OutlineEditor

The Outline Editor window is the main editing window to change the outline of the work and the location of cuts. It also allows you to change information about the cutter being used. For more information on the cutter parameters, see the Help section on Cutters.

Just below the editing window at the far left, you select whether you are editing the Outline or you wish to edit CutPoints. To the right of that you see the location of the cursor at any time, along with any measured distance (the distance between pressing the mouse button and lifting the mouse button). On the far right edge is the total length of the curve (either inside or outside, depending on where the cutter is located).

You can change the thickness of your bowl by setting a new value for the "Thickness" field.

The "Resolution" field is the over-all accuracy of the outline (and the 3D shape). A good number for this is around 0.020". Values below 0.005" will result in much slower response time when rendering a 3D cut surface. However, for very fine patterns you may need to set this to a small value to see the details of your cut surface.

The "Write Data" button allows you to write the coordinates of the outline to a tab-delimited file (compatible with spreadsheet programs). You will be prompted for the approximate distance between points. The file will be placed in the same directory as the .xml file with the same name and a .txt extension.

You have the option of showing CutPoints for all cutters (when multiple cutters are used) or show only the CutPoints which use the selected cutter.

The "Offset" button is enabled after digitizing points from the stage (probing the surface). Such points represent the center of the cutter which is not the outline of the shape (when using an HCF or UCF cutting frame). Pressing this button will correct the curve after all points of the shape have been probed.

The panel on the bottom is for editing Cutter information. You can select which cutter is being used. See the Help file on Cutters for more information on the other cutter parameters.

Maneuvering

To zoom in/out, use the scroll wheel on your mouse or two-finger up/down on a trackpad. To pan, do a right click and move the mouse or control-click on a trackpad (two-finger click followed by one finger drag). Command-F (on a Mac) will zoom to fit the curve in the window.

Editing outline points

There are several different curves that you might see in the window:

- The inside surface is a purple/magenta color.
- The outside surface is an orange/tan color.
- A solid white line indicates the path of the cutter. CutPoints will snap onto this path (unless snap is disabled fot that CutPoint).
- A light dotted gray line with round dots is the curve-fitted line that determines the shape of the work. The dots are the points which you entered and can move. These digitized points might be on the path of the cutter (for files imported from older versions of RESurface). On new shapes that are digitized by clicking with the mouse, these will be points on either the inside or outside of the curve (depending on where the cutter is when you first start making the shape).

To enter a point in the "Edit Outline" mode, simply double-click where you want the new point to go. To move a point, click on it and drag it somewhere else. To remove a point, drag it outside the window and it will go away.

Points should be entered starting at the bottom. As you enter additional points, they are in sorted order from bottom to top. If you want a point that is out of this order (as when you have a rim of a bowl that recurves downward), first enter the point up higher (to get it in proper sequence) then drag it down to where you want it.

To get tighter curves, put points closer together. For example, one can approximate a corner by using a very tight curve with several points close together.

If you see funny kinks in your curves, this is generally an indication that you won't be able to cut that shape with a cutter of the given radius. For example, you can't make a shape with an internal curvature that is a smaller radius than your cutter. Also, going around the outside edge of a corner can give an unusual appearance.

Menu for the "Outline"

The menu bar has several items that only relate to the Outline Editor:

- **2Pts: Vertical** -- If you only have 2 points, this will make them perfectly vertical.
- **2Pts: Horizontal** -- If you only have 2 points, this will make them perfectly horizontal.
- **Offset Curve...** -- This brings up a menu with several options. You can move all the curves vertically so that the top or bottom of the selected curve is zero. Alternately you can move all the curves vertically so that the top or bottom of the selected curve is at a specified location. You can also move the curves perpendicular to the curvature with a given offset.
- **Invert** -- Inverts the shape (i.e. turns it upside-down).
- **Clear CutPoints** -- Deletes all CutPoints, leaving the outline.
- **Clear All** -- Clears the CutPoints and the outline (for a fresh start).
- **Zoom to Fit** -- The window is zoomed in or out so that the curves fit nicely within the window.

- **Spiral to Cutpoints** -- A SpiralRosette or SpiralIndex can be converted to a number of discrete RosettePoints or IndexPoints with some uniform spacing. The spacing can be uniform in X, uniform in Z, or uniform in distance following the spiral.

Editing CutPoints

To add a CutPoint in the "Edit CutPoints" mode, select the desired CutPoint on the pallet and double-click close to the white line (which is the path of the cutter). The added CutPoint will snap to the curve. Alternately, drag and drop a CutPoint from the pallet to a point close to the white line. The first CutPoint will have default values which can be edited by selecting the CutPoint in the DataNavigator and editing the properties in the Property Editor.

About View3D

The 3D View window is for viewing the 3D bowl.

Using the mouse

To ZOOM in or out, use a 2-finger up/down motion on the trackpad to zoom out/in.

To ROTATE, click and use a 1-finger motion on the trackpad to rotate the view left/right/up/down.

To PAN, use a 2-finger click on the trackpad followed by a 1-finger movement on the trackpad.

While rotating the view, you'll notice that the grid moves as well, and the light sources remain stationary.

Other controls

The "Reset" button always brings you back to the starting default viewpoint.

The "Grid" button will show or hide the 3D grid lines.

The "In/Out" button selects viewing the inside or outside surface of the shape.

The "SnapShot" button will save the view as a png file.

Showing details

You will see the inside or outside surface of the shape. As CutPoints are added, you will generally also see some black lines superimposed on the surface which are similar to a "pen chuck". This is a quick and easy way to see the basic pattern of a cut.

Pressing the "Render" button will show you the inside or outside of the shape with the details of the cuts. Note that rendering can take a lot of computer power and might take anywhere from a

few seconds to many minutes. Smaller resolutions (in the Outline Editor window) will take a lot more time than larger resolutions. You should start with resolutions of about 0.020 for a starting point which will give a reasonable trade-off between speed and resolution of the details. For a final image (that you might wish to save) you can go to a resolution of 0.010. Warning -- resolutions less than 0.005 will be VERY SLOW!

The "Render" button is always un-selected whenever the View3D window is not open to avoid rendering delays.

Setting the Color of the shape

The color of the shape can be changed by selecting "Outline" in the DataNavigator window and changing the color in the Property Editor window. The color information is saved in the xml file.

About CutPoints

A CutPoint describes how a cutter will perform at a given position. There are a number of different kinds of CutPoints, and they may behave in different fashions depending on the type of cutter being used.

Common to all CutPoints:

All CutPoints have a location and an option to snap to the white cutting curve (shown in the Outline Editor).

- **X-Location:** the radial distance from the centerline of the lathe.
- **Z-Location:** the distance along the axis of the lathe.
- **Snap:** this forces the CutPoint to be on the cutting curve (i.e. the white solid line shown in the Outline Editor). This is the preferred setting in most situations.
- **Visible:** flag which if un-checked will keep the CutPoint from being drawn in the Outline Editor window. This is mainly used when there are a lot of CutPoints and you only want to view certain ones to make positioning easier. Note that this does NOT hide the CutPoint for cutting purposes. Also note that this information is not saved in the file.
- **Cutter:** The cutter to use for this CutPoint. Note that one build a design using multiple cutters. When generating g-code, only the CutPoints using the cutter which is selected in the Outline Editor will generate g-code.
- **Cut Depth:** The total cutting depth from the at-rest position.

What you will see in the Outline Editor is a dotted yellow line which represents the very tip of the cutter at any given location. You will also see a text number to help in identifying the various CutPoints.

IndexPoints:

An IndexPoint will make cuts only at certain spindle rotations (like locking a pin on various holes on an index wheel). The parameters for an IndexPoint are:

- **Direction:** Describes the direction of movement:
  - **INDEX_X:** cutting movement is in the x-direction only
  - **INDEX_Z:** cutting movement is in the z-direction only
  - **INDEX_CURVE:** cutting movement is always perpendicular to the surface
- **Repeat:** The number of cuts that are made around the rotation of the work piece.
- **Phase:** Phase shift for the cut. Phase shift can be displayed in two different ways depending on how you have set your preferences (see the Help topic on Preferences). In "Engineering" mode, phase shift is a value between 0 and 360 degrees where 360 degrees represents a full pattern shift, 180 degrees means 1/2 pattern shift, 90 degrees means 1/4 pattern shift, etc. Note that this is NOT the actual spindle rotation. The other mode you can set in the Preferences is "Fraction" mode where 1.0 means a full pattern shift, 0.5 means 1/2 pattern shift, etc.
- **Mask:** Optional information for skipping some of the index positions. When left blank, all index positions are used. To mask certain positions, enter a series of 0 and 1 digits. A 0 (zero) means to skip the position. A 1 (one) means to enable the position. If the sequence of digits is shorter than the repeat value, then the sequence will be used repeatedly. For example -- entering 0111 with Repeat=12 will skip the 1st position, the 5th position, and the 9th position and use all other positions.

What you see in the Outline Editor is a solid cyan arc showing the maximum depth of the cut. There is also a short solid cyan line originating at the center of the IndexPoint showing the depth and direction of the cut.

RosettePoints:

A RosettePoint can have a rocking motion (most common), or a pumping motion, or both rocking and pumping together (with different rosettes for each). The parameters for a RosettePoint are:

- **Motion:** The direction of the motion of the rosette:
  - **ROCK:** Traditional rocking motion.
  - **PUMP:** Pumping motion (parallel to the axis of the spindle).
  - **PERP:** Motion is always perpendicular to the curve of the shape. Note that this is not a typical option on a traditional (analog) ornamental lathe.
  - **TANGENT:** Motion is always tangental to curve of the shape. Note that this is not a typical option on a traditional (analog) ornamental lathe.
  - **BOTH:** Both rocking and pumping motion. A different rosette is used for each.
  - **PERPTAN:** Both perpendicular and tangental motion. A different rosette is used for each.

Each rosette can be either a simple rosette, or a compound rosette (see RosetteBuilder help file for more information on compound rosettes). For each RosettePoint, the rosette can be changed from a simple rosette to a compound rosette by selecting the rosette node in the DataNavigator

and right clicking on the rosette node and selecting "Change to CompoundRosette". Likewise a compound rosette can be changed to a simple rosette by selecting it in the DataNavigator and right clicking on "Change to Simple Rosette".

For simple rosettes, you have the following parameters:

- **Pattern:** See the help file on Patterns for more information on the various patterns.
- **Repeat:** The number of times the pattern is repeated around the perimeter of the rosette.
- **Amplitude:** The peak-to-peak amplitude of the rosette.
- **Phase:** Phase shift for the cut. Phase shift can be displayed in two different ways depending on how you have set your preferences (see the Help topic on Preferences). In "Engineering" mode, phase shift is a value between 0 and 360 degrees where 360 degrees represents a full pattern shift, 180 degrees means 1/2 pattern shift, 90 degrees means 1/4 pattern shift, etc. Note that this is NOT the actual spindle rotation. The other mode you can set in the Preferences is "Fraction" mode where 1.0 means a full pattern shift, 0.5 means 1/2 pattern shift, etc.
- **Invert** -- Invert the pattern on the rosette.
- **Mask:** Optional information for skipping some of the repeats. When left blank, all repeats are used. To mask certain repeat, enter a series of 0 and 1 digits. A 0 (zero) means to skip the repeat. A 1 (one) means to enable the repeat. If the sequence of digits is shorter than the repeat value, then the sequence will be used repeatedly. For example -- entering 0111 with Repeat=12 will skip the 1st repeat, the 5th repeat, and the 9th repeat and use all other repeats.
- **MaskPhase:** Optional information for shifting the point in the pattern where the masking will start. As with Phase above, the number is either "Engineering" mode or "Fraction" mode depending on how you have set your preferences. In general, when you are cutting on the inside of a shape, you will probably want to start the masking at a point in the pattern where the pattern is at "1.0" in the pattern editor (which corresponds to a valley on the rosette). Likewise, when you are cutting on the outside of a shape, you will probably want to start the masking at a point in the pattern where the pattern is at "0.0" in the pattern editor (which corresponds to a peak on the rosette).
- **MaskHiLo:** Flag indicating if masking causes rosette to be the highest or the lowest in the pattern.
- **N2:** Some patterns use the optional **N2** parameter which is the number of small bumps within a repeat. For example -- an E rosette with 5 repeats and N2=6 will have a total of 30 bumps.
- **Amplitude2:** Some patterns use the optional **Amplitude2** parameter which is the amplitude of the small bumps as a fraction if the total amplitude. For example -- a Q rosette with a total amplitude of 0.3" and amplitude2=0.2" will have small bumps that are 0.06" (0.3 * 0.2 = 0.06) high superimposed on the major shape.
- **SymmetryAmplitude:** Optional information for changing the symmetry of a rosette by varying the amplitude of the various repeats. When left blank, there will be no variation in the amplitudes. If the sequence of numbers is shorter than the repeat value, then the sequence will be used repeatedly.
- **SymmetryWidth:** Optional information for changing the symmetry of a rosette by varying the width of the various repeats. When left blank, there will be no variation in the

widths. If the sequence of numbers is shorter than the repeat value, then the sequence will be used repeatedly.

For compound rosettes, you have the following parameters:

- **Amplitude:** The peak-to-peak amplitude of the compound rosette.
- **Phase:** Phase shift for the cut. Phase shift can be displayed in two different ways depending on how you have set your preferences (see the Help topic on Preferences). In "Engineering" mode, phase shift is a value between 0 and 360 degrees where 360 degrees represents a full pattern shift, 180 degrees means 1/2 pattern shift, 90 degrees means 1/4 pattern shift, etc. Note that for a compound rosette this is the actual spindle rotation since there is no explicit repeat parameter for a compound rosette. The other mode you can set in the Preferences is "Fraction" mode where 1.0 means a full pattern shift, 0.5 means 1/2 pattern shift, etc.
- **Invert** -- Invert the pattern on the rosette.

What you see in the Outline Editor is a solid yellow arc to indicate the maximum depth of the cut which is always perpendicular to the surface. There is also a short solid yellow line originating at the center of the RosettePoint showing the depth and direction of the cut. You will also see a solid green arc to indicate the minimum depth of the cut for a given cut depth and rosette amplitude. When using BOTH rocking and pumping, you will also see a solid green arc to indicate the minimum depth of the rocking motion and a solid blue arc to indicate the minimum depth of the pumping motion.

PiercePoint:

This is used when you want to move a tool into the work with the spindle running at a high rpm (as with plain turning). The parameters for a PiercePoint are:

- **Direction:** Describes the direction of movement (similar to IndexPoints above):
  - **MOVE_X:** cutting movement is in the x-direction only
  - **MOVE_Z:** cutting movement is in the z-direction only
  - **MOVE_CURVE:** cutting movement is always perpendicular to the surface

What you see in the Outline Editor is a solid orange arc to indicate the maximum depth of the cut which is always perpendicular to the surface. There is also a short solid orange line originating at the center of the RosettePoint showing the depth and direction of the cut.

Various Spiral Cuts:

There are 3 kinds of spiral cuts: SpiralIndex, SpiralLine, and SpiralRosette. They have a start point and an end point.

- **End Cut Depth:** The cut depth may be different at the end than at the beginning. If so, the depth is changed proportionally over the length of the spiral.

See the help file on Spirals for more information on the various kinds of spirals and parameters.

The step size when moving is the value in the "Curve Resolution" field of the Outline Editor window. For smooth cuts, you will want something on the order of 0.030" or less. Note that this type of can will take a long time to render even on the more powerful computers.

SpiralIndex:

The SpiralIndex CutPoint starts cutting at a number of points around the work piece (just like the IndexPoint above). Then it moves along the outside of the shape (following the white cut curve in the Outline Editor) while the spindle is rotating. This produces simple fluting (when twist=0) or it can produce a variety of spiral cuts.

The parameters for the starting point are the same as for IndexPoint listed above.

What you see in the Outline Editor is a starting IndexPoint and a separate end point (with the same text number ending with "E"). The end point can be moved independent of the start point. (Note that initially, the end point will be coincident with the start point until you move it.)

SpiralRosette:

The SpiralRosette CutPoint starts cutting with a rosette just (like the RosettePoint above). Then it moves along the outside of the shape (following the white cut curve in the Outline Editor) while the spindle is rotating. This produces a rosette pattern that varies smoothly as it spirals around the piece.

The parameters for the starting point are the same as for RosettePoint listed above.

If the starting depth is the same as the amplitude of the rosette (either rocking amplitude or pumping amplitude) and the end depth is different from the starting depth, then the rosette amplitude will be tapered as well. If you desire a taper in the depth without changing the amplitude of the rosette, then make one of them slightly different and the rosette amplitude will not be tapered.

What you see in the Outline Editor is a starting RosettePoint and a separate end point (with the same text number ending with "E"). The end point can be moved independent of the start point. (Note that initially, the end point will be coincident with the start point until you move it.)

SpiralLine:

The SpiralLine CutPoint starts cutting at a number of points around the work piece (similar to the SpiralIndex above). Then it moves along the outside of the shape (following the white cut curve in the Outline Editor) while the spindle is rotating forward and reverse to create a wave pattern in the line similar to what is produced on a straight line machine. The pattern is controlled by a PatternBar.

- **Scale Depth:** This specifies that the depth of the cut is to be scaled with the radius of the piece. The default value is "false".
- **Scale Amplitude:** This specifies that the amplitude of the pattern bar is to be scaled with the radius of the piece. The default value is "false".

The parameters for the starting LinePoint are:

- **Repeat:** The number of lines that are made around the rotation of the work piece.
- **Phase:** Phase shift for the lines. Phase shift can be displayed in two different ways depending on how you have set your preferences (see the Help topic on Preferences). In "Engineering" mode, phase shift is a value between 0 and 360 degrees where 360 degrees represents a full pattern shift, 180 degrees means 1/2 pattern shift, 90 degrees means 1/4 pattern shift, etc. Note that this is NOT the actual spindle rotation. The other mode you can set in the Preferences is "Fraction" mode where 1.0 means a full pattern shift, 0.5 means 1/2 pattern shift, etc.
- **Mask:** Optional information for skipping some of the line positions. When left blank, all line positions are used. To mask certain positions, enter a series of 0 and 1 digits. A 0 (zero) means to skip the position. A 1 (one) means to enable the position. If the sequence of digits is shorter than the repeat value, then the sequence will be used repeatedly. For example -- entering 0111 with Repeat=12 will skip the 1st position, the 5th position, and the 9th position and use all other positions.

For a PatternBar, you have the following parameters:

- **Pattern:** See the help file on Patterns for more information on the various patterns.
- **Amplitude:** The peak-to-peak amplitude of the PatternBar.
- **Period:** The distance before the pattern repeats.
- **Phase:** Phase shift for the cut. Phase shift can be displayed in two different ways depending on how you have set your preferences (see the Help topic on Preferences). In "Engineering" mode, phase shift is a value between 0 and 360 degrees where 360 degrees represents a full pattern shift, 180 degrees means 1/2 pattern shift, 90 degrees means 1/4 pattern shift, etc. Note that this is NOT the actual spindle rotation. The other mode you can set in the Preferences is "Fraction" mode where 1.0 means a full pattern shift, 0.5 means 1/2 pattern shift, etc.
- **Invert** -- Invert the pattern on the PatternBar.
- **N2:** Some patterns use the optional **N2** parameter which is the number of small bumps within a repeat. For example -- an E pattern with 5 repeats and N2=6 will have a total of 30 bumps.
- **Amplitude2:** Some patterns use the optional **Amplitude2** parameter which is the amplitude of the small bumps as a fraction if the total amplitude. For example -- a Q pattern with a total amplitude of 0.3" and amplitude2=0.2" will have small bumps that are 0.06" (0.3 * 0.2 = 0.06) high superimposed on the major shape.

What you see in the Outline Editor is a starting LinePoint and a separate end point (with the same text number ending with "E"). The end point can be moved independent of the start point. (Note that initially, the end point will be coincident with the start point until you move it.)

GoToPoint:

A GoToPoint does not do any cutting. It merely directs the motion of the cutter when moving from one CutPoint to another. This is typically used when you need to go around a convex curve section of the work. If no GoToPoints occur between two CutPoints, the movement of the cutter is a straight line from one to the next.

A GoToPoint has cutter information so that when there are multiple cutters we can filter only those GoToPoints that are required for a given cutter's CutPoints.

GoToPoints may also be used to direct the motion of the cutter from the end of a SpiralLine or SpiralIndex CutPoint back to the beginning of the CutPoint. This is often needed to prevent the cutter from hitting a portion of the work as multiple spirals are being cut. To add GoToPoints to a SpiralLine or SpiralIndex, first add one or more GoToPoints, then drag/drop them onto the end point of the SpiralLine or SpiralIndex in the order that should be followed. Note that after the last cut of such a spiral the cutter does NOT follow these GoToPoints but the cutter remains at the end of the last spiral.

Various Offset CutPoints:

Offset CutPoints include a PatternPoint and an OffsetGroup (one or more RosettePoints).

Offset CutPoints are used to cut the work when it is held in a dome or eccentric chuck. The location of the Offset CutPoint becomes the top/center of the work when it is positioned by the dome/eccentric chuck.

For an Offset CutPoint, you have the following parameters:

- **Repeat:** The number of cuts that are made around the rotation of the work piece (as with an eccentric chuck). Valid values for repeat can be any sub-multiple of 24 or 35 (the rotation is indexed with 24 or 35 holes).
- **IndexOffset:** The number of holes to skip before starting the repeats.

What you see in the Outline Editor is a pink line that is tangental to the surface, and a pink line that is perpendicular to the surface. When the work is positioned in the dome/eccentric chuck, the line perpendicular to the surface is brought to the center of rotation of the spindle.

PatternPoint:

A PatternPoint is used to cut a pattern around the point of rotation. It is to be used with a Horizontal Cutting Frame (HCF) and a custom pattern that is made from an outline of a shape (like a leaf or butterfly).

For a PatternPoint, you have the following parameters:

- **Pattern:** This is a custom pattern.

- **PatternRepeat:** The number of times the pattern is repeated (usually this is set to one).
- **Phase:** Phase shift for the pattern. Phase shift can be displayed in two different ways depending on how you have set your preferences (see the Help topic on Preferences). In "Engineering" mode, phase shift is a value between 0 and 360 degrees where 360 degrees represents a full pattern shift, 180 degrees means 1/2 pattern shift, 90 degrees means 1/4 pattern shift, etc. Note that this is NOT the actual spindle rotation. The other mode you can set in the Preferences is "Fraction" mode where 1.0 means a full pattern shift, 0.5 means 1/2 pattern shift, etc.
- **Optimize:** A flag indicating that the depth of the cut be adjusted based on the curvature of the shape to reduce the distortion of the pattern due to curvature.

A custom pattern is made from the outline of some shape with radial symmetry. Measure the radial distance for various rotations from 0 to 360 degrees. Then scale the pattern to a horizontal scale ranging from 0 to 1 and a vertical scale of 0 to 1.

When the pattern has a value of zero, no cut is made. When the pattern has a value of one, then the cutter will be at the specified cut depth. For other pattern values, the depth and position of the cutter is adjusted during spindle rotation so that the cut spans the distance from the center of rotation to the point indicated by the pattern. Thus the PatternPoint will reproduce outline of the shape that was used as a basis for the pattern.

A custom pattern may also have dual lines. In that case, there are two pattern points for each position. The first point would be positive and represent the outline of the shape as described above. The second point can be negative and indicates that the extent of the cut is from some other point other than the center of rotation. This can be used, for example, for accentuating the stem on a leaf pattern.

What you see in the Outline Editor is a pink arc indicating the maximum cut depth, and green arcs on either side of the perpendicular pink line to show the extent of the cut.

OffsetGroup:

The OffsetGroup allows you to add one or more RosettePoints to the group. First drag and drop an OffsetGroup from the pallet. Then drag and drop one or more RosettePoints onto the curve, and then drag/drop the RosettePoints onto the center of the OffsetGroup. Now the RosettePoint is part of the group and can be positioned as desired relative to the group.

What you see in the Outline Editor is similar to a regular RosettePoint, but the arcs are mirrored on either side of the pink lines indicating the origin of the group.

Changing the order of CutPoints:

The order of the CutPoints can be changed in the DataNavigator window. Select a CutPoint, then right-click (Mac CTRL-click) and choose "Move Up" or "Move Down" to move that CutPoint's position in the list. You can also use the keyboard shortcuts (which can be changed in the Preferences window).

Built-In Spirals

Various kinds of spirals are used by SpiralRosette, SpiralIndex, and SpiralLine CutPoints. The following spirals are "built-in" to the software. A user may program their own spirals and make them permanent additions to their copy of the software (or distribute them as plug-ins to others).

- **UNIFORMZ:** The angle varies as a function of height (z-distance).
- **UNIFORMD:** The angle varies uniformly with the distance traveled.
- **PROPORTION:** The angle varies more at big diameters than small diameters.
- **SINE:** Superimpose a sine wave on a UNIFORM_D spiral. The amplitude of the sine wave is entered in the "Spiral Amplitude" field and can be positive or negative.
- **SIN4:** Superimpose a quarter of a sine wave on a UNIFORM_D spiral.
- **COS4:** Superimpose a quarter of a cosine wave on a UNIFORM_D spiral.

In addition to selecting the style of the spiral, there are additional parameters:

- **Twist:** This is the total twist of the spiral. It is measured in total rotation of the spindle in degrees (not relative to the number of repeats).
- **Amplitude:** This optional amplitude is used by the SINE spiral to indicate the amplitude of the superimposed sine wave (may be positive or negative).

DataNavigator

The DataNavigator window gives you the ability to manually edit nearly any parameter for your project. To use this window, you will also want to show the "Properties" window which shows all the parameters of any object and lets you edit the values that can be changed. As with any other window, the DataNavigator window and the Properties Window can be re-sized and moved on the screen (or even detached from the main window to be "floating"). You will find it easier to use if you have both of these windows near each other and enlarged enough to see more content.

The data structures are hierarchical, just like folders and files on your computer. When you see a small gray triangle pointing toward the right, there is more content. Click on the arrow (or double click on the line of the object) to see more content.

You can also collapse the object to hide the information that you don't need to see. When you see a small gray triangle pointing down, you can hide the details. Click on the arrow (or double click on the line of the object) to hide the details.

When you click on any line, the Properties Window shows all the data associated with that object. Some of the data might be informational only (and cannot be edited). These values are grayed. All editable data is in black.

When you click on a line in the DataNavigator, you may also have additional options by right-clicking on the selected line (CTRL-click on a Mac if you don't have a 2-button mouse or two-finger click with a trackpad). The right-click options will vary depending on what kind of object has been selected.

You can edit multiple items at the same time by selecting more than one object. When you enter a new value for some parameter shown in the Properties window, you will change that value on all selected objects.

Cutters

There are a variety of cutting frames supported by this program. Current options are:

- **HCF** -- Horizontal Cutting Frame
- **UCF** -- Universal Cutting Frame
- **Drill** -- Drilling Frame
- **ECF** -- Eccentric Cutting Frame
- **Fixed** -- A fixed (non-rotating) tool

Cut Location

The cutter can be in one of 4 positions relative to a bowl:

- **Front, Inside** -- Inside the bowl and forward of the axis of the spindle.
- **Front, Outside** -- Outside the bowl and forward of the axis of the spindle.
- **Back, Inside** -- Inside the bowl and behind the axis of the spindle.
- **Back, Outside** -- Outside the bowl and behind the axis of the spindle.

A small icon is shown below the selection to illustrate the position.

Cutter Profile

This is the profile of the cutting tip:

- **Ideal** -- A infinitely sharp and narrow cutter. If the cutting is all done by a very sharp tip, then this is a good approximation. Note: Using any other option will **significantly** slow down the rendering of the cut surface!
- **Point60** -- The cutting tip is a 60 degree angle (as with a triangluar carbide insert). Use this only if your cut pattern depends on significant cutting on the side of the cutter (rather than just the tip).

- **Point90** -- The cutting tip is a 90 degree angle. Use this only if your cut pattern depends on significant cutting on the side of the cutter (rather than just the tip).
- **Point120** -- The cutting tip is a 120 degree angle. Use this only if your cut pattern depends on significant cutting on the side of the cutter (rather than just the tip).
- **Point150** -- The cutting tip is a 150 degree angle. Use this only if your cut pattern depends on significant cutting on the side of the cutter (rather than just the tip).
- **Flat** -- The cutting tip is flat on the end. You would use this, for example, when doing a "basket" style pattern.
- **Round** -- The cutting tip is a convex half circle. Use this only if your cut pattern depends on significant cutting on the side of the cutter (rather than just the tip).
- **Concave** -- The cutting tip is a concave half circle. You would use this, for example, when doing a "bamboo" style pattern.

You can create your own cutter profiles with the Profile Editor. See the Help file for the Profile Editor for more information.

Cut Radius

Cut Radius is the radius of the circle inscribed by the cutting tip. This has meaning for HCF, UCF, and ECF but not for Drill.

Cutter Diameter

This is the diameter (or width) of the cutting tip. If you have a sharpened rod (or rectangular stock) that is spinning, this is the diameter (or width) of that cutter. In the case of a Drill, it is the diameter of the drill.

UCF/Drill Angle

Rotation of the cutting frame around y-axis. Zero means oriented along Z-axis, + angle is rotated toward front, - angle is rotated toward the back. This has no meaning for a HCF.

UCF Rotation

Rotation of UCF on it's axis. Zero is horizontal, + angle is CCW looking at the wood, - angle is CW looking at the wood. This has no meaning for a HCF or Drill.

About COrnLathe XML Files

Information is saved in files using an .xml file format. This is a somewhat human-readable format that can be edited by any text editor with care. A document type definition (dtd) for the file is available at www.billooms.com/dtds/cornlathe3_0.dtd. The second line in the xml files

contains a link to this file. Your editor understands xml formats, it will have a command to validate that the edits you made conform to the rules in the dtd file.

Favorites Window

The best way to gain access to your files is with the "Favorites" window within the program. You can mark certain directories as being a favorite so that you don't have to navigate your way through the entire file structure.

To create a new file, right click (or 2-finger click with a touchpad) on a directory and select "New", then select "COrnTemplate.xml" and give it a new name.

To open a file, simply double click it's name. Other options appear when you do a right click (or 2-finger click on a touchpad). Note that you can open the xml file in a text editor within the program by choosing "Open" on the option menu. You can also choose "Revert to Saved" to go back to the last saved version of the file.

File Menu Actions

Many of the menu items are standard on most programs:

- **Save g-code** -- Writes a standard g-code file for cutting on LinuxCNC. See the Help file on g-code for more information.
- **Open File...** -- Open a previously saved xml file
- **Open Recent File** -- A list of recently opened files is displayed
- **Save All** -- Save all open files after edits have been made.
- **Page Setup...** -- Set page orientation for printing
- **Print...** -- Prints the currently active window. It's best to first click in the window you want to print to make sure that window is currently the active window.

COrnLathe Preferences

The Preferences are found under the Preferences menu item (Mac users) or under the "Tools --> Options" menu (PC and UNIX). There are a number of capabilities that are available from the window platform used by this software. In particular, the "Keymap" tab allows you to assign/change the keyboard shortcut for any action.

Phase Shift Preferences

You can set your preference for how phase shift is presented and edited:

Engineering phase shift means that a phase shift of 360 means one full pattern phase shift. Likewise, 180 degrees means 1/2 pattern shift, and 90 degrees means 1/4 pattern shift. This is

NOT the actual spindle rotation. The actual spindle rotation is this phase shift divided by the number of repeats. Those with an engineering background may feel more comfortable with this notation.

Fractional phase shift means that a value of 1.0 means a full pattern phase shift. Likewise, 0.5 means 1/2 pattern shift, and 0.25 means 1/4 pattern shift. Many people will find this notation easier to understand.

Important: You will want to restart the program after changing the phase shift preference to make sure that all the user interface values are set properly. Also, note that the numerical values in the saved XML files will always be in engineering notation to allow compatibility with files saved by users with other settings.

Cutter Library

You can specify an xml file to use as a cutter library. If you have a lot of cutting frames you will find this useful. Create an xml file and add as many cutters as you would like to have in your library (each with a unique name). Then open the COrnLathe Preferences and browse for that file. Your preferences will be saved after you exit the program and will be loaded again the next time you run the program.

When you are editing any other xml file, you can load from the library by right clicking on the "Cutters" node in the Data Navigator and choose "Add Cutter from Library". A pop-up dialog will appear which will let you select the cutter you wish to add. Once added, you can make further edits on the newly added cutter.

COrnLathe Preferences

The Preferences are found under the Preferences menu item (Mac users) or under the "Tools --> Options" menu (PC and UNIX). There are a number of capabilities that are available from the window platform used by this software. In particular, the "Keymap" tab allows you to assign/change the keyboard shortcut for any action.

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RosetteBuilder

The RosetteBuilder window allows for editing and viewing a CompoundRosette which is a combination of some number of rosettes. The RosetteBuilder is currently limited to combining a maximum of 3 rosettes, although more than 3 can be combined if read directly from the xml file.

The window is filled with three editing panes, one for each simple rosette that can be used in the combination. For each simple rosette, you have the following parameters:

- **Pattern:** See the help file on Patterns for more information on the various patterns. Note that you can specify patterns that you design with the Pattern Editor as well as for the built-in patterns.
- **Repeat:** The number of times the pattern is repeated around the perimeter of the rosette.
- **Amplitude:** The peak-to-peak amplitude of the rosette.
- **Phase:** Phase shift for the cut. Phase shift can be displayed in two different ways depending on how you have set your preferences (see the Help topic on Preferences). In "Engineering" mode, phase shift is a value between 0 and 360 degrees where 360 degrees represents a full pattern shift, 180 degrees means 1/2 pattern shift, 90 degrees means 1/4 pattern shift, etc. Note that this is NOT the actual spindle rotation. The other mode you can set in the Preferences is "Fraction" mode where 1.0 means a full pattern shift, 0.5 means 1/2 pattern shift, etc.
- **Invert** -- Invert the pattern on the rosette.

- **Mask:** Optional information for skipping some of the repeats. When left blank, all repeats are used. To mask certain repeat, enter a series of 0 and 1 digits. A 0 (zero) means to skip the repeat. A 1 (one) means to enable the repeat. If the sequence of digits is shorter than the repeat value, then the sequence will be used repeatedly. For example -- entering 0111 with Repeat=12 will skip the 1st repeat, the 5th repeat, and the 9th repeat and use all other repeats.
- **MaskPhase:** Optional information for shifting the point in the pattern where the masking will start. As with Phase above, the number is either "Engineering" mode or "Fraction" mode depending on how you have set your preferences. In general, when you are cutting on the inside of a shape, you will probably want to start the masking at a point in the pattern where the pattern is at "1.0" in the pattern editor (which corresponds to a valley on the rosette). Likewise, when you are cutting on the outside of a shape, you will probably want to start the masking at a point in the pattern where the pattern is at "0.0" in the pattern editor (which corresponds to a peak on the rosette).
- **MaskHiLo:** Flag indicating if masking causes rosette to be the highest or the lowest in the pattern.
- **N2:** Some patterns use the optional **N2** parameter which is the number of small bumps within a repeat. For example -- an E rosette with 5 repeats and N2=6 will have a total of 30 bumps.
- **Amplitude2:** Some patterns use the optional **Amplitude2** parameter which is the amplitude of the small bumps as a fraction if the total amplitude. For example -- a Q rosette with a total amplitude of 0.3" and amplitude2=0.2" will have small bumps that are 0.06" (0.3 * 0.2 = 0.06) high superimposed on the major shape.
- **SymmetryAmplitude:** Optional information for changing the symmetry of a rosette by varying the amplitude of the various repeats. When left blank, there will be no variation in the amplitudes. If the sequence of numbers is shorter than the repeat value, then the sequence will be used repeatedly.
- **SymmetryWidth:** Optional information for changing the symmetry of a rosette by varying the width of the various repeats. When left blank, there will be no variation in the widths. If the sequence of numbers is shorter than the repeat value, then the sequence will be used repeatedly.

In the lowest pane, you see a graphical representation of the combined result. The amplitude if the pattern in the graphical representation is not particularly important since the combined result will be scaled to the amplitude specified when used in a RosettePoint.

On the left edge of the lowest pane, you see the possible ways of combining the rosettes. The first two rosettes are combined first with the first combine parameter, then that result is combined with the 3rd rosette base on the second combine parameter.

The combine parameters refer to the deflection from the maximum radius of the rosette. Note that the deflection is always toward the center of the rosette (never outward from the center). Possible ways of combining are:

- **NONE:** No combination -- the 1st rosette is used and the 2nd is ignored.
- **MIN:** Use the minimum deflection of the two rosettes at every point in the rotation.

- **MAX:** Use the maximum deflection of the two rosettes at every point in the rotation.
- **ADD:** Add the deflection of the two rosettes at every point in the rotation.
- **SUB:** Subtract the deflection of the two rosettes at every point in the rotation. Note that this could result a som points of the rosette being outside the maximum radius of the rosette in the graphical representation. This will not cause any problem, because the actual deflection will be based on the amplitude specified when used in a RosettePoint.

To edit a CompoundRosette that is used in a RosettePoint, select the CompoundRosette's node in the DataNavigator window. Then press the "Get Selected" button in the RosetteBuilder window. This will load the selected CompoundRosette for editing. Any edits you make in the Properties window will be reflected in the RosetteBuilder window, and edits in the RosetteBuilder window will be reflected in the Properties window.

Write Rosette Data

This allows you to write out the coordinates of the compound rosette to a tab-delimited file that can be read by a spreadsheet program. This is useful for those who wish to make their own rosettes. You have the option of specifying the maximum radius of the rosette and specifying the rotational spacing between points. The file will list the radius at each rotation from 0 to 360 degrees. Note that this option works for patterns that you design with the Pattern Editor as well as for the built-in patterns.

PatternEditor

The Pattern Editor allows you to quickly create your own rosette patterns. The plot shows a normalized version of a single repeat of the pattern. The horizontal scale goes from zero to one, and the vertical scale goes from zero to one.

A point at the bottom represents zero deflection from the maximum radius of the rosette. A point at the top represents a maximum deflection of the rosette as determined by the rosette's peak-to-peak amplitude. You will find it helpful to look at the rosette with the Rosette Viewer as you are constructing a pattern. As changes are made, you will see a small icon below the pattern selection box.

Important -- for the software to work properly, the plot must completely fill the total height and total width of the outlined box. In general, you will want the left side and right side to be the same height or you will have a sharp step in the rosette where one pattern repeat meets the adjacent pattern repeat.

- **New Pattern** -- This creates a new pattern with the name that you provide. You have the option of creating several different kinds of lines/curves as indicated below.
- **Adding Points** -- Double click on the display window to add a point. To move a point, click near it and drag it to a new location. To delete a point, drag it off the display area. Points are in sorted order from left to right.

- **Manually editing points** -- you can manually edit the precise positions of the coordinates by using the DataNavigator Window together with the Properties Window. Click on "Patterns:" and expand the listing to see all the points. When you select a point, you will be able to manually edit the coordinates in the "Properties" window. See the Help file on the DataNavigator Window for more information.
- **Normalize** -- This re-adjusts the curve you entered so that the curve completely fills the area. You should always use the Normalize function at the end of all edits.
- **Invert** -- Flip the curve top to bottom.
- **Delete** -- Delete this pattern.
- **Mirror L->R** -- Mirror the curve left to right. Points to the right of center are deleted, and all points to the left of center are mirrored and added to the right side.
- **Clear** -- Clear all points and start over again.

The built-in patterns cannot be edited or deleted.

You can also write a short program for your own custom patterns and have them permanently added to your copy of the software. This enables you do write a pattern module and share it with other users of this software.

Various styles of lines/curves

- **Straight Lines** -- a straight line is drawn between each point.
- **Curve Fit** -- all points are fit to a single curve. This works best when you have more points close together. If you have only a few points that are widely separated, you may get a bizarre result.
- **Arc Segments** -- each group of 3 points is a curve-fit arc. Each segment shares a point with the previous segment to form a continuous line. For example, the 1st, 2nd, 3rd points form an arc segment, the 3rd point is shared with the next segment, the 3rd, 4th, 5th points are the next arc segment, etc. If there are an even number of points, the last arc segment is a straight line.
- **Sine/Cosine Segments** -- Similar to the Arc Segments style above, but the segments are fit to a quarter of a sine/cosine curve. The even numbered points define whether the curve segment is concave or convex. Note that the even numbered points do not necessarily end up on the curve -- they only indicate the direction of curvature.

Patterns

Each rosette has a specified pattern which describes the fundamental shape of each lobe. Although users with traditional machines may prefer the "A, B, C..." designation, many newcomers find the nomenclature to be difficult to remember as it is not descriptive. This program attempts to use more descriptive terms for the rosette patterns. A full collection of the traditional Holtzapffel patterns is also available.

Any pattern may be inverted by checking the "invert" box in the property editor.

The following patterns are "built-in" to the software. Additional patterns may be added by the user (see the help file on the Pattern Editor). Also, a user may program their own patterns and make them permanent additions to their copy of the software (or distribute them as plug-ins to others).

- **NONE** is just a plain round circle with no bumps or lobes.

- **NSIDE** is similar to a **C** rosette on traditional rose engines. It is made from an n-sided polygon (i.e. triangle, square, pentagon, hexagon, etc). At some amplitude, it will accurately reproduce the n-sided polygon.

- **FLOWER** is similar to a **D** rosette on traditional rose engines. It is the inverse of the **N-Side** rosette. That is, you get the same effect from rubbing on the front side of a **Flower** rosette as you get by rubbing on the back of an **N-Side** rosette.

- **SINE** is similar to an **A** rosette on traditional rose engines. The lobes are defined by a sine wave function.

- **HALFSINE** is the first half of a sine wave.

- **HEART** is similar to an **F** rosette on traditional rose engines. With a single repeat, it will show a traditional heart shape. With more repeats, the heart pattern is repeated around the rosette.

- **LOTUS** is similar to the lotus pattern on a rosette made for the MDF rose engine by Jon Magill.

- **BIGSMALL** is similar to a **B** rosette on traditional rose engines. The larger lobe consumes 2/3 of the pattern repeat distance, and the smaller lobe consumes 1/3 of the pattern repeat distance. Each lobe is the same as a **Flower** lobe.

- **TRIANGLE** is a simple triangle that is "bent" around the round shape of a rosette.

- **TUDOR** is inspired by a traditional tudor rose pattern. Although the traditional pattern has 5 repeats, the user is free to specify any number of repeats around the rosette.

-

Holtzapffel Patterns

For those who prefer using the Holtzapffel rosette system, I've added the full library of lettered rosettes. For more details on the Holtzapffel rosettes, John Edwards has spent a lot of time documenting the characteristics of the various rosettes on historic machines. Also, John Tarpley recently published an excellent article on rosettes in the Lindow newsletter (Vol 3, Number 1).

The numbering system used with the Holtzapffel rosettes is inconsistent. Computers don't like inconsistencies in handling parameters. So for the purpose of this program the following guidelines are used:

- The **amplitude** parameter is always the maximum amplitude of the total pattern.
- The **repeat** parameter is always the number of repetitions of the total pattern.
- Some patterns use the optional **n2** parameter which is the number of small bumps within a repeat. For example -- an E rosette with 5 repeats and n2=6 will have a total of 30 bumps.
- Some patterns use the optional **amplitude2** parameter which is the amplitude of the small bumps as a fraction if the total amplitude. For example -- a Q rosette with a total amplitude of 0.3" and amplitude2=0.2" will have small bumps that are 0.06" (0.3 * 0.2 = 0.06) high superimposed on the major shape.

Note that these rosettes are very close approximations to the historic Holtzapffel rosettes. There is insufficient documentation to reproduce the exact patterns without digitizing the actual historic rosettes. Following is a list of the lettered Holtzapffel rosettes. See the Help Files in the program for the illustrations.

- **HoltzA** Sine Wave.
- **HoltzB** Interrupted sine wave, where every third valley is omitted.
- **HoltzC** Concave dips between peaks.
- **HoltzD** Convex bumps, i.e. the opposite of C.
- **HoltzE** Sine wave gradually diminishing and then increasing in amplitude. This pattern uses the optional **n2** parameter.

- **HoltzF** Heart shape or Cupid’s Bow shape.

- **HoltzG** Like 'B' except that every second wave is omitted.

- **HoltzH** Like 'E' except that there is just one diminution after two full-sized waves. This pattern uses the optional **n2** and **amp2** parameters.

- **HoltzI** A 'Puffy Polygon' with a sine wave superimposed. This pattern uses the optional **n2** and **amp2** parameters.

- **HoltzJ** Arcs of eccentric circles then superimposing on each resulting arc a sine wave. This pattern uses the optional **n2** and **amp2** parameters.

- **HoltzK** Cupid’s Bow shapes, as in 'F', each separated by two elements of a sine wave.

- **HoltzL** Each element comprises a short wave followed by a wave of twice its length.

- **HoltzM** Each element comprises three short convex bumps followed by a long bump of three times the length of a short bump.

- **HoltzN** Each element comprises four short convex bumps followed by a long bump of twice the length of a short bump.

- **HoltzO** Each element comprises five short convex bumps followed by a long bump of three times the length of a short bump.

- **HoltzP** Interrupted sine wave, where the fifth and sixth valleys are omitted.

- **HoltzQ** A 'Puffy Polygon' with convex bumps superimposed. This pattern uses the optional **n2** and **amp2** parameters.

- **HoltzR** Two short convex bumps followed by one convex bumps of twice the length of the short ones.

- **HoltzS** Heart shape with superimposed convex bumps. This pattern uses the optional **n2** and **amp2** parameters.

The most recently added CutPoint will be duplicated at the new position. To move a CutPoint, click on it and drag it somewhere else. To remove a CutPoint, drag it outside the window and it will go away.

For more information on the various types of CutPoints and what the colored curves mean, see the Help section on CutPoints.

ProfileEditor

The Profile Editor allows you to quickly create your own cutter profile. The display shows the outline of the cutter tip -- the orientation is such that the shank of the cutter is up, and the point of the cutter is down. The line in the center of the window represents the center of the cutter. As changes are made, you will see a small icon below the profile selection box.

Important -- for the software to work properly, the bottom point must go all the way down to the bottom line in the display window. Also, the width of the curve you enter must go all the way to the left line and all the way to the right line.

- **New Profile** -- This creates a new profile with the name that you provide. You have the option of creating the outline with straight lines between the points or curve-fit lines between the points.
- **Adding Points** -- Double click on the display window to add a point. To move a point, click near it and drag it to a new location. To delete a point, drag it off the display area. Points are in sorted order from left to right.
- **Manually editing points** -- you can manually edit the precise positions of the coordinates by using the DataNavigator Window together with the Properties Window. Click on "Profiles:" and expand the listing to see all the points. When you select a point, you will be able to manually edit the coordinates in the "Properties" window. See the Help file on the DataNavigator Window for more information.
- **Normalize** -- This re-adjusts the curve you entered so that the bottom point goes exactly to the bottom and the left and right sides go all the way to the edges. This is important for the software to work properly. You should always use the Normalize function at the end of all edits.

- **L-R Mirror** -- This takes the points on the right half of the display and mirrors them to the left side of the display. Any prior points on the left side of the display are deleted. This is a convenient way to make a symmetrical cutter profile.
- **Clear** -- Clear all points and start over again.
- **Delete** -- Delete this profile.

The built-in profiles cannot be edited or deleted.

You can also write a short program for your own custom profiles and have them permanently added to your copy of the software. This enables you do write a profile module and share it with other users of this software.

Cutter Profiles

Profiles define the shape of the cutter tip.

The following profiles are "built-in" to the software. Additional profiles may be added by the user (see the help file on the Profile Editor). Also, a user may program their own profiles and make them permanent additions to their copy of the software (or distribute them as plug-ins to others).

- **IDEAL** -- A infinitely sharp and narrow cutter. If the cutting is all done by a very sharp tip, then this is a good approximation. Note: Using any other option will **significantly** slow down the rendering of the cut surface!

- **POINT60** -- The cutting tip is a 60 degree angle (as with a triangular carbide insert). Use this only if your cut pattern depends on significant cutting on the side of the cutter (rather than just the tip).

- **POINT90** -- The cutting tip is a 90 degree angle. Use this only if your cut pattern depends on significant cutting on the side of the cutter (rather than just the tip).

- **POINT120** -- The cutting tip is a 120 degree angle. Use this only if your cut pattern depends on significant cutting on the side of the cutter (rather than just the tip).

- **FLAT** -- The cutting tip is flat on the end. You would use this, for example, when doing a "basket" style pattern.

- **ROUND** -- The cutting tip is a convex half circle. Use this only if your cut pattern depends on significant cutting on the side of the cutter (rather than just the tip).

- **CONCAVE** -- The cutting tip is a concave half circle. You would use this, for example, when doing a "bamboo" style pattern.

Hardware Preferences

The Preferences are found under the Preferences menu item (Mac users) or under the "Tools --> Options" menu (PC and UNIX). These must be set to match your hardware configