



FlowPATH User's Guide

M-320 Version 6.02

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Flow International Corporation
23500 64th Avenue South
Kent, WA 98032 USA

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CHAPTER 1

Introduction

FlowPATH is part of the FlowMaster software produced by Flow International Corporation (FLOW). The FlowPATH manual includes:

- FlowMaster Overview (Chapter 1)
- Installing FlowPATH (Chapter 1)
- Getting Started with FlowPATH (Chapter 2)
- FlowPATH Step-by-Step (Chapter 3)
- Drawing Tools (Chapter 4)
- Troubleshooting and FAQ's (Chapter 5)
- Appendix A. How to Be Successful with the FlowMaster 6.0 Programmable-Z

FlowMaster overview

FlowMaster is a fully automated machine-tool software program created specifically for waterjet and abrasive waterjet shapecutting. Operators of all skill levels can easily use the system, which integrates the ultrahigh-pressure pump, PASER ECL Plus, and the X-Y cutting table.

FlowMaster requires FlowPATH and FlowCUT. FlowNEST is an available option.

- FlowPATH is used for CAD and part program processing to order the jet-cutting path. It imports or produces vector-based (DXF) drawing files and outputs an ordered path (ORD) file to use in FlowCUT.
- FlowCUT uses the ORD file from FlowPATH to generate and communicate code to the machine tool and drive the PASER ECL Plus or waterjet to cut parts.
- FlowNEST is used to geometrically nest different parts on selected sheet material. It takes ORD (or DXF) files of individual parts and automatically combines them into a new larger ORD file suitable for use in FlowCUT. It can also save the quantity and types of parts nested into an NST file for later use.

User manuals for FlowPATH, FlowCUT and FlowNEST are provided on the FlowMaster CD.

- M-320, *FlowPATH User's Guide*
- M-322, *FlowCUT User's Guide*
- M-323, *FlowNEST User's Guide*

The following FLOW manuals were provided with your system.

- M-359, *PASER ECL Plus Operation and Service Manual*
- A high-pressure pump manual or an integrated X-Y machine tool manual

System requirements

	Waterjet Machine PC		Office PC	
	Minimum*	Standard	Minimum	Recommended
<i>Processor</i>	1 GHz	2.26 GHz or higher	1.6 GHz	2.4 GHz
<i>Memory</i>	128 MB	512 MB	256 MB	1 GB
<i>Graphics acceleration</i>	Onboard hardware acceleration	Onboard hardware acceleration	AGP 4x mid-range hardware acceleration with 64Mb of video RAM (OpenGL 1.1 compliance preferred)	AGP 8x mid-range hardware acceleration with 128Mb of video RAM and OpenGL 1.1 compliance.
<i>Mouse</i>	Optical 3-button wheel mouse	Optical 3-button wheel mouse	3 Button Wheel Mouse	3 Button Wheel Mouse
<i>Required disk space</i>	1 GB	1 GB	1 GB	1 GB
<i>Supported operating systems</i>	Windows 98 SE Windows XP SP2	Windows 98 SE Windows XP SP2	Windows 98 SE Windows 2000 with Service Pack 4 Windows XP with Service Pack 2	
<i>Temperature rating</i>	32° - 140° F	32° - 140° F	N/A	N/A
* Note: Based on the above minimum specifications for the machine PC, 100,000 non-elevated lines (including path arrows) were rendered at 5 frames per second.				

Note: Software performance is primarily a function of processor speed, memory capacity, and hardware acceleration. If you will be importing, manipulating, or pathing complex CAD geometry, the "recommended" specification should be considered.

Installation and setup

The installation of FlowMaster 6.02 is compatible with all versions of FlowMaster 3.1 or higher. Before installing the software, you will need the serial number located on the back of the software package. You will also need access to the Internet or a telephone in order to complete the FlowMaster 6.02 registration process.

Note: Registration is not required when upgrading from FlowMaster 6.0 or 6.01.

It is recommended that before beginning the installation process, you make a backup copy of your current System folder.

If you have any questions during installation, contact FLOW Technical Service at (253) 813-3318.

Installation Steps

1. Close all applications.
2. Insert the FlowMaster CD-ROM into your CD-ROM drive. An auto-run dialog box automatically appears.
3. Click on **Install software**.
4. Instructions appear on your computer screen to guide you through the remainder of the installation.
5. Following the Windows restart, you will need to register the software.

Registering FlowMaster

1. On the FlowMaster registration screen, verify that the serial number shown is the same as the serial number on the back of the software package. If the serial number is correct, click **OK**.
2. The Generate Activation Code screen will appear.
3. Click on the method you would like to use to obtain your activation code (Internet or by phone).
4. After receiving your activation code, click the Enter Activation Code button on the Activation Code screen.
5. Enter the code and click Continue Setup. If the registration is completed correctly you will receive a confirmation message.

You are now ready to run the FlowMaster Software Suite.

Installation troubleshooting

1. After system restart if you are not automatically prompted to enter the serial number, browse to C:\FlowMaster 6.0 and double-click **Register60.exe**, where c:\FlowMaster 6.0 is the default installation location. Follow *Installation steps* above.
2. When inserting the software CD, if the auto-run dialog does not start automatically, browse to your CD-ROM drive and double click **FlowMaster6.0.exe**. Follow *Installation steps* above.

Uninstalling FlowMaster

1. From the **Start** menu, select **Control Panel**.
2. Select **Add or Remove Programs** from the list.
3. Select the **Change/Remove** button associated with the FlowMaster 6.02 software and proceed with the uninstall program.

Conventions

Important	Notes marked Important provide operational instructions necessary for proper use of the program.
Tip	FlowPATH Tips are instructions that help you use the program more effectively.

Technical support

If you have a question about a specific FlowMaster program, consult the User's Guide for that program. If you have a question about the PASER ECL *Plus*, refer to manual M-359, PASER ECL *Plus* Operation and Service. If you have a question about the X-Y machine tool or the intensifier pump, consult these equipment manual(s).

If you cannot find the answer using these resources, telephone the FLOW support network in Kent, Washington, at (253) 813-3318. When you call, you should be at the machine tool or computer and have the appropriate product documentation at hand. Be prepared to give the following information:

- The version number of FlowPATH that you are using.
- The machine tool configuration you are using (Integrated Flying Bridge, Waterjet Machining Center™, etc.).
- What happened and what you were doing when the error occurred (document the error if possible).
- How you tried to solve the problem.

CHAPTER 2

Getting Started with FlowPATH

The FlowPATH application window is shown in Figure 1. Several FlowPATH toolbars are available: File, 2D View, Selection, Draw, Snap, Path, Path Utility, Modify, Style, 3D bar (see the Appendix), and Message. The FlowPATH toolbars give you instant access to the most frequently used FlowPATH commands. Many of these commands are also accessible through menu selections. The toolbars are shown or hidden using the **Window** pull-down menu. When you move the mouse pointer to an icon on a toolbar, a description appears near the icon and in the message bar at the bottom of the screen. The toolbar icons are described later in this chapter.

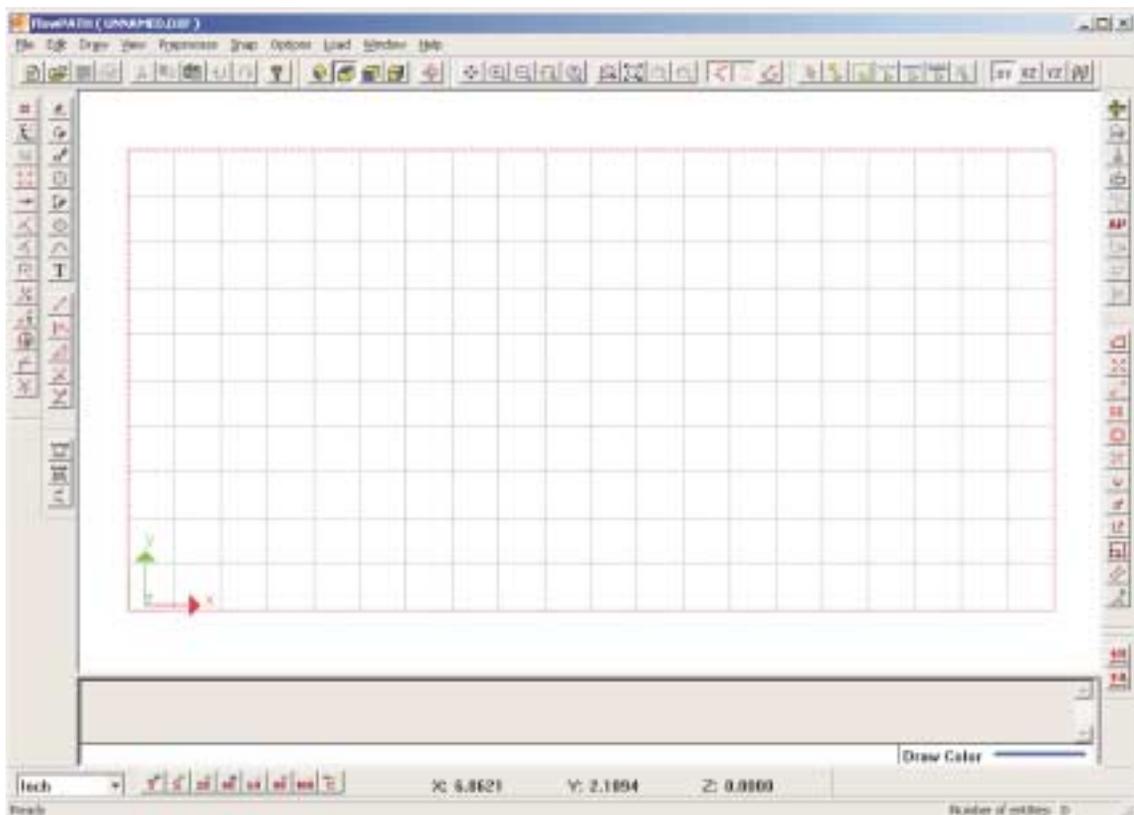


Figure 1. FlowPATH application window

Display options

The FlowPATH application window can be set to your specifications.

1. Select **Options | Display options** (see Figure 2).
2. Click on Selection: **Color** to open the color options dialog box (see Figure 3).

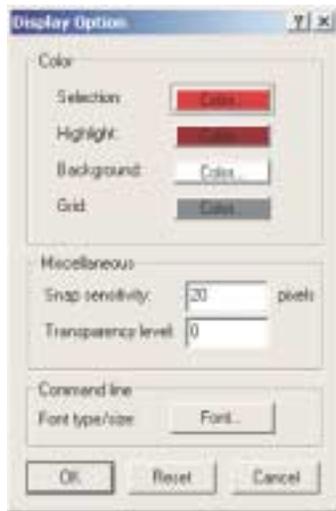


Figure 2. Display options



Figure 3. Color options

3. Click on a color and click **OK**. If you want a color that is not in the Basic colors grid, click on **Define Custom Colors>>**, click on a color, and click **OK**.
4. Repeat steps 2 and 3 to set Highlight, Background, and Grid options.
5. Enter a number for Snap sensitivity for your mouse. Snap sensitivity is how close you need to click to snap to an entity.
6. Enter a number for Transparency level.
7. Click on **Font** to open the Font dialog box (see Figure 4).
8. Select a font, font style, and font size.
9. Click **OK** to return to the Display options dialog box.
10. Click **OK** to accept changes or click **Reset** to return to the default settings.

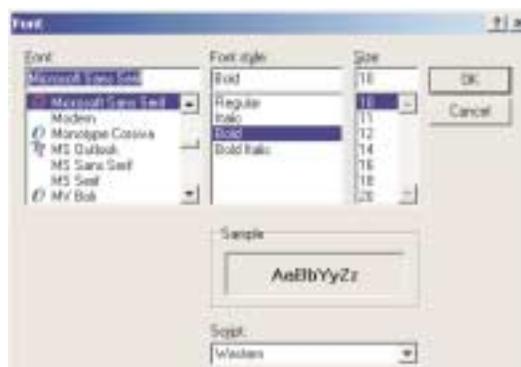


Figure 4. Font options

Icon size

The FlowPATH icons are available in two different sizes, and the **Window | Large icons** selection toggles between them. Select **Window | Large icons** to check the selection. A checkmark appears next to the selection when the large icons are in use. Select **Window | Large icons** again to return the icons to their original size.

Languages

The FlowPATH application screen can be viewed in several different languages.

Select **Options | Language** to choose the language you wish to use. A checkmark appears next to the selected language and the application window changes to the language you selected.

Note editor

The Note Editor dialog box is accessed by selecting **File | Note...** This box can be used for notes or comments associated with the drawing, which are saved in a separate file with the same file name as the DXF, but with a NTE extension. If the drawing is to be used at another location, be sure to include the NTE file with the drawing when you move it to its new location.

Data input

Data can be entered at the command line no matter where the cursor is located. Commands and prompts appear in the upper part of the window; values entered appear in the lower left area of the window (see Figure 5). A scrollbar on the right side of the input region allows you to view the previous commands entered.



Figure 5. Data input in instruction window

When you issue a drawing command by clicking on a drawing icon or by choosing a **Draw** menu selection, a prompt appears in the instruction window. Enter the requested value(s) and press <Enter>. If a coordinate pair is required, simply enter the X value and Y value separated by a comma, then press <Enter>.

Tip: If you choose to enter values, you must enter values for all requested data. For example, in the case where X and Y values are requested, if you enter the X coordinate and click the mouse before entering the Y coordinate, the X value you entered is ignored.

Dialog based

Some selections in FlowPATH have the option of entering information into a dialog box or at the command line. To access the dialog boxes, select **Options | Dialog based**. When Dialog based is checked, if a dialog box is available for your selection, it appears for you to enter text; if it is not checked or no dialog box is available for that selection, you can enter information at the command line.

Permanent and floating snap bars

Select **Window | Snap bar** to show or hide the permanent snap bar. Multiple selections can be made from the permanent snap bar.

Select **Snap | Snap bar** or right-click while any editing or drawing tools are selected. The floating Snap bar appears in the drawing window. Only one "snap" can be done at a time with the floating snap bar. After a snap function is selected from the floating snap bar, the snap bar disappears. To reopen the floating snap bar, right-click.

Figure 6 shows both snap bars in the screen image.



Figure 6. Permanent and floating snap bars

If one of the snap icons is clicked in the permanent snap bar, the snap function associated with that icon is the default snap operation. It then becomes unnecessary to use the floating snap bar or **Snap** menu because clicking the mouse automatically applies the selected snap function. If an icon on the permanent snap bar is clicked but the floating snap bar or **Snap** menu selection is used, then the floating snap bar and **Snap** menu selection override the permanent snap bar selection for the next point or value specified.

Important: Using the permanent snap bar can save many mouse operations if one type of snap is done frequently. However, be sure to disable the permanent snap bar by selecting the Disable snap icon  if operations are desired without snaps. For example, many users drag and drop entities "by eye" into a new location using the move function. The selected entities can snap into an unexpected location if one of the icons on the permanent snap bar is selected.

File toolbar icons

	Command	Menu	Description
	New	File	Creates a new document.
	Open	File	Opens an existing document.
	Save	File	Saves the active document.
	Print	File	Prints the active file.
	Cut	Edit	Cuts the selected entities.
	Copy	Edit	Copies selected entities to the clipboard.
	Paste	Edit	Pastes selected entities from the clipboard.
	Undo	Edit	Undoes the previous action (up to five operations).
	Redo	Edit	Redoes the previous action (up to five operations).
	About FlowPATH	Help	Displays program information.

2D view toolbar icons

	Pan	View	Pans the view
	Zoom in	View	Increases the size of the drawing in the drawing window.
	Zoom out	View	Decreases the size of the drawing in the drawing window.
	Zoom window	View	Defines a zoom window to increase the size of the drawing in the drawing window.
	Dynamic zoom	View	Zooms in or out of the drawing window by dragging the mouse.
	Zoom table	View	Restores and shows the part placement on the cutting table.
	Zoom extent	View	Fills the window with the part(s).
	Previous view	View	Returns the display to the previous window.
	Next view	View	Goes to the next display view.
	Show/hide path arrows	View	Shows or hides the path arrows.
	Show/hide grid	View	Shows or hides the grid.
	Show/hide nodes	View	Shows or hides nodes at entity endpoints.

Selection toolbar icons

	Select	Options	Left mouse button selects, right button deselects. Selected entities are highlighted. Ctrl + click toggles the selection. Click and drag to select more than one entity. Note: If you click at a location with more than one entity, a pop-up box appears for you to select one, all, or none of the entities.
	Select same speed	Options	Selects all entities of one speed. In the dialog box, enter the speed or drag the scroll bar to choose a speed. Selected entities are highlighted.
	Select contour entities	Options	Selects all entities that lie along a continuous path through the selected point. Ctrl + click toggles the contour. Note: If you click at a location with more than one entity, a pop-up box appears for you to select one, all, or none of the entities.
	Select traverse lines	Options	Selects all traverse line entities in the drawing.
	Select cutting lines	Options	Selects all cutting line entities.
	Select all	Options	Selects cutting entities and rapid traverse lines. Selected entities are highlighted.
	Invert	Options	Inverts selection. NO ICON-only available through the Options menu.
	Deselect	Options	Deselects the selected entities.

Draw toolbar icons

See "Drawing Tools" (Chapter 4) for more information.

	Command	Menu	Description
	Line drawing functions	Draw	Enables line drawing functions.
	Arc drawing functions	Draw	Enables arc drawing functions.
	Rectangle drawing functions	Draw	Enables rectangle drawing functions.
	Circle drawing functions	Draw	Enables circle drawing functions.
	Arc-line drawing functions	Draw	Enables arc-line drawing functions.
	Ellipse drawing functions	Draw	Enables ellipse drawing functions.
	Curve drawing functions	Draw	Enables curve drawing functions.
	Text drawing functions	Draw	Enables text drawing functions.

Snap toolbar icons

The snap bar icons appear on both the permanent and floating snap bars. See "Snap tools" (in Chapter 4) and "Permanent and Floating Snap Bars" earlier in this chapter for more information.

	Command	Menu	Description
	Cancel procedure	Snap	Cancels the current procedure.
	Disable snap	None	Disables any active snap icon.
	Snap grid	Snap	Snaps to the set snap spacing.
	Snap orthogonal	Snap	Snaps to the horizontal, vertical, or set degree angle.
	Snap endpoint	Snap	Snaps to the endpoint of the nearest entity.
	Snap perpendicular point	Snap	Snaps to a point perpendicular to nearest entity.
	Snap nearest	Snap	Snaps to the nearest entity.
	Snap center point	Snap	Snaps to the center point of arc or circle.
	Snap one-third point	Snap	Snaps to the one-third point of nearest entity.
	Snap middle point	Snap	Snaps to the middle point of nearest entity.
	Snap quadrant point	Snap	Snaps to the quadrant point of nearest entity.
	Snap tangent point	Snap	Snaps to the tangent point of nearest entity.
	Snap intersection	Snap	Snaps to the intersection of the nearest entities.

Path toolbar icons

	Command	Menu	Description
	Tape measure	Options	Measures the distance between two points.
	Examine drawing	Options	Examines the drawing for gaps and offset problems.
	Purge	Edit	Purges all duplicated and zero-length entities.
	Avoid cutting area	Preprocess	Avoids rapid traverses across previously cut parts when using Auto order path.
	Draw traverse lines	Draw	Draws traverse lines between lead-ins/lead-outs.
	Auto order path	Preprocess	Automatically orders the path with the selected entities.
	Manual order path	Preprocess	Manually orders the path.
	Back up	None	Backs up to previous intersection and reselects path direction.
	Remove current path	None	Deletes existing path ordering information so that the path can be reordered.

Path utility toolbar icons

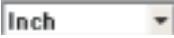
	Draw lead-in/lead-out	Draw	Draws lead-in and lead-out lines.
	Draw lead-in/lead-out with traverse	Draw	Draws lead-in and lead-out lines with traverse line.
	Property settings for lead-in/lead-out	Draw	Defines lead-in and lead-out properties.
	Tab	Draw	Draws tab lines.

Modify toolbar icons

See "Editing Tools" (in Chapter 4) for more information.

	Fillet	Edit	Creates a fillet between two selected entities.
	Create intersection	Edit	Creates an intersection between two entities.
	Split/Extend	Edit	Splits or extends the entity to the new end point.
	Array rectangular	Edit	Arrays selected entities by row and column.
	Array circular	Edit	Arrays selected entities radially.
	Mirror	Edit	Mirrors entities.
	Rotate	Edit	Rotates selected entities.
	Move	Edit	Moves selected entities.
	Scale by factor	Edit	Scales entities by a factor (number).
	Scale entities	Edit	Scales selected entities.
	Offset	Edit	Draws an offset to the last selected entity.
	Rubber Banding	Edit	"Stretches" an entity or a node between entities.

Style toolbar icons

	Command	Menu	Description
		None	Selects either millimeter or inch for system unit of measurement.
	Traverse	Preprocess	Moves the PASER or waterjet without cutting.
	Scribe	Preprocess	Moves the PASER with water only (no abrasive).
	20% speed	Preprocess	Assigns very slow cutting speed (20%), excellent cut surface. The entity selected appears light green.
	40% speed	Preprocess	Assigns slow cutting speed (40%), good cut surface. The entity selected appears dark blue.
	60% speed	Preprocess	Assigns moderate cutting speed (60%), moderate cut surface. The entity selected appears light blue.
	80% speed	Preprocess	Assigns fast cutting speed (80%), slightly rough cut surface. The entity selected appears magenta.
	100% speed	Preprocess	Assigns very fast cutting speed (100%), rough cut surface. The entity selected appears yellow.
	Custom	Preprocess	Allows customer to define cutting speed. Initiates the Speed Selection dialog box. When selecting a custom speed between two standard speeds, the color will be a darker version of the higher speed. For example, if the custom speed selected is 47%, the color will be between dark blue (40%) and light blue (60%).

Notes

FlowPATH Step by Step

Start FlowPATH

Select **Start | Programs | FlowMaster 6.0 | FlowPATH** or click on the FlowPATH icon.

Open the drawing file

You can draw a new part in FlowPATH or open an existing file created in another CAD package. For information on drawing a part, refer to the drawing tools in Chapter 4. FlowPATH can open DXF, IGS, CDL, and HPL file types. FlowPATH can also open bitmap files (BMP, JPG, PNG, PICT, TIFF, etc.)

Notes:

You can also open ORD files from FlowPATH, FlowNEST, or FlowCUT.

FlowPATH does not support all files created by other CAD packages.

Load drawing file

1. Select **File | Open...** or click the Open file icon  .
2. Click the down arrow on the "Files of type" box to select the file type.
3. Click on the file name and click **Open**.

To reload a recently used file, select **File**. The last four files used are displayed at the bottom. Click on the file name.

Load sample file

Sample files are located in the c:\FlowMaster6.0\examples folder. It is best to change a file's name so that you don't accidentally save it over the sample file.

1. Open a sample file.
2. Select **File | Save as....** Enter a file name in the "File name" box and click **Save**.

Draw or create new file

1. Use the FlowPATH drawing tools (see Chapter 4) to draw or create a new file.
2. Select **File | Save** or the Save icon  to save the drawing as a DXF file.

Open raster image (bitmap) file

1. Select **File | Load Image File...** to open an existing raster image (bitmap) file.
2. Click the down arrow on the "Files of type" box to select the file type, then click on the file name.
3. Click **Open**. The file is displayed.

Vectorize setup

To vectorize part of an image, go to *Vectorize selected image*. To vectorize entire image, go to *Vectorize image*.

Vectorize selected image

Select **File | Vectorize Selected Area**. Click and drag to select the part of the image to vectorize. After the image is selected, the Vectorize Setup dialog box opens (see Figure 7).

Vectorize image

Select **File | Vectorize Image** to open the Vectorize Setup dialog box (see Figure 7).

Note: For black and white and most monochrome images, use the default RGB settings provided by FlowPATH. If necessary, adjust the size by using the pixels per inch setting.

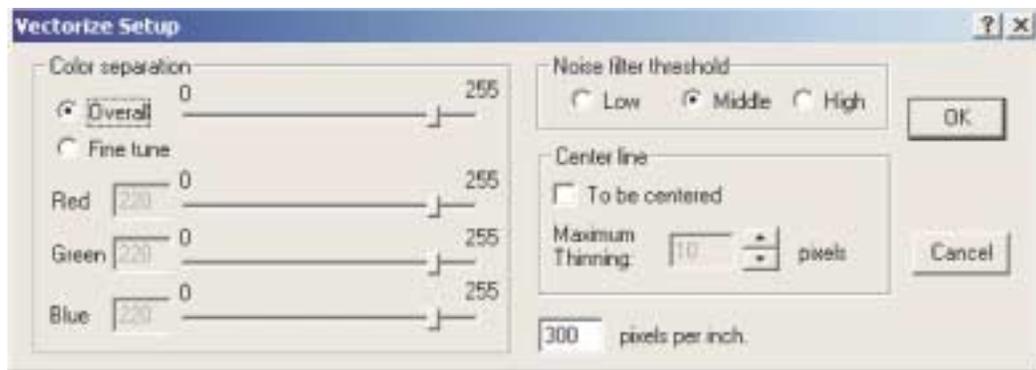


Figure 7. Vectorize Setup dialog box

Color separation

Overall—Select **Overall**. Click on the slide bar to adjust the overall RGB setting. Drag the control bar to see the dynamic change

Fine tune—Select **Fine tune**. Click on the slide bar to individually adjust the red, green, and blue color settings. Drag the control bar to see the dynamic change for each color.

Noise filter threshold

Select **Low**, **Middle**, or **High** to filter unwanted pixels from the raster data.

Note: The lower the filter, the more pixels used.

Center line

Check **To be centered** to enable the centering feature. This generates a middle line image instead of an outline of the raster image.

Note: The Center line feature only applies to an area with less than the number of pixels defined in Maximum Thinning.

Pixels per inch

1. Enter the pixels per inch parameter to control the size of the vector image.

Note: Show/hide the image file by selecting **View | Show Image** or pressing Ctrl+D.

2. Select **File | Save as....** Enter a file name in the "File name" box and click **Save**.

Note: The file saves as a .DXF.

Shape library

The shape library consists of common, predefined shapes. A dialog box allows you to specify parameters of the shape.

1. Select **Load | Library** to open the Shape Library dialog box (see Figure 8).
2. Click on a shape to select it and open the dialog box for that shape.



Figure 8. Shape library

3. Enter the parameters.

Note: To keep the shape dialog box open so you can add more parts of that specific shape, go to step 4. If you are only adding one shape from the dialog box, go to step 5.

4. Select **Apply** to add the shape to the parts list and to keep the dialog box open. When you have added as many parts as you need from the shape dialog box, go to step 5.
5. Select **OK** to add the shape to the parts list and close the dialog box.

Define and position entities

Entities must be defined and positioned on the cutting table at the desired scale before FlowPATH can prepare an ordered path for cutting.

Tip: The first time a DXF file is imported from a CAD software package, entities can appear as rapid traverse lines (light dashed lines). Rapid traverses are not considered entities with an assigned speed; therefore, you must first convert the traverses to cutting entities.

Select **Options | Select all traverse lines** or click on the Select traverse lines icon  or select **Options | Select** or click on the Select icon . Click to start and define a window around all lines/entities. The rapid traverse lines are highlighted. Click on one of the speed buttons in the style bar to convert all traverses to cutting entities.

Select **Options | Deselect** or click on the Deselect icon  to deselect all entities.

1. Click on the Zoom table icon  to view the part in relation to the cutting table.

Position the part for cutting by selecting the part and moving it to the desired location on the screen.

2. Select **Options | Select all entities** or click on the Select all icon  (or press Ctrl+A) to select ALL entities (including traverse lines) of the part before you move it. Selected entities are highlighted.
3. Select **Edit | Move entities** or click the Move icon  (or press F9), to move the entities to the desired location on the cutting table.

You can also select **Edit | Move all entities**, which does not require that the entities be selected first. Click to activate the move function. As you move the mouse, you'll see the image move around on the cutting table display. Click to place the part in the desired location. To reposition the part, repeat steps 1, 2, and 3. Snap functions (see "Snap Tools" in Chapter 4) can be used for exact positioning of entities.

4. If necessary, scale the part to enlarge or reduce the size. To scale a part, select all entities of the part. There are two options to scale the part.
 - Select **Edit | Scale by factor** or click on Scale by factor icon . In the dialog box or at the command line, enter the scaling factor (2 to double the size, 0.5 to reduce by half, etc.). Click OK.
 - Select **Edit | Scale entities**. Click to select the origin point, click to select the first reference point, click to select the second reference point, or enter values at the command line.

Assign cutting speeds

Each entity, or segment of the shape, is assigned a cutting speed, which can vary within the shape. Cutting speed represents edge quality: a fast cut produces a rougher edge finish; a slow cut produces a smoother edge finish. The cutting model accommodates corners, so it's not necessary to assign a slower speed around corners.

Tip: The first time a DXF file is opened in FlowPATH, entities often default to rapid traverse lines (dashed lines). In the "Define and position entities" procedure you should have selected all components of the shape to convert these traverse lines to entities.

1. To assign or change cutting speeds, select entities by using **Options | Select** or click on the Select icon , then click near each desired entity one at a time; the entity nearest the cursor is selected when you click. You can also use the other selection tools to select the entities. Selected entities are highlighted.
2. Choose **Preprocess | Assign speed** and select the speed, or click on the appropriate style bar speed buttons. The entities appear in the color on the icon representing the assigned speed. For example, an entity at 40% speed appears in dark blue, and an entity at 80% speed appears in magenta.
3. To assign speeds to another entity or set of entities, select those entities and then repeat steps 1 and 2.

Note: You can also manually draw traverse paths or scribe paths by using either the **Preprocess | Assign speed** menu choices or the Traverse  or Scribe  style bar icons.

Examine the drawing

The Examine drawing function is designed to help locate any gaps in a drawing before the path is ordered. In addition, this function helps identify any potential problems caused with the tool offset when it is applied in FlowCUT.

A sample part is used in these instructions to show how a drawing is examined. In this example, the part is a simple plate with two holes and a V-groove (see Figure 9). At this point the drawing contains no lead-ins or lead-outs. A drawing can be examined with or without lead-ins and lead-outs, but this example is clearer without them.

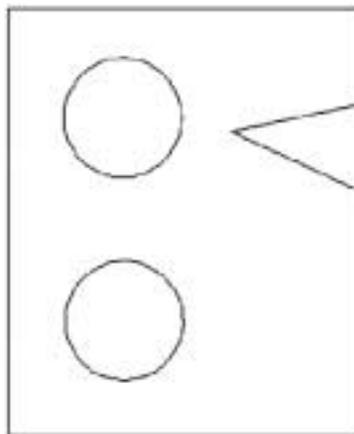


Figure 9. Simple part before examination

1. After the part is drawn, select **Options | Examination properties...**(see Figure 10).
 - Enter the anticipated cutting offset.
 - Enter the connected point tolerance (allowed gap size).

Once you have entered the desired values, click **OK**. If you want to save these values as the default values, click on **Save as default**.



Figure 10. Options | Examination Properties... dialog box

2. Select **Options | Examine Drawing** or click on the Examine drawing icon  to check the drawing. Figure 11 shows how the drawing looks after being examined. Comments on the image point out some of the features of the examined image.

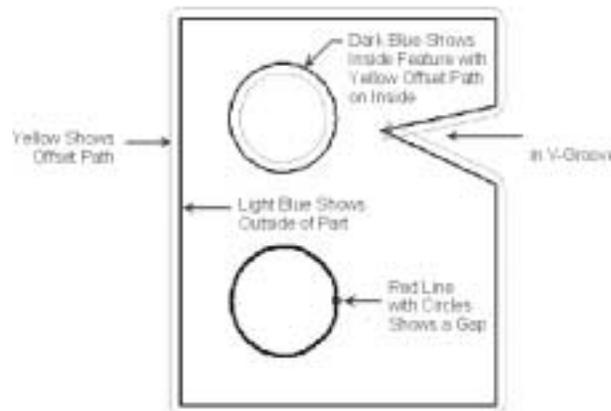


Figure 11. Simple part after examination

3. Select **Options | Examine Drawing** or click on the Examine drawing  icon again to restore the original drawing.

When the drawing is examined, it is first checked to identify all closed paths. The outermost closed path is drawn in light blue. This is assumed to be the outside of the part, and an estimated offset path is drawn in yellow outside of it. Any closed paths found inside of the outermost light blue path are assumed to be "holes" and drawn in dark blue. For these paths the estimated offset is drawn in yellow on its inside. If there are any more closed paths inside of the holes they are drawn in alternating colors of light blue and dark blue with the offset path drawn on the appropriate side.

If there are any open paths, they are drawn in red with the open ends surrounded by small circles. This allows any unexpected gaps or overlapping entities to be identified and modified before the path is ordered. If the lead-ins and lead-outs have already been drawn, they are displayed in red with the open ends circled. Any single-pass "slots" are also open-ended and drawn in red. In Figure 11

the examination revealed that there is an unwanted gap in the middle circle that needs to be closed. Figure 11 also shows that there is an unexpected difference between the offset path of the V-groove and the drawing. Zooming in on the point of the V-groove reveals a small entity at the point of the V that caused the offset path to be different from what would be expected. By finding and correcting this problem in FlowPATH, the machine operator does not have to deal with it when cutting the part.

Note that the location of the offset path is based on the assumption that the outermost path requires an outside offset and that a hole requires an inside offset. If the part being cut does not follow this convention, simply ignore the offset image and use the gap checking feature.

Tape measure

The tape measure allows you to determine the measurement between two points on the drawing.

1. Select **Options | Tape measure** or click the Tape measure icon .
2. Click to select the start point.
3. Drag the mouse. The distance is displayed dynamically while the mouse is moving.
4. Click to select the end point.
5. The distance is shown in the instruction window (see Figure 12.)

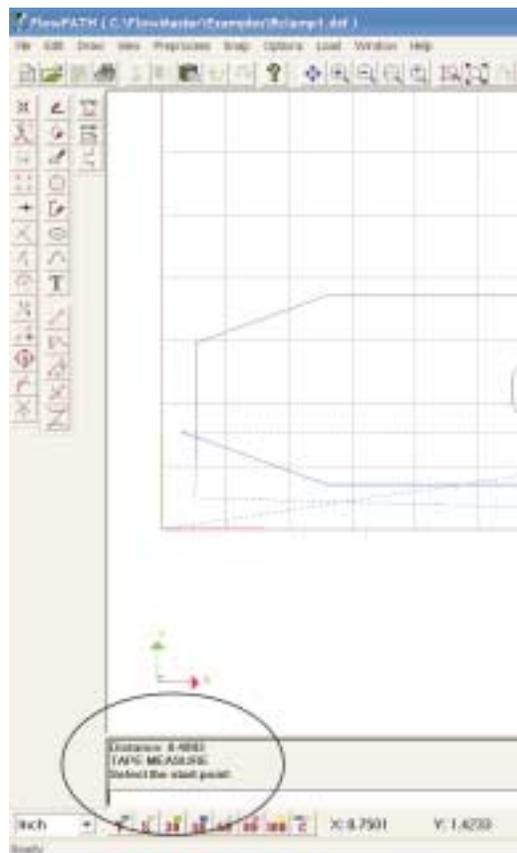


Figure 12. Tape measure distance location

Order the cutting path

After the shape is drawn/imported and you have assigned cutting speeds and checked the drawing for offsets or gaps, you can then proceed with either manual or automatic path ordering.

The auto path ordering feature is extremely powerful when linked with the manual path ordering feature. Some drawings may not lend themselves to automatic path ordering because they have open-ended lines or special tool offset conditions, and it is possible to manually order one part of a drawing and automatically order the rest of it.

For example, these two brackets are on the same drawing. One bracket could be drawn with all of the lead-ins/lead-outs and rapid traverse lines, while the other bracket has just the main geometry. Manually order the first bracket, then highlight the second bracket and use the Auto path ordering tool. Not only is the second bracket ordered, but also a rapid traverse is drawn between the manually ordered part and the automatically ordered one.

Avoid cutting area

Select **Preprocess | Avoid cutting area** or click on the Avoid cutting area icon . A checkmark shows that this feature is turned on. This mode prevents traverse lines from crossing previously cut parts.

Manual path ordering

In manual path ordering, you must first assign lead-ins/lead-outs and link the leads with traverses before you order the path. You can either assign lead-ins/lead-outs, then link the leads with traverses (see *Draw lead-in/lead-out and link leads with traverse*) or you can assign lead-ins/lead-outs and traverse lines at the same time (see *Draw lead-in/lead-out with traverse*).

Lead-ins and lead-outs are entry and exit points for the jet as it cuts one or more shapes. Lead-in is the point at which the jet enters the shape, and lead-out is the point at which the jet exits the shape. The profiles are cut in the order in which you assign lead-ins/lead-outs, so it's important to think the path through before you begin this step. Since the jet leaves a small cut on the lead-in/lead-out, add the lead-in/lead-out on the inside or outside of the shape as appropriate. For example, if your finished part is a disk, assign the lead-in/lead-out on the *outside* of the shape. If the shape is the silhouette of a circle or a hole, assign the lead-in/lead-out on the *inside* of the shape.

When you add a lead-in/lead-out at a corner, if the corner is made from two arcs, the arcs at the corner are extended. If the corner is made from two lines, the lines are extended. If the lead-in/lead-out is placed at a point that is not a corner, the lead-in/lead-out is placed along the entity containing that point for "piercing on the line."

Tip: It is a good idea to save a copy of the file prior to assigning lead-ins/lead-outs.

Note: A snap tool must be activated to draw a lead-in/lead-out.

Draw lead-in/lead-out and link leads with traverse

1. Select **Draw | Lead-in/lead-out properties...** to open the Lead-in/Lead-out Properties dialog box (see Figure 13) where you can confirm or make changes to the properties. These values are used when you draw lead-ins/lead-outs. If you want to save these values as the default values, click on **Save as default**.
2. Select **Draw | Draw lead-in/lead-out** or click on the Draw lead-in/lead-out icon .



Figure 13. Lead-in/Lead-out Properties dialog box

3. Define the point(s) at which the jet should begin and end the cut by clicking at the appropriate points on each geometry of the shape. Begin with the inside geometries, then move the jet to the outside perimeter. Remember that the jet cuts the profile in the order that you assign lead-ins/lead-outs. Assign a lead-in/lead-out to each geometry of the shape. Click on the outside of the entity to place the lead-in/lead-out on the outside of the geometry, and click on the inside of the entity to assign the lead-in/lead-out to the inside of the geometry.
4. After all geometries have been assigned lead-ins/lead-outs, select **Draw | Link leads with traverse** or click on the Draw traverse lines icon . Rapid traverse lines (linkage lines) link the lead-ins/lead-outs to move the jet to the next cutting point. Rapid traverse lines are indicated by light dashed lines and show cutting head movement only; they are not cutting lines.

Tip: When you add lead-ins/lead-outs, do so in sequence with no interruptions. For example, if during the process of adding lead-ins/lead-outs you decide to add a new entity, the program cannot automatically link leads with rapid traverse lines.

Draw lead-in/lead-out with traverse

1. Select **Draw | Lead-in/lead-out properties...** to open the Lead-in/Lead-out Properties dialog box (see Figure 13) where you can confirm or make changes to the properties. These values are used when you draw lead-ins/lead-outs. If you want to save these values as the default values, click on **Save as default**.
2. Select **Draw | Draw lead-in/lead-out with traverse** or click on the Draw lead-in/lead-out with traverse icon .

3. Define the point(s) at which the jet should begin and end the cut by clicking at the appropriate points on each geometry of the shape. Note as you click to define the points, a traverse line is automatically added.

Tip: Add lead-in/lead-outs in sequence with no interruptions. For example, while adding lead-ins/lead-outs you add a new entity, then draw lead-in/lead-out with traverse again. The program cannot automatically link from the last lead-out to the new lead-in with rapid traverse lines.

Order the path

Once you have assigned lead-ins/lead-outs and have linked the leads with traverses, you can proceed to order the path.

Tip: Before you order the path, you should remove unnecessary or duplicated entities that may have been created in an imported drawing. Select **Edit | Purge entities** or click on the Purge icon  to open the Purge Entities dialog box. Click **OK**. Another dialog box appears saying how many entities were purged; click **OK**.

Tip: You can cancel the path ordering process right after you have pressed the Manual order path icon  but before you have clicked on a lead-in entity by pressing the Cancel procedure icon  on either the permanent or floating snap bar.

Tip: At this point you can correct for potential gaps in the entity connections to ensure a continuous cut (see Examine drawing and Figure 10).

1. Select **Preprocess | Manual order path** or click on the Manual order path icon . When prompted, select the lead-in node for the shape (it might help to zoom in on the shape to select the node). This is the starting point of the jet's cutting path, and it should be the first lead-in you assigned.
2. After you select the open entity, the Path Properties: Kerf Offset dialog box (see Figure 14) opens for you to set kerf offset options:
 - **Semi-automated**—Check this box to enable semi-automated path ordering. This looks for the direction of the path and keeps going. If it can't find the direction, it will stop and ask traverse and cutting lines.
 - **Kerf offset**—Define the direction of tool offset (sometimes called cutter compensation). The jet is offset slightly (left, right, or none) from the cutting line to accommodate the radius of the jet itself. If semi-automated is not checked, and if you know all offsets are in the same direction, check "Offset valid for all entities" in the dialog box. Then you are not prompted for an offset direction after each rapid traverse. Check "No offset for lead-in and lead-out" if you do not want offsets for lead-in and lead-out. If you want an offset for lead-in/lead-out at a corner, check "Offset for lead-in/lead-out at corner".

Note: Right offset is recommended for DWJ cutting.

- **Automatically lift up Z for traverse**—Check to automatically lift up Z for traverse and enter the absolute value to lift the Z.

Note: This only applies to traverse lines created by FlowPATH. The program does not modify user-defined traverse.

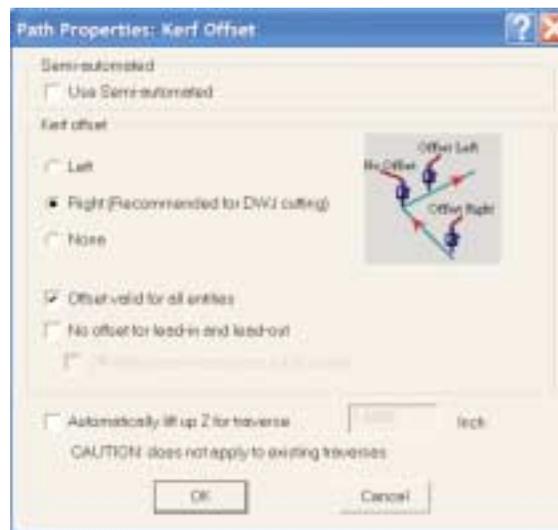


Figure 14. Path Properties: Kerf Offset dialog box

3. After the first offset is defined, click **OK** to begin ordering the path. As FlowPATH programs the jet's path (if semi-automated is not selected or when multiple direction is found), choose one of the highlighted entities for the direction of the tool path by clicking on that selection. Choose the direction. If you did not select "Offset valid for all entities," you are prompted for an offset direction after each rapid traverse. Click "Left", "Right", or "None". Continue choosing the tool path for the remaining profiles.

To stop the program or to add a different path, select **Preprocess | Remove current path** or click on the Remove current path icon . To return to the previous intersection and modify the path, click on the Back up icon . You can back up 20 intersections.

4. When the program ends, you will see this prompt: "Do you want to complete the manual path process?". Choose **Yes** to finish the manual path ordering. Choose **No** to continue to manually order another part. A dialog box prompts you to pick the link entity type. You can link the next part with a cutting line or rapid traverse line.
5. Click **OK** when the path ordering is complete. The jet's path is displayed with red arrows. Use these arrows to ensure the tool offset is displayed as you intended (i.e., arrows showing offset to the inside of the inner path geometries, like holes, and arrows showing offset to the outside of the part periphery).

Automatic path ordering

Important: Before using auto path ordering, first examine the drawing (as described in the previous section, *Examine the drawing*) and make any necessary corrections to the drawing. Also select **Edit | Purge entities** or use the Purge icon  to remove unnecessary or duplicated entities.

1. Select the part (or parts) to be ordered.
2. Select **Preprocess | Auto order path** or press the Auto order path icon . FlowPATH goes through the same analysis of closed paths that it does when examining the part. FlowPATH is able to determine if a closed path contains a lead-in or lead-out.

Note: If no selection is made, the user is prompted to make a selection.

3. If no lead-ins or lead-outs are detected, the auto path function adds these based on the settings from the **Draw | Lead-in/lead-out properties...** dialog box (see Figure 13). For example, the lead-in/lead-out is placed on the side of the estimated offset and located in the center of the longest line. If no line exists, the lead-in and lead-out is placed in the center of the longest arc.

Depending on the size of the entity you wish to cut, the lead-in/lead-out may overlap. If an entity is smaller than the defined lead-in/lead-out, the radius/length will be automatically trimmed in half until it fits the entity.

Select the **Trim Length of Lead-in/Lead-out for Arcs** tab to set range(s) for a percentage of the radius/length defined in the lead-in/lead-out properties (see Figure 15). If an arc is too small, the lead-in/lead-out can be unsatisfactory. Set arc size ranges and choose what percent of the lead-in/lead-out properties to use.

Check Enable to use the table.

- Enter the number of ranges you wish to use.
- Enter the radius between two numbers for each range.
- Enter the percentage of the radius/length (defined in the Lead-in/Lead-out Properties tab).

Uncheck Enable to dim the table so it cannot be used. If Enable is unchecked, the current settings remain.

If lead-ins and lead-outs already exist, FlowPATH uses these when linking sections with rapid traverse lines. Figure 16 shows how the part from Figures 9 and 11 was automatically ordered. Note the automatic addition of the lead-ins and lead-outs.

The automatic path ordering routine is consistent in the direction it orders the path. Outside loops (e.g., the outside of the part) are always ordered in a counterclockwise direction with a right offset. Inside loops (e.g., a hole) are always run in a clockwise direction with a right offset.

Note: Trim length does not apply to manual path or if the lead-in/lead-out already exists.

4. Select **Preprocess | Auto order path** to open the Auto path setting dialog box (see Figure 17).
 - Select offset choice (left, right, or no offset).
 - Check "No offset for lead-in and lead-out" if you do not want offsets for lead-in and lead-out.
 - Check "Offset for lead-in/lead-out at corner" if you want and offset for lead-in/lead-out at a corner.
 - Enter the corner angle and click the drop down box to select where the corner lead-in/lead-out should be.

Note: Entering 0.0 in the corner angle effectively "turns off" this feature. The larger the number entered, the greater the likelihood that an angle will be considered a corner and a lead-in/lead-out will be assigned.

- Check "Automatically lift up Z for traverse" and enter the absolute value to lift the Z.
- Enter a value for the "Clearance for avoiding cutting area." This will add an offset to the cutting instead of cutting right on the line.
- Click **OK** or **Save as default**.

Note: The Auto path setting only affects the automatic path ordering. Manual path ordering is still controlled by the user.

Tip: While the automatic path ordering feature is extremely powerful, there are always some cases where the path ordering does not do what is most desired by the user. As a general rule, **it is strongly recommended that a drawing be saved as a DXF file before automatic ordering.** This is especially important if FlowPATH is adding the lead-ins and lead-outs. By saving the drawing as a DXF file it is possible to recover the drawing in case custom features need to be added manually before the automatic process.

It is also important to properly use the Remove current path icon . Clicking this icon allows the path to be reordered. This could be necessary if parts of the drawing are edited after it has already been ordered. To ensure proper path ordering, click the Remove current path icon and reorder the path using either the manual or automatic tools provided. **If an ORD file is imported into FlowPATH to be modified, it is also necessary to click the Remove current path icon before using the auto path feature. If this is not done, the part might run twice when brought into FlowCUT.** This is because FlowPATH analyzes and remembers features of the ordered path when the file is opened. (This allows immediate display of the path order arrows even though the path was ordered during another FlowPATH session.)

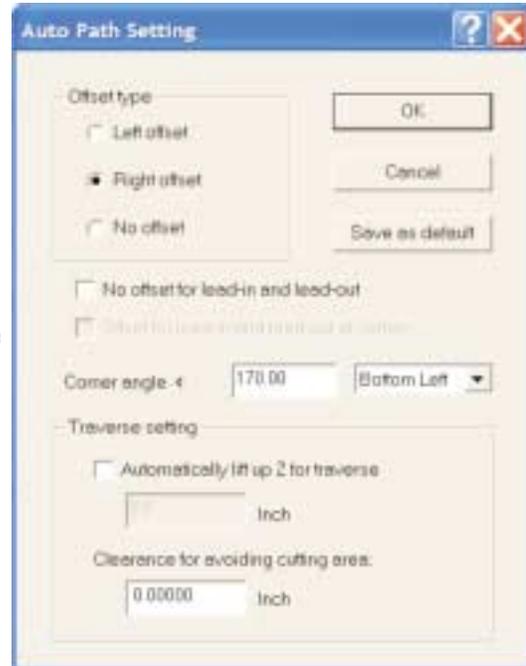


Figure 17. Auto Path Setting dialog box

If a drawing is to be reordered using the automatic path ordering function, the drawing most likely has existing rapid traverse lines. When the drawing is reordered, it is possible that some of the pre-existing rapid traverse lines might not be used. Select the **Edit | Delete unused rapid traverse line** command to remove these unnecessary lines.

After the path has been ordered, lead-ins and lead-outs can be dragged and dropped to new locations along the same contour. Select **Edit | Drag lead-in/out** to drag the lead-in or lead-out to a new location along the same contour. If the lead-in/lead-out is at a corner, a note in the command bar asks what entity to base the orientation on.

Note: If you edit drawings after the path is ordered, some commands will bring up a dialog box and require that you reorder the path.

Export/save the file

After FlowPATH has finished ordering the path, export the file as an ORD (path) file. The ORD file is used by FlowCUT. You can also save the drawing as a DXF file.

1. Select **File | Export path as...** to export the file as an ORD file. Select the appropriate drive and folder, enter the file name and click **Save**.

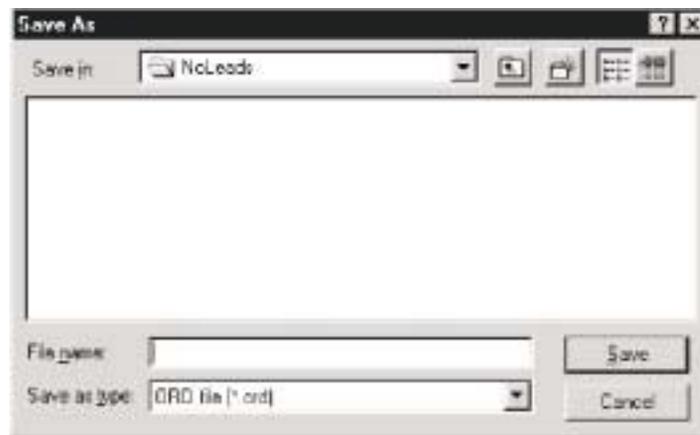


Figure 18. File | Export path as... dialog box

2. To save the drawing as a DXF file, click on the Save icon  on the file bar or select **File | Save as...** Select the appropriate drive and folder, enter the file name, and click **Save**.
3. To save selected entities of the part profile, select the desired entities. Select **File | Save selected entities as...** Select the appropriate drive and folder, enter the file name, and click **OK**.

Export 5.x path as...

To save the file as an earlier version of FlowPATH (with Z-axis information), select **File | Export 5.x Path as. . .** Select the appropriate drive and folder, enter the file name and click **Save**.

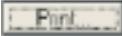
Print file

The print feature allows you to set up and print your active document.

1. Select **File | Page Setup** to open the Print Page Setup dialog box (Figure 19).



Figure 19. Page Setup dialog box

2. Enter the information you would like displayed on your printed drawing.
3. Click **OK** to save the information for current drawing. Click **Save as default** to save the information as the default settings.
4. Select **File | Print Setup** on the menu bar to open the Print Setup dialog box.
5. Change the printer and printer options (if necessary).
6. Click **OK** to save the information for the current drawing.
7. Select **File | Print Preview** on the menu bar. A preview of your printed page is displayed (Figure 20).
8. Click the Print button  to print from the print preview mode or click the Close button  to Close the print preview and return to FlowPATH.
9. Select **File | Print** or click Print icon  to print the file.

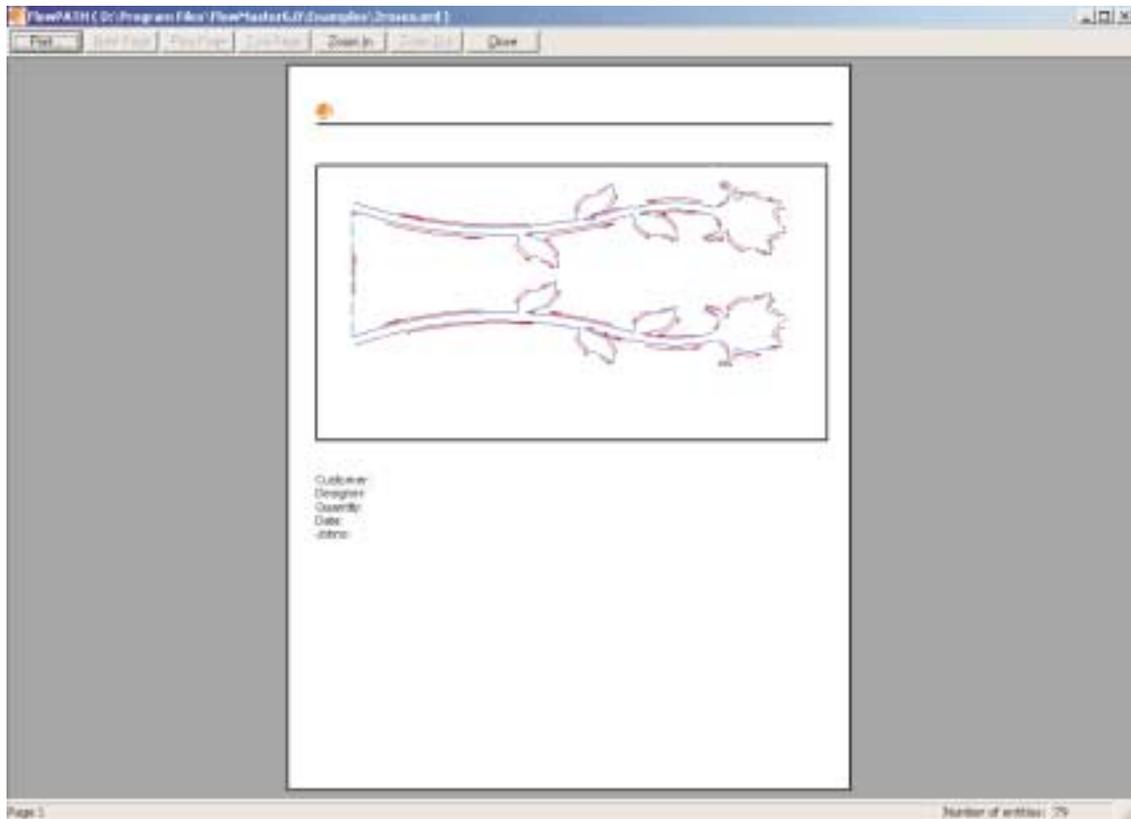


Figure 20. Print preview

Advance to FlowCUT

Close FlowPATH. Select **Start | Programs | FlowMaster6.0 | FlowCUT**.

Notes

CHAPTER 4

Drawing Tools

This chapter contains step-by-step procedures for using the drawing tools available in FlowPATH. These include the drawing tools available on the Draw and Path Utility toolbars, the editing tools available on the Modify toolbar, and the snap tools available on the Snap toolbar.

To cancel an editing, drawing, or snap function once you have enabled it, press the <Esc> key or click the Cancel procedure icon  on the permanent or floating snap bar. You can also click one of the select entity icons to cancel a drawing function.

Line drawing tools

-  Draw a line point to point [Line (PP)]
-  Draw a series of connected lines [Polyline]
-  Draw a line from start point to X,Y end point [Line (PXY)]
-  Draw a line to defined length and angle [Line (PLA)]
-  Draw a line tangent to two arcs

Note: If available, hot keys are shown in <brackets> after the drawing tool name.

Single line tool <Shift+F1>

Use the single line tool to draw a line between two defined points.

1. Select **Draw | Line | Single line** or click the Line(PP) icon.
2. Click to define the first point.
3. Move the cursor to the desired end point and click to define the second point.

To use the command line, enter the absolute X and Y values separated by a comma, then press <Enter>. Follow the directions in the instruction window to complete the function.

Polyline tool <Shift+F2>

Use the polyline tool to draw a series of connected lines between defined points. You can define each point in the series using any of the snap modes.

1. Select **Draw | Line | Polyline** or click the Polyline icon.
2. Click to define the first point.
3. Move the cursor to the desired point and click to define the second point.
4. Continue defining points in the series by clicking at your chosen locations.
5. After defining the final point, press <Enter>.

To use the command line, enter the absolute X and Y values separated by a comma, then press <Enter>. Follow the directions in the instruction window to complete the function.

Note: Press <Esc> to delete all lines just created.

Start point, delta X, delta Y line tool <Shift+F3>

Use the start point, delta X,Y line tool to draw a line with defined X and Y coordinates.

1. Select **Draw | Line | Start point, delta X, delta Y** or click the Line(PXY) icon.
2. Click to define the start point.
3. Move the cursor to the desired end point and click to define the second point.

To use the command line, enter the absolute X and Y values separated by a comma, then press <Enter>. Follow the directions in the instruction window to complete the function.

 **Start point, length, angle line tool**
<Shift+F4>

Use the start point, length, angle line tool to draw a line with a defined length at a defined angle.

1. Select **Draw | Line | Start point, length, angle** or click the Line(PLA) icon.
2. Click to define the start point.
3. Move the cursor the desired length and angle and click.

To use the command line, enter the absolute X and Y values separated by a comma, then press <Enter>. Follow the directions in the instruction window to complete the function.

 **Tangent Arc, Arc**

Use the tangent arc, arc line tool to draw a line tangent to two arcs.

1. Select **Draw | Line | Tangent arc, arc** or click the Line(TAA) icon.
2. Click to define a point on an arc to be tangent from.
3. Click to define a point on an arc to be tangent.

To use the command line, enter the absolute X and Y values separated by a comma, then press <Enter>. Follow the directions in the instruction window to complete the function.

Arc drawing tools

-  Draw an arc; set any three points [Arc (PPP)]
-  Draw an arc; set center, start, and end points [Arc (CSE)]
-  Draw an arc; set center, start, and angle [Arc (CSA)]

Note: If available, hot keys are shown in <brackets> after the arc drawing tool name.

Three-points arc tool <Ctrl+F5>

Use this tool to draw an arc with three defined points.

1. Select **Draw | Arc | Three points** or click the Arc(PPP) icon.
2. Click to define the first point.
3. Move the cursor to the second point and click.
4. Move the cursor to the desired end point and click.

To use the command line, enter the absolute X and Y values separated by a comma, then press <Enter>. Follow the directions in the instruction window to complete the function.

Center, start, end arc tool <Ctrl+F6>

Use this tool to draw an arc with center, start, and end defined points.

1. Select **Draw | Arc | Center, start, end** or click the Arc(CSE) icon.
2. Click to define the center point.
3. Move the cursor to the desired start point and click.
4. Move the cursor to the desired end point and click.

To use the command line, enter the absolute X and Y values separated by a comma, then press <Enter>. Follow the directions in the instruction window to complete the function.

Center, start, angle arc tool <Ctrl+F7>

Use this tool to draw an arc with center, start, and angle.

1. Select **Draw | Arc | Center, start, angle** or click the Arc(CSA) icon.
2. Click to define the center point.
3. Move the cursor to the desired start point and click.
4. Move the cursor to the desired angle and click.

To use the command line, enter the absolute X and Y values separated by a comma, then press <Enter>. Follow the directions in the instruction window to complete the function.

 **Rectangle drawing tools**

-  Draw a rectangle by defining opposite corners [Box (PP)]
-  Draw a rectangle; set corner, width and height [Box (PWH)]
-  Draw a rectangle; set center and any corner [Box (CP)]

Note: If available, hot keys are shown in <brackets> after the rectangle drawing tool name.

 **Two-point rectangle tool**
<Shift+F5>

Use the two-point rectangle tool to draw a rectangle by specifying two opposite corners.

1. Select **Draw | Rectangle | Two points** or click the Box(PP) icon.
2. Click to define the first point.
3. Move the cursor to the desired end point and click to define the second point.

To use the command line, enter the absolute X and Y values separated by a comma, then press <Enter>. Follow the directions in the instruction window to complete the function.

 **First corner, width, height rectangle tool**
<Shift+F6>

Use this tool to draw a rectangle with a defined width and height.

1. Select **Draw | Rectangle | First corner, X distance, Y distance** or click the Box(PWH) icon.
2. Click to define the first corner.
3. Move the cursor to the desired end point and click to define the second point.

To use the command line, enter the absolute X and Y values separated by a comma, then press <Enter>. Follow the directions in the instruction window to complete the function.

 **Center point, width, height rectangle tool**
<Shift+F7>

Use this tool to draw a rectangle with a defined center point, width, and height.

1. Select **Draw | Rectangle | Center point, width, height** or click the Box(CP) icon.
2. Click to define the center point.
3. Move the cursor to the desired end point and click to define the second point.

To use the command line, enter the absolute X and Y values separated by a comma, then press <Enter>. Follow the directions in the instruction window to complete the function.

Circle drawing tools

-  Draw a circle; set center, radius circle [Circle (CR)]
-  Draw a circle; set center and diameter [Circle (CD)]
-  Draw a circle; set diameter end points [Circle (PP)]
-  Draw a circle; set any three points [Circle (PPP)]

Note: If available, hot keys are shown in <brackets> after the circle drawing tool name.

Center, radius circle tool <Ctrl+F1>

Use this tool to draw a circle by defining the center point and radius length.

1. Select **Draw | Circle | Center, radius** or click the Circle(CR) icon.
2. Click to define the center point.
3. Move the cursor to the desired radius and click.

To use the command line, enter the absolute X and Y values separated by a comma, then press <Enter>. Follow the directions in the instruction window to complete the function.

Center, diameter circle tool <Ctrl+F2>

Use this tool to draw a circle by defining the center point and diameter length.

1. Select **Draw | Circle | Center, diameter** or click the Circle(CD) icon.
2. Click to define the center point.
3. Move the cursor to the desired diameter and click.

To use the command line, enter the absolute X and Y values separated by a comma, then press <Enter>. Follow the directions in the instruction window to complete the function.

Two-point circle tool <Ctrl+F3>

Use this tool to draw a circle by defining two points.

1. Select **Draw | Circle | Two point** or click the Circle(PP) icon.
2. Click to define the first point.
3. Move the cursor to the desired end point and click to define the second point.

To use the command line, enter the absolute X and Y values separated by a comma, then press <Enter>. Follow the directions in the instruction window to complete the function.

 **Three-point circle tool**
<Ctrl+F4>

Use this tool to draw a circle by defining three points.

1. Select **Draw | Circle | Three point** or click the Circle(PPP) icon.
2. Click to define the first point.
3. Move the cursor to the desired point and click to define the second point.
4. Move the cursor to the desired point and click to define the third point.

To use the command line, enter the absolute X and Y values separated by a comma, then press <Enter>. Follow the directions in the instruction window to complete the function.

Arc-line drawing tools

-  Draw a three point arc using lines [Arc-Line(PPP)]
-  Draw an arc using lines; set center, start, end [Arc-Line(CSE)]
-  Draw an arc using lines; set center, start, angle [Arc-Line(CSA)]

Three points arc-line tool

Use this tool to draw an arc using lines with three defined points.

1. Select **Draw | Arc-Line | Three points** or click the Arc-Line(PPP) icon.
2. Enter the number of arc segments at the command line and press <Enter>.
3. Click to define the start point.
4. Move the cursor to the second point and click.
5. Move the cursor to the desired end point and click.

To use the command line, enter the absolute X and Y values separated by a comma, then press <Enter>. Follow the directions in the instruction window to complete the function.

Center, start, end arc-line tool

Use this tool to draw an arc-line with three defined points (center, start, and end points).

1. Select **Draw | Arc-Line | Center, start, end** or click the Arc-Line(CSE) icon.
2. Enter the number of arc segments at the command line and press <Enter>.
3. Click to define the center point.
4. Move the cursor to the desired start point and click.
5. Move the cursor to the desired end point and click.

To use the command line, enter the absolute X and Y values separated by a comma, then press <Enter>. Follow the directions in the instruction window to complete the function.

Center, start, angle arc-line tool

Use this tool to draw an arc by defining three points (center and start points, and angle).

1. Select **Draw | Arc-Line | Center, start, angle** or click the Arc-Line(CSA) icon.
2. Enter the number of arc segments at the command line and press <Enter>.
3. Click to define the center point.
4. Move the cursor to the desired start point and click.
5. Move the cursor to the desired angle and click.

To use the command line, enter the absolute X and Y values separated by a comma, then press <Enter>. Follow the directions in the instruction window to complete the function.

 **Ellipse drawing tools**

-  Draw an ellipse; set center, endpoints of major and minor axes (Center)
-  Draw an ellipse; set endpoints of major and minor axes (Axis, end)

 **Center ellipse tool**

Use this tool to draw an ellipse by defining the center and endpoints for the major and minor axes.

1. Select **Draw | Ellipse | Center** or click the Ellipse(Center) icon.
2. Click to define the center.
3. Move the cursor to the desired end point to define the major axis.
4. Move the cursor to the desired end point to define the minor axis.

To use the command line, enter the absolute X and Y values separated by a comma, then press <Enter>. Follow the directions in the instruction window to complete the function.

 **Axis, end ellipse tool**

Use this tool to draw an ellipse by defining endpoints of the major axis and the minor axis distance.

1. Select **Draw | Ellipse | Axis, end** or click the Ellipse(Axis,End) icon.
2. Click to define the first endpoint of the major axis.
3. Move the cursor to the desired second endpoint of the major axis and click.
4. Move the cursor to the desired point to of the minor axis and click.

To use the command line, enter the absolute X and Y values separated by a comma, then press <Enter>. Follow the directions in the instruction window to complete the function.

Curve drawing tools

-  Draw a B-Spline curve
-  Draw a Bezier curve
-  Create a curve fillet

B-Spline curve tool

Use this tool to draw a B-Spline curve where points are defined and a smooth curve is drawn from one point to the next.

1. Select **Draw | Curve | Spline** or click the B-Spline icon.
2. Click to define the first point of the curve.
3. Click at the desired points to continue to draw the curve.
4. After selecting the final point, press <Enter> to end the function.

To use the command line, enter the absolute X and Y values separated by a comma, then press <Enter>. Follow the directions in the instruction window to complete the function.

Bezier curve tool

Use this tool to draw a Bezier curve where points are defined and the smoothest curve between the defined points is drawn.

Note: The curve cannot pass through the points, but it is controlled by them.

1. Select **Draw | Curve | Bezier** or click the Bezier icon.
2. Click to define the first point of the curve.
3. Click at the desired points to continue to draw the curve.
4. After selecting the final point, press <Esc> to end the function.

To use the command line, enter the absolute X and Y values separated by a comma, then press <Enter>. Follow the directions in the instruction window to complete the function.

Curve fillet tool

Use this tool to create a curve fillet (smooth arc connection) between two entities.

1. Select **Draw | Curve | Curve fillet** or click the Curve fillet icon.
2. Click on the end of an entity to define the first point to be connected.
3. Click on the end of an entity to define the second point to be connected.
4. Select two control points to define the curve of the fillet.

To use the command line, enter the absolute X and Y values separated by a comma, then press <Enter>. Follow the directions in the instruction window to complete the function.

T Text drawing tool

Use this tool to draw text. Text can be drawn horizontally, vertically, or in a polar orientation (around an arc).

1. Select **Draw | Text...** or click on the Text drawing functions icon to open the Font dialog box (Figure 21).
2. Select the text font and style. Any TrueType font installed on the system can be used and appears in the "Font" box.



Figure 21. Font dialog box

3. Enter text size. Size is specified in inches or millimeters, and the actual size varies depending on the font. You might need to experiment to get the desired font size.
4. Select the text orientation in the "Effects" box. Text can be horizontal, vertical, or in a polar orientation. For the polar orientation, you can also specify the radius size.
5. Click **OK** to exit the dialog box.
6. Enter text at the command line, then press <Enter>.
7. Click to select a reference point.
8. Move the cursor to the desired location and click.

Tab tool

The tab tool is located on the Path Utility toolbar.

Tabs are small gaps that allow the part to remain attached to the sheet and prevent it from falling into the catcher tank.

1. Select **Draw | Tab Properties** to open the Tab Properties dialog box (see Figure 22) and set the length and width of tabs.
2. Select **Draw | Draw Tab** or click the Draw tab lines icon ; a checkmark shows this feature is turned on. Click at the desired tab location. You can add as many tabs to a part as you think necessary.

Tip: Click any selection icon or zoom icon to turn this feature off.

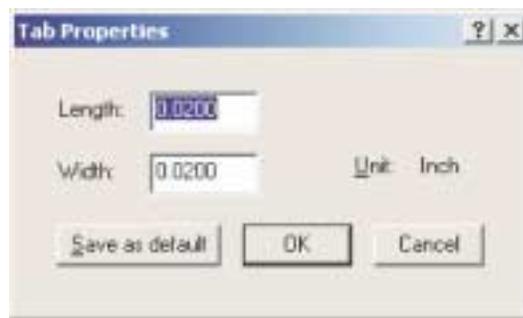


Figure 22. Tab Properties dialog box

Editing tools

The editing tools are located on the Modify toolbar.

Note: If available, hot keys are shown in <brackets> after the editing tool name.

Fillet tool <F1>

Use this tool to connect two entities with a smooth arc, creating a rounded corner.

1. Select the two entities you want to join.
2. Select **Edit | Fillet** or click the Fillet icon.
3. Enter the radius in the Radius dialog box and click **OK**.

To use the command line, enter the radius of the fillet and press <Enter>.

Note: You can first select **Edit | Fillet**, and then select the two entities.

Create intersection tool <F2>

Use this tool to define the intersection of two entities.

1. Select the two entities for which you want to find the intersection.
2. Select **Edit | Create Intersection** or click the Create Intersection icon.

Note: You can first select **Edit | Create Intersection**, and then select the two entities.

Split or extend tool <F3>

Use this tool to split or extend an entity.

1. Select the entity you want to split or extend.
2. Select **Edit | Split/Extend** or click the Split/Extend icon. A drag line appears.
3. To split the entity move the drag line to the split point.
4. To extend the entity move the drag line to the desired end point or enter the absolute X and Y values separated by a comma and press <Enter>.

To use the command line, enter the absolute X and Y values separated by a comma, then press <Enter>.

Note: You can first select **Edit | Split/Extend**, and then select the entity.

Rectangular array tool <F4>

Use this tool to duplicate selected entities in a rectangular array.

1. Select the entities you want to array and press <Enter>.
2. Select **Edit | Array Rectangular** or click the Array Rectangular icon.
3. Enter the information in the dialog box and click **OK**.

To use the command line, make a selection and press <Enter>. Follow the directions in the instruction window to complete the function.

Note: If you select **Edit | Array Rectangular** first, you are prompted at the command line to make a selection and press <Enter> when done (go to step 3).



Circular array tool

<F5>

Use this tool to duplicate selected entities in a circular array.

1. Select the entities you want to array.
2. Select **Edit | Array Circular** or click the Array Circular icon.
3. Click on the desired center point of the array on the cutting table display.
4. Enter the number of copies, angle to fill and, if different, the absolute X and Y values for the center point of the array and click **OK**.

To use the command line, make a selection and press <Enter>. Follow the directions in the instruction window to complete the function.

Note: If you select **Edit | Array Circular** first, you are prompted to make a selection and press <Enter>. When done (go to step 3).



Mirror tool

<F6>

Use this tool to mirror selected entities horizontally, vertically, or at any desired angle.

1. Select the entities you want to mirror.
2. Select **Edit | Mirror** or click the Mirror icon.
3. Click a point to start the mirror frame.
4. Move the mirrored entity to the desired location and click the left mouse button.

To use the command line, make a selection and press <Enter>. Follow the directions in the instruction window to complete the function.

Note: You can first select **Edit | Mirror**, then select the entities, and continue to step 3.



Rotate tool

<F8>

Use this tool to rotate selected entities.

1. Select the entities you want to rotate.
2. Select **Edit | Rotate entities** or click the Rotate icon.
3. Click to select the rotation center point.
4. Select the rotation start point.
5. Move the rotation box to the desired location and click.

To use the command line, enter the absolute X and Y values separated by a comma and press <Enter>. Follow the directions in the instruction window to complete the function.

Note: You can first select **Edit | Rotate entities**, then select the entities, and continue to step 3.

 **Move tool**
<F9>

Use this tool to move selected entities.

1. Select the entities you want to move.
2. Select **Edit | Move entities** or click the Move icon.
3. Click anywhere on the workspace, move to the desired location, and click.

To use the command line, enter the absolute X and Y values separated by a comma and press <Enter>. Follow the directions in the instruction window to complete the function.

Note: You can first select **Edit | Move entities**, then select the entities, and continue to step 3.

 **Scale tool**

Use this tool to scale selected entities.

1. Select the entities you want to scale.
2. Select **Edit | Scale entities** or click the Scale icon.
3. Click an origin point to begin scaling.
4. Click a second point and drag the entities to scale to the size you choose.

To use the command line, enter the absolute X and Y values separated by a comma and press <Enter>. Follow the directions in the instruction window to complete the function.

Note: You can first select **Edit | Scale entities**, then select the entities, and continue to step 3.

 **Scale by factor tool**

Use this tool to scale selected entities by a specific quantity.

1. Select the entities you want to scale.
2. Select **Edit | Scale by factor** or click the Scale by factor icon.
3. Enter the desired scaling factor (2 to double the size, 0.5 to reduce by half, etc.) in the dialog box and click **OK**.

To use the command line, enter the scaling factor and press <Enter>.

Note: You can first select **Edit | Scale by factor**, then select the entities, and continue to step 3.

 **Offset**
<F11>

Offset lines or arcs can be used as construction lines when drawing a part. You can draw a line or arc parallel to and the same length as that selected at a specified offset distance. To specify an offset for a selected entity:

1. Select the entity.
2. Select **Edit | Offset** or click the Offset icon. Enter the offset value and press <Enter>.
3. Click on the side of the entity where you want to place the duplicate. The entity is duplicated on that side at the offset distance specified in the previous step.

Rubber banding

Rubber banding is used to stretch entities into new shapes.

1. Select **Edit | Rubber Banding** or click on the Rubber Banding icon .
 - Click the middle of an entity to modify that entity only; the endpoints remained fixed while the entity stretches into an arc of variable radius.
 - Click on one endpoint of an entity to modify the entity into a new line or arc; the entities other endpoint remains fixed.
 - Click a node (where multiple entities meet) to modify all adjoining entities.

Note: You can first select an entity and then select **Edit | Rubber Banding** or click on the Rubber Banding icon.

Tip: Click any drawing icon to turn this feature off.

Smoothing

Smoothing can be used to smooth and reduce the number of entities in a drawing.

Tip: Smoothing can significantly alter the drawing. It is recommended that you save the file before smoothing.

Manual smooth

Manual smooth is recommended for smoothing an isolated section of a large contour.

1. Select **Draw | Smooth | Manual smooth**.
 - Click a starting entity. FlowPATH zooms in on the selected entity and displays two direction arrows (see Figure 23).

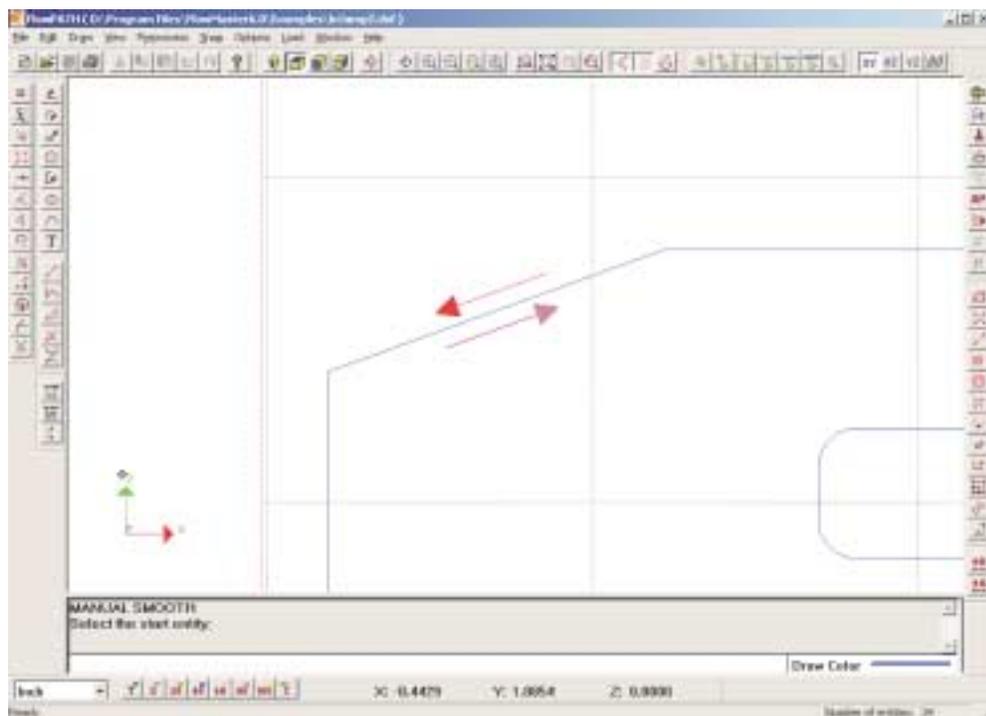


Figure 23. Example of smoothing direction arrows

- Click the arrow that points in the direction you want to smooth. FlowPATH will zoom out to show the entire path.
- Click on the location where you want the smoothing process to end. The Smoothing Option dialog box appears (see Figure 24). Several options are available to control the smoothing process.



Figure 24. Smoothing Option dialog box

2. Enter a tolerance value (the maximum allowed deviation from the original contour) and a maximum gap value (the largest gap in the geometry the smoothing function will attempt to close).
3. Check "Modifiable" to adjust the smoothing at your discretion.
4. Click **OK**.
5. If "Modifiable" was checked, control points appear (see Figure 25). Drag the control points using the left mouse button. If "Modifiable" was not checked, the smoothing process will be automatic.
6. Right click the mouse button to set the final contour.

