maXym

T E C H N O L O G I E S

Pattern Maker® Software

User Guide

Sample Pattern

(angled view of screen or something)

possibly behind these boxes to the left

Welcome to the Maxym Pattern Maker software program. This tool provides great flexibility in creating and managing machine patterns easily from your personal computer. Your CNC machine uses the patterns you create to cut or shape the products you design.

You draw and the robot cuts what you have drawn. It is as simple as that. Instructions embedded in the pattern lines tell the robot how fast and how deep to cut. The Pattern Maker software also imports DXF and additional pattern files from other drawing or computer-assisted drawing programs. This makes Pattern Maker compatible with a wide range of programs in the CNC and CAD field.

The program is designed to be easily learned, while offering unusual flexibility and power. Use it to design a simple two-dimensional pattern or a complex three-dimensional shape.

This flexibility and ease of use make the Maxym Pattern Maker software ideal for all jobs, ranging from the development of prototype products, to full-scale production work.

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Using this manual

This manual provides detailed instructions designed to get you started creating patterns immediately. It also includes a description of how various machines interpret the pattern data.

This manual assumes you have a basic knowledge of the Windows operating systems.

This manual begins with a description of the software working environment, the drawing and menu tools used to create patterns, and how to specify pattern line properties.

The remainder of the manual describes machine controls and drawing techniques.

Styles used in this manual

This manual uses different type styles to explain the use of the Pattern Maker software. These styles are followed throughout the manual to help make learning the software easier.

Bold type

The names of menus, commands and buttons are in **bold type**.

Buttons

The word *button* indicates an on-screen box that performs a function or displays a menu when it is selected.

The word *button* also refers to the pc mouse buttons.

Submenus

When a reference is made to a submenu found within another menu or button, the path to the submenu is indicated by a **>**.

For example, **Transform > Disconnect** indicates the **Disconnect** command is found under the **Transform** menu.

Dialog boxes

A dialog box refers to a window that pops up on screen following a command or action. Dialog boxes present information or offer more options within a given function.

Keyboard

When a reference is made lo a particular keyboard command, the key combination necessary for that command is indicated in parenthesis.

For example, to view handles on patterns, turn on the handle control **(H)**.

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Screen cursor

The term *screen cursor* indicates the arrow, pointer or tool cursor appearing on the computer screen.

User actions

The following words are used consistently throughout the manual:

Select: Indicates use of the **Enter** key or the **left mouse button**.

Cancel: Indicates use of the **Esc** key or the **right mouse button**.

Hold: Indicates holding a mouse button down without releasing.

Click: Means to press the mouse button once and release it.

> #### Note
>
> A **Note** denotes a helpful hint or important piece of information about the current subject.

System requirements

The Pattern Maker software requires an IBM-compatible computer. The minimum system requirements are:

- Pentium II (or equivalent) or higher microprocessor
- Windows 95 or higher
- 32 MB of RAM
- Standard 2 button mouse

> #### Note
>
> You may use any Windows-compatible pointing device such as a track ball or drawing tablet.

Setting up the system

Installing the software

- Close any open programs running on Windows.
- Insert the Maxym diskette or CD-ROM into your drive.
- **Select Run** from the **Start** menu and browse for the file named "setup.exe" on the disk.
- **Select** the file "setup.exe.
- **Select Open**.
- **Select Ok** to launch the Maxym software installation program.
- Follow the instructions provided by the installation program.

Starting the software

To start the Pattern Maker Software, select the Pattern Maker Software Icon in Windows under **Start > Programs > Maxym**.

You may create a shortcut to the software on the Windows desktop by holding the control key and dragging the Pattern Maker Software icon from the **Start** menu to the desktop.

The screen environment

Each time you launch the Pattern Maker software, the program opens a large window containing the workspace, menu and function bars listed below and shown in *Figure 2.1*.

These menus and bars are described in this section.

* **Windows Menu Bar**
* **Pointer Bar**
* **Drawing Tools Bar**
* **Transformation Bar**
* **Settings Bar**
* **Maxym Bar**
* **Status Bar**
* **Object and Statics**
* **Rulers** - appear on the top and left of the workspace

You may choose to hide or display the various bars using options in the Windows' **View** menu.

View menu

The view menu allows you to control how menu bars and tool bars are displayed, as well as workspace grid settings. A check mark next to any of the above menus or functions under the **View** menu indicates that the display is visible.

Workspace

The workspace is the large white area filling most of the window. You draw patterns in this area. The size of the workspace is 800 inches (width) x 800 inches (height). The absolute zero point (0, 0) is located in the very top left of the workspace window. Positive X is to the right and positive Y is down from the absolute zero point.

You may change your view of the workspace by zooming in and out of the workspace. See *Drawing tool bar on page 18*.

Workspace grid

A horizontal and vertical grid lies under the workspace. This grid can be used to help align objects in a pattern.

Use the keyboard arrow keys to move the cursor one grid space and place it on a grid point.

View > Grid allows you to set the workspace grid size and turn the grid display on or off.

Grid Size

The grid size default is 1 inch. You may set the grid size to any dimension between 800 inches and .005 inches.

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Grid snap

When the grid snap function is turned on, all tools set the beginning and end point of an object at an intersecting grid point.

With grid snap on, you can see the screen cursor jump from grid point to grid point as you draw objects

Turn the grid snap on or off using the **Snaps > Grid Snap** function or by hitting the **G** key.

Windows' menu bar

The Windows menu bar appears on the top of the window. Various Windows and Pattern Maker software functions are accessed through the menu bar.

The title of the pattern file appears above the menu bar.
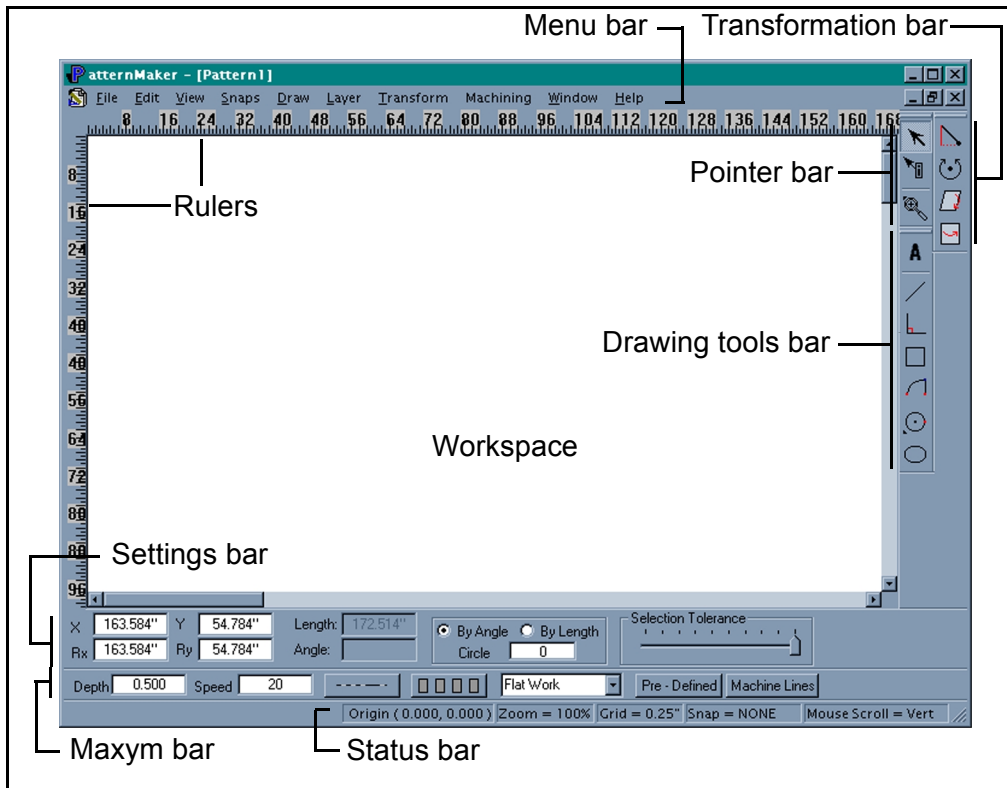
Figure 2.1 *The workspace window*

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Pointer bar

The pointer bar appears on the right side of the workspace. This bar contains the zoom, select and information cursors.

The pointers are explained in detail in *Pointer tool bar on page 15*.

Drawing tools bar

The drawing tools bar appears on the right side of the workspace. The drawing tools create and adjust patterns in the workspace. These tools are explained in detail in *Drawing tool bar on page 18*.

Transformation tools bar

The transformation bar appears to the right of the pointer bar. The tools in this bar move, rotate and flip objects in the workspace. These tools are explained in detail in *Transformation tool bar on page 25*.

Settings bar

The settings bar appears under the workspace. Relative and absolute X and Y distances are shown here, as well as the length and angle used to draw objects.

You may enter values in this menu when drawing objects.

Selection tolerance

The settings bar contains the selection tolerance adjustment. This controls the cursor sensitivity - how close the cursor needs to be to an object in order to select it. Increase the selection tolerance by sliding the bar to the right. Decrease by sliding to the left.

Maxym bar

The Maxym bar appears under the line information bar and displays the line depth, cutting speed, line type and I/O switches.

This bar also has buttons to open the property settings for pre-defined and special line types. The Maxym bar controls are described in detail in *Maxym bar on page 49*.

Status bar

The status bar appears under the Maxym bar and lists the origin point, zoom level, drawing grid, snap status and mouse scroll.

Objects and statics

Objects and statics appear on the left side of the workspace when set to display in the **View** menu. This window lists the total number of layers, vectors, objects and individual types of objects used in the current pattern.

Rulers

Rulers show dimensions in inches along the top and left side of the workspace.

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Using the pc mouse

Your pc mouse is the primary tool used to create patterns. You only need a two-button mouse. However, the software recognizes the third scroll wheel on some three button mouses. See *Mouse scroll (third wheel button) on page 6*.

Throughout this manual, buttons are referred to as left and right mouse buttons and the mouse scroll button (found on some three-button mouses).

The left and right mouse buttons have equivalent keys on your keyboard. Refer to *Keyboard input on page 8* for a complete list of your keyboard commands.

Left mouse button - Select (Enter)

The **left mouse button** is used for selecting objects, or menus, or for indicating the position of objects to be placed on the screen. It is also used to set the beginning and end points when drawing a line or object. The **Enter** key on the keyboard has the same function as the left mouse button in the workspace.

All Pattern Maker menus are opened by clicking once with the **left mouse button**. The **left mouse button** is also used to create a box

that selects portions of a pattern. This selection box is created by clicking and holding the **left mouse button** while dragging the mouse. When the box is the proper size, release the button The pattern lines enclosed by the box are selected.

Right mouse button - Cancel (Esc)

The **right mouse button** is used to deselect objects. It is also used to complete a drawing operation or function.

Clicking the **right mouse button** once while using a tool deselects any selected objects and leaves the tool active.

Clicking the **right mouse button** twice cancels an operation or function and brings up the selection cursor.

When the selection cursor is the active cursor, clicking the right mouse button with the arrow on the workspace opens a shortcut menu to various workspace functions.

The **Esc** key on the keyboard has the same function as the **right mouse button**.

Mouse scroll (third wheel button)

The mouse scroll button wheel included on some mouses is

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recognized by the Pattern Maker software. This button is usually located between the left and right mouse button. Click this button to switch between three mouse scrolling modes:

• **zoom - increases or decreases magnification of workspace view**
• **vertical - moves workspace view up or down**
• **horizontal - moves workspace view left or right**

The current mouse scroll mode is indicated in the status bar (see *Status bar on page 5*).

Roll the mouse scroll button to change your workspace view according to the mouse scroll mode.

Mouse pan

Click and hold the mouse scroll button and drag the mouse to pan the workspace view. This allows you to move the workspace view up, down, left and right, regardless of mouse scroll mode.

Screen cursor types

There are eight types of screen cursors, shown in *Figure 2.2*.
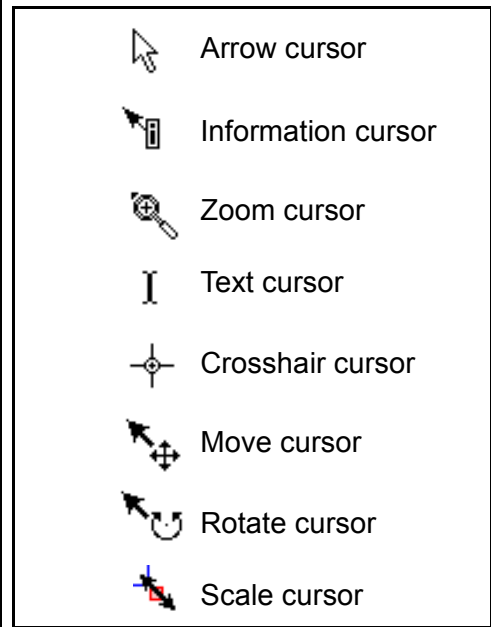
Figure 2.2 *Screen cursors*

⌖ **Arrow cursor**

The arrow is the **selection cursor**. It is used to select lines and objects, drawing tools or function buttons. Its reference point is at the tip. See *Arrow cursor on page 15*.

⌖ **Information cursor**

The information cursor appears when you use the **information cursor tool**. See *Information cursor on page 16*.

Zoom cursor

The zoom cursor appears when you zoom in or out of the workspace. See *Zoom cursor on page 17*.

Text cursor

The text cursor appears when you use the notes tool. See *Notes on page 25*.

Crosshair cursor

The crosshair cursor appears when you use the drawing tools. The line points are created in the center of the crosshair.

Move cursor

The move cursor appears when you use the **move point** function or you move the arrow cursor over the object reference point of a selected object. See *Move Point on page 26* and *Move object on page 32*.

Rotate cursor

The rotate cursor appears when you use the rotate tool. See *Rotate on page 26*.

Scale cursor

The scale cursor appears when you move the arrow cursor over a corner of the bounding box of a selected object. See *Scale object on page 33*.

