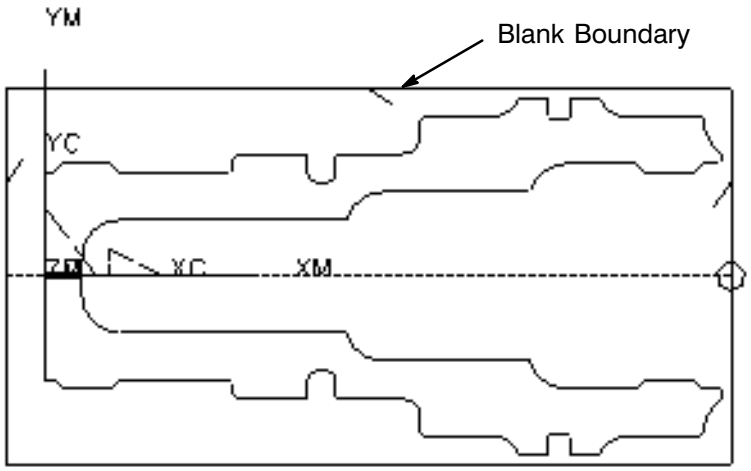
- Threading tools:

ID_THREAD_L:	
Left Angle	30
Right Angle	30
Orient Angle	270.00
Tool Number	11
Adjust Number	11

Step 3 Create the boundaries in the existing WORKPIECE object. Select Aluminum for the Part Material.

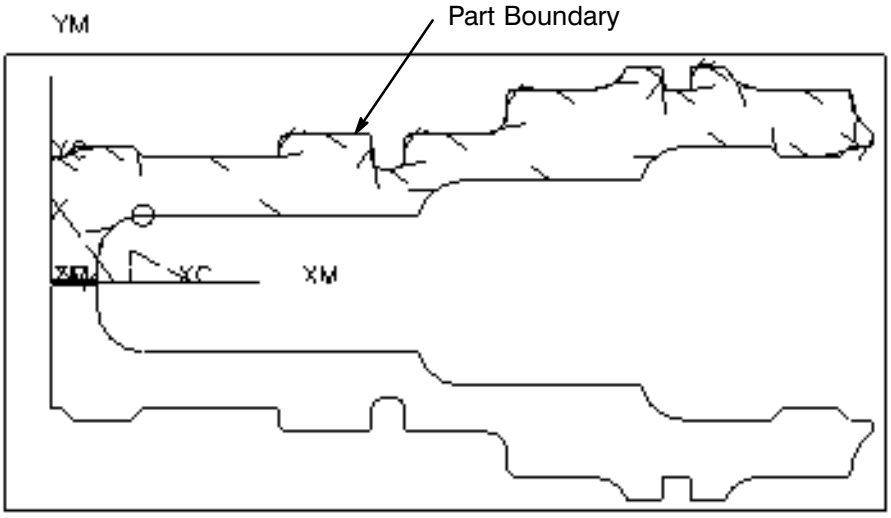
❑ Verify that the MCS_SPINDLE Parent Group is defined correctly.

❑ The WORKPIECE object should already be created under the MCS_SPINDLE Parent Group (in order to inherit the MCS coordinates).



❑ Create an open Blank Boundary in the existing WORKPIECE object.

Step 4 Create a closed Part boundary in the existing WORKPIECE object.



Step 5 Save the part file.

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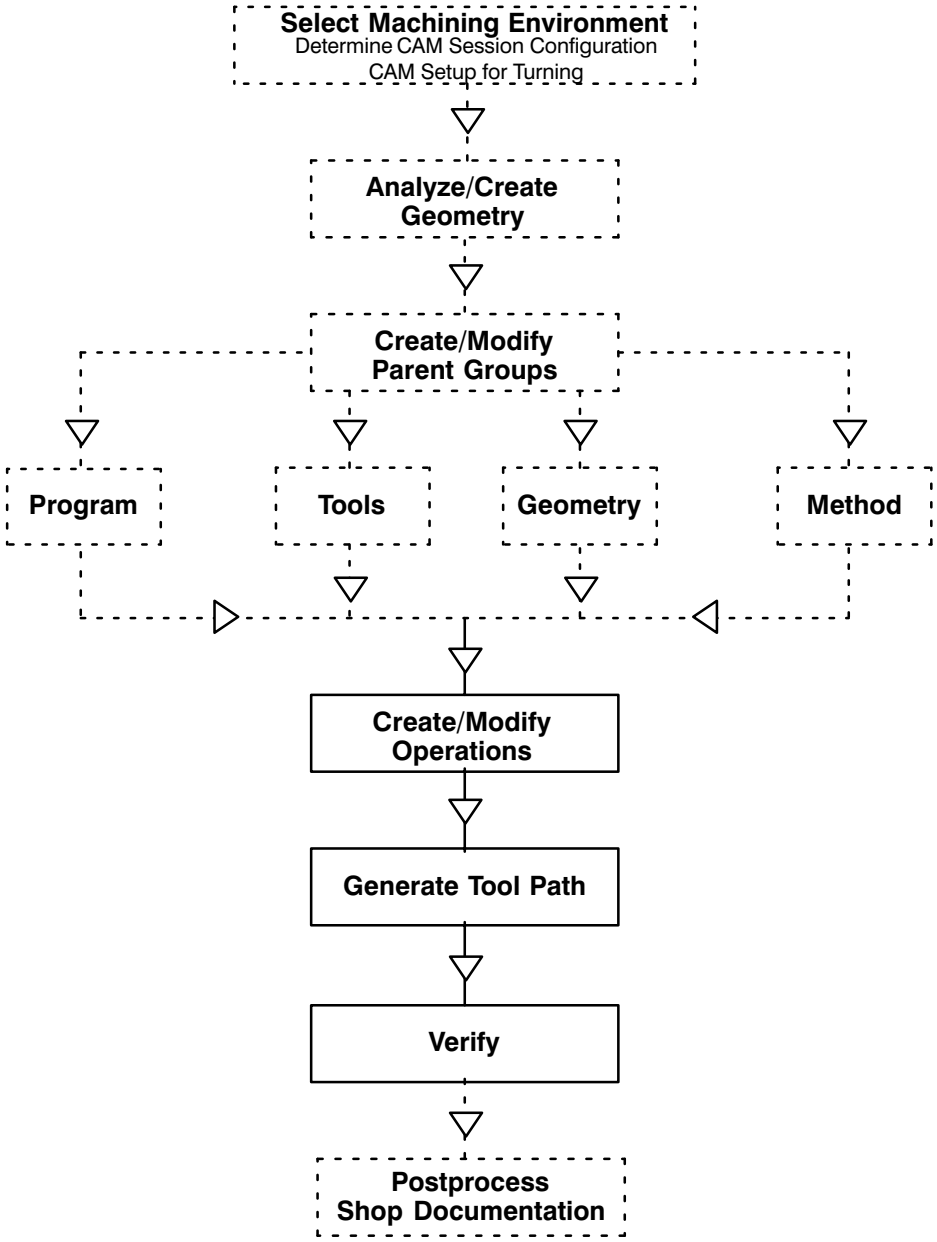
Facing Operation

Section 4

Unigraphics Manufacturing Process

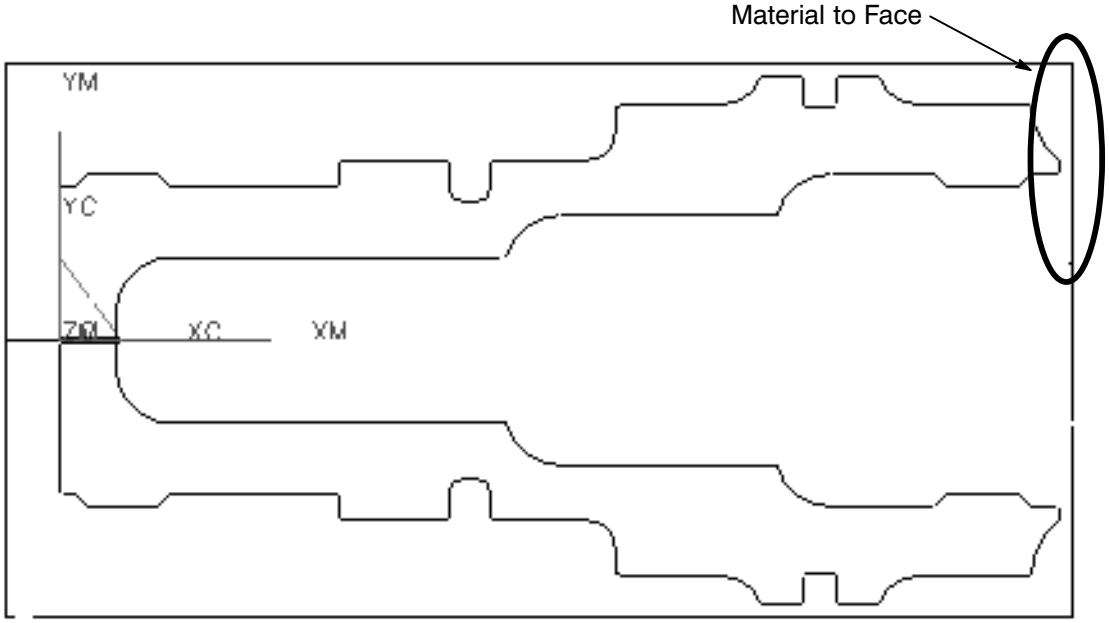
Turning



4

There are eight different roughing and three different finishing operation subtypes in Turning. Each operation subtype represents a different method of material removal. Selection of the operation subtype is normally based on cutting tool availability, machine rigidity, type of material being cut, geometry or feature configuration, speeds and feeds and desired finish.

In this section of the workbook, you will use one of the roughing subtypes (Facing) to face the right front of the piston.



Remember that when you are creating these operations, common options such as engage and retract parameters, avoidance parameters, containment, and feeds and speeds may need to be specified.

4

Step 1 If necessary, open the part, ***_piston_mfg_asmb_1.prt.**

Step 2 Create an operation to rough face the right of the blank using the OD_80_L tool (name the operation RGH_FACE).

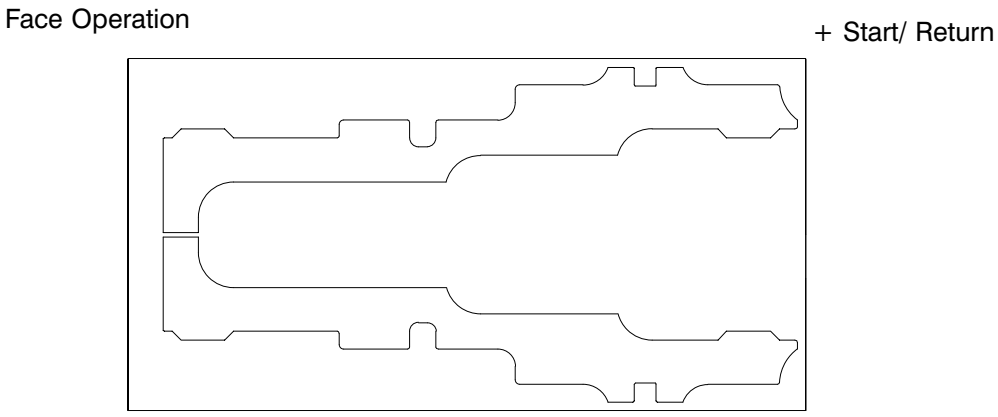
HINT Remember to define the Program, Tool, Method and Geometry Parent Groups for the operation.

❑ Choose WORKPIECE as the geometry Parent Group.

- ❑ Set the Containment options and then display the containment area.
- ❑ Turn off the Cleanup option. You do not need to make the additional pass to cleanup step material left from previous passes.

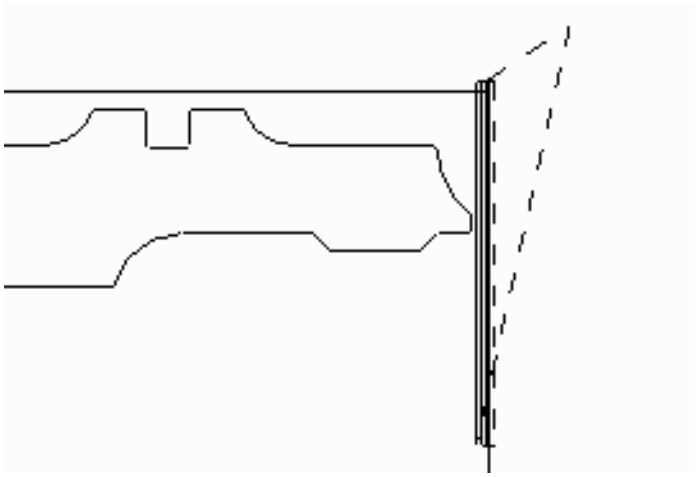
Step 3 Add Start and Return points to the operation.

HINT The system will move from the last tool position in the previous tool path to the first GOTO of the next tool path. In some cases this can cause the tool to gouge the part.



Step 4 Generate and verify the tool path.

Your tool path should look similar to the tool path shown.



Step 5 Save the part**.**

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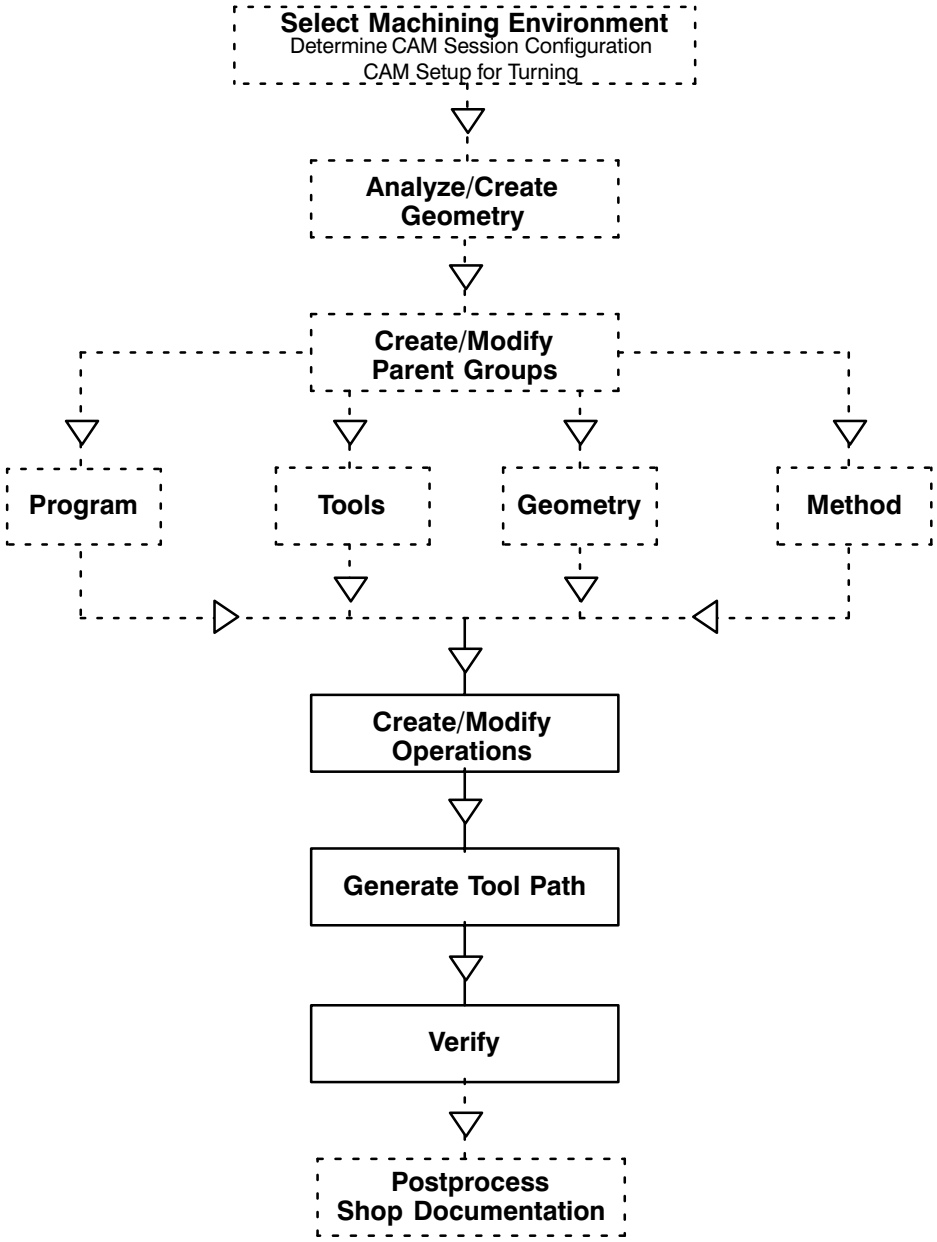
Drilling to Rough the ID

Section 5

Unigraphics Manufacturing Process

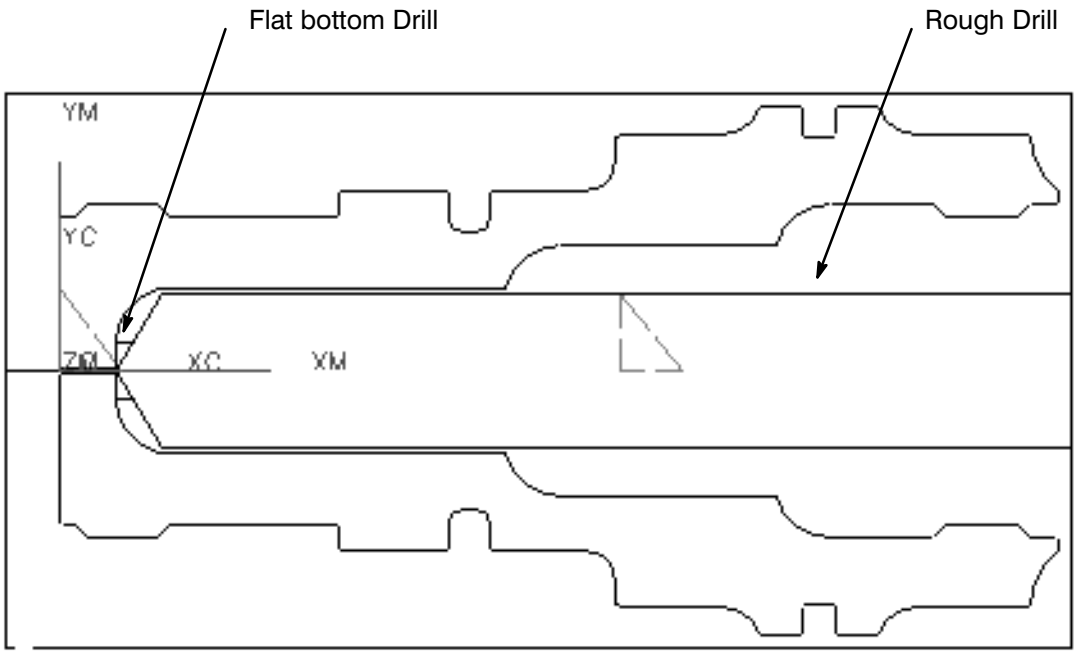
Turning



5

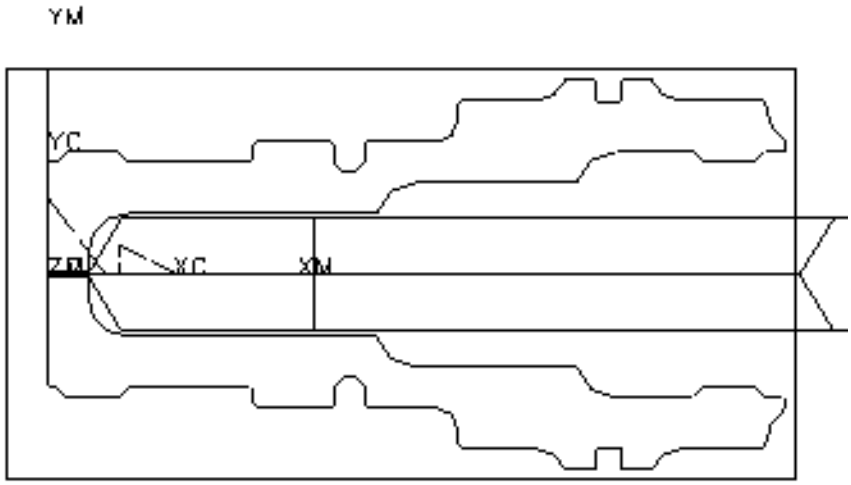
In this section, you will rough the ID of the piston using two drilling operations. The first operation will use the DRILL_2.750 to cut to the bottom of the hole. The second operation will use the flat bottom drill to clear material left by the drill tip. This will allow the ID turning tool (used later) to cut without gouging.