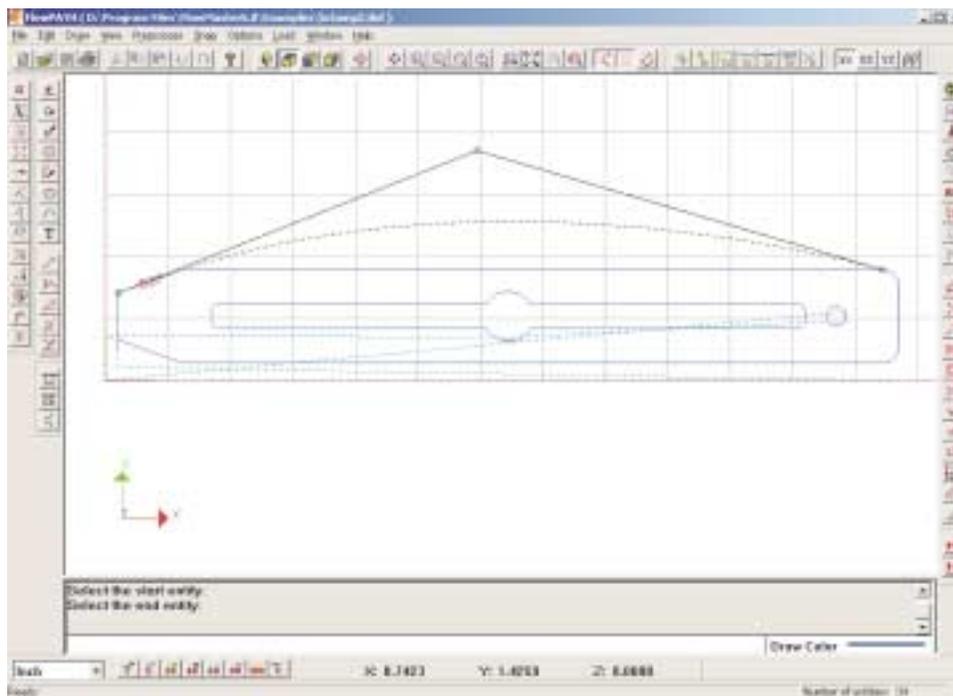


Figure 25. Smoothing example

Tips for successful manual smoothing

- When clicking the direction to smooth, click very close to the arrow on the side of the line in the direction you want to go.
- When clicking the ending entity, the direction must match the arrow direction you selected.
- Use undo and redo to recover original geometry and compare to smooth geometry.

Auto smooth

Auto smooth is best for use on continuous, closed contours (such as complete holes or complete outer edges).

1. Select **Options | Select Contour Entities** or click the Contour entities icon  to select the contour you want to smooth.
2. Select **Draw | Smooth | Auto smooth** to open the Auto Smooth dialog box (see Figure 26).
3. Check "Modifiable" to adjust the smoothing at your discretion.
4. Click **OK**.
5. If "Modifiable" was checked, control points appear (see Figure 26). Drag the control points using the left mouse button. If "Modifiable" was not checked, the smoothing process will be automatic.
6. Right click mouse button to set the final contour.

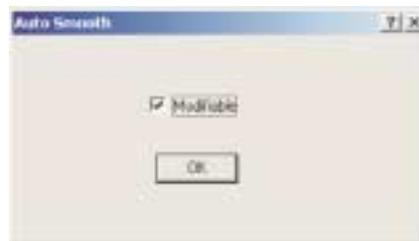


Figure 26. Auto Smooth dialog box

Snap tools

The snap tools are located on both the permanent and floating snap bars. The snap tools can be used with any of the drawing and editing tools. (For more information see "Permanent and floating snap bars" in Chapter 2.)

To enable a snap tool, do one of the following:

- Select the desired snap tool from the permanent snap bar.
- Select the desired Snap menu item.
- Click on the right mouse button to activate the floating Snap bar, and select the desired snap tool.
- Press the hot key on the keyboard, if available (listed in the Snap pull-down menu and shown below in brackets).

Tip: The last two methods are used to enable a snap tool for one occurrence—that is, for the next point you select with the mouse or by entering data in the instruction window. You must select a snap tool for each point you are entering. The snap tool setting reverts to the default after each use.

Multiple selections can be made with the permanent snap bar. Only one selection is possible with the floating snap bar.

Grid size setting

You can set the grid spacing, snap spacing, and orthogonal spacing to help you snap to the entities you choose.

1. Select **Snap | Spacing...** to open the Grid Size Setting dialog box.
2. Enter the grid spacing. The grid spacing is the distance between grid dots on the drawing window.
3. Enter the snap spacing. The snap spacing can be set separate from the grid spacing. You can set the snap spacing at any interval (between the grid dots or every other grid dot, for example).
4. Enter the orthogonal snap angle. The orthogonal snap spacing is where you set a line horizontally, vertically, or at a set angle in degrees.
5. Click **OK** to accept the changes or click **Reset** to set the spacing to the manufacturer's preset values.

Snap cancel tool <Esc>

Use this tool to cancel the current snap, edit or draw function. Select **Snap | Cancel** or click the Cancel icon.

Disable snap tool

Use this tool to disable any permanent snap bar functions.



Snap grid tool
<Alt+G>

Use this tool to snap to the nearest snap intersection.

To adjust the grid size, see "*Grid size setting*" on the previous page.

1. Select **Snap | Grid** or click the Snap grid point icon.
2. Move the cursor near the desired intersection.
3. Click to snap.



Snap orthogonal tool
<Alt+O>

Use this tool to snap a line horizontally, vertically, or at a set angle in degrees. This is often called ortho snapping.

To adjust the orthogonal snap angle, see "*Grid size setting*" on the previous page.

1. Select **Snap | Orthogonal** or click the Snap orthogonal icon.
2. Move the cursor near the desired position.
3. Click to snap.



Snap to endpoint tool
<Alt+E>

Use this tool to snap to the endpoint of the nearest entity.

1. Select **Snap | End** or click the Snap endpoint icon.
2. Move the cursor near the desired position/endpoint.
3. Click to snap.



Snap perpendicular tool
<Alt+P>

Use this tool to create a perpendicular line to the nearest entity.

1. Select **Snap | Perpendicular** or click the Snap perpendicular point icon.
2. Move the cursor near the desired position/entity.
3. Click to snap.

Note: Perpendicular snap does not apply to the start point.



Snap nearest tool
<Alt+N>

Use this tool to snap to the nearest object to create an intersection.

1. Select **Snap | Nearest** or click the Snap nearest icon.
2. Move the cursor near the desired position/entity.
3. Click to snap.

 **Snap to center tool**
<Alt+C>

Use this tool to snap to the center of an arc or circle.

1. Select **Snap | Center** or click the Snap center point icon.
2. Move the cursor near the arc or circle, depending on what center should be found.
3. Click to snap.

 **Snap to one-third point tool**

Use this tool to snap to the nearest one-third point of an object.

1. Select **Snap | One-third** or click the Snap one-third point icon.
2. Move the cursor near the desired position.
3. Click to snap.

 **Snap to midpoint tool**
<Alt+M>

Use this tool to snap to the midpoint the nearest entity.

1. Select **Snap | Middle** or click on the Snap middle point icon.
2. Move the cursor near the desired position.
3. Click to snap.

 **Snap to quadrant tool**

Use this tool to snap to quarter points of a selected entity.

1. Select **Snap | Quadrant point** or click the Snap quadrant point icon.
2. Move the cursor near the desired position.
3. Click to snap.

 **Snap tangent tool**
<Alt+T>

Use this tool to snap tangent to the nearest entity.

1. Select **Snap | Tangent** or click the Snap tangent point icon.
2. Move the cursor near the desired position.
3. Click to snap.

Note: Tangent snap does not apply to the start point.

 **Snap intersection tool**

Use this tool to snap to the intersection of lines or arc.

1. Select **Snap | Intersection** or click the Snap intersection point icon.
2. Move the cursor near the desired position.
3. Click to snap.

Notes

CHAPTER 5

Troubleshooting and FAQ's

FlowMaster

Problem	Solution
<i>What is the best way to array a part?</i>	The most efficient way to array parts is to use the Duplicate function in FlowCUT because this does not increase the entity count of the drawing.
<i>I used to be able to toggle the view using the Zoom Previous tool, but this doesn't work anymore.</i>	Two new tools replace and enhance the old Zoom Previous tool. These tools, Previous view and Next view, work just like undo/redo except you can go back as far as when you first opened or created a file. The zoom level is unlimited. To toggle between views, use Previous view then Next view to move between the current zoom level and the last zoom level in your drawing. This will give you the same toggle ability of previous versions of FlowPATH.
<i>Whenever I select the pan or orbit commands, they only execute once. This makes it difficult to pan and orbit across large drawings.</i>	Hot keys have been added to make these two commands easier to use. To pan continuously, hold down the <Alt> key and click the left mouse button. To orbit continuously, hold down the <Alt> key and click the right mouse button. This shortcut will work even if you do not activate the tool using the toolbar button or menu item.
<i>I used to be able to change the unit setting by accessing the Table.ini file in my system directory, but now it doesn't do anything. How do I change this setting?</i>	The unit setting is now saved in the registry for FlowCUT and FlowPATH. If you change it in the application and close, it will be saved to the registry and the application will remember it the next time you open it.
<i>Can I open ORD files created in FlowPATH 6.0 in FlowCUT 5.x?</i>	Yes, by using a new feature in FlowPATH 6.0 called "Export 5.x path as...". This feature, located in the File menu, will allow the file to be opened in FlowCUT 5.x.
<i>Why was the Group Select tool removed from FlowPATH and FlowCUT?</i>	The new functionality of the selection tools allows for the old Group Select tool to be integrated with the new Select tool (formerly the Single Select tool). If you enable the Select tool and drag the mouse from top to bottom, all entities that are completely contained within the box will be selected. If you drag the mouse from bottom to top all entities that are even partially inside the box will be selected.

Problem	Solution
<i>I keep getting a pop-up window that says line, line, arc, etc. when trying to select entities. Why?</i>	Usually this means that you are in an area of geometry where there are several small entities close together, and FlowMaster cannot decipher which one you want to select. So, we give you an alternate way to select an entity. If you move your mouse over the words in the pop-up window, you will see different entities being highlighted. Choose the entity that you want to be selected. Note: Sometimes when you see this pop-up it means that there are multiple entities directly on top of each other. You may need to purge your drawing.
<i>The white background/black background color choices are missing from the View menu. How do I change my background color?</i>	There is a new dialog located in the Options Display Options menu. This dialog includes choices for background, selection, highlight and grid colors along with font selections for the command line. This new dialog lets you choose any of the standard colors or designate a custom color for these items.
<i>Why is the Options Properties menu item greyed out?</i>	This feature will not work if more than one entity is selected. Make sure that you have not selected multiple entities.
<i>There are no scroll bars. How do I scroll around my drawing?</i>	The scroll bars have been replaced by the Pan tool located in the View menu. This tool will allow you to pan in any direction within the drawing.

FlowPATH

Problem	Solution
<i>The Window 3D Bars selection in FlowPATH is greyed out. How do I enable it?</i>	To enable these settings open the Customer.ini file (see System directory of FlowMaster 6.0 folder). Inside this file there is a 3D_FLAG keyword. Change the setting from 0 to 1. This will enable the 3D viewing and editing toolbars in FlowPATH. Then save the file and close it, restart FlowPATH and turn on the appropriate 3D toolbars by accessing the Window 3D Bars menu.
<i>I've selected "Lead-In Only" and "Corner Lead-In Only" as my lead-in/out properties. Now I can't change the properties because everything is greyed out. How do I change the lead-in/out type?</i>	Select Arc as the In/Out Line Type and the rest of the dialog will be enabled again. Now you can select one of the other in/out types to make the dialog fully functional again.
<i>When I try to drag my lead-in/lead-out I get a runtime error. Why?</i>	See if the examine drawing feature is turned on. This feature should not be turned on during modify commands.
<i>I cannot place lead-in/lead-outs anywhere on my part. What am I doing wrong?</i>	In order to place a lead-in/lead-out you must activate one of the snap tools. The reason for this is to be sure that the leads are placed on an entity and not somewhere in space. Tip: For random placement of leads use the Snap Nearest tool.
<i>Why do all of the Snap tools stay turned on together?</i>	This gives you more freedom to use the snap tools in conjunction with one another. For instance you can now snap to the grid and also to endpoints at the same time without having to select a new snap tool.

Problem	Solution
<i>I have been working with a specific file for a few hours and need to undo a mistake I made, but my undo tool is not working.</i>	Check to see if any of the modify tools are enabled (rubberband, fillet, rotate, move, etc). If there is a modify tool enabled the undo/redo feature will be unavailable until the modify command is aborted (press the <esc> key to abort the modify command).
<i>I used to be able to draw a line tangent to two arcs using the snap tangent tool. How do I do this now?</i>	The snap tangent tool requires an initial input point before the tangent point therefore this functionality no longer exists within the snap tool. An additional drawing tool has been added to accommodate this functionality. Draw your arcs and then select the Draw Line Tangent , Arc, Arc tool to draw a line tangent to two arcs.
<i>Why can't I select arcs when trying to rotate entities?</i>	Make sure that you are in the XY construction plane as arcs cannot exist in any non-XY plane. To do this press the <esc> key to end the rotate command, go to the View menu and select 3D View, Construction Plane. There should be a check mark next to the construction plane that you are currently drawing in. If the check mark is in either the Front or Right construction planes switch to the Top construction plane. Now try the rotate command again.
<i>If I can't create arcs in non-XY planes then how do I create 3D arc shapes?</i>	A new drawing tool called the Arc-Line tool allows you to approximate arcs in planes other than the XY plane using lines.
<i>I've already purged my drawing, but I just found a duplicate entity when trying to manually order my path. Why didn't Purge delete this entity?</i>	The purge function will delete entities that are exact duplicates of one another, but chances are that your entities have opposite start and end points even though they are in the exact same location with the same length. Purge will not delete entities that have opposite start and end points. (i.e.: Line #1 has a start point of (2,2) and an end point of (6,2), Line #2 has a start point of (6,2) and an end point of (2,2) these are not deleted by the purge function)
<i>Why can't I use the drag lead-in/lead-out command?</i>	You must first order the path before dragging lead-in/lead-out pairs.
<i>Why are the 3D toolbars greyed out?</i>	Verify that there are no drawing or editing tools enabled. You cannot change the 3D view or construction plane while using these tools.
<i>Why is my Snap Grid command snapping between grid points?</i>	First make sure no other snap functions are active. If the problem persists go to Snap Spacing... In this dialog see if the numbers in the Grid Spacing and Snap Spacing fields match. If they do not match this indicates that the Snap Grid tool is snapping at a different interval than the actual grid is set to. If you want this tool to snap only to the grid points, change the numbers so they match.

Notes

APPENDIX A

How to Be Successful with the FlowMaster 6.0 Programmable-Z

3D view bar icons

	Isometric	View 3D view	Views drawing window isometrically.
	Top	View 3D view	Views drawing window from the top.
	Front	View 3D view	Views drawing window from the front.
	Right	View 3D view	Views drawing window from the right.
	Orbit	View 3D view	Orbits ("travels around") the view.

Construction plane bar icons

	Top (XY)	View 3D view Construction plane	Sets the construction plane to the top (XY).
	Front (XZ)	View 3D view Construction plane	Sets the construction plane to the front (XZ).
	Right (YZ)	View 3D view Construction plane	Sets the construction plane to the right (YZ).
	Plane offset	View 3D view Construction plane	Changes the offset of the active construction plane.

3D modify bar icons

	Elevate relative	Edit	Elevates relative to the current position.
	Elevate absolute	Edit	Elevates absolute to the cutting table.

Introduction

New to FlowPATH 6.0 and FlowCUT 6.0 is the ability to program and cut a part in the Z-axis. Any FlowMaster-driven system with programmable Z-hardware can use these new features.

In previous versions, all parts cut using FlowMaster were simple flat-stock parts. FlowMaster makes cutting these parts easy with a very simple process. Cutting parts with an additional Z-dimension is much more complex than flat-stock cutting. It is not as difficult as full 5-axis part production, but the additional steps for Z-dimension require a higher skill level than basic cutting.

This section explains some complexities involved when programming with the Z-axis and how to avoid the most common problems, using examples to illustrate methods for success. It is assumed that you have read the FlowPATH 6.0 and FlowCUT 6.0 manuals and are familiar with the subject matter. This guide is not meant to replace these manuals, but to supplement them with helpful application material.

Basic sample task

Figure A-1 shows the relationship between the blank and the piece that will be discussed in the sample task. The following information will explain how easy it is to create this figure with the programmable-Z.