Keyboard input

The keyboard is used to enter file names and numeric values. In addition, several keys have control functions:

Zero point (space bar)

The **space bar** switches the screen coordinates between absolute zero and relative zero modes.

Absolute zero is always the upper left-hand corner of the workspace. Relative zero is set by clicking **space bar** anywhere on the workspace. In the relative zero mode, the X and Y coordinates displayed in the line information bar are measured from this relative zero point.

The relative zero point is shown on the screen by the marker shown in *Figure 2.3*

Figure 2.3 *Relative zero point marker*

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If a relative zero point is set, clicking the space bar again removes it.

For more information, see *X and Y coordinate boxes on page 10*.

Select (Enter)

The **Enter** key has the same function as the **left mouse button** in the workspace. See *Left mouse button - Select (Enter) on page 6*. **Enter** is also used to complete the input of a parameter in the information section.

Multiple select (shift)

The **Shift** key allows you to select multiple objects with the **left mouse button**.

Delete

The **Delete** key deletes selected objects in the workspace.

Backspace

Backspace deletes characters (when using the Notes tool) or numbers in coordinate boxes.

X - lock/unlock (X)

The **X** character key locks the cursor's X-axis movement, allowing only Y axis movement. Pressing **X** again unlocks the cursor.

Y - lock/unlock (Y)

The **Y** character key locks the cursor's Y-axis movement, allowing only Y axis movement. Pressing **Y** again unlocks the cursor.

Switch cursor to keyboard inputs (Tab)

The **Tab** key allows you to enter coordinates in the settings bar coordinate boxes. This moves control of the cursor from your hand-held device to the keyboard.

Pressing **Tab** once activates the X-coordinate box (the text in the box becomes highlighted). Pressing **Tab** again moves to the next coordinate box. Repeating this process cycles you through all of the coordinate boxes and eventually returns the cursor to the screen.

Note

Entering coordinates with the **Tab** function locks X and/or Y cursor.

Handles - on/off (H)

Handles are small boxes appearing at the end of each line in the workspace.

The **H** key turns the handles on (visible) or off.

The **Draw > Handles** function also turns handles on or off.

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Grid snap

The **G** character key turns the grid snap control on and off. See *Grid snap on page 4*.

Point snap

The **P** character key turns the point snap control on and off. The point snap forces the cursor to move to the nearest object point.

This function may also be turned on or off using the **Snaps > Point Snap**.

Arrow keys

The arrow keys allow you to move the screen cursor in the X and Y axes. Each time you press an arrow key, the cursor moves one grid space in that direction. Using the arrow keys locks the cursor. The amount of movement can be controlled by changing the grid size in the system variable box.

X and Y coordinate boxes

Absolute coordinates (World Coordinates)

The X and Y coordinate boxes in the settings bar indicate the cursor's position from the absolute zero point, as long as a relative zero point has not been set using the space bar. Refer to *Zero point (space bar) on page 8*.

As discussed earlier, absolute zero is the upper left-hand corner of the workspace. This point does not change. When drawing in the absolute zero mode, coordinates in the X and Y coordinate boxes are measured from that corner.

The Rx and Ry coordinates indicate the distance from the last entered vector beginning point to the current cursor position.

Figure 2.4 shows the difference between relative coordinates when the relative zero point is set (top example) or not (bottom example).

Relative coordinates

The X and Y coordinate boxes indicate the cursor distance from the relative zero point if a relative zero point is set with the space bar. Refer to *Zero point (space bar) on page 8*.

The Rx and Ry coordinates indicate the distance from the last entered vector beginning point to the current cursor position.

The relative zero point can be set anywhere on the workspace, as often as you want.

Relative zero is used to measure the various sections of a pattern or to measure between the various sections of a pattern.

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Relative Coordinates

Absolute Coordinates
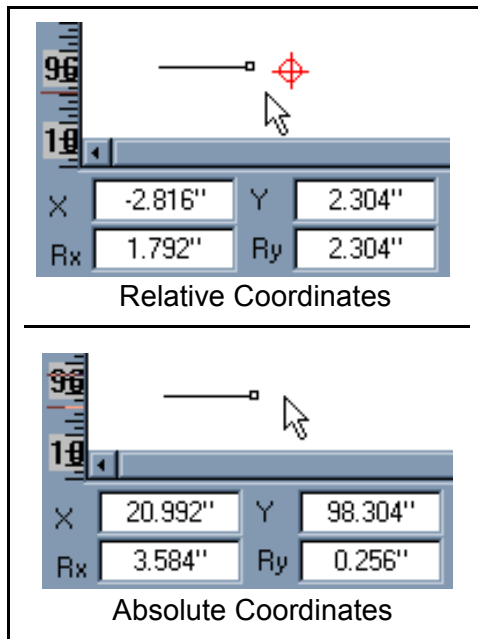
Figure 2.4 *Coordinate boxes*

Figure 2.4 shows the difference between relative coordinates when the relative zero point is set (top example) or not (bottom example).

In the top example, X and Y are measured from the relative zero point.

In the bottom example, X and Y are measured from the absolute zero point as a relative zero point has not been set.

Lines

Colors

The Pattern Maker program uses color to display certain line characteristics. These include whether the line is selected or unselected, whether it is a part of a pattern or a guide line. The line colors are not interpreted by the CNC machine.

Blue - selected lines

A blue line is **active**, or **selected**.

If you change tools while drawing, or begin drawing a new line, the line or object automatically attaches to the end of the last selected line.

All draw menu functions (except group) act only on selected lines. Thus, if you want to rotate, flip, copy, or move a line, it must be selected.

Red - new lines

A red line is a line in the process of being drawn. Red lines change to blue lines once an end point is entered.

Black - deselected lines

Black lines are **inactive**, or **deselected**.

To deselect a selected line, **cancel** (**right mouse button**) while the

screen cursor is in the workspace. The line turns black.

New lines do not attach to unselected lines.

Layers

Layer menu

The layer menu allows you to create and manage multiple layers in the pattern file.

Using layers allows you to see parts of your pattern with or without other parts of the pattern.

Another good use of layers is to separate different tool size compensations when you have tool changes. When you tool compensate a pattern, a new layer is automatically created with the tool size attached to it. This lets the machine know there is a tool change if the size is different between two or more layers

New Layer

Layer > New Layer creates a new layer in the current pattern file.

Merge Layer

Layer > Merge Layer combines selected layers into one layer. To select multiple layers, click the **left mouse button** while holding the **ctrl** key. To select all layers between two layers, click the **left**

mouse button** while holding the **shift** key.

Layer Dialog

Layer > Dialog displays the layer dialog box. The layer dialog box displays the layers and allows you to add, merge and delete layers. It also allows you to turn the display of a layer on or off, by selecting the eye icon to the left of the layer.See *Figure 2.5*.

Double click with the **left mouse button** on the name of a layer to change its name.
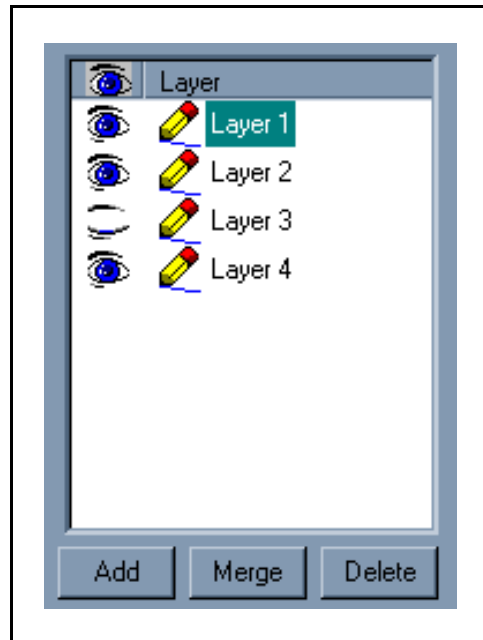
Figure 2.5 *Layer Dialog Box*

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Save Active Layer

Layer > Save Active Layer

Layer > Save Active Layer saves the contents of the current layer in a new pattern file.

Load New Layer

Layer > Load New Layer loads all layers from a saved file into your current pattern. Any loaded layers containing the same name as a layer in the current file will have a number added to their name.

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Overview

The Pattern Maker software contains fourteen drawing tools and more than a dozen functions for manipulating patterns and lines. When used together, these features give you a wide range of options for designing products to be manufactured by a CNC machine.

The drawing tools are found on the right side of the Pattern Maker software window.

This chapter discusses each of the drawing tools and functions and how they are used.

Pointer tool bar

The pointer tool bar contains three cursor tools, the arrow cursor, the information cursor and the zoom cursor.

The pointer tool bar is shown in *Figure 3.1*.

You may move the pointer tool bar anywhere in the software window by clicking the **left mouse button** on, and dragging the tool bar handle.
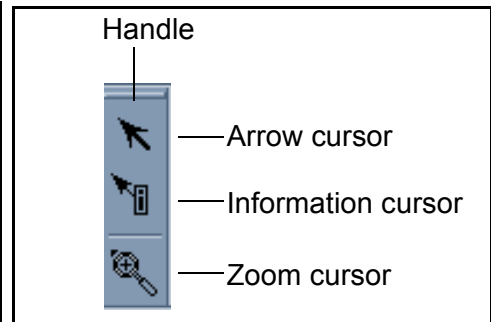
Figure 3.1 *Pointer tool bar*

Arrow cursor

The arrow cursor selects objects. To select an object, position the cursor over the object and click the left mouse button. To select multiple objects, hold the shift key while clicking the left mouse button over the objects.

You may also select multiple objects by clicking the left mouse button and holding it while you drag the cursor to create a box around multiple objects. All objects in this box become selected.

Select matching objects

You may use the arrow cursor to select all objects with matching vector properties.

To select matching objects:

• **Select** the **arrow cursor**.

- Hold **ctrl** while selecting an object. This launches the match selection dialog box.

- Click **OK** to select all objects with matching properties to those of the selected object.

  or

- Define the vector properties for the objects you wish to select in the match selection dialog box and click **OK** to complete the selection of the matching objects.

Information cursor

The information cursor allows you to view or modify vector properties of selected objects.

Note

This tool may be used on selected or unselected lines.

Viewing object vector properties

To use the line information cursor to view object vector properties:

- **Select** the line information cursor.

- Move the cursor over the object and **select**. This opens the vector information dialog box.

While in the vector information dialog box, you may also set the current line settings for new objects

to those of the selected object. See *Figure 3.2*.

Modifying object vector properties

To use the line information cursor to modify object vector properties:

- **Select** the line information cursor.

- Move the cursor over the object and **select** while holding the **ctrl** key. This opens the modify vector dialog box.

Use the modify vector dialog box, to edit the line type, z-depth, speed, line display type and I/O settings of the selected object(s). Use the check boxes in the bottom of the dialog box to edit a selected object, any objects with the same properties as the selected objects, a group of selected objects, or all objects at the same time. You may also choose to modify all vectors in the pattern that match those of the selected object, or all vectors in the pattern.

If you use the information cursor while multiple objects are selected, you may also choose to modify all selected vectors according to the settings you enter in the modify vector dialog box. See *Figure 3.3*.

Machining > Edit Vector also opens the modify vector properties dialog box.
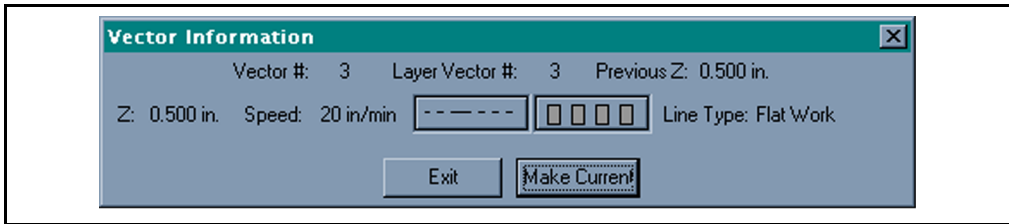
Figure 3.2 *Vector information dialog box*
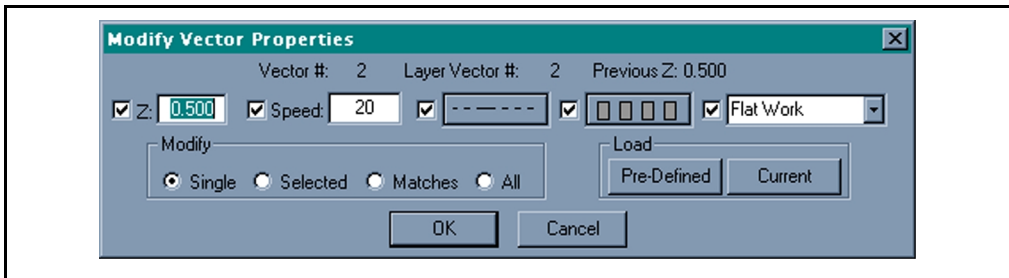
Figure 3.3 *Modify vector dialog box*

🔍 Zoom cursor

The zoom cursor changes the workspace view by increasing or decreasing the magnification of the workspace. The maximum zoom displays 250 inches (width) of the workspace. The minimum zoom displays 800 inches (width) of the workspace.

To use the zoom cursor:

• **Select** the zoom cursor tool.

• Click the **left mouse button** over the workspace to zoom in one zoom increment (2 x the current zoom percentage).

• To zoom a selected workspace area, click and hold the **left mouse button** and drag the cursor to create a box. Release to zoom as close as possible to this selected area.

• Hold **ctrl** and click the **left mouse button** over the workspace to zoom out one zoom increment (1/2 of the current zoom percentage).

View > Zoom

View > Zoom also allows you to zoom in or out of the workspace view using one of seven specified zoom settings.

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Drawing tool bar

The Pattern Maker drawing tools allow you to draw straight, angled and free-form lines; arcs; circles; squares and ellipses. Some of the tools have more than one function.

The tools are activated by selecting them. This causes the screen cursor to change from a pointer to a crosshair. After selecting the tool, place the crosshair on the workspace where you want to begin drawing, click once and release. This begins the drawing operation. As you move the cursor, the tool creates the type of line selected. The drawing tools are shown in *Figure 3.4*.

You may move the drawing tools bar anywhere in the software window by clicking the left mouse button on, and dragging the tool bar handle.

The **Draw** menu in the Windows menu bar also allows you to choose one of the drawing tools included in the Drawing Tools Bar.
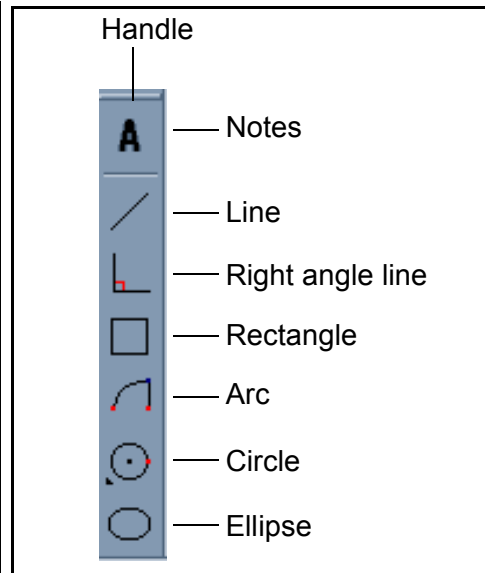
Figure 3.4 *Drawing tools*

Line

The line tool draws straight lines in the workspace. See *Figure 3.5*.

To draw a straight line:

- **Select** the line tool.
- Move the crosshair cursor to the workspace. **Select** again to set beginning of the line.
- Move the cursor in the direction you want to draw.
- **Select** again to set the line point.
- Move the cursor and **select** again to draw another line or **use cancel** to end the operation or to change drawing tools.

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As you draw the line, its length and angle are displayed in the line information bar. You can enter dimensions in these boxes to create the line by moving to the boxes with the mouse or by hitting the tab key.

Press **enter** after entering the values to complete the line.

Figure 3.5 *Using the line tool*

Note

You may hold **ctrl** while pressing the **right mouse button** to delete the last drawn segment when using the line tool. Repeat to continue deleting segments in the line

Right angle line

The right angle line tool draws lines at right angles to the absolute coordinates.

To draw a right angle line.

• **Select** the right angle line tool.

• Move the crosshair cursor to the workspace. **Select** again to set beginning of the line.

• Move the cursor in the direction you want to draw.

• **Select** again to set the line point;

• Move the cursor and **select** again to draw another line or **use cancel** to end the operation or to change drawing tools.

Note

As you draw the line, its length and angle are displayed in the line information bar. You can enter dimensions in these boxes to create the line by moving to the boxes with the mouse or by hitting the tab key.

Press **enter** after entering the values to complete the line.
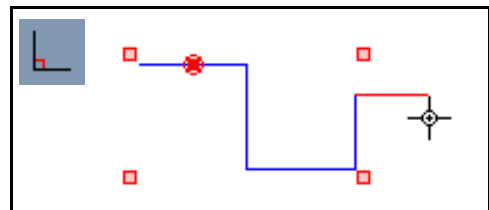
Figure 3.6 *Using the right angle line tool*

▢ Rectangle

The rectangle tool draws squares and rectangles.

To use:

- **Select** the rectangle tool.
- Move the screen cursor to the workspace and **select** to set the starting point.
- Move the cursor to draw the rectangle.
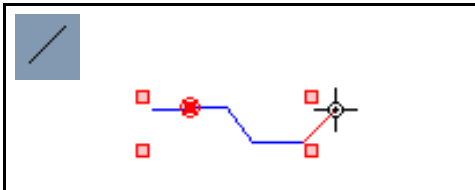- **Select** again to complete the rectangle and end the drawing operation.

Note

As you draw the rectangle, its length is displayed in the line information bar. You may enter dimension a dimension in the length box to to create a square by moving to the boxes with the mouse or by hitting the tab key.

Press **enter** after entering the values to complete the square.

Rectangles are drawn according to the mouse movement after the beginning point is set.

Figure 3.7 shows how to create rectangles in four different directions. Box A is created by pulling the cursor up and to the left. Box B is created by pulling the

cursor up and to the right. Box C is created by pulling the cursor down and to the left. Box D is created by pulling the cursor down and to the right.
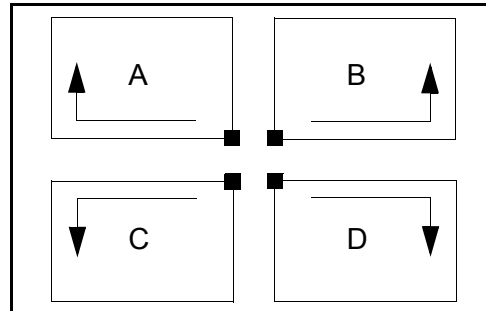
Figure 3.7 *Rectangle vector directions*

The direction in which the rectangle is created determines the direction of the CNC machine arm The starting point of each rectangle is indicated by the small black square.
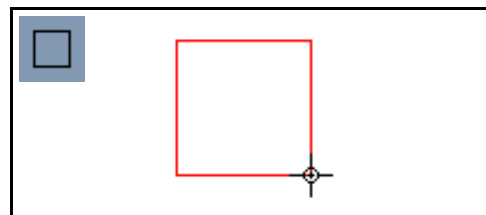
Figure 3.8 *Using the rectangle tool*

⊙ Circles

The circle tool draws circles. The circle shape can be created either by the by the length of each side in

the circle, or by the angles used to create these lines. This is done by changing the circle variables in the line information menu.

To use:

- **Select** the circle tool.
- **Select** one of the three circle types shown in *Figure 3.9*.

  Center-to edge circle sets the center of the circle first, then draws the circle according to the radius set by the cursor.

Note

The start point of a center-to-edge circle forms at the end of the last selected line in a drawing (if no objects are selected, it starts where you set the starting point). The circle itself, however, does not attach to the line. It is a separate object unless it is tied with a tie line.

  Edge-to-center circle sets a perimeter point first, then draws the circle according to the radius set by the cursor. The cursor appears in the center of the circle while setting the radius.

  Three point circle sets a perimeter point first, then draws the circle according to the radius set by the cursor. The cursor

appears on another perimeter point of the circle while setting the radius.

Note

There is no difference in the circle drawn using these three circle types. They only offer three different methods to create circles.
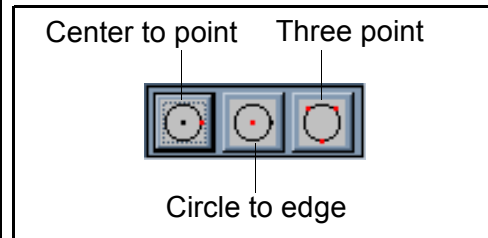
Figure 3.9 *Circle types*

- Move the cursor to the workspace and **select**. This sets the center or perimeter point (depending on the tool) of the circle.
- Move the cursor away until the desired size of the circle is reached and **select** to set the circle and end the drawing operation.

  The radius of the circle is listed in the settings bar.

Note

Circles are drawn in the direction of the cursor following the setting of the center or perimeter point. The beginning and ending points are located where you set the final point of the circle.

Note

A circle may be flipped in a variety of directions to reverse its direction. See *Flip on page 27*.

Circle settings - by angle or length

The circle settings in the line information menu controls how the circle, arc or ellipse is drawn. The Pattern Maker software uses a series of straight lines (vectors) to draw objects, including circles and arcs.

The software allows you to control either the length of the lines that make up a circle, or the angles used to create the lines that make up the circle.

Note

You can enter a dimension in the radius box in the line information bar to draw the circle after setting the start point. Move to this box with the mouse or by hitting the tab key.

Press **enter** after entering the value to complete the circle.

Circles by length

The circle by **length** function allows to set a value limiting the circle sides to a length from .001" to 60". Shorter line lengths create a smoother circle. This also increases the number of sides in a circle, adding greatly to the memory load on the computer.

The number of sides in the circle varies depending on the size of the circle (larger circles contain more lines).

To set the circle parameters to length, select the **By Length** button, enter the length of each side and press **Enter**.

Circles by angle

The circles **by angle** function allows you to set the angle between the two rays drawn from the center of the circle to the end points of one of the line segments (sector) used to represent the final circle.

Smaller angles create a smoother circle. This also increases the number of sides in a circle, adding greatly to the memory load on the computer.

The maximum angle is 120 degrees, since this makes a 3-sided

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triangle. An angle greater than 120 degrees only forms two unconnected lines or a distorted triangle.

To set the circle parameters to angle, select the **By Angle** button, enter the angle and press **Enter**.
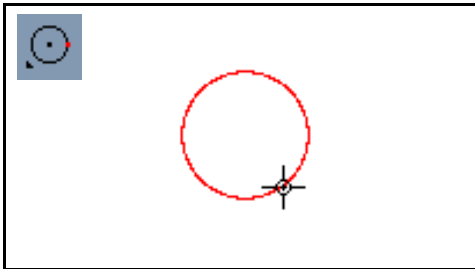
Figure 3.10 *Using the circle tool*

Arc

The arc tool draws arcs from 1 to 360 degrees.

If no lines are selected on the screen, the arc begins at the point you select with the screen cursor. The arc forms in the direction in which you drag the cursor after setting the starting point.

If an object is already selected when you begin drawing the arc, the arc begins at the end of that line and sweeps toward the cursor point. Thus, if the cursor is to the right of the line, the arc attachs to

the end of the line and sweeps to the right.

To create an arc:

• **Select** the arc tool.

• Move the screen cursor to the workspace.

• **Select** to set the beginning point. If an object is already selected, the beginning point of the arc is the last drawn point in the selected object.

• Set the direction of the arc sweep by dragging the cursor to the left or right.

• Move the cursor to the desired arc radius and **select** to set the radius.

• Drag the mouse to adjust the arc angle and select to set the arc. This also ends the drawing operation.

Note

You can enter exact values for the arc radius and angle in the line information bar.

Figure 3.11 shows the parts of an arc sweeping to the left.

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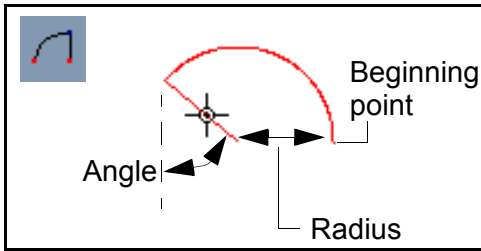
Figure 3.11 *Parts of an arc*

Arc settings - by angle or length

Arc settings for angle or length are similar to those for circles. Refer to *Circle settings - by angle or length on page 22*.

⬭ Ellipse

The ellipse tool draws ellipses. It works in a similar manner to the circle tool.

To use:

- **Select** the ellipse tool.
- Move the screen cursor to the workplace.
- **Select** to set center of ellipse.
- Drag the cursor to form the ellipse.
- **Select** to set the ellipse when the ellipse is the proper size. The diameters in the X and Y axes are displayed in the line information menu.

Note

The center of an ellipse forms at the end of the last selected line in a drawing. The ellipse itself, however, does not attach to the line. It is considered a separate object unless it is tied with a tie line.

Note

The reference point is located in the center of the ellipse. The beginning and ending point is wherever the cursor is when you **select** to set the end point.

Figure 3.12 shows an ellipse with its reference point in the center. The direction of an ellipse is always created in a counter-clockwise direction.
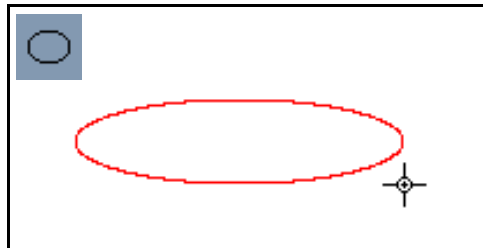
Figure 3.12 *Using the ellipse tool*

Note

An ellipse may be flipped in a variety of ways to reverse its direction. See *Flip on page 27*.

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Ellipse settings - by angle or length

Arc settings for length or angle are similar to those for circles. Refer to *Circle settings - by angle or length on page 22*.

Notes

The notes tool adds text to the pattern. This text only appears on the screen for your reference. It does not affect the pattern.

To use the notes tool:

• **Select** the notes tool.
• Move the screen cursor to the workspace.
• **Select** to set the starting point.
• Enter the text.
• **Select** again to end the drawing operation.

Transformation tool bar

Transformation tools allow you to change object shapes, sizes and orientations. Many of these tools act in relation to the object reference point, described in *Object reference point on page 25*.

The transformation tools are shown in *Figure 3.13*.

You may move the transformation tool bar anywhere in the software window by clicking the left mouse button on, and dragging the tool bar handle.
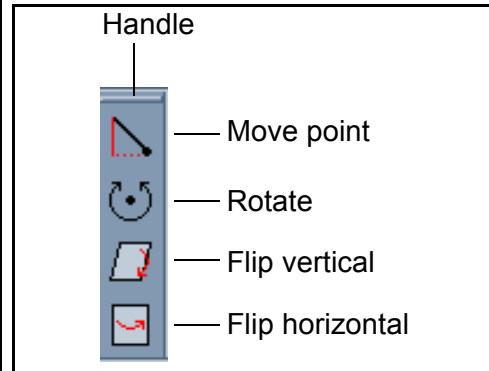
Figure 3.13 *Transformation tool bar*

Object reference point

Each object has a reference point. The object reference point is a red circle with a solid x, appearing when an object is selected. Transformation tools act on the object with respect to the object reference point.
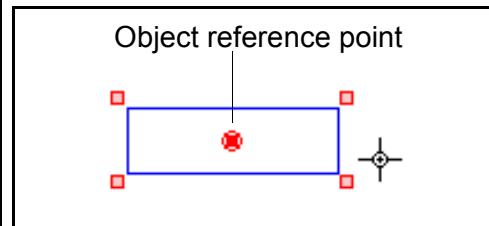
Figure 3.14 *Object reference point*

The reference point is created in the center of the object, but it may be moved to another location in the workspace.

To move the reference point, move the cursor over the reference point, click and hold the **right mouse button** and drag the reference point to a new location.

Release the **right mouse button** to set the reference point.

Move Point

The move point tool moves a point that already exists in a pattern, allowing you to reshape or resize existing objects.

To use:

- **Select** the move point tool.
- Move the screen cursor to the point you would like to move.
- **Select** to grab the point.
- Move the cursor to the new point location.
- **Select** to set the point in the new location.

Note

If you cannot see points on lines in the pattern, the handle function is probably turned off. To turn it on, press **H** on the keyboard.

Figure 3.15 shows how the move point tool is used to move the right hand line point downward.

Note

You may also enter coordinates in the line information bar for the destination of a selected point when using the move function. Start to move the point then use the mouse or **tab** to enter the coordinate boxes. Type in the coordinates and hit **enter** to complete the operation.

Figure 3.15 *Using the move point tool*

Rotate

The rotate tool rotates an object about the object's reference point. To use the rotate tool:

- **Select** an object in the workspace.
- **Select** the rotate tool.
- Move the cursor to the workspace.
- Move the object reference point if needed.
- **Select** to begin rotating the object.

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• Move the cursor to rotate the object about the reference point.

Note

The further away from the reference point you move the cursor, the more control you have in rotating the object.

• **Select** to complete the operation.
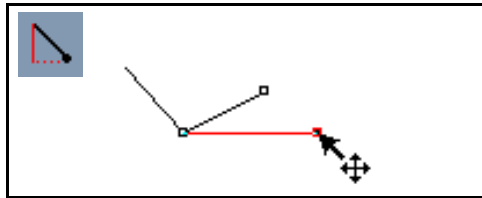
• Click the **right mouse button** to switch the cursor to the arrow, or select another drawing tool to finish using the rotate tool.

Note

You may also enter coordinates in the line information bar for angle of the rotation. Start to rotate an object then use the mouse or tab to enter the angle box. Type in the angle and hit **enter** to complete the operation.

Note

Holding **ctrl** while releasing the left mouse button creates a copy of the object in the new location and leaves the original object as is.
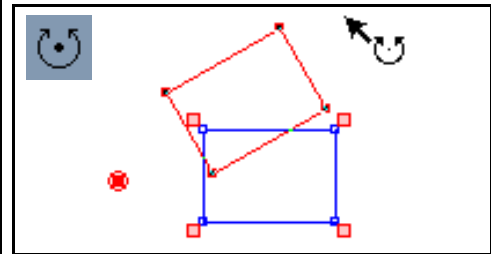
Figure 3.16 *Using the rotate tool*

Flip

The **flip** tool allows you to change the orientation of an item 180 degrees by flipping it horizontally or vertically over the object reference point.

Note

The flip tool can be used to create symmetrical items. You can draw half of the item, copy and flip it, then tie the two halves together to form a symmetrical whole.

• **Select** an object in the workspace.

• Move the cursor to the workspace.

• Move the object reference point if needed.

• Flip the object by **selecting** the flip vertical or flip horizontal tool.

• Click either mouse button to switch the cursor to the arrow, or select another drawing tool to finish using the flip tool.

Figure 3.17 shows the horizontal flip.

Figure 3.18 shows the vertical flip.

Note

Holding **ctrl** while releasing the left mouse button creates a copy of the object in the new location and leaves the original object in its location.
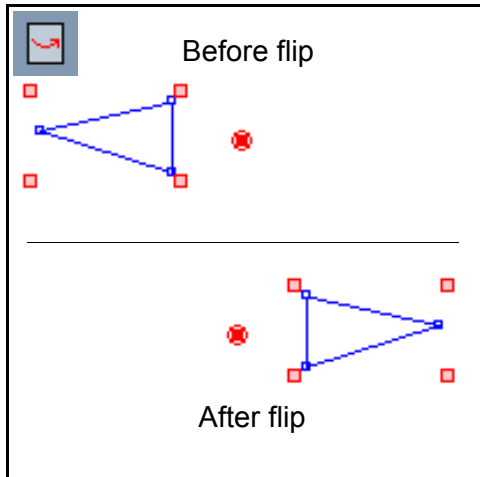
Figure 3.17 *Flip horizontally*
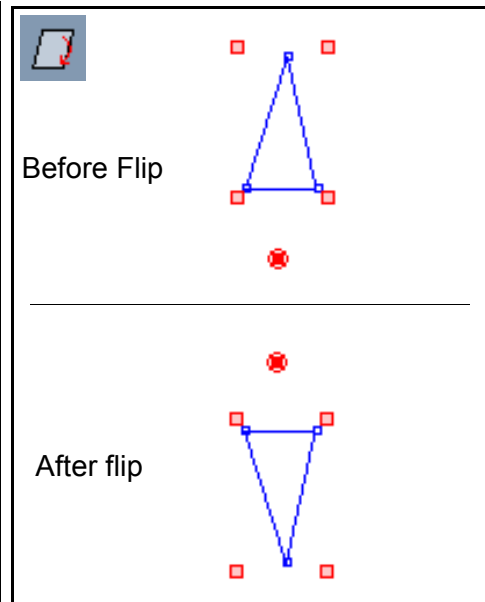
Figure 3.18 *Flip vertically*

Transform menu

The Transform Menu provides another way to choose functions included in the Transformation Bar, as well as additional functions. The functions listed under the Transform Menu include:

- **Move point**
- **Horizontal flip**
- **Vertical flip**
- **Rotate**

Reverse

Transform > Reverse reverses the direction of vectors in an object.

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Manipulate Z

Transform > Manipulate Z allows you to modify the Z values of a selected group of objects. This provides even more flexibility in creating 3D patterns. The **Transform > Manipulate Z** dialog box is shown below.
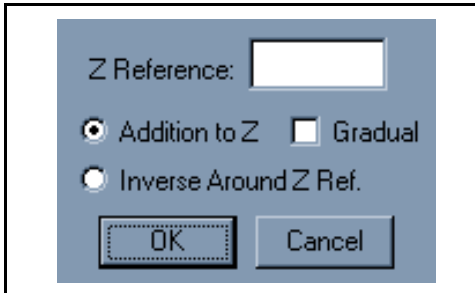
Figure 3.19 *The manipulate Z function*

Transform > Manipulate Z modifies Z values in the following three ways:

- **Addition to Z**
- **Gradual addition to Z**
- **Inverse around Z reference**

Addition to Z

Addition to Z adds the Z amount you specify in the "Z Reference" box to each of the existing Z values of the selected objects in a group. You may enter a positive or negative number using this function.

For example, if you select a group of objects, each with a Z value of 1, and you set the "Z Reference" to .25, when applied using the **Addition to Z** function, the new Z values become 1.25.

Gradual addition to Z

Gradual addition to Z applies the total amount of the Z value you enter in the "Z Reference" box gradually to each object in the selection, according to the sequence of the objects.

For example, if you selected 4 objects and you specified the "Z Reference" as 1, a value of 0 would be applied to the first object, a value of .25 to the second, a value of .5 to the third, and a value of .5 to the fourth.

Inverse around Z reference

Inverse around Z reference creates a "mirror image" of the Z values for a selected group of objects. The "Z Reference" value you enter in the dialog box is the Z value of the object which you want to be the reference point for the inverse transformation.

For example, if you have drawn a pattern to create a 3D model of a person's face, you could use this function to change the pattern to create a mask of this face. You

would do this by selecting the objects in the pattern and entering the highest Z value in the pattern as the "Z Reference" when performing this transformation.

Scale offset

Transform > Scale Offset resizes the vectors of a selected object by recreating them parallel to their original location and offset to the left of right of the vector according to the distance you specify.

To use the **Transform > Scale Offset** function:

• **Select** the object(s) you want to scale offset.

• **Select Transform > Scale Offset**.

• Enter the size of the offset and the side of the vector for the offset to occur.

• Click the **OK** button.

• **Select** to complete the operation.

Connect

The **Transform > Connect** function connects separate, selected objects in the workspace in two ways, directly or displaced. The individual objects become one object using this command.

To connect objects, first select the objects then choose one of the following connect methods:

Transform > Connect > Directly moves lines and objects together to make them one object. Objects are connected in sequence, either the order in which they were drawn, or the order in which they were sequenced.

The function leaves the first sequenced object in its original location and moves the other objects to connect the end point of the earliest sequenced object with the start point of the next object. *Figure 3.20* shows two objects connected directly. The arrows in the figure indicate the order and direction in which the objects were drawn.

For information on sequencing, see *Sequencing Objects on page 46*.

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Seperate objects

1   2

Connected objects (directly)
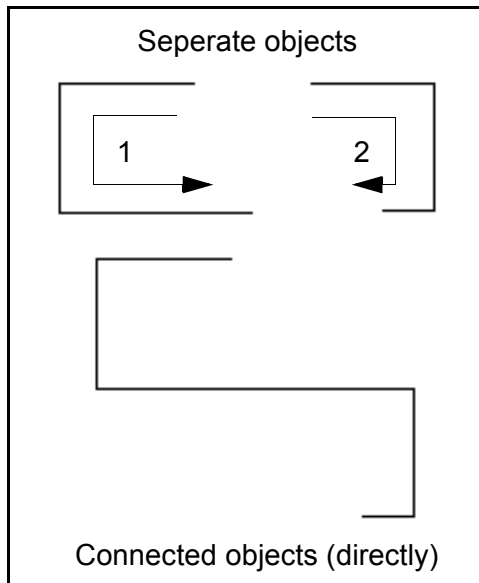
Figure 3.20 *The connect directly function*

All objects except the first sequenced object move from their original location when connected with the **Transform > Connect > Directly** function.

If **Transform > Connect> Directly** is used when there are selected objects on the workspace, only those selected objects are connected. If no objects are selected, **Transform > Connect> Directly** connects all objects on the workspace.

To connect objects using the **Transform > Connect> Directly** function:

- **Select** the lines or objects you want to connect directly.

- Select **Transform > Connect > Directly**.

  The program moves the objects to connect them as one object.

Transform > Connect > Displaced creates one object out of several by drawing pattern lines from the end point of an object to the start point of another. Items are connected in sequence, either the order in which they were drawn, or the order in which they were sequenced.

This function works on selected objects or all objects if none are selected.

All of the objects remain in their original location. *Figure 3.21* shows two objects connected directly. The arrows in the figure indicate the order and direction in which the objects were drawn.

For information on sequencing, see *Sequencing Objects on page 46*.

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Seperate objects

Connected objects (displaced)
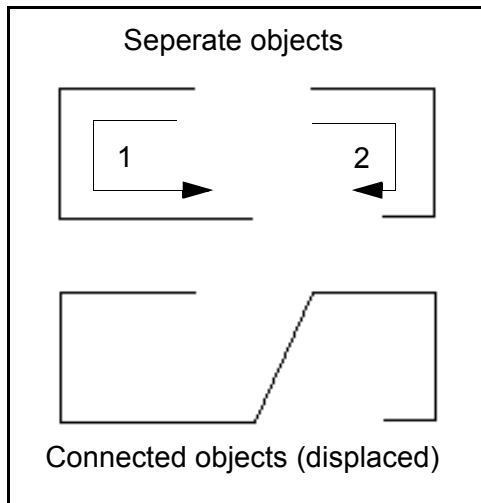
Figure 3.21 *The connect displaced function*

To connect objects using the **Transform > Connect > Displaced** function:

•   **Select** the lines or objects you want to connect directly.

•   Select **Transform > Connect > Displaced**.

The program draws pattern lines to connect the objects.

Disconnect

Transform > Disconnect disconnects an object previously created from two or more objects using the connect function. Select the object then **Transform > Disconnect** to break the connected object into the original objects.

Note

The objects *do not* move to their original locations using this function.

This function works on selected objects or on all objects if none are selected.

Mouse functions

The Pattern Maker software allows you to perform various functions using the mouse.

Move object

The move object function moves objects in the workspace using the cursor and the object's reference point.

To use the move function:

•   **Select** an object in the workspace

•   Move the object reference point if needed.

•   Place the cursor on the reference point and hold the **left mouse**

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button while dragging the object to the new location.

•   Release the **left mouse button** to set the object in the new location.

•   **Select** again to end the operation.

Figure 3.22 shows the how the move object function is used to move a rectangle up and to the left.
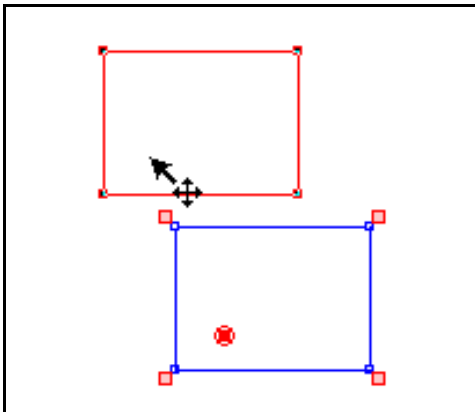
Figure 3.22 *Using the move function*

Note

You may also enter coordinates in the line information bar to specify the destination of the reference point when moving an object. Use the mouse or hit tab to enter the coordinate boxes. Enter the values and hit enter to complete the operation.

Note

Holding **ctrl** while releasing the left mouse button creates a copy of the object in the new location and leaves the original object in its location.

Scale object

The **Scale** function allows you to increase or decrease the size of an object or pattern. The change is measured as a percentage of the original size.

To use the **scale** an object:

•   **Select** the object.

•   Place the cursor on one of the corners of the bounding box of the selected object.

Note

The object's corner box opposite to the one you select remains in the same place, while the others move accordingly with the scaling.

•   Click the **left mouse button** and drag the box to scale the object. The scale change is displayed in the line properties menu. The numbers indicate the change in percentage in the X and Y dimensions.