The results of the two operations should look similar to the results shown below.



Step 1 If necessary, open the part, ***_piston_mfg_asmb_1.prt.**

Step 2 Create a CENTERLINE_DRILLING operation, named DRILL_2.750, to drill to the bottom ID of the piston using the DRILL_2.750 tool.



HINT Remember to define the Program, Tool, Method and Geometry Parent Groups for the operation. Choose WORKPIECE as the Geometry Parent Group.

HINT When selecting the Method Parent Group, remember that this is a drilling operation.

HINT Remember to define the Avoidance Geometry.

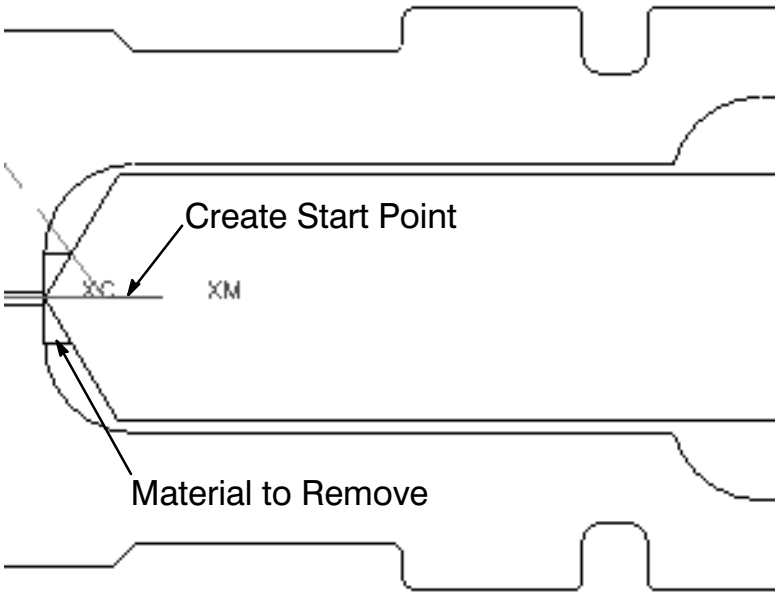
❑ Define the Drilling Geometry.

Step 3 Generate and verify the tool path.

Your tool path should look similar to the tool path shown.

5

Step 4 Create a CENTERLINE_DRILLING operation, named DRILL_1.00_FLT_BOT, to drill to the bottom ID of the piston using the DRILL_1.00_FLT_BOT tool.

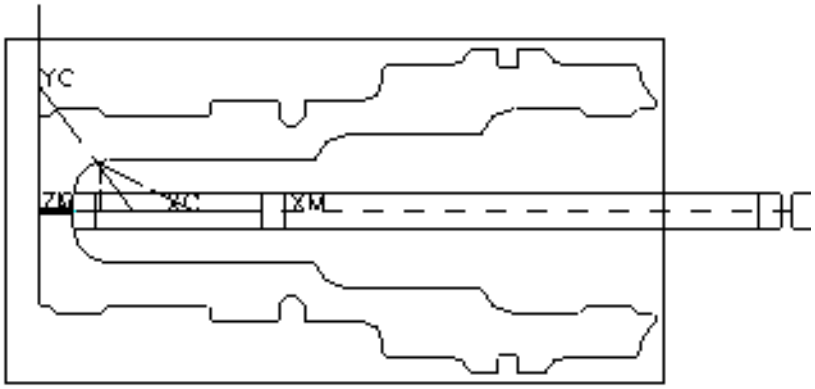


- ❑ Define the Drilling Geometry.
- ❑ Define the Avoidance Geometry.

Step 5 Add a Return point on the centerline so the tool clears the part.

Step 6 Generate and verify the tool path.

Your tool path should look similar to the tool path shown.



Step 7 Save the part.

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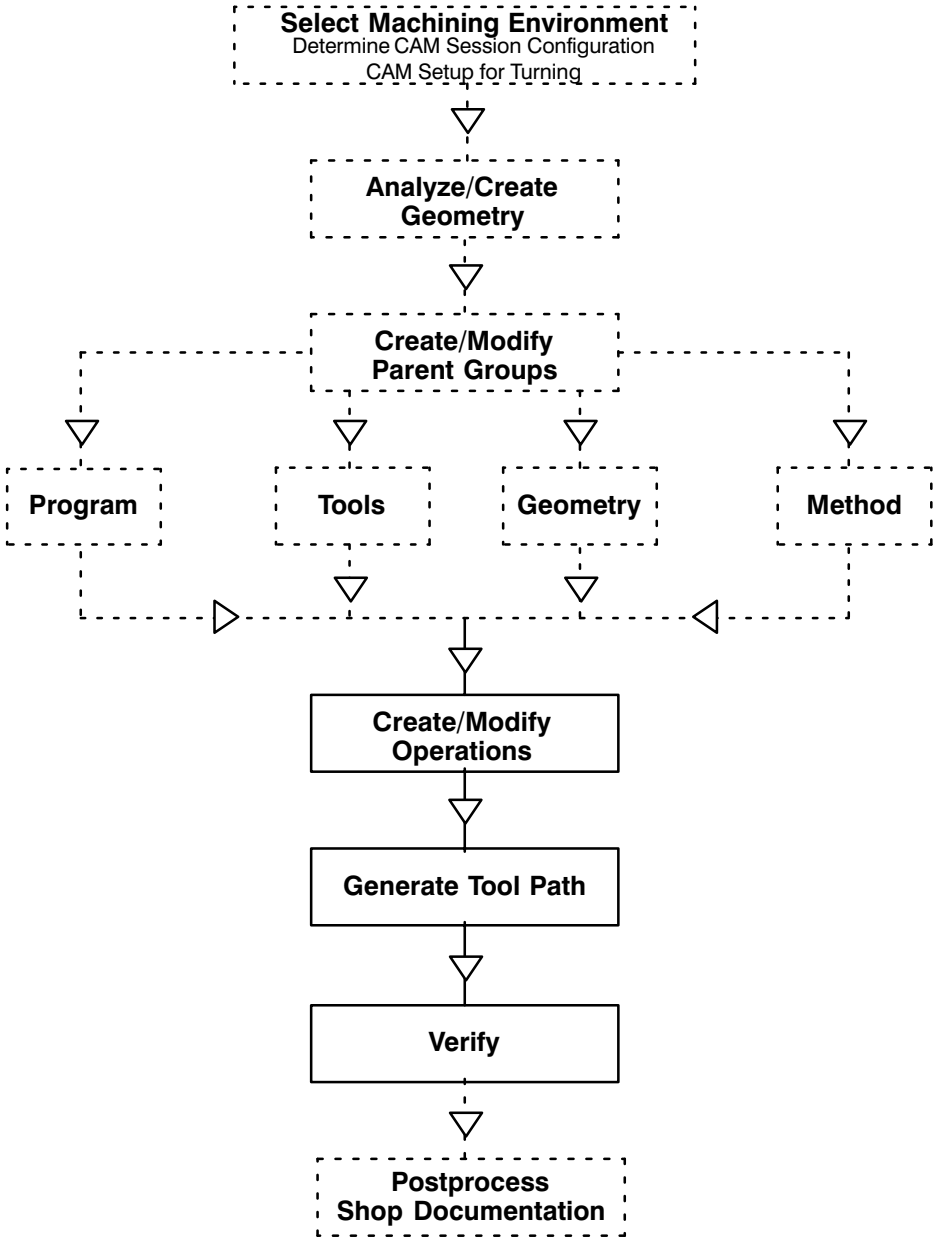
Roughing the OD

Section 6

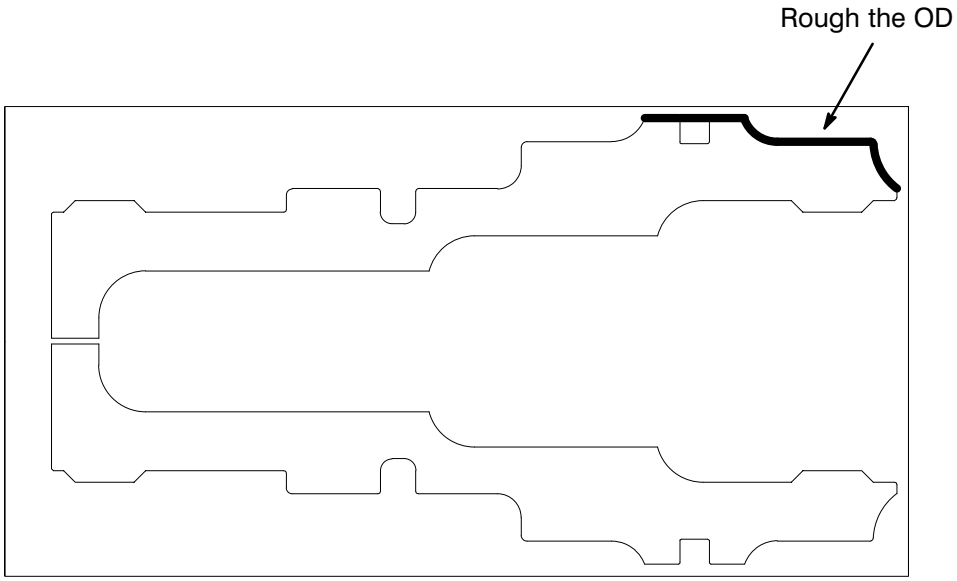
Unigraphics Manufacturing Process

Turning



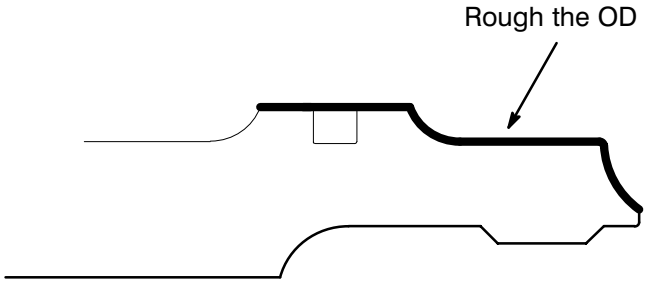
6

In this section of the workbook, you will use ROUGH_TURN_OD to machine the right end of the piston.