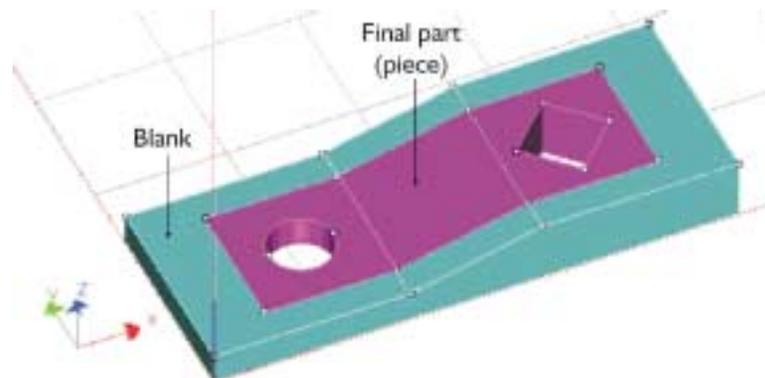


Figure A-1. Relationship between the blank and the piece

Figure A-2 shows a part that demonstrates some of the most common techniques for using the programmable Z-axis. The sample part is a rectangular-shaped piece of material with one end thicker than the other. One end contains a round hole and the other contains a square cut-out. This shape might be used in a hand crank assembly where the round hole accommodates a bolt for a handle and the square cut-out fits over a square-ended shaft.

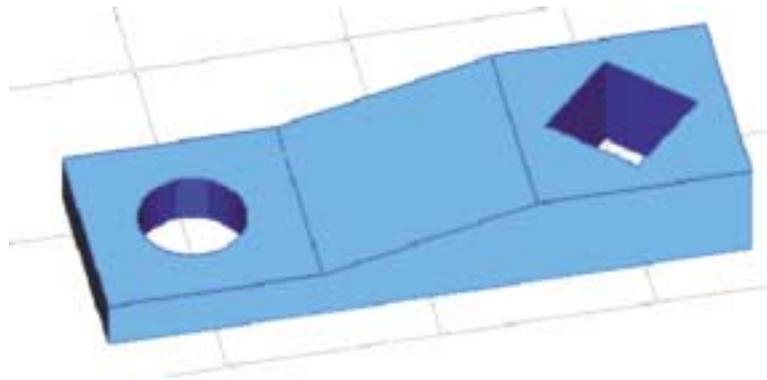


Figure A-2. A simple part to be made using the programmable-Z

A two-stage approach

The part shown in Figure A-2 can be produced from flat-stock material by using a two-stage approach.

The first step is to cut a blank of material that contains the side profile of the part. Figure A-3 shows the shape that will be cut out of flat-stock material.

Note: This method only works if the thickness of the material used to cut the blank is greater than the width of the final part shown in Figure A-2.

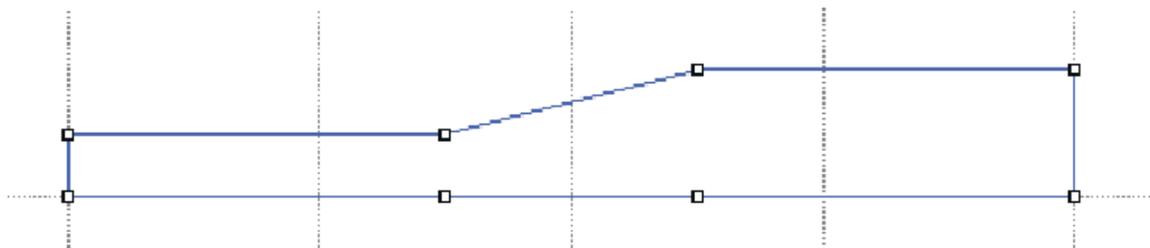


Figure A-3. The material blank drawing in FlowPATH 6.0 (before adding leads)

The blank shown in Figure A-3 can be quickly drawn in FlowPATH (see M-320, FlowPATH User's Guide). The blank must be longer than the final part to allow space on each end for clamps to hold the material during cutting. Holding the blank while cutting must be taken into account when using the two-stage method. The shape of the final part will determine the best type of holding fixture to use.

After the blank is cut, remove it from the base flat-stock material, and turn on its side (see Figure A-4). The final part is created from this piece in the second stage of the process.

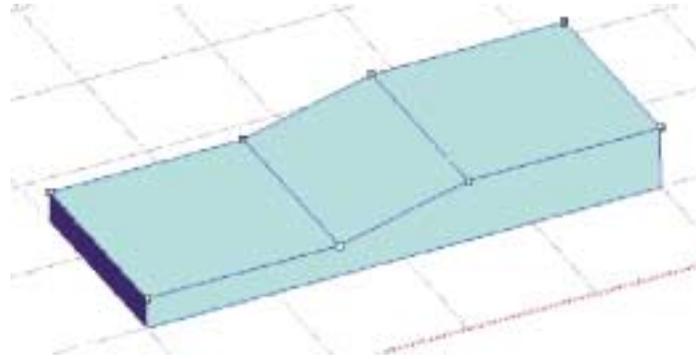


Figure A-4. The blank after it is cut and flipped on its side

Note: The blank in FlowPATH 6.0 is drawn with the 2D drawing tools. The blank is cut out of flat material and requires no special treatment when drawing or cutting. Drawing and cutting the piece, however, requires the use of the 3D drawing tools in FlowPATH 6.0 and special care when using FlowCUT 6.0.

The second step is to use the FlowPATH 3D tools to draw the round and square holes with a portion of the surrounding rectangle. Figure A-5 shows a top view of the basic geometry used to cut the piece.

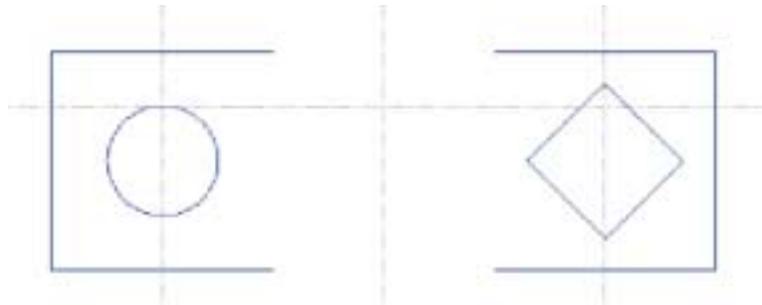


Figure A-5. Basic geometry of the piece first drawn "flat" in FlowPATH 6.0

After the basic geometry is drawn, the elevations can be assigned to each section of the drawing.

- Highlight the drawing section and click the Absolute elevation icon . After each part has an assigned elevation, an isometric view will appear (see Figure A-6).
- Draw lines to the two elevations. Figure A-7 shows an isometric view of the completed drawing before any lead-ins or lead-outs have been added.

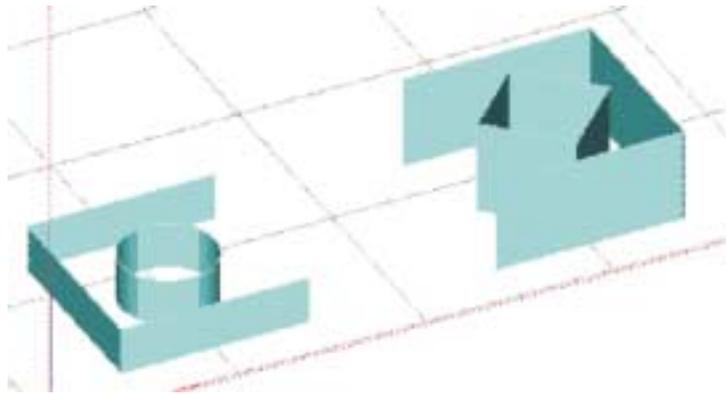


Figure A-6. After elevations are assigned in FlowPATH 6.0

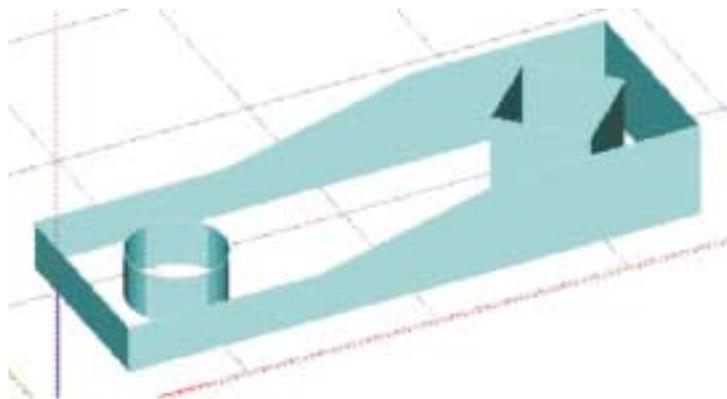


Figure A-7. Completed piece before any leads (as drawn in FlowPATH 6.0)

Figure A-8 shows the relationship between the blank and the piece. When the piece is drawn, the home of the drawing should be located to make it easy to cut the piece out of the blank. For example, the home of the piece could coincide with the lower left corner of the blank. The piece itself would be drawn the proper distance in the positive-X and positive-Y direction from the home position so that the slope of the piece matches the corresponding slope on the blank. This allows the finished blank to be registered in a fixture and the user home set at the lower-left corner of the blank. With this home arrangement, the piece will be cut correctly out of the blank.

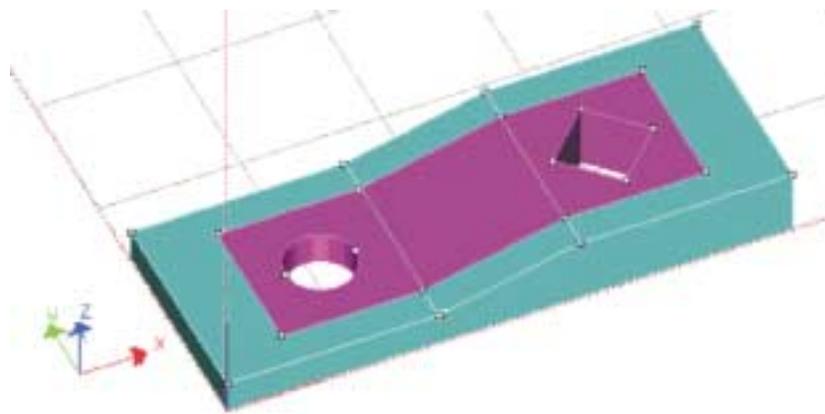


Figure A-8. Relationship between the piece and the blank

Note: Not all parts can be created using this two stage process. Understanding this method allows for more creativity and the construction of parts that were not possible with only flat-stock material.

Success Tip #1: Verify that rapid moves do not collide with the part

For simplicity, the drawings in the previous sections did not show any rapid traverse moves or lead-ins and lead-outs. When ordering the path in a drawing with Z-dimensions, it is important to recognize that the rapid moves could cause a collision with the part. For example, Figure A-9 shows the rapid traverse path after the two inside holes were ordered using the automatic path feature in FlowPATH 6.0. A collision will occur as the rapid move approaches the lead-in of the square cut-out.

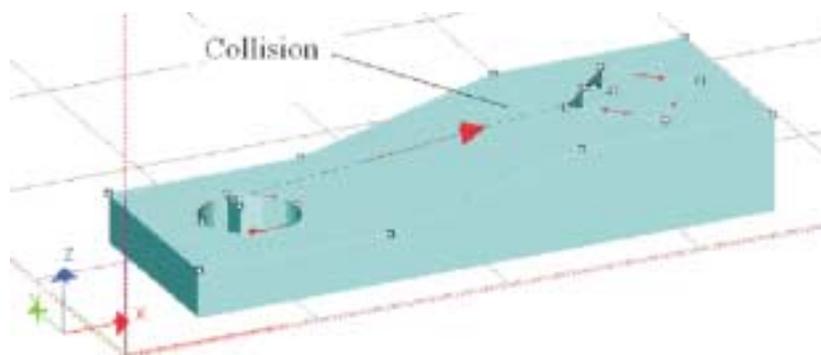


Figure A-9. Rapid traverse can collide with the part

To prevent the rapid moves from colliding with the part, the rapid moves can be drawn and the path ordered manually or select **Preprocess | Auto Path Settings...**, check **Automatically lift up Z** for traverse checkbox (see Figure A-10) and automatically order the path (see Figure A-11). Either method offers a viable solution to prevent collision with the part.

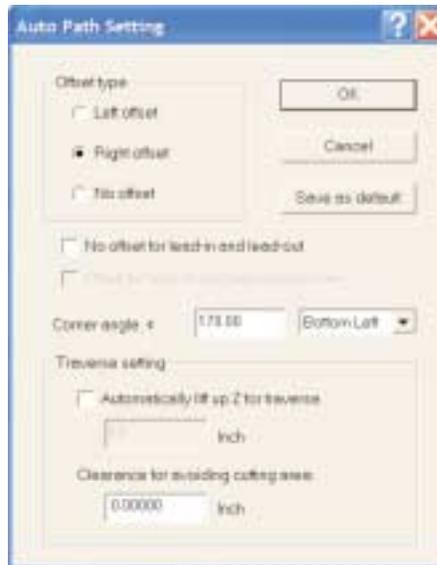


Figure A-10. Auto Path Setting dialog box

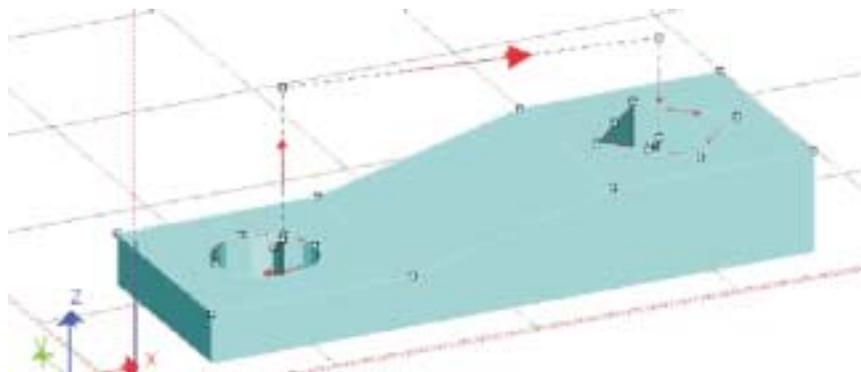


Figure A-11. Avoid collision from the rapid moves by lifting the Z

Success Tip #2: Verify that leads are not below the material surface

A collision between the cutting head and material can occur when lead-ins or lead-outs are drawn lower than the material surface. Figure A-12 shows a close up of a rectangular cut-out in a piece of material that has a sloped surface. The cut-out is sloped, but the leads are drawn horizontally in the XY-plane. This occurs if the automatic path ordering tool is used to add the leads. When the part is cut, material occupies the space shown as the cut-out in Figure A-12. When the cutting head is moved to the start of the lead-in, a collision occurs if the slope is greater in relation to the standoff distance between the mixing tube and the material.

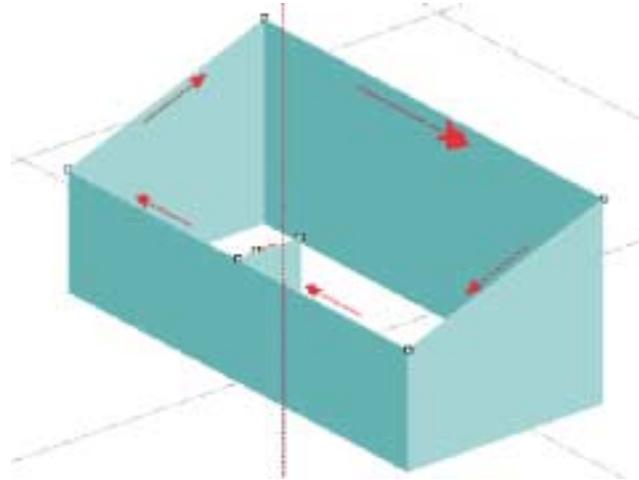


Figure A-12. Start of lead-in and end of lead-out are below material surface

There are several ways to avoid this problem:

- Manually draw the leads in a preferred location. Figure A-13 shows how to orient the leads horizontally. The leads are at the "top" of the slope so no collision occurs. The standoff between the leads and the mixing tube tip will be greater than the standoff throughout the part, but any differences in cutting should be minimal and in waste material. The leads can also be oriented along the slope to obtain the desired standoff.
- The automatic path tool can be used and the leads examined in various features throughout the part. If problems like those shown in Figure A-12 are present, select **Edit | Drag Lead-in/out** to reposition the lead as shown in Figure A-13.
- Manually draw leads with a component in the Z-direction to avoid any collision. This only works with leads composed of lines (FlowPATH 6.0 does not support drawing circles or arcs with a Z-component).
- If the automatic path tool is used to add lines for the leads, the ends of the leads **can** be "lifted" above the part by selecting **Edit | Rubber banding**. Circular leads **cannot** be lifted.

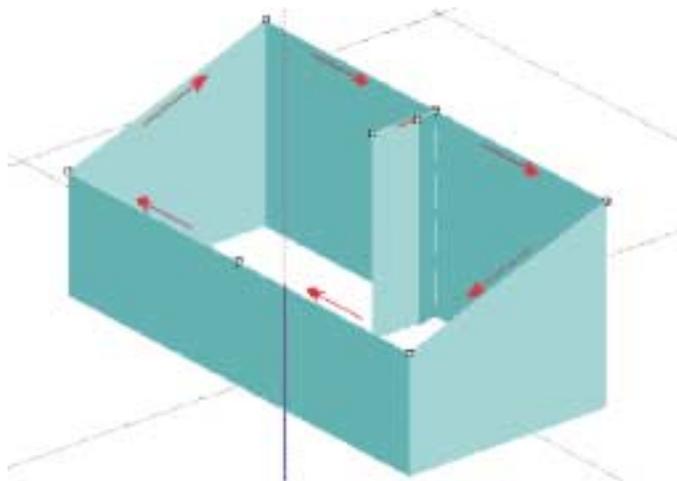


Figure A-13. Start of lead-in and end of the lead-out are above material surface

Opening drawings in FlowCUT

Previously, a two-stage approach was used to produce the basic part shown in Figure A-1. With this method, two drawings are produced: one for the blank and one for the part. Fundamentally, the two drawings are very different. The drawing for the blank (shown without the leads in Figure A-3) is a conventional drawing with no Z-elevations. The drawing for the piece (shown in Figure A-7 without the leads) contains Z-elevations. When these drawings are opened in FlowCUT, it responds differently depending on if the drawing has Z-elevations.

Figure A-14 shows a partial screen image of FlowCUT 6.0 when the drawing for the blank is opened. This drawing contains no Z-dimensions, so the Use elevation checkbox in the upper right of the screen is dimmed. When this checkbox is dimmed, FlowCUT does not produce any Z-axis moves and FlowCUT cutting operations work like previous versions.

Note: Even if the part does not have Z-dimensions, FlowCUT allows the drawing to be viewed using the 3D views (isometric, front and right) or the orbit tool. There is no technical need for this, but some users prefer the isometric view even for flat parts. The user can use a top view to restore the part image into a standard flat-stock display.

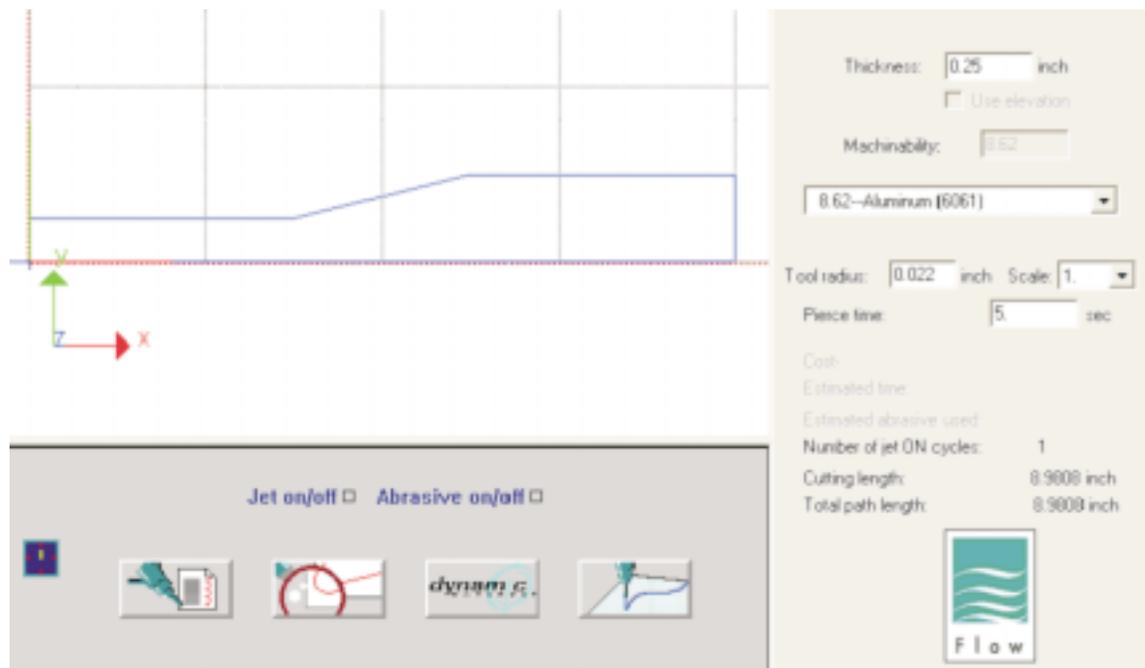


Figure A-14. Part loaded with no moves in Z-direction

When a part with Z-dimensions is opened in FlowCUT 6.0, FlowCUT notifies the user that multiple Z-heights are in the drawing and to be cautious when setting the user home. This message is shown in Figure A-15. Click **OK** and the image appears (see Figure A-16).

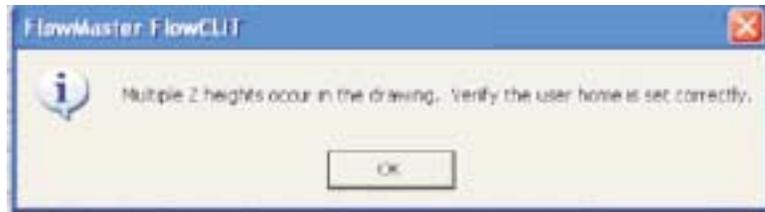


Figure A-15. Warning message when a part with Z-dimensions is opened in FlowCUT 6.0.

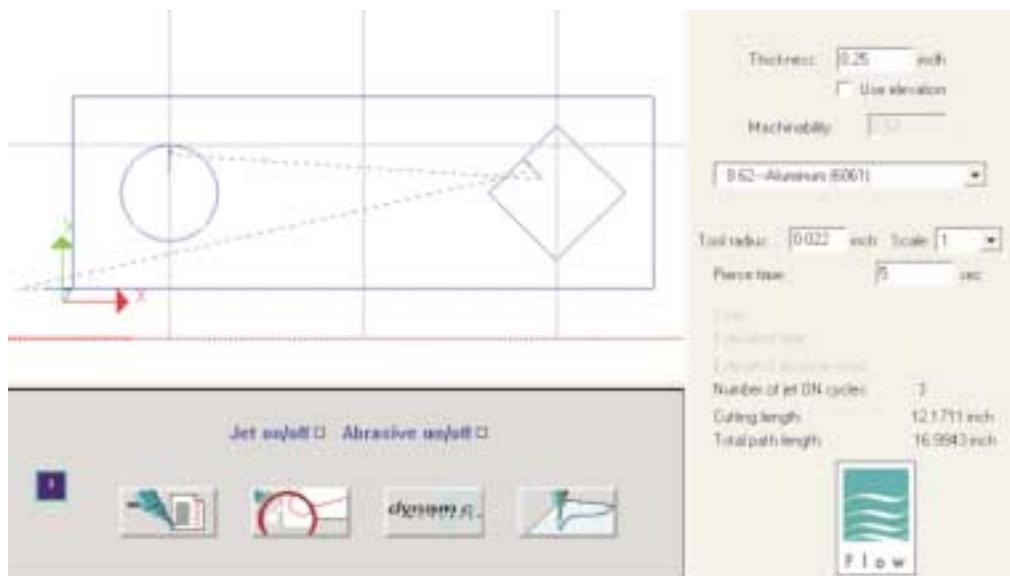


Figure A-16. Part loaded with moves in Z-direction

Note: The Use elevation checkbox is no longer dimmed when a part with Z-elevations is opened in FlowCUT 6.0 (see Figure A-16). This checkbox affects the cutting speeds used by FlowCUT and will be explained later.

Use elevation checkbox

The Use elevation checkbox assists FlowCUT 6.0 with determining how cutting speeds are calculated for the part.

- If the Use elevation checkbox is **not** checked, FlowCUT generates cutting speeds based on the material thickness entered by the user in the appropriate FlowCUT data entry field.
- If the Use elevation checkbox **is** checked, FlowCUT 6.0 calculates the cutting speeds based on the value of the Z-heights set when the part was drawn.

Note: If the Use elevation box is checked, FlowCUT calculates the cutting speeds based on the value of the Z-heights set in the drawing; however, the Thickness number is still used for Corner Control model. (For example, if a part contains multiple Z's from 1 to 3 inches, it is suggested for the user to enter 2 inches in the Thickness box. FlowCUT will apply the 2-inch Corner Control model setting in the Advanced Model dialog box.)

Figure A-17 shows the material has a relatively uniform thickness throughout. In this application the cutting speeds do not need to change as a function of material thickness. Leaving the Use elevation box unchecked is appropriate in this case. In the case of the part shown in Figure A-11, the Use elevation box is checked. This lets FlowCUT 6.0 know that speeds must be modified as the thickness changes. For example, the cutting speeds are slower over the thicker sections.

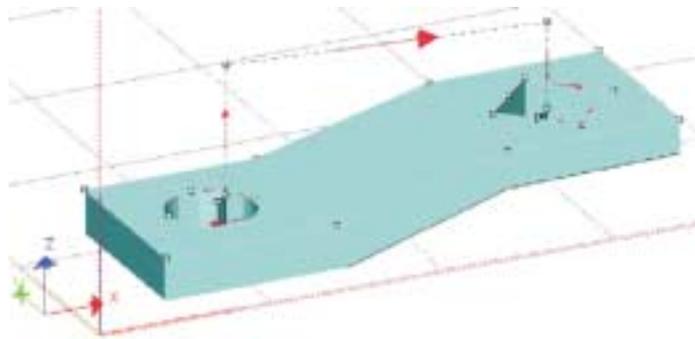


Figure A-17. Part with Z-elevations and relatively uniform thickness

Success Tip #3: Draw flat parts without Z-elevations

It might be tempting to assign Z-elevations to parts that are flat. This is strongly discouraged because it limits what can be done with the drawing in FlowCUT. If a flat part is drawn with no Z-height, that part can be cut with any thickness of material by typing in the correct thickness in FlowCUT. If the part is actually drawn with the thickness, then it is possible for FlowCUT to calculate the wrong cutting speed. This occurs if the Use elevation box is not checked and the wrong thickness is entered into FlowCUT. In this situation the cutting head moves to the Z-elevation as programmed in the part, but uses the cutting speed entered into FlowCUT. If the two thicknesses are different, an incorrect speed is assigned. If elevations are assigned to a flat part, check the Use elevation box to prevent the wrong thickness from being entered.

Drawing a flat part without assigning an elevation is useful if the same part is cut from different material thicknesses. This is how it's done using previous versions of FlowCUT. The operator changes the material thickness and enters the appropriate value in FlowCUT. Cutting speeds are automatically adjusted.

Success Tip #4: Correctly use the Use Elevation checkbox

Summary of Use Elevation checkbox:

Part Description	Use elevation checkbox status
Part has varying material thickness (e.g., a wedge shape)	Checked
Part has uniform thickness, but varying height (e.g., a piece of flat material bent into a curved surface)	Not checked
Part is flat with no assigned elevations (recommended)	Not checked
Part is flat with assigned elevations (not recommended)	Checked

Setting the user home

The most difficult part about using the programmable-Z is setting the user home. In FlowCUT 6.0, flat parts drawn without any elevations are set to the user home like all previous versions. After moving the cutting head to the proper X,Y location and standoff above the material, the operator opens the homing dialog (see Figure A-18).

Click Set current position as user home and click **OK**.



Figure A-18. Standard homing dialog

Setting user home with programmable-Z

There are two principles to understanding how the user home works with the programmable-Z:

1. When the user home position is set using the dialog shown in Figure A-18, the X, Y and Z user home coordinates are all set to the current position.
2. All programmed Z-moves are done relative to the user home. If the user home is set to a position 1 in. (25.4 mm) above the catcher top, a part with a programmed elevation of 0.5 in. (12.7 mm) will be 1.5 in. (38.1 mm) above the catcher.

User home example

1. Open drawing (as shown in Figure A-16).
2. Check the Use elevation box, preview the part, and enter the Run Machine mode.

Assume several blank pieces have been cut and one is loaded in a fixture.

The **WRONG** approach is to move the cutting head over the blank part and set the user home at the desired standoff above the material. Setting the user home this way places the Z-coordinate of the user home above the material surface. When the cut begins, the first Z-move is done relative to the user home Z-coordinate. The cutting head immediately moves up a distance equal to the programmed thickness of the part. The standoff is too great and the blank piece is ruined.

The **RIGHT** approach is to set the user home **BEFORE** the part is placed in the fixture. The cutting head moves down and sets the desired standoff above the catcher (or fixture) surface. At this point the user home should be set, the cutting head lifted, and the blank placed in the fixture. When the cut is started the cutting head will now move to the proper elevation because it is correctly referenced to the fixture at the bottom of the material.

Setting user home at other X,Y location

To set a user home at another X,Y location, select **Cutting | Set XY user home only**. This menu selection keeps the existing Z-home elevation, but allows a part to be cut at a different location on the table. **Cutting | Go to XY user home only** allows the user move to the X,Y home position without driving the cutting head down into the material.

Note: By using a combination of the standard homing dialog and the special menu selections, it is possible to set the correct user home position for any condition. This combination of menu selections and homing dialog was done to maintain the consistent use of the standard homing dialog. The homing dialog as it exists in FlowCUT 6.0 is unchanged from previous versions to prevent any confusion for prior users. The extra menu selections are only used by operators taking advantage of the Z-programming capabilities.

Cycle start change

Previous users of FlowCUT 5.1 and the Dynamic Waterjet will notice another change when clicking Cycle Start. Before cutting a part, FlowCUT 5.1 forced the user to set the cutting head at the Z-home elevation. This was done to prevent inadvertent firing of the jet with an overly large standoff. With FlowCUT 6.0 it was necessary to remove this constraint because the Z-home position is at the bottom of the material, which makes it impossible to set the cutting head at this elevation. If a part has Z-elevations assigned to it, the cutting head does not have to begin at the Z-home elevation; but if the part does not have Z-elevations assigned to it, the constraint is still present.

Success Tip #5: Practice using the feed rate override

When learning how to use the programmable-Z, first try simulating parts cutting. This allows mistakes to be made without any loss of material or damage to the cutting system. While learning, set the Feed Rate Override to a low speed to give yourself time to stop the motion if a mistake is made.

Success Tip #6: Be cautious when sending the cutting head to user home

When cutting a part with the programmable-Z, the user home is typically near the surface of the catcher. If you place material on the table, sending the cutting head to user home with the standard dialog can cause a crash into the part. Select **Cutting | Go to XY user home only**.

Note: The cutting head goes to the user home by the most direct route. Before sending the cutting head to user home, make sure there are no fixtures or high spots in the material that could be hit by the end effector.

Success Tip #7: Be cautious when using cut-from-a-point

Selecting **Cut-from-a-point** sends the cutting head to the starting point of the program in the most direct route. Be sure this avoids the material or any part fixtures.

Success Tip #8: Check the cutting head hardware for possible collisions

Depending on the slope of the material and the size of the standoff, it is possible for the cutting head hardware to collide with the material. It might be necessary to remove the outside cup of the pierce shield in many applications.

**Success Tip # 9:
Do not use height setting devices when the part has assigned elevations**

Devices used to automatically set the distance between the cutting head and material surface typically reset the Z-component of the user home. If elevations are assigned to the part, this overrides any properly set Z-home value and causes the cutting head to lift too high above the part. Height setting devices can be used if no elevations are drawn into the part geometry.