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You can lock the cursor in the X or Y axis once the desired percentage in that axis is reached. Then you can move the cursor in the other direction to obtain the second percentage. This is easier than trying to reach both percentages at the same time.

You can also hold the **ctrl** key while dragging the corner of the bounding box to scale the image proportionally, according to the longest scale value.

• Release the **left mouse button** to set the object to the new size.

Figure 3.23 shows how the scale function is used to make a rectangle larger.

Figure 3.24 shows an item scaled proportionately and disproportionately.

The **scale** function allows you to change the size of items in the pattern, including objects created using the **Transform > Connect** functions.
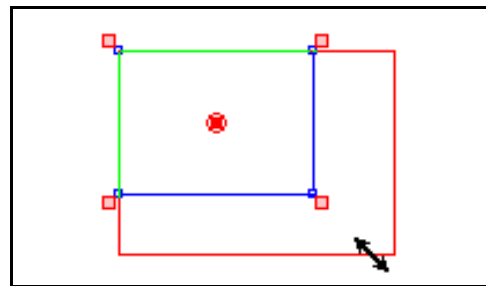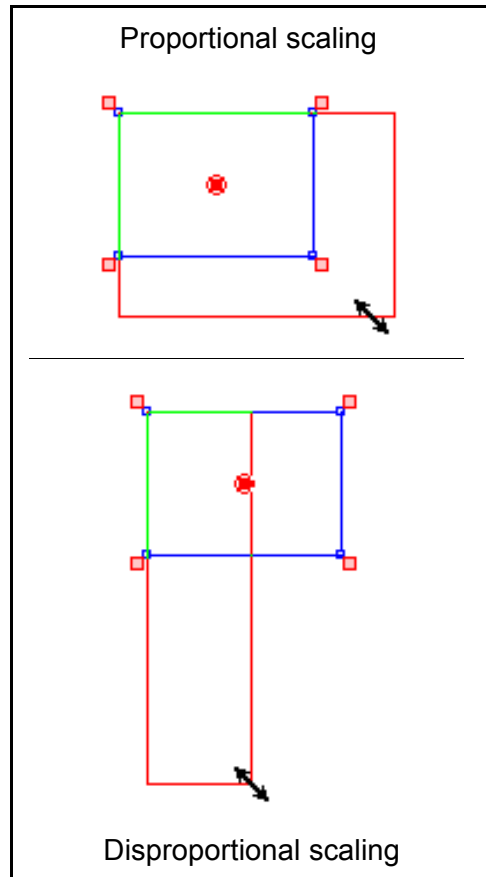

Figure 3.23 *Using the scale function*

Proportional scaling

Disproportional scaling

Figure 3.24 *Proportional and disproportional scaling*

Overview

This chapter discusses some techniques for efficient drawing and design. This chapter also discusses how to design patterns for some basic CNC machine functions, such as flat and three-dimensional cutting.

Using numeric X and Y coordinates

There may be times when you use the Pattern Maker software to copy a pattern already designed on paper. You can use the cursor to trace the pattern, or you can enter the pattern coordinates directly into the program.

This is more accurate and in some cases easier than using the cursor, particularly if you are copying a pattern that already has the dimensions marked on it.

To enter the numeric coordinates for a drawing, use the **Tab** key to switch control of the cursor from the mouse to the keyboard.

When you press the **Tab** key, the numerical value in the **X coordinate box** becomes highlighted.

When the **X coordinate box** is highlighted, you may enter the numerical cursor coordinate for the

X axis. Pressing the **Tab** key again moves you to the **Y coordinate box**.

Note

If you tab through a box without making an entry, the value remains unchanged.

Each time you press **Tab**, the next input box in the settings bar becomes highlighted, allowing you to enter numerical values. Pressing **Tab** repeatedly continues to cycle through the input boxes.

Press **Enter** when you have completed entering numeric information. You will see the cursor jump to its new position.

Note

Remember, when entering coordinates in the absolute zero mode, the program measures from absolute zero - the upper left hand corner of the workspace. Thus, if you enter an X coordinate of 10 and a Y coordinate of 20, the cursor moves to a position 10 inches away from the left hand edge of the workspace and 20 down from the top of the workspace.

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Note

If you enter an incorrect number in the coordinate box, press the **right mouse button** to delete the entry and return to the cursor.

Note

Using the coordinate boxes locks the screen cursor in that particular axis. To unlock the screen cursor, press the X or Y key. See *X - lock/unlock (X)* and *Y - lock/unlock (Y) on page 9*.

To measure from the cursor's existing position, you need to change to relative zero mode. To do this press the **space bar** once. This switches the program into relative zero and sets the current screen cursor position as 0,0.

Note

If you are already in relative zero mode and want to create a new 0,0 point, press the **space bar** twice.

Note

When using numeric input to draw, it is easiest to lock the screen cursor before beginning the drawing. This blocks input from the cursor, preventing you from accidentally moving the screen

Examples using numeric coordinates

Drawing a 10-inch straight line

To draw a straight line using numeric coordinates:

- **Select** the straight line tool.
- Move the screen cursor to the workspace.
- Lock the cursor by pressing the **X** and **Y** keys.
- **Select** to set the beginning of the line.
- Set a zero point (press the **space bar**).

Note

Remember, you have to press the **space bar** twice if you are already in relative zero mode.

- Press **Tab** once to enter the **X-coordinate box** (the value in the box becomes highlighted).
- Enter 10 in the box.
- Press **Enter** to draw the line.
- Click the **right mouse button** to complete the drawing operation.
- Unlock the cursor by pressing the **X** and **Y** keys.

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Drawing a 10 by 20-inch box

To draw a box using numeric coordinates:

- Move the screen cursor to the point where you want to begin the box.

- Lock the cursor by pressing the **X** and **Y** keys.

- **Select** to set the corner of the box.

- Set a zero point (press the **space bar**).

Note

Remember, you have to press the **space bar** twice if you are already in relative zero mode.

- Press **Tab** once to enter the **X-coordinate box** (the value in the box becomes highlighted).

- Enter 10 in the box.

- Press **Tab** once to enter the **Y-coordinate box** (the value in the box becomes highlighted).

- Enter 20.

- Press **Enter** to draw the box.

- Click the right mouse button to complete the drawing operation.

- Unlock the cursor by pressing the **X** and **Y** keys.

Drawing circles

Circles may be drawn in this same manner. Keep in mind that when drawing a circle, enter coordinates only in one box (it doesn't matter which). Also, when drawing a circle, enter the radius of the circle in the box, not the diameter. Thus, if you want a circle with a 10-inch diameter, you must enter 5 in the **X** or **Y** coordinate box.

Drawing ellipses

Ellipses are drawn in the same manner as circles, except you must enter both an **X** value and a **Y** value. Like circles, these values are the radii for the completed ellipse.

Changing line parameters

Once you have drawn a pattern on the screen, you can go back and change the parameters of one, all, or matching (to selected) lines. This is done using the **information cursor**. Refer to *Modifying object vector properties on page 16*.

There are several ways to change a line. You may change a single parameter on one line or several parameters and lines at once. When you change a single parameter, other parameters attached to the line(s) are not affected.

Because each use of this function has different results, we will discuss each one separately.

Changing parameters on a single line

To change parameters on a single:

- **Select** the line you want to change.
- Open the **modify vector properties dialog box (ctrl + information cursor)**.
- **Select** the "single" option under the "modify" category.
- **Select** the parameters you want to change.
- Enter the new parameters or select one from the menus that appear. In the case of Z-depth and speed changes, you enter a new value.*

In the case of line type, select a new type from the menu that appears. In the case of an I/O change, select a new switch from the menu that appears.

- When you have entered the new parameters, **select** OK to complete the operation.

Changing parameters on a group of selected lines

To use the change line function to change parameters on a group of selected lines at one time:

- **Select** the line or lines you wish to change.

- Open the **modify vector properties dialog box (ctrl + information cursor)**.
- **Select** the "selected" option under the "modify" category.
- Enter the new values*.
- When you have entered the new parameters, **select** OK to complete the operation.

All the line parameter information will now be attached to the selected lines.

Changing parameters on matching lines

To use the change line function to change parameters on all lines matching a particular line type.

- **Select** the line you want to change.
- Open the **modify vector properties dialog box (ctrl + information cursor)**.
- **Select** the "matches" option under the "modify" category.

  This allows you to change all lines exactly matching the selected line in every parameter: line pattern, Z- depth, speed, type and I/O selection.

- **Select** the parameters you wish to change.
- When you have entered the new parameters, **select** OK to complete the operation.

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Changing parameters on all lines

To use the change line function to change parameters on all lines in a pattern.

- Open the **modify vector properties dialog box (ctrl + information cursor)** on any line.

- **Select** the "all" option under the "modify" category.

  This allows you to change all lines in the pattern, in every parameter: line pattern, Z- depth, speed, type and I/O selection.

- **Select** the parameters you wish to change.

- When you have entered the new parameters, **select** OK to complete the operation.

Simple drawing examples

This section shows you simple drawing examples using specific pattern types.

Flat work

Flatwork patterns are the easiest to design. When properly drawn, what you draw on the screen is what the CNC machine cuts.

Two-dimensional pattern

Flatwork patterns are two-dimensional. They are designed using flatwork lines that have instructions for depth of cut (Z-depth) and speed of the CNC machine.

Example: You want to use cut a Christmas-tree shaped ornament from 1/2-inch plywood. You have been given a pattern for the ornament that you will trace into the computer.

To begin, create a cutting line in the Maxym bar:

- Set a pattern for the cutting line you will be using.

- Set the Z-depth.

  This value is the sum of the following measurements: the distance you want the tool to remain above the workpiece as it travels between cuts (this is usually .5 inches); the thickness of the stock (in this case, it is .5 inches); an extra amount to insure that the endmill completely penetrates the stock (this is usually .1 inches).
  Adding these values together you get 1.1 inches for the Z-depth value.

- Enter the CNC machine speed.

- Set the line type.

  Because this is a two-dimensional project, choose the flatwork line type (F)

- Set the I/O control.

  Because only the CNC machine router runs during this operation, **select** the first switch.

- **Cancel** to leave the Maxym line menu.

Now you are ready to draw.

Place the drawing of the ornament on the graphics tablet. Select the angled line tool and begin tracing the ornament's shape onto the workspace. As you trace the shape, **select** at each point in the pattern.

When you have completed tracing the ornament pattern and have set the final point, **cancel** to complete the drawing operation. Your pattern is complete.

This pattern tells the CNC machine to begin cutting the pattern at the point you began drawing.* It plunges the endmill into the stock, then follows the pattern lines until it reaches the end of the pattern. Once there it pulls the endmill from the stock, leaving behind the ornament.

*This assumes you have positioned the CNC machine tool over the starting point of the pattern.

Using contours to produce 3D shape

You can instruct the CNC machine to cut a three-dimensional shape while using a two-dimensional drawing program.

This is accomplished by drawing a series of contours of the shape you want to produce using the X- or Y-contour lines.

The X- and Y-contour lines instruct the CNC machine to travel along one coordinate and to use the other to control the movement of the Z-head.

By cutting a series of contours over a block of material, you can produce a three-dimensional shape.

Example:

You want to produce a solid model boat hull from a block of maple. You do not have a drawing, but you do have a sample hull you want to reproduce.

Using a contour gauge, get an impression of the hull's contour at intervals of 1/2 inch.

Trace each contour onto a piece of paper. When all the contours have been taken and traced onto paper, trace them into the computer using the line tool and a Y-contour line.

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Note

Draw each contour as a separate line.

Position the separate contours in the Y-axis (stacked one over another). Separate each by 1/2 inch.

When all the contours are aligned, tie them together using the **Machining > Tie Line** function.

When this pattern is run on the CNC machine, the arm follows each contour in the X-axis while interpreting Y-axis coordinates as Z-depth instructions.

The CNC machine head rises and falls along the contour line as the arm moves along the X-axis.

When the arm comes to the end of a contour, it follows the tie line to the beginning of the next contour and repeats the process.

When the pattern is completed, the three-dimensional shape of the boat hull will have been carved from the block of wood, one contour at a time.

Sloped-plunge lead-in carving

You can use the 3D line type to ease the router tool into the workpiece. This allows you to use a tool that lacks cutting surfaces on its bottom and thus cannot be plunged directly into the work.

To use this method, draw a 3D line that begins outside the pattern and ends at the beginning point of the pattern. The line's Z-depth should be set so that the tool will be in the proper position when it reaches the end of the 3D line.

When this line is run on the CNC machine, the arm follows the line into the workpiece, descending on a steady slope. This allows the tool to enter the workpiece gradually, at an angle.

MAXYM

How the CNC machine interprets patterns

The Pattern Maker software is designed to control the movement of the CNC machine using lines drawn on the screen in a manner similar to that of most computer drawing programs.

A pattern is composed of a series of lines or vectors. Each vector denotes a direction and distance. It has a beginning and an ending point.

It is also important to note that a line drawn on the screen may actually contain several vectors. This manual describes how to do draw lines, arcs, circles, and squares. It is important to remember that all these shapes are made up of connected vectors.

Each vector also contains information to control how fast the CNC machine moves, how deep it cuts and what kind of cut it makes.

Anytime a line changes direction, a new vector is required

Figure 5.1 shows vectors in a line and vectors in a square.
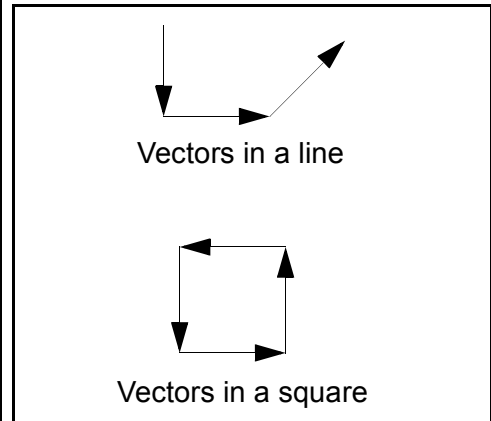

Vectors in a line

Vectors in a square

Figure 5.1 *Vectors*

Thus a square, which would appear to be a single line, is actually composed of four connected vectors. The same is true of a circle, which may contain thousands of connected vectors.

The X, Y and Z axes on the screen and CNC machine

The Pattern Maker software contains several different line types, each of which carries different instructions to the CNC machine. See *Line types on page 52*.

With the simplest line types (and the ones most commonly used) the CNC machine arm follows the line as an automobile driver follows a map.

Lines drawn on the X-axis (horizontal) cause the CNC machine arm to move left and right

across the cutting table. See *Figure 5.2*.

Lines drawn on the Y-axis (vertical) cause the CNC machine arm to move forward and backward over the cutting table. See *Figure 5.3*.
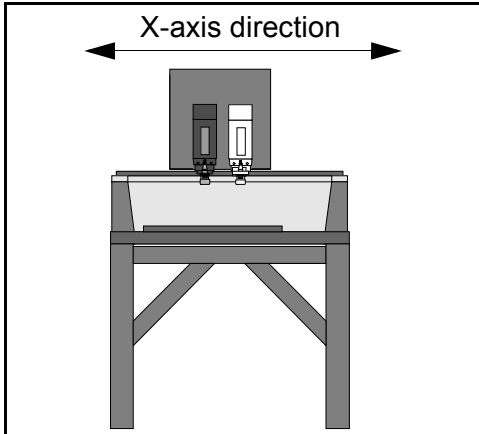

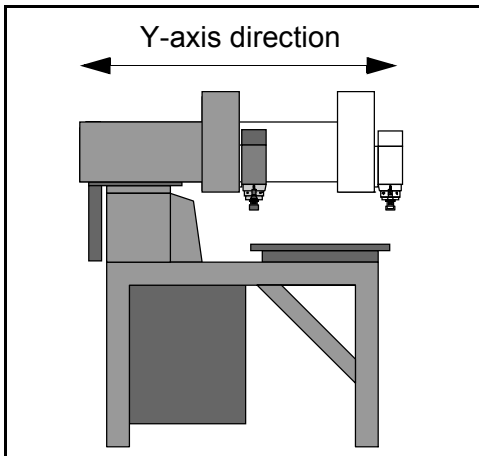Figure 5.2 *X-axis machine movement*

Figure 5.3 *Y-axis machine movement*

Z-depth instructions included in each line cause the CNC machine head to move up and down, in and out of the workpiece. See *Figure 5.4*
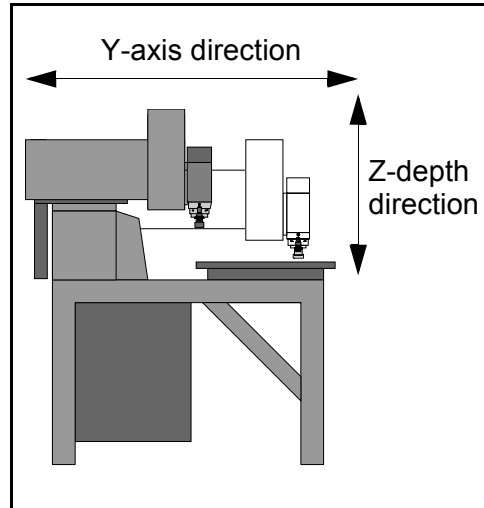

Figure 5.4 *Z-axis machine movement*

Information in a line

Colors

The Pattern Maker software uses color to display certain line characteristics. These include whether the line is selected or unselected, whether it is a part of a pattern, a guide line or other type of line. The line colors are not interpreted by the CNC machine.

Lines on page 11 describes the object line colors in the workspace. The remainder of this section

describes the line types that affect the behavior of the CNC machine.

The following machine lines have unique colors:

- **Tie lines** - magenta
- **Sequencing lines** - green
- **Guide Lines** - red

Tie lines

Tie lines are colored magenta. Tie lines guide the CNC machine from object to object in a pattern, with the router head removed from the workpiece. Without tie lines, the robot does not know how to travel to the next section of a pattern to begin cutting.

The default tie line is a "no cut" line. That is, the robot lifts the router head our of the work before travelling to the next item to be cut.

Creating Tie Lines

Machining > Tie Line ties separate objects together to make them one object. Tie lines run from the end of one object to the beginning of another. Objects are tied together in sequence, either the order in which they were drawn, or the order in which they were sequenced.

The objects remain in their original location. *Figure 5.5* shows two objects connected with tie lines. The arrows in the figure indicate the

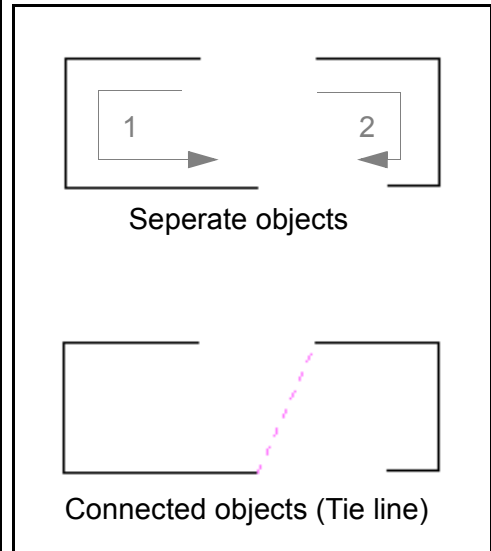order and direction in which the objects were drawn.

Figure 5.5 *Tie lines*

The function ties only selected objects. If no objects are selected, this function draws tie lines between all objects in the order in which they were drawn or sequenced.

To use the **Machining > Tie Line** function:

- **Select** the lines or objects you want to connect with a straight line.
- Select **Machining > Tie Line**.

  The program draws a tie line between the objects.

Untie

Machining > Untie removes tie lines between selected objects, or all tie lines if no objects are selected.

Loop Line

Machining > Loop creates a tie line from the last point in the pattern to the CNC machine's starting position.

The machine follows this line from the end of the pattern to the robot's starting position. Use this function when you want the machine to return to its starting position after cutting an item or a group of items for repeated cutting of production parts.

Note

If all lines of a pattern are not tied together, the loop line may not appear to return to the beginning of the pattern. However, the machine returns to its starting position.

Note

If all the lines of a pattern are not tied together, the loop line may not appear to return to the beginning of the pattern. The CNC machine arm, however, returns to its starting position.

Sequencing lines

Green lines are used in the sequencing process to indicate when a line has been selected for sequencing. The CNC machine cuts objects in sequence order. The first drawn object is the first in the sequence, the second drawn object is next, and so on.

Sequencing allows you to chance the sequence order of objects in a pattern

Sequencing Objects

Machining > Sequence allows you to change the sequence order of objects.

As objects are drawn in a pattern, they are put in a sequence that the machine uses when cutting the pattern. Normally, this is the order in which the objects were drawn. Thus, the first object drawn is the first cut by the robot. The second object drawn is the second cut.

Machining > Sequence allows you to rearrange the sequence of the objects for more efficient cutting. This allows you to ignore cutting sequences until you have completed the pattern.

You may sequence all objects in a pattern or only those you select.

To sequence all objects in a pattern:

Deselect all objects you want to sequence.

• **Select Machining > Sequence**.

• **Select** each object in the order in which you want it to be cut.

• **Cancel** to complete the operation when all items in the pattern have been selected.

Note

If for some reason you fail to select all objects in the pattern, the unselected objects are be cut in their original order *after* the sequenced items.

Selected Sequencing

You may want to set the sequence for only a portion of a pattern. To do this:

• Deselect all objects.

• **Select** the ejects you want to sequence. (Their lines turn blue.)

• **Select Machining > Sequence**.

• **Select** each of the active objects in the order in which you want them to be sequenced. (Their lines turn green.)

• **Cancel** to complete the operation.

These objects now have their own order within the overall sequence of the entire drawing. Their order begins with the first item sequenced.

Example: Take a drawing with four items, A, B, C, D.

A is the first item drawn, B the second, C the third and D the last. They would normally be cut in the order A, B, C, D.

Instead, you want to cut them in the order A, C, B, D, reversing the order of B and C, but keeping A and D in the original order.

To select this sequence;

• **Select** items B and C;

• **Select Machining > Sequence**.

• **Select** item C, then item B;

• **Cancel** to complete the operation.

You have reversed the order of items B and C without changing the order of items A and D.

Before sequencing

A B C D

1st cut **2nd cut 3rd cut** 4th cut

A B C D

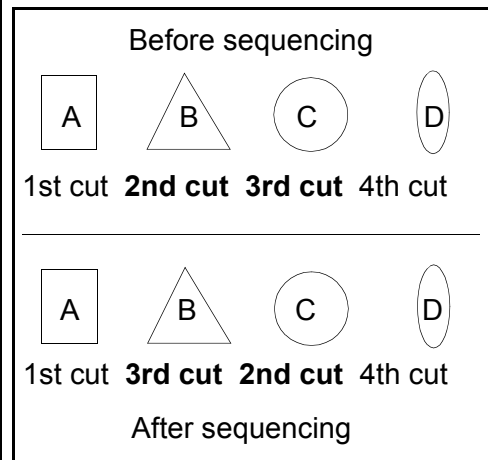1st cut **3rd cut 2nd cut** 4th cut

After sequencing

Figure 5.6 *Selected sequencing*

Selecting lines

You can select lines by clicking on them with the selection cursor and the **left mouse button**. As you select each line, all other lines become automatically deselected.

You can select more than one line at a time by holding the **shift** key and selecting the lines you wish. You can also deselect lines in the same manner.

You may wish to select a single vector instead of an entire line. To do this, hold the **left mouse button** and drag the cursor to produce a selection box around the vector you wish to select. Release the button to select the vector.

Note

Only a portion of a vector needs to be encompassed by the selection box for the entire vector to be selected. This method can be used to select a large group of lines or vectors. Simply drag the selection box around the lines you wish to select.

Beginning and ending points

Lines created in the Pattern Maker software have a beginning and an end. When the CNC machine is cutting a pattern, it follows each line from beginning to end.

A line begins where you select the first point on the workspace. It ends where you complete the drawing operation by selecting the final point.

The endpoint of a line can be marked by a small square point called a handle which can be turned on or off by pressing the **H** key. The beginning of a line has no point. *Figure 5.7* shows a line and handle.

Figure 5.7 *Typical line with a handle*

If you begin drawing a line with a selected object on the workspace, the last point of that object becomes the first point of the line. In effect, this means a newly drawn line or object attaches itself to the last selected point on the workspace.

Maxym Bar and Pre-Defined Settings

Overview

The lines in a pattern tell the CNC machine which direction to move in two dimensions, the X and Y axes.

The CNC machine also needs instructions for how fast (speed) and how deep to cut (Z-depth).

These parameters and several others are entered in the **Maxym bar** and the **Pre-Defined** dialog box accessed through the Pre-Defined button on the Maxym bar.

Maxym bar

The Maxym bar is located on the bottom of the workspace window. This bar displays the current line properties for new objects.

The line properties include the z depth of the cut, the speed of the machine (in inches per minute), the screen display line style, the type of line and any I/O auxiliary settings.

For information on line type, refer to *Line types on page 52*.

For information on I/O settings, refer to *I/O controllers on page 55*.

Any new objects made with the drawing tools have the properties shown in this menu. The Maxym bar is shown in *Figure 2.1*.

Pre-defined lines button

Selecting the **Pre-Defined** button in the Maxym bar opens the Pre-Defined dialog box for user-created lines. In this menu you may enter the properties for up to

five different line types. The Pre-Defined menu is shown in *Figure 5.8*.

With this menu open, you can also change the current line used in the Maxym bar, either by selecting a stored line type, or by entering new parameters.
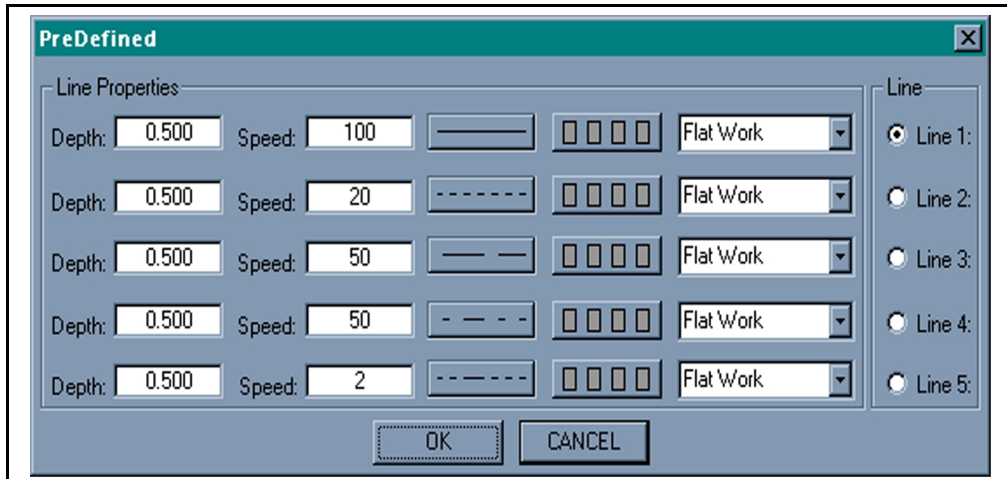
Figure 5.8 *Pre-defined line dialog box*

Machine lines button

Selecting the **Machine Lines button** in the Maxym bar opens the special lines dialog box for the three stored machine line types - tie lines, loop lines and lead-in lines.

In this box you may set the speed and any I/O auxiliary settings for the three line types, as well as the lead-in coordinate for the lead-in line.
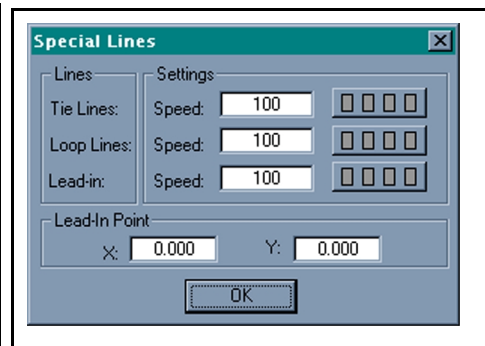
The special lines dialog box is shown in *Figure 5.9*.

Figure 5.9 *Special lines dialog box*

Lead-in Line

The **lead-in line** instructs the CNC machine how to move from the machine starting point to the first object start point. Enter the point for the machine to start under the **Machine lines button** in the Maxym bar.

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Vector properties

The **information cursor** found in the drawing tools window (see *Figure 3.4*) allows you to view information about, or modify object vectors.

The cursor opens the vector information dialog box when it is used to select an object.

The cursor opens the modify vector properties dialog box when it is used to select on object while holding the **ctrl** key.

The information cursor is described in detail in *Information cursor on page 16*.

Parameters for the current line displayed in the Maxym bar are erased and replaced with those of a stored line if you open the modify vector properties dialog box.

Setting a line pattern

The properties for a line may be set in several places.

Setting the current line

Set the properties for the current line in the Maxym bar.

Setting stored lines

Set the properties for stored lines in the Pre-Defined dialog box, accessed through the Pre-Defined button on the Maxym bar. Stored lines allow you to quickly change the current line by simply selecting the line type icon in the settings bar.

Changing existing lines

Change the properties of existing lines using the information cursor. See *Modifying object vector properties on page 16*.

Z-depth setting

Z-depth is the distance the CNC machine head travels in the Z-axis - the 3rd dimension.

Z-depth is always a positive number measured downward from the starting position of the CNC machine tool.

For example: Assume the CNC machine tool is positioned a half-inch above a board. A Z-depth value of 1 inch causes the tool to drop 1/2-inch to the surface of the board, then plunge another 1/2-inch into the board. See *Figure 5.10*.
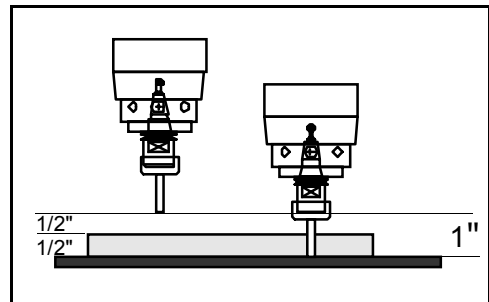

Figure 5.10 *Z-depth plunge*

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The Z-depth can be set from 0 - 60 inches.[*]

Speed

The speed parameter controls the rate at which the CNC machine arm moves over the workpiece. It is measured in inches per minute and can be set between 1 and 100.

Line types

Eight different types of lines are listed in the line type pull down menu in the Pre-defined line dialog box and the Maxym bar:

- **Flatwork**
- **2nd Z flatwork**
- **X contour**
- **Y contour**
- **XY 4th**
- **2nd Z 3D**
- **3D**
- **Guide**

Each line type gives you a different way to control the CNC machine arm.

Flatwork line

The **flatwork line** indicates two-dimensional movement over the surface of the workpiece. The CNC machine arm follows the pattern in the X and Y axes. This line is usually used for cutting shapes from flat material.

When interpreting a flatwork line, the CNC machine arm first performs any Z-depth instructions attached to the line.

2nd Z flatwork line

The **2nd Z flatwork line** works the same as the flat work line, in that it performs any Z motion first, then follows the pattern in the X and Y-axis. The difference is that the Z motion is performed on the 4th axis when supplied as a second Z-axis.

When the 4th axis is supplied as a rotation the Z value rotates the 4th axis at a rate of 20 inches of Z for 360 degrees.

X and Y contour lines

The X and Y contour lines are usually used for cutting three-dimensional shapes using a series of contours. These lines instruct the CNC machine to interpret the X (X-contour) or Y (Y-contour) coordinates in a line as Z-axis instructions.

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A CNC machine arm following a X contour line travels in the Y-axis, while the X coordinates controll the Z movement of the CNC machine head.

Figure 5.11 shows movement of the CNC machine arm while following an X-contour line. The X-axis coordinates are interpreted by the CNC machine as Z-depth instructions, causing the head to move up and down while moving in the Y-axis.

A CNC machine arm following an Y contour line travels in the X-axis (side to side), while the CNC machine head travels up and down in the Z-axis, following the Y coordinates.

Figure 5.12 shows movement of the CNC machine arm while following a Y-contour line. The X-axis coordinates are interpreted by the CNC machine as Z-depth instructions, causing the head to move up and down while moving in the X-axis.

In both cases, Z-depth information in the line is ignored by the CNC machine.
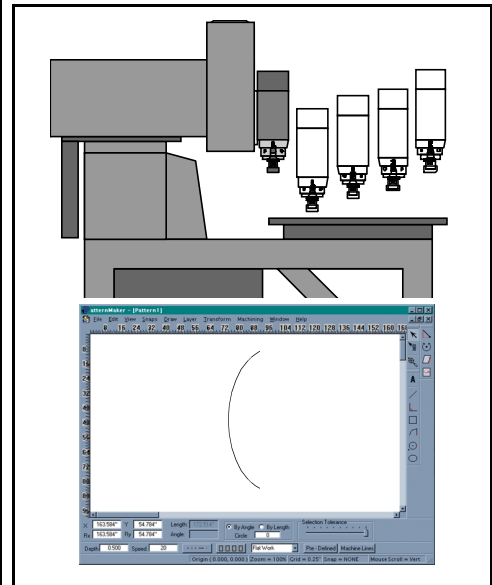
Figure 5.11 *X-contour line motion*
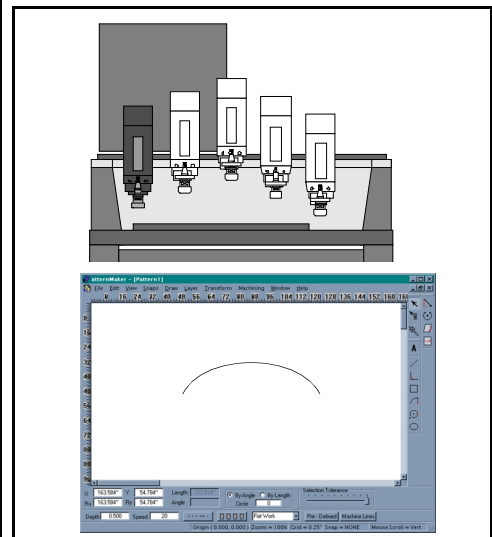
Figure 5.12 *Y-contour line motion*

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XY 4th line

The **XY 4th line** sends Z-depth movement instructions to the 4th axis motor while the CNC machine arm moves along the X and Y axes.

When the 4th axis is supplied as a second Z-axis it performs its motion the same as 3D line but on the second Z. When supplied as a rotation, the 4th axis rotates at a constant rate as the CNC machine arm moves along the X and Y-axis.

The amount of rotation is controlled by the Z-depth value. The ratio of Z-depth to rotation is set at 20 to 1. This means that for every 20 inches of Z- depth the 4th axis motor rotates 360 degrees.

(like 2nd z 3d, allows you to set rotation scales, rotary- designed to operate the rotary 4th axis).

3D lines

The 3D line causes the Z-depth position of the CNC machine head to change at a constant rate as it moves along an X or Y line. The head moves from its current position at the beginning of the line to the new Z-depth position at the end, creating a constant slope in the workpiece.

For example:

The CNC machine tool is 1 inch into the workpiece when the CNC machine encounters a 3D line with a Z-depth value of 1/2-inch. As the CNC machine follows that line, it gradually moves the head to the 1/2-inch Z-depth value. At the end of the line, the CNC machine head will be at the 1/2-inch level. The resulting cut will be sloped. This line works in both the X and Y axes.

Figure 5.13 shows movement of the CNC machine arm while following a 3D line.
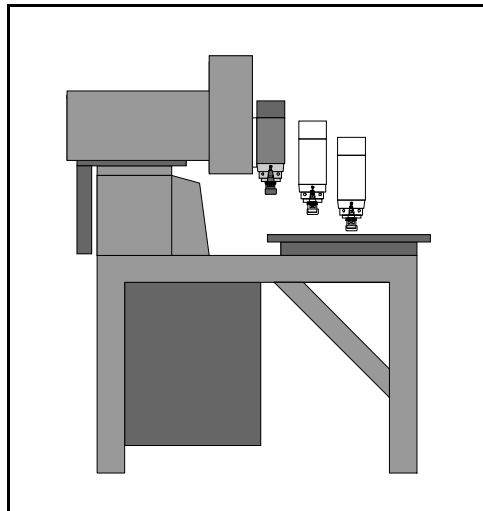
Figure 5.13 *3D line motion*

2nd Z 3D line

The 2nd Z 3d line works the same as 3D line , but on another spindle.

Guide lines

Guide lines are used as a drawing aid to help create patterns. They are not interpreted by the CNC machine.

Figure 5.14 shows a guide line being used as a bounding box. Guide lines appear as red lines (even when deselected) in the workspace window.
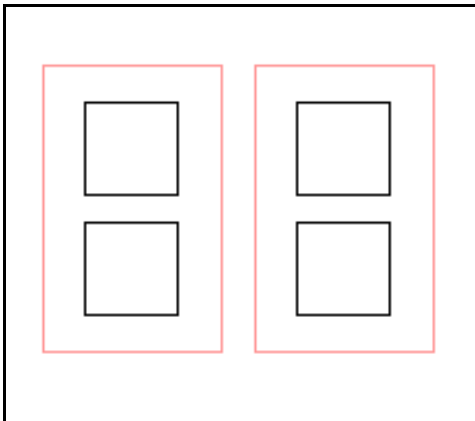

Figure 5.14 *Guide lines*

I/O controllers

You can attach and control up to four auxiliary motors or devices through the CNC machine and Pattern Maker software. One of these devices is usually the router mounted on the CNC machine head. The remaining three can be air compressors, vacuums, etc.

The devices are plugged into the I/O box on the CNC machine and controlled by selecting the **I/O control button**, then by clicking on the numbered buttons in the auxiliary I/O settings dialog box.

The **I/O control button** is located in the the Maxym bar, the Pre-Defined dialog box accessed through the Pre-Defined button on the Maxym bar, and in the Modify Vector Properties dialog box accessed through the information cursor.

The auxiliary control menu is shown in *Figure 5.15*. A checked box indicates the device is on, an unchecked box indicates off.
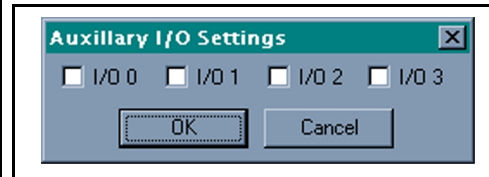
Figure 5.15 *Auxiliary control menu*

Tool compensate

Machining > Tool Compensate adjusts the pattern to account for the diameter of the cutting tool.

MAXYM

Overview

This chapter describes how to load and save files to and from the workspace, and explains the different kinds of files used by the Pattern Maker software.

This chapter also discusses how patterns created in other design programs may be used by the Pattern Maker software and Maxym CNC machine.

The file menu

The **File** menu allows you to perform the following tasks to manage your files:

New (ctrl-n)

File > New creates a new pattern file with an empty workspace.

The default name for a new pattern file is Pattern1.pmf (with the number increasing if a file with the same name is currently open).

You may create a new pattern at any time without closing or saving other open patterns. Windows allows you to work on multiple files at the same time.

Open (ctrl-o)

File > Open opens a pattern file from a disk.

Close

File > Close closes the current pattern file and removes it from the screen. If you have not saved the current version of the file, you will be prompted to do so before the file closes.

Save (ctrl-s)

File > Save writes the pattern to a file. The first time you save a file, a Windows dialog box opens. In this box, choose the file name, file type and directory to store the file.

Following the first save of an open pattern file, each time you select **File > Save**, the current pattern rewrites the previously saved version without asking you for a name.

Note

If you enter a file name that already exists in that directory, Windows will ask if you want to replace the existing file. If you choose "yes", the existing file is replaced by the new pattern file. If you choose "no", the save operation is canceled.

Save As

File > Save As opens the Windows save box each time, allowing you to change the file name, file type and directory of the current pattern.

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Use the File > Save As function to export files as different file types. See *Supported file types on page 58* for a complete description of the file types.

Print (ctrl-p)

File > Print prints the pattern to your printer. The entire pattern prints on a single page.

Print Preview

File > Print Preview displays on the screen how the pattern will appear printed on a piece of paper.

Print Setup

File > Print Setup allows you to adjust your printer settings.

Exit

File > Exit closes the Pattern Maker program. If you have any open patterns with changes that have not been saved, you will be prompted to do so before the program closes.

Supported file types

The Pattern Maker software can open the following file types:

- Patter Maker files (.pmf)
- Output files (.pat)
- G-code files (.nc)

Note

When opening G-code (.nc) files, refer to *Loading G code files on page 58*

- DXF Files (.dxf)
- CPattern View files

Pattern Maker files (.pmf)

These are the native files for drawing from the current release of the Pattern Maker software.

OutPut file (.pat)

These are the native files for drawings from previous Pattern Maker software releases. Also referred to as PATTERN files.

G-Code (.nc)

These are CNC machine motion files from CAM programs.

Loading G code files

To load a G Code file into Pattern Maker, the file must first have the extension ".nc". If the CAD-CAM program uses a different file extension you can rename the file.

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Note

To rename a file in Windows, click the **right mouse button** on the file name in the file list and choose "**rename**".

G-code patterns loads into Pattern Maker at 0.0X, 48.0Y, which is in the lower left side of the drawing world.

If the G-Code file contains negative coordinates, all coordinates are offset into positive X,Y coordinate space in Pattern Maker, the Z data is also inverted to most CAD-CAM systems. In the CAD-CAM system the zero position is the top of the part and positive Z raises the Tool. When reading the Z data Pattern Maker take the highest tool position and converts it to zero, with positive Z data going down into the work.

The G codes that Pattern Maker can convert are listed below. This section also describes how Pattern Maker interprets the code. Mode control words remain in effect until a new mode control word is read.

- **G90** *Absolute Mode:* Absolute positive or negative coordinates offset to positive

- **G91** *Incremental Mode:* Relative positive or negative coordinates converted and offset into positive absolute.

- **G00** *Positioning Mode:* Converted to Tie Line

- **G01** *Linear Interpolation:* Converted to 3D line

- **G02** *Clockwise Arc*

- **G03** *Counter Clockwise Arc*

Arc Conversion:

Absolute: G90 G02 X_Y_Z_I_J_

Absolute positions for both arc end point words X,Y,Z and arc center words I, J.

Incremental: G91 G02 X_Y_Z_I_J_
Incremental positions for both arc end point words X,Y,Z and arc center words I, J.

Arcs are converted to a series of straight 3D Lines based on the settings of the Circle Sides and Circle Type system variables.

Program Words:

X = X Axis Position inches
Y = Y Axis Position inches
Z = Z Axis Position inches
I = X Axis Arc Center inches
J = Y Axis Arc Center inches
F = Feed-rate inches/min.

The feed-rate program word remains in effect until a new feed-rate word is read.

G00 Positioning mode is always the speed of the tie line. Each line in the file can not contain more than one move for each axis.

DXF (.DXF)

These are drawings to or from other CAD or drawing programs.

There may be times when you want to use the Maxym CNC machine to create a product designed on a program other than the Pattern Maker software. This is possible through the use of DXF files

A DXF file contains only the vectors of a drawing. These vectors do not have any Pattern Maker line parameters (such as speed or line type) attached to them. They do, however, retain their individual identities in the form of a "color number."

DXF is a universal file format created in a Computer Assisted Drawing (CAD) or similar program. These files are designed to be used by many different kinds of programs, including the Pattern Maker software.

Thus, if a drawing contained three different styles or colors of lines,

each line is identified by a different number in the DXF file.

When the DXF file is loaded into the Pattern Maker program, the file is converted into a format the Pattern Maker program can use. During this process, the different lines in the DXF file are assigned Pattern Maker line parameters based upon existing line parameters in the Maxym line menu.

Like G-code files, Pattern Maker assigns the DXF pattern origin point to (0, 48) when loading.

Lines are assigned parameters beginning with the current line bar and working up the Maxym line menu. Thus, a line identified by color number 1 would be assigned the parameters in the current line bar. A line identified by color number 2 would be assigned the parameters at the bottom of the Maxym line menu.

If there are more DXF lines than styles in the Maxym line menu, the remaining lines are assigned the parameters from the current line menu.

This also happens if there are no color numbers assigned to the lines in the DXF file. In this case, all the lines in the DXF files are assigned

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the parameters in the current line bar.

Arcs and circles in DXF and G code files

Both the DXF and G Code files store arcs and circles separately from lines. Pattern Maker converts these to a series of straight lines based on the settings of Circle Sides and Circle Type system variables. See *Circle settings - by angle or length on page 22*.

Note

When there is a large variety of arc sizes, sometimes setting the Circle Type variable to Length produces better results.

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Overview

This chapter is designed to help you use the CNC machine efficiently. It discusses the correct way to position the CNC machine arm before cutting a pattern, some methods for laying out a series of patterns so that they can be cut from a single sheet of stock, and methods of clamping stock to the CNC machine worktable.

Positioning the CNC machine arm

Before a pattern can be cut with the CNC machine arm, the arm must be positioned properly. This is because the CNC machine does not have any knowledge of its position on the workspace. It follows only the directions in the patterns stored in its memory.

When a pattern is downloaded to the CNC machine, the CNC machine begins work on the pattern **wherever the arm happens to be sitting at the time**.

Thus, if the CNC machine arm is positioned over the middle of the worktable, it begins cutting a pattern at that point - even if you want the pattern to start in the corner of your stock.

There are two ways to insure the CNC machine arm is positioned properly before beginning a pattern:

• Return the CNC machine arm to the home position and use a "lead-in" pattern to guide the CNC machine to the starting point.

The second option requires you to draw two lines to guide the CNC machine from its home position to its starting position over the workpiece.

This pattern consists of two lines. The first is a "lead-in" line that begins at absolute zero and connects to the pattern's starting point. This line is normally a "no cut" flatwork line.

The second line is a Y-contour line that is sequenced after the "lead-in" line. This line moves the CNC machine's Z-head to the proper height above the first point of the pattern.

Figure 7.1 shows a pattern with a lead-in line.
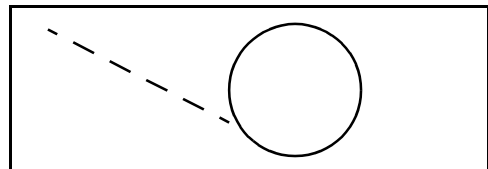
Figure 7.1 *A pattern with a lead-in line*

Setting the starting depth

The Z-depth values in a pattern assume that the CNC machine arm will begin cutting from a certain height above the workpiece. In order to cut the pattern properly, the CNC machine tool must be positioned at the proper height above the workpiece before the pattern is downloaded to the CNC machine.

Example:

Assume you are cutting through a piece of 1/2-inch stock. You know the Z-depth of the pattern lines is 1 inch. If you position the CNC machine tool at .4 inch above the workpiece, the CNC machine tool will be able to cut through the material with .1 inch to spare.

Organizing your work

Pattern layout

When cutting many copies of a pattern from a sheet of flat stock, it is usually most efficient to cut an entire sheet of patterns at once.

To do this, you need to make copies of the pattern and lay them out on the workspace in a series of columns or rows.

It is helpful first to draw a bounding box on the workspace the same size as your stock. Then, by using

the copy function, you can copy and place the patterns in a column or raw within the bounding box.

Note

Use a guideline to draw the bounding box.
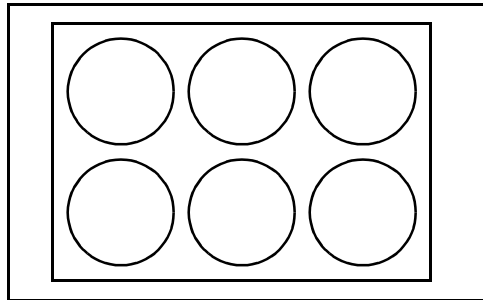
Figure 7.2 *Items within a bounding box*

Efficient layout

There are several methods for laying out a sheet of patterns. One is to use the workspace grid as a guide.

To do this:

- Draw a box that represents the boundaries of your stock.

- Place your original pattern in the upper left- hand corner of the box. Be sure to leave enough space along the edge to accommodate whatever clamping method you will be using.

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- Measure the width of the pattern. Then set the drawing grid to a slightly larger size

- Make sure the entire pattern is selected. Then select **Edit > Copy**.

Note

Make sure you have tied together all the elements that need to be tied before copying the original pattern.

- Place the cursor on the first point of the pattern. Then press the right keyboard arrow to move the cursor to the next grid space. Repeat until you are just beyond the pattern

- **Edit > Paste** to place a copy of the pattern in the workspace. The copy should appear in alignment with the original.

You can repeat this action, using the arrow key to move at regular intervals across the workspace. When you reach the end, you should have a row of patterns.

When you come to the edge of the bounding box, you have two options:

You can move the cursor down and repeat the process you just completed.

Or, you can select the entire row of patterns, copy it and place it just below the top row.

When you have filled the bounding box with patterns, you need to tie everything together. To do this, make sure all the patterns are selected, then select **Machining > Tie Line**. This creates a tie line that guides the CNC machine arm from pattern to pattern.

You may also want to create a loop line (**Machining > Loop**). This guides the CNC machine arm back to the beginning of the stock once it has cut a complete sheet of patterns.

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The following checklist is provided to help you make complete pattern files.

1. Draw all pattern objects.

2. Verify the Z-depth for all lines.

3. Verify the speed for all lines.

4. Verify the line type for all lines.

5. Create a tie line for the entire pattern.

6. Create a loop line if necessary for production work. Refer to *Loop Line on page 46*.

7. Enter the lead-in point. (Refer to *Lead-in Line on page 50*.)

8. Set the tool compensation for the pattern. Refer to *Tool compensate on page 55*.

9. Save the file.

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Appendix 1: Cutting tips

CNC machines are versatile and can be used in many different situations to cut many different types of material. Because of this, it is difficult to cover every cutting situation here completely.

We have included some basic information for selecting router bits and choosing cutting speeds as well as instructions for certain cutting methods and tips. We recommend, however, you discuss your particular situation with a reputable manufacturer of CNC machine bits for specific advice. We will also be glad to advise you based on the experience we have accumulated with the Maxym CNC Machine.

Bit selection

While you can use many different types of bits with the CNC machine router, there are a few characteristics to keep in mind when choosing your cutting tool.

Bits or end mills should be purchased from a dealer who specializes in machine tools or CNC equipment. In some cases bits may be ordered by mail. Onsrud Cutter Inc., 800 Liberty Drive, Libertyville, IL 60048 (708) 362-1 560 offers a full line of CNC machine bits through its catalog. The catalog also contains many helpful cutting hints.

DO NOT USE bits designed for woodshop routers with the Maxym CNC Machine system.

All bits used with the Maxym CNC Machine arm should have cutting surfaces on the bottom as well as the sides. This allows the bit to plunge cleanly into your workpiece. We recommend using carbide bits because they last longer than high-speed steel bits.

For most flat stock cutting jobs we recommend using **two-flute spiral bits**. These bits eject chips upward where they can be removed by a vacuum attachment.

Because these bits may tend to lift the stock off the cutting table, you must ensure the workpiece is well clamped before you begin cutting.

If you are using very thin stock, you may want to consider using a **downcut spiral bit**. This bit actually pushes the stock against the cutting table. This bit is not recommended for use in thick stock because it does not clear chips efficiently.

In some cases, a straight-edged bit may produce a smoother cut. If you use a **straight-edged** bit, however, you must reduce the speed of the CNC Machine arm to compensate

for the slower cutting speed of that bit style.

Bit size

The size of the bit depends on the thickness of the material you are cutting. The cutting edge of the bit must be at least as long as the stock's thickness. This is true even in cases where you may not be able to cut the stock in a single pass.

The cutting edge, however, should not be significantly longer than the thickness of the stock.

Bits with longer cutting edges have a larger diameter than bits with short cutting edges. This is important to keep in mind when designing your pattern. If you will be cutting thick stock, your pat- tern should be designed to accommodate the larger tool diameter.

Cutting direction

In most woods, the smoothest cut is one made with the arm moving against the direction of router rotation. Cuts made in the opposite direction, called "climb cuts," can leave a rough surface behind.

In some cases, you may need to reverse the direction of your pattern in order to avoid climb cutting.

Feed rates

The rate at which the CNC machine can move the cutting router through the stock varies depending on bit size and type, stock type and thickness.

In general, the bit should be moved through the stock fast enough to cut its way freely. Moving the tool too quickly causes strain and deflection. Moving the tool too slowly causes friction and burning.

Clamping

USA CNC Machine offers several types of clamping equipment to hold stock under the CNC machine arms.

Worktable

The worktable is a welded steel frame with a PVC work surface. USA CNC Machine recommends using a sheet of MDF wasteboard on top of this as a cutting surface.

Your workpiece can be clamped to the worktable using any method you choose.

Pressure table

The pressure table uses a vacuum created by a high-pressure blower to hold the stock. The table comes with a machined grid, high-pressure blower, electrical switch and terminal box. A piece of porous

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wasteboard is placed on top of the table as a cutting surface.

The blower is able to maintain adequate pressure even as patterns are cut from the stock.

Clamp tables

USA CNC Machine also offers clamp tables with two or three horizontally positioned air-operated clamps. When activated, the clamps pin the stock against a fixed steel fence. The clamps and fence are drilled so that you can attach a wasteboard.

Hold-in tabs

If you will be cutting many parts from a sheet of stock, you may want to use hold-in tabs to prevent already cut parts from being ejected by the spinning router tool.

Hold-in tabs are designed into the pattern by slightly reducing the Z-depth values at two or three points around the boundary of the part. This causes the CNC machine to leave a small piece of stock holding the part. After the CNC machine has completed cutting, the parts can be snapped away from the stock and trimmed by hand if necessary.

Note

Hold-in tabs are not necessary when using a pressure table to hold the stock.

Efficient cutting

In order to increase the efficiency of the CNC machine, you may use several methods to cut multiple copies of a product from a single pattern.

One method is to cut several sheets of stock at once. You can do this if the stock is thin enough and the router tool long enough.

Note

You may need to reduce the speed of the CNC machine arm to compensate for the extra cutting effort.

You can also use more than one router head on some CNC machines, including Maxym CNC machines. USA CNC Machine offers an adjustable quick-change plate that will hold two router heads. This allows you to cut two parts while the CNC machine is following a single pattern.

When using this arrangement, you may need to rethink the layout of your patterns on the working surface.

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For instance, if you are cutting a sheet of parts that were laid out for a single router head, you need to eliminate every other column of patterns to account for the second router head.

Cutting with two Z-heads

USA CNC Machine offers the option of a second Z-head to the Maxym CNC Machine arm. This head is controlled in- dependently of the first Z-head and can be used to mount an air drill or other device.

The second Z-head is controlled through the Rotate 4th axis line.

Appendix 2: Troubleshooting

Error messages

When the Pattern Maker software encounters an error, it will notify you by using an error message dialog box. Error messages produced by the program are explained below.

File menu

Message: *No entities found in DXF file*

Problem: There is no drawing contained in the DXF file you are attempting to load.

Solution: Check the program that created the DXF file.

Message: *Error reading DXF file*

Problem: The DXF file you are attempting to load is corrupted.

Solution: Check the program which created the DXF file.

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