Step 1 If necessary, open the part from the workbook_parts directory, ***_piston_mfg_asmb_1.prt**.

Step 2 Create a ROUGH_TURN_OD operation, named RGH_OD, using the OD_80_L tool to cut the geometry as shown.



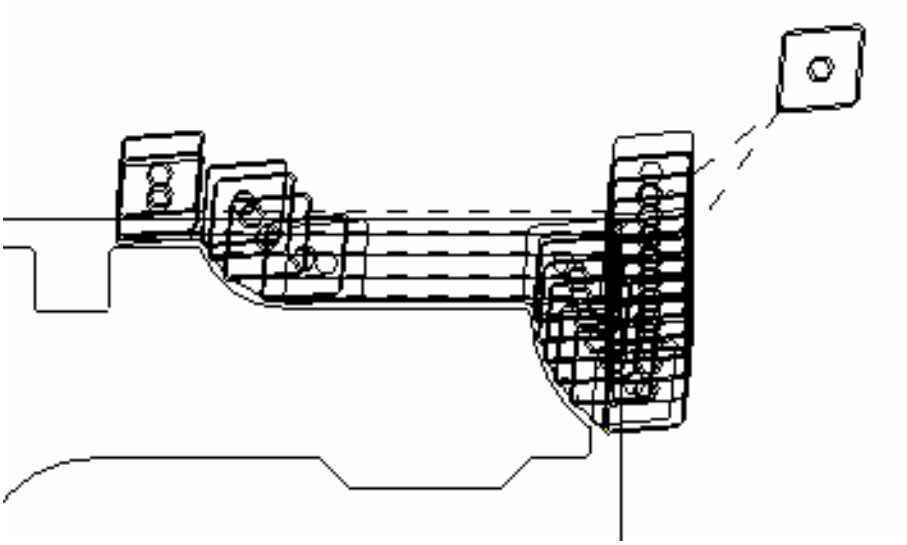
HINT Remember to define the Program, Tool, Method and Geometry Parent Groups for the operation. Choose WORKPIECE as the Geometry Parent Group.

- ❑ Define an appropriate Cut depth.
- ❑ Set the Containment options and then display the containment area.

- ❑ Add Start and Return Points.
- ❑ Remember to select Reversal Mode, Omit.

Step 3 Generate and verify the tool path.

Your tool path should look similar to the tool path shown.



Step 4 Save the part.

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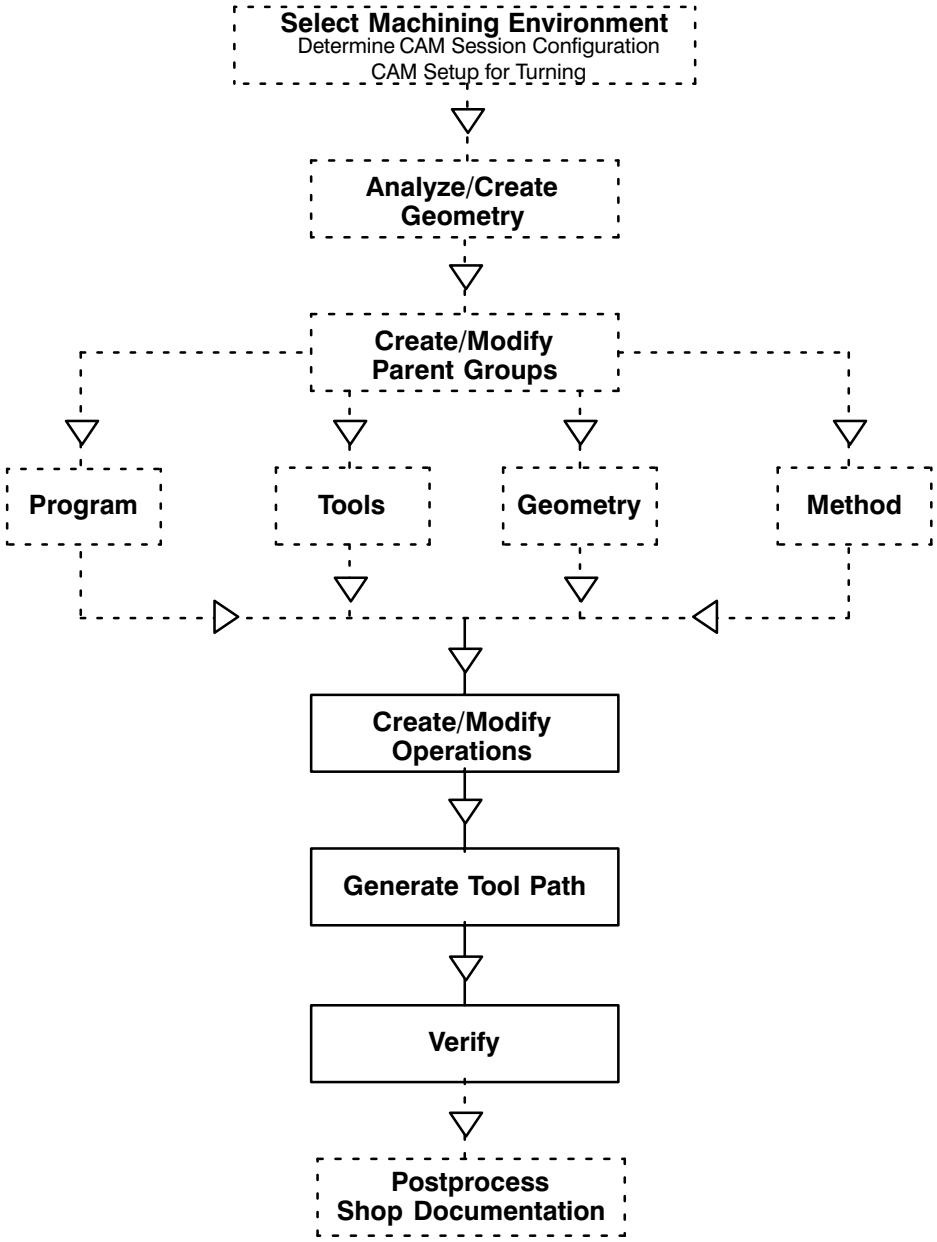
Roughing the ID

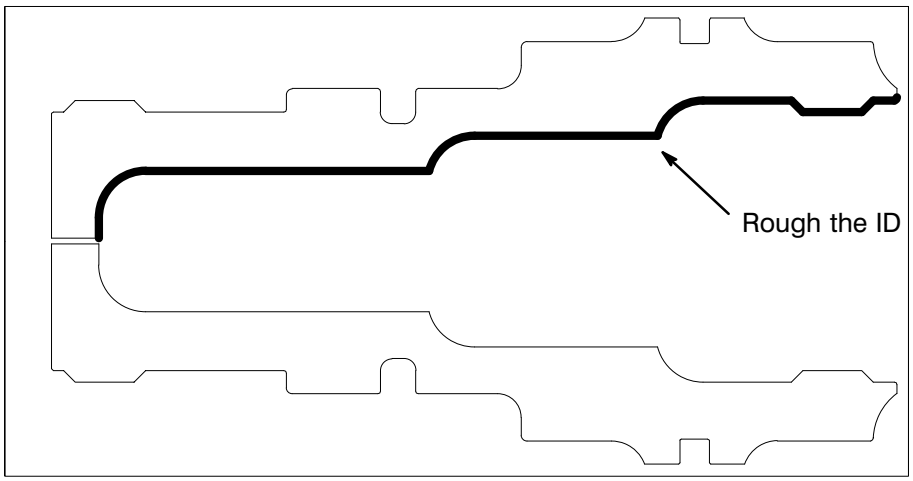
Section 7

Unigraphics Manufacturing Process

Turning

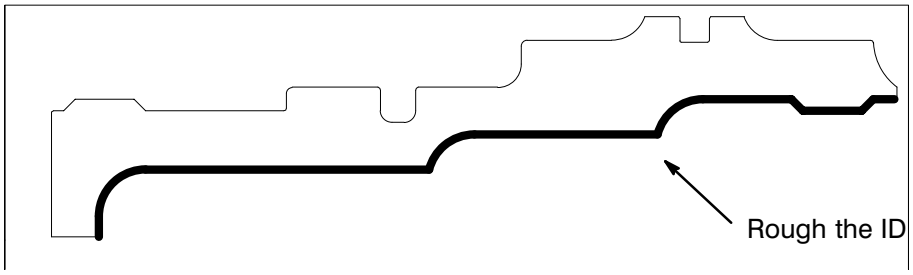


In this section of the workbook, you will use ROUGH_BORE_ID to machine the ID of the piston.

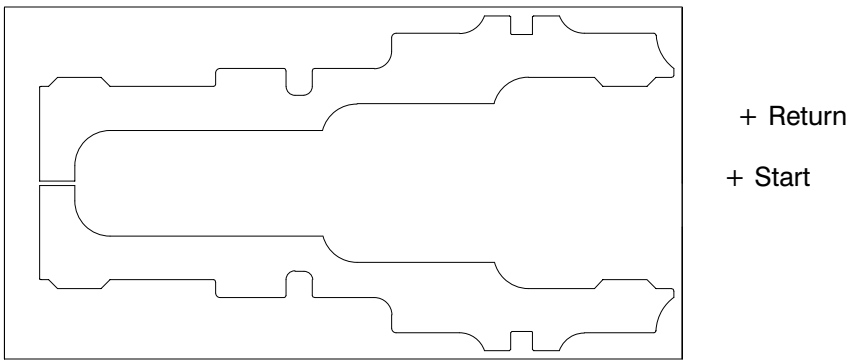


Step 1 If necessary, open the part, ***_piston_mfg_asmb_1.prt**.

Step 2 Create a roughing operation called RGH_ID, using the ID_80_L tool to cut the geometry as shown.

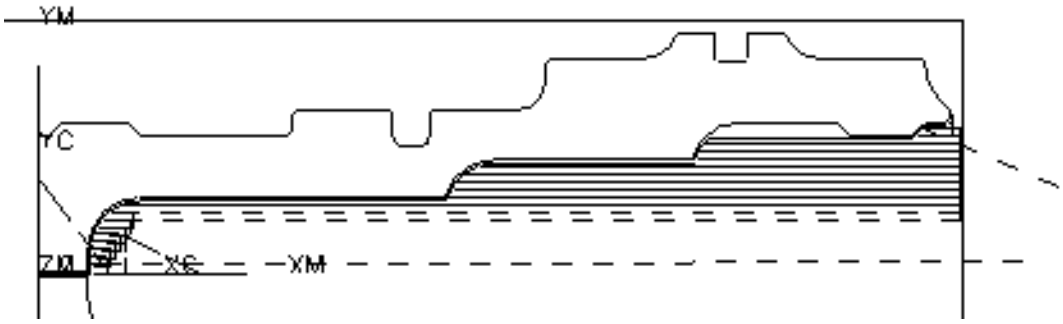


HINT Some of the options you may want to set are: Reversal Mode, Cut Depth, and Avoidance moves.



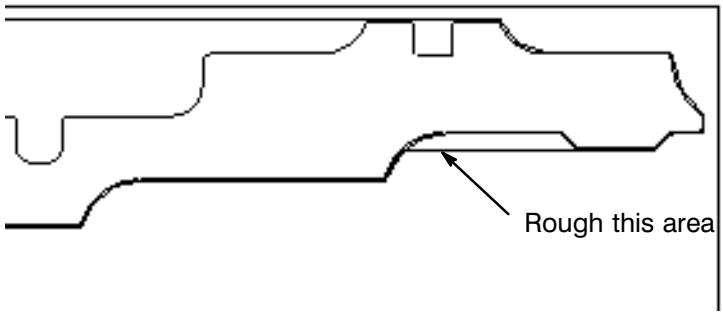
Step 3 Generate the tool path.

Your tool path should look similar to the tool path shown.



Step 4 You are going to create two operations to remove the material in the undercut region.

❑ Use **Workpiece→Show 2D** to verify the geometry to be cut.



Step 5 Create a roughing operation using the ID_55_L tool to cut the geometry as shown in the undercut (name the operation RGH_RELIEF_LEFT.).

❑ The Cleanup options should be set to Down Only.

Step 6 Create a second roughing operation using the ID_35_L tool to cut the remaining geometry in the undercut (name the operation RGH_RELIEF_RIGHT.).

Step 7 Save the part.

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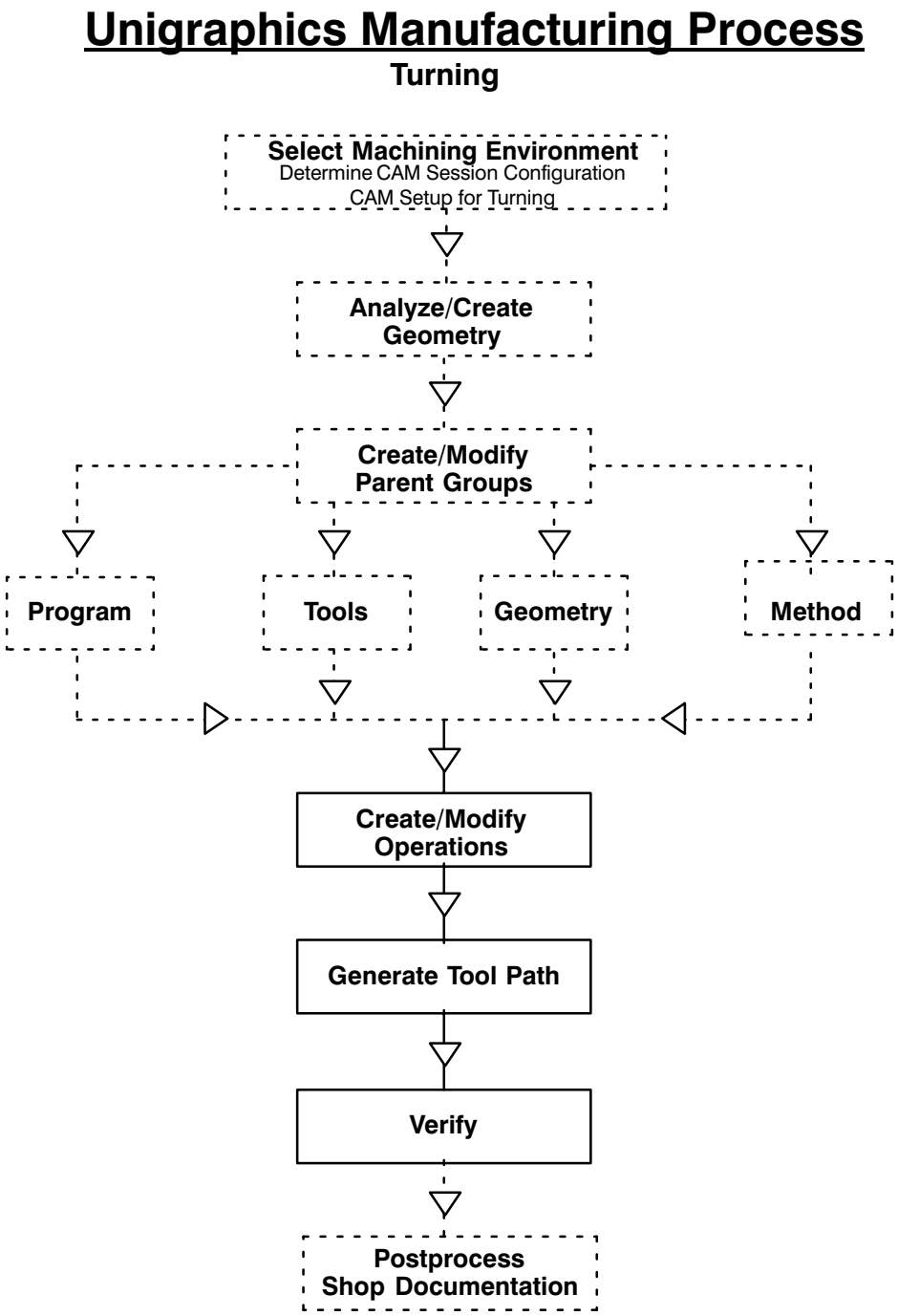
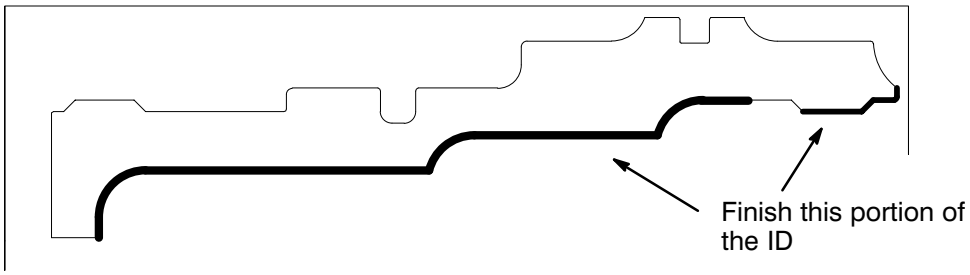
Finishing the ID and OD

Section 8



In this section, you will finish turning the ID and OD of the piston.

You will create three operations to finish the ID. The first and second operations will cut the geometry as shown in the following illustration.



Step 1 If necessary, open the part, *****_piston_mfg_asmb_1.prt.**

Step 2 Create an FINISH_BORE_ID operation, called FIN_FRT_ID, to finish the front of the ID using the ID_55_L tool.

❑ Set a Start Point only for the first operation.

HINT Check your Fillets setting, you may want to adjust this option.

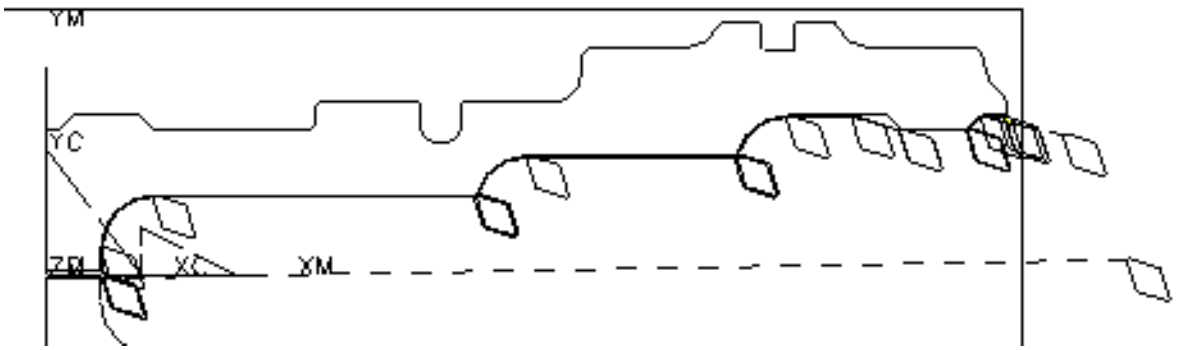
❑ Generate the tool path.

Step 3 Create another FINISH_BORE_ID operation, called FIN_ID, to finish the rest of the ID using the ID_55_L tool.

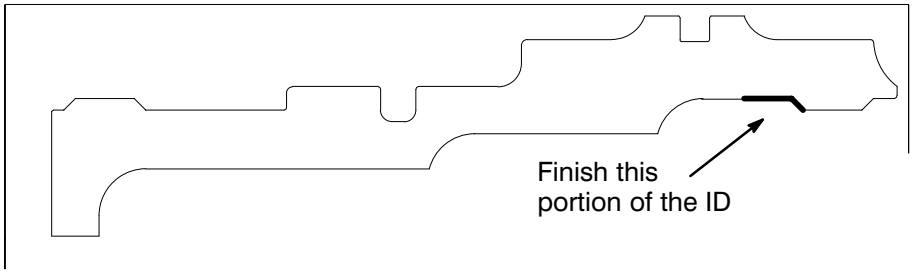
❑ Set a Return Point only for the second operation.

❑ Generate the tool path.

Your tool paths should look similar to the tool paths shown.



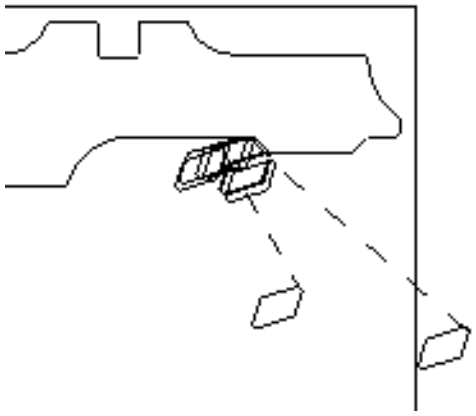
Step 4 Create a FINISH_BACK_BORE, called FIN_RELIEF_RIGHT, operation to finish the remaining portion of the ID using the BACKBORE_35_L tool.



❑ Add Start and Return Points.

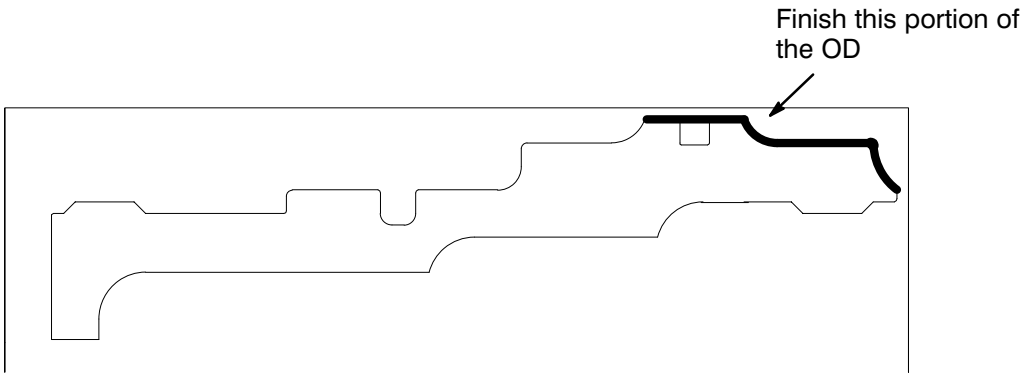
Step 5 Generate the tool path.

Your tool paths should look similar to the tool paths shown.



In this section, you will finish the OD of the piston.

Step 6 Create an operation to finish the OD, called FIN_OD, using the OD_55_L tool as shown.



❑ Set the Containment using Trim Points.

HINT Remember how to set Engage and Retract settings to control the engage and retract behavior at the Trim Points.

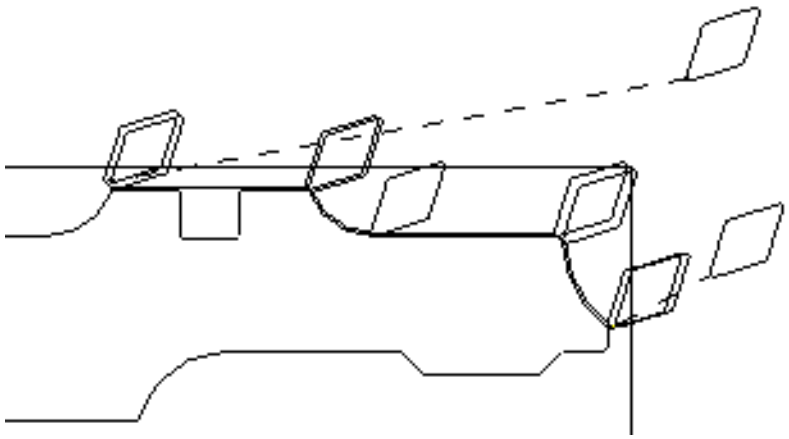
8

HINT Remember the Omit Reversals option.

❑ Add Start and Return Points.

Step 7 Generate the tool path.

Your tool path should look similar to the tool path shown.



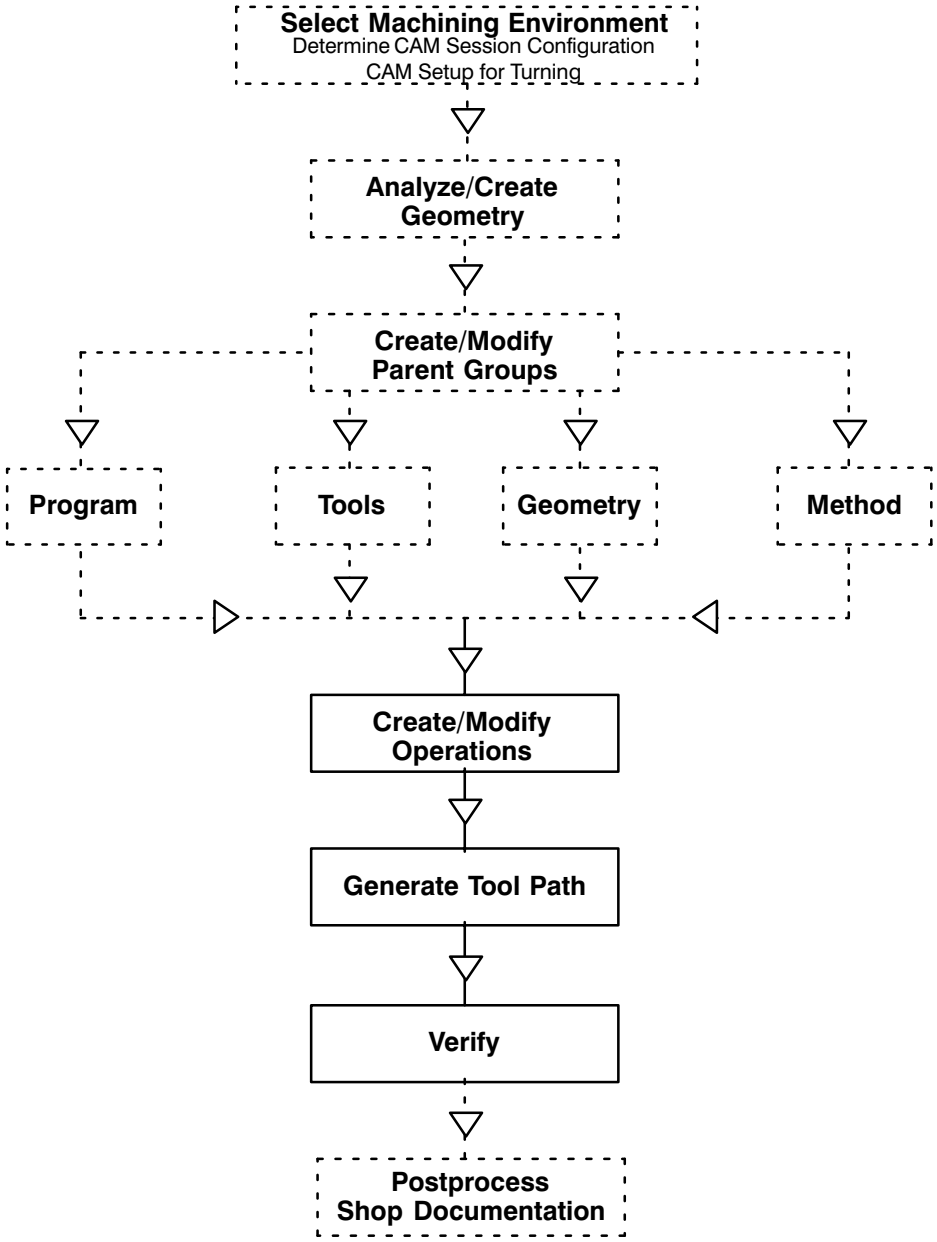
Step 8 Save the part.

Cutting the Groove

Section 9

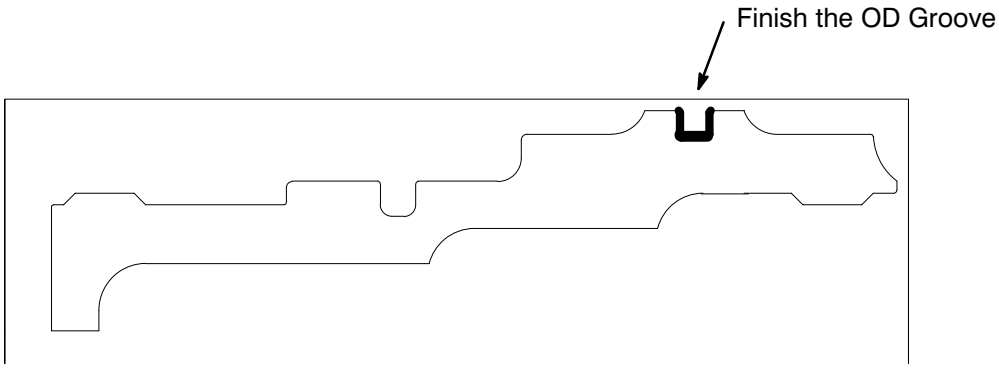
Unigraphics Manufacturing Process

Turning



9

You will use the Groove operation type to finish the grooved portion of the Piston OD.



Step 1 **If necessary, open the part, ***_piston_mfg_asmb_1.prt**.

Step 2 Create an operation to finish the groove, called FIN_GRV, using the OD_GROOVE_L tool.

- ❑ Use the Down Only Cut Pattern.
- ❑ Add Start and Return points.

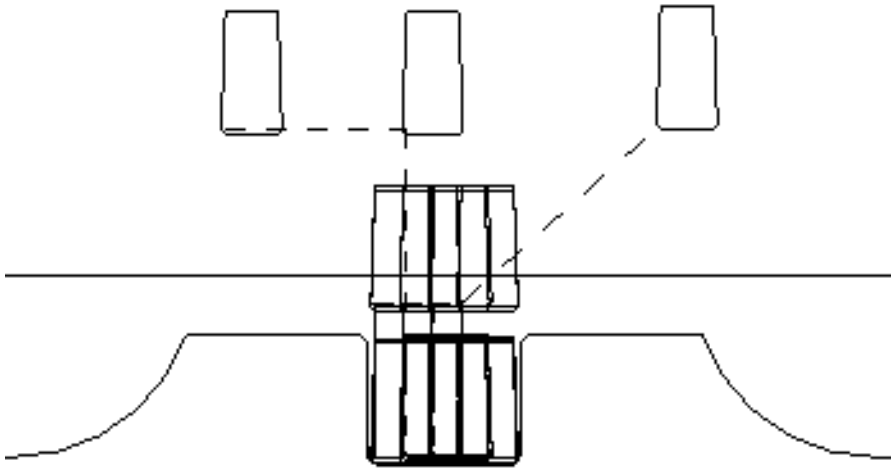
HINT Pay special attention to the motion you use to the Return Point.

- ❑ Modify the Retract Move (Level/Part).
- ❑ Define the Stepover (50%).

Step 3 Generate the grooving operation.

Step 4 Use the **Workpiece→Show 2D** to verify the cut.

Your tool path should look similar to the tool path shown.



Step 5 Save the part.

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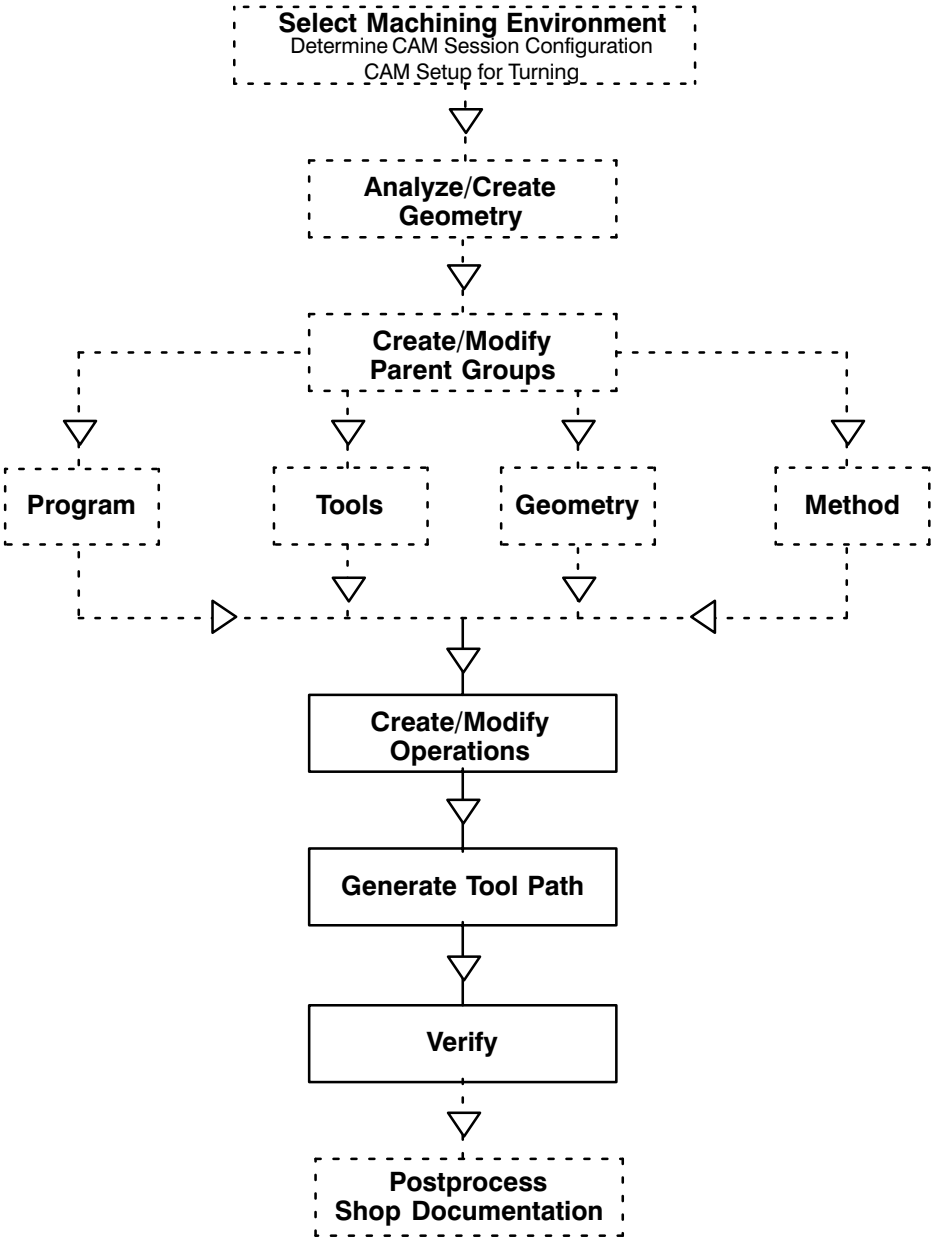
Teach Mode — Finish ID

Section 10

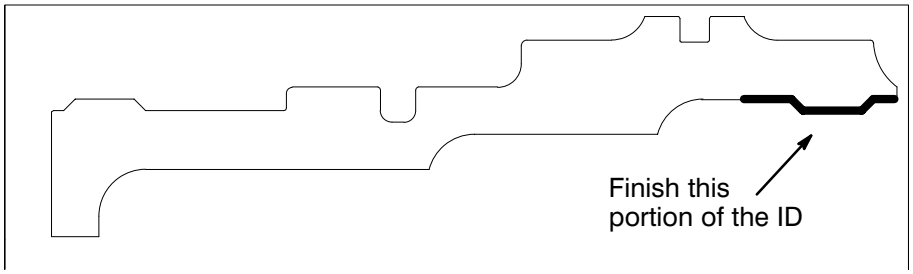
Unigraphics Manufacturing Process

Turning

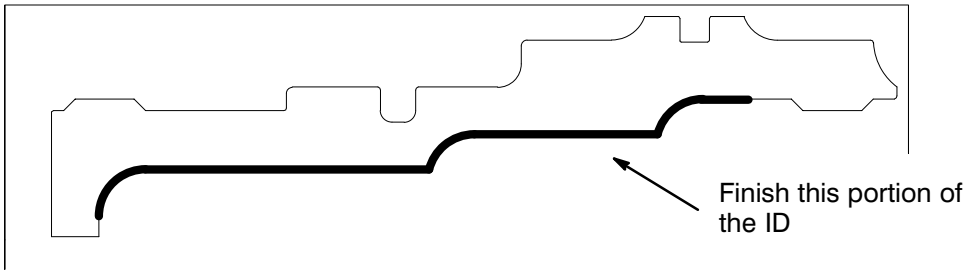


10

You will use the Teach Mode operation type to finish the front portion of the Piston ID.



You will then create a second operation to finish cut the ID as shown in the following illustration.



In this section, you are going to use a different part file to create the following operations. In your original part file, you have already finished this bore using the FINISH_BORE_ID and FINISH_BACK_BORE operation types. Later you will return to the original part file, ***_piston_mfg_asmb_1.prt**, and finish the programming. The new part, which looks the same as the original part, is used to show that you can finish this ID using a different operation type and to give you practice using Teach Mode.

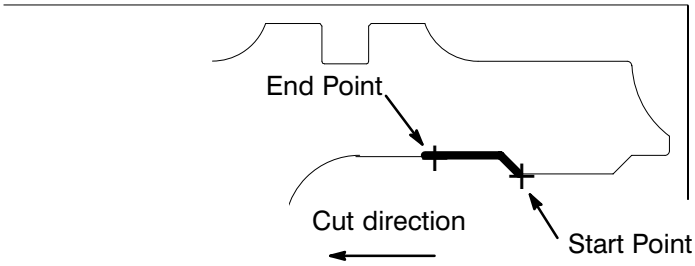
Step 1 Open the part from the workbook_parts directory, **tmp_piston_mfg_teach.prt**.

Step 2 Rename the part ***_mfg_piston_teach**.

Step 3 Create a Teach Mode operation to cut the front portion of the part using ID for the geometry parent group and BACK_BORE_35_L for the tool.

- ❑ Use the Auto Engage and Retract moves.
- ❑ Create two sub-operations.

Create the first Follow Curve Motion to cut the backside of the first large radius as shown.



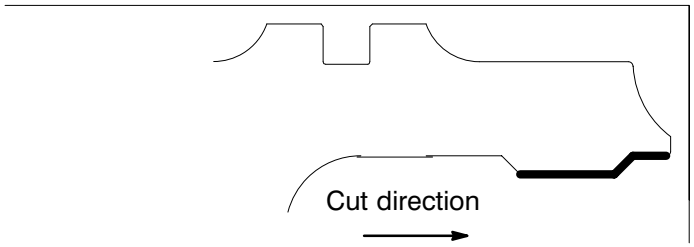
HINT Remember to select the material side in Follow Curve Motion before selecting the curves.

HINT The first motion sub-operation will use end points to define the cut geometry.

HINT The direction the ID geometry that was originally selected determines the cut direction.

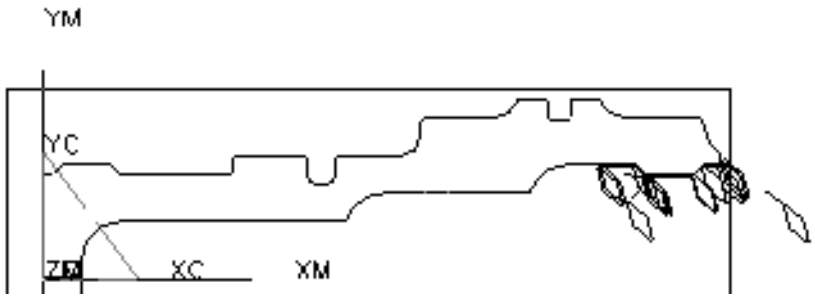
10

Create the second Follow Curve Motion to cut the flat towards the front face as shown.



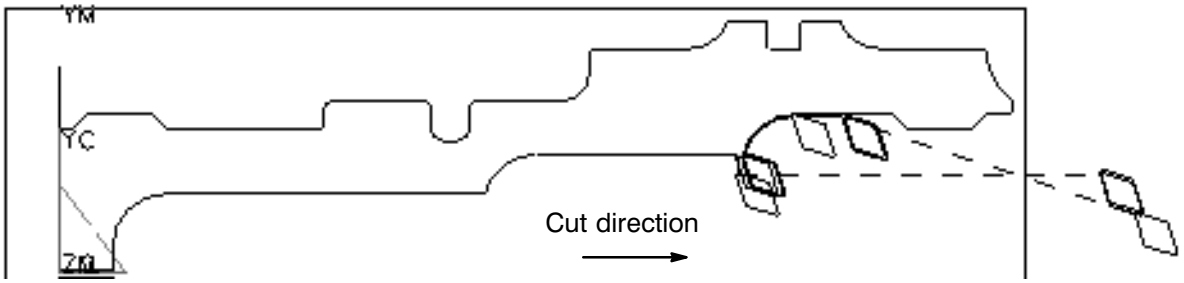
HINT The second cut motion sub-operation will require an offset from the start point. The Along Curve offset method works well.

Your tool path should look similar to the tool path shown.

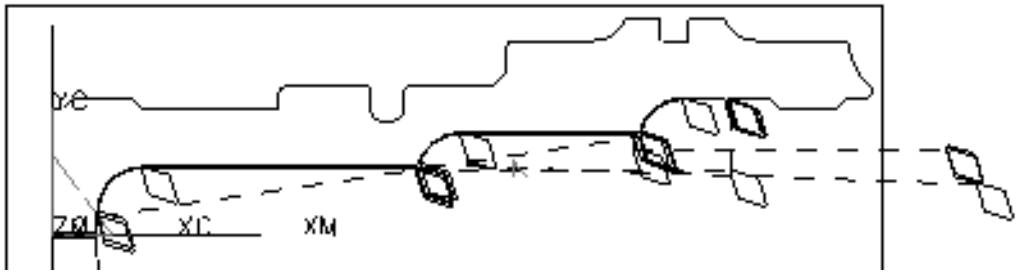


Step 4 Create a second Teach Mode operation to finish the remaining portion of the ID using the ID_55_L tool.

HINT This operation requires at least 3 tool motion sub-operations, each using points for the start and end geometry. The first Follow Curve Motion is shown below.



Your tool path should look similar to the tool path shown.



Step 5 Save the part.

10

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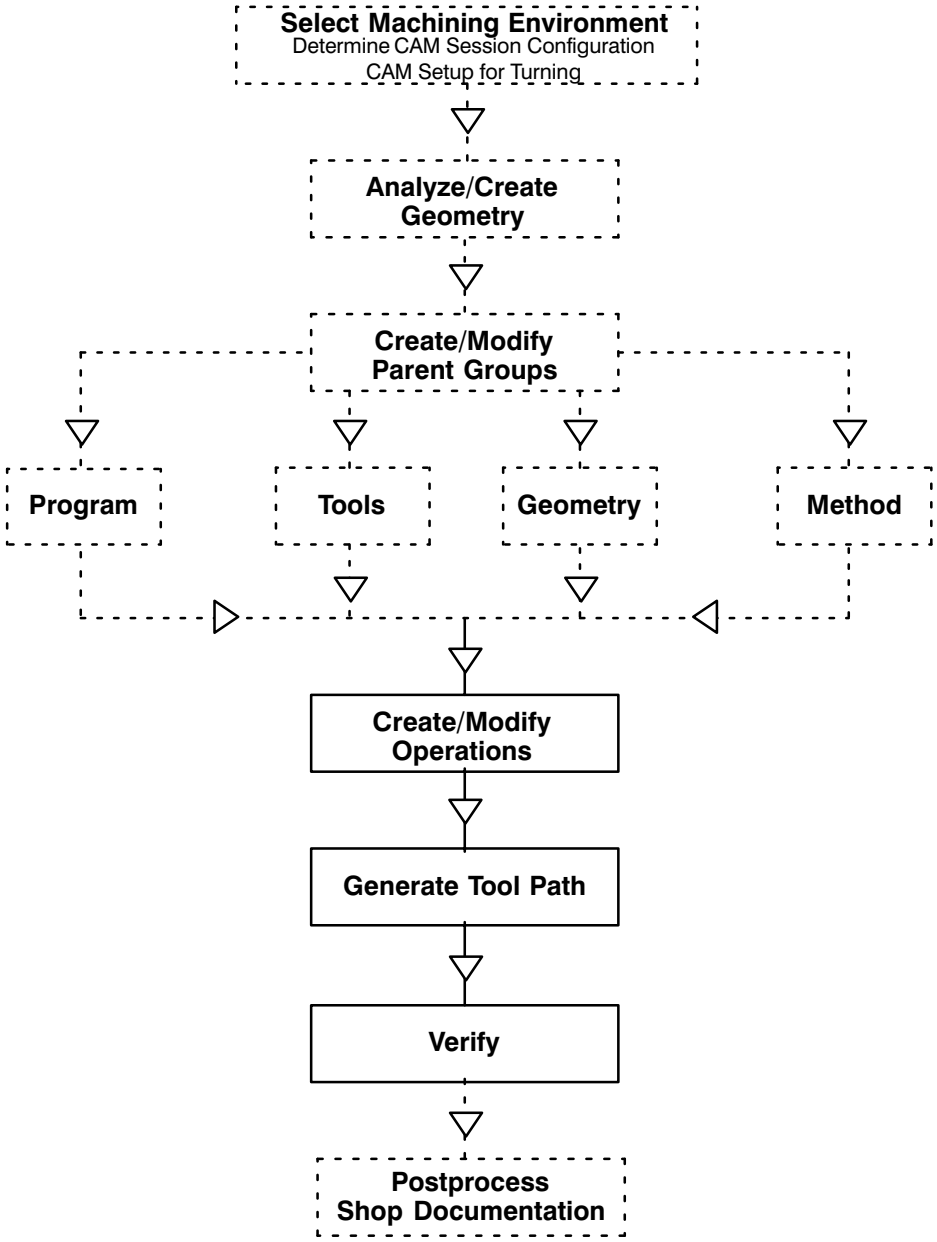
Cutting Threads

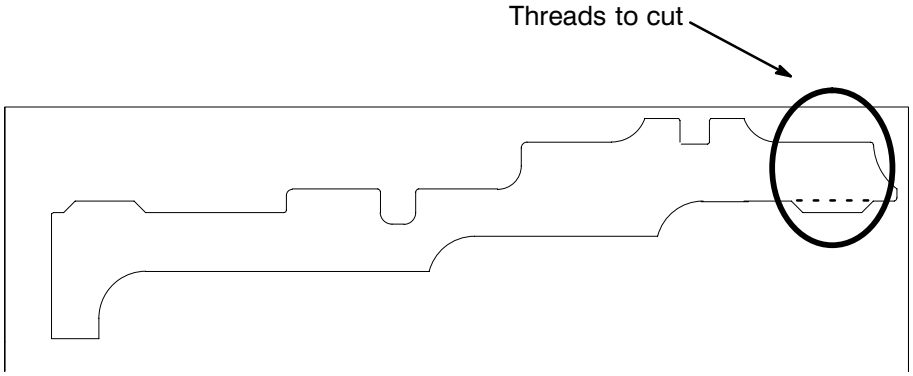
Section 11

Unigraphics Manufacturing Process

Turning



In this section, you are going to cut threads on the ID of the part as shown in the following illustration.



Remember, when you are creating these operations, common options, such as engage and retract parameters, and feeds and speeds must be specified.

You will now return to the part file that you were working with in a previous session.

Step 1 Open the part, ***_piston_mfg_asmb_1.prt.**

Step 2 Create an operation to thread the ID on the right end of the part, called THRD_ID, using the ID_THREAD_L tool.

HINT Remember to define the Program, Tool, Method and Geometry Parent Groups for the operation.

Step 3 Define the Thread Geometry.

HINT The crest line is the outside of the thread.

Step 4 Define the Pitch.

HINT This determines the threads per inch.

Step 5 Define the Total Depth the tool will cut (Depth & Angle; .225 depth & 180 deg).

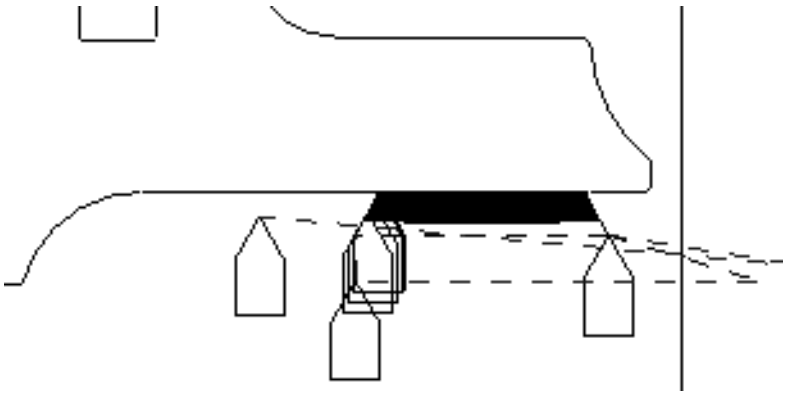
❑ Make sure to define the Increment setting.

HINT Remember, the increment defines how the tool will move from the crest line to the root line.

Step 6 Define an Offset for the Start and End of the Thread.

Step 7 Specify Finish and Chase Passes.

Your tool path should look similar to the tool path shown below.



Step 8 Save the part**.**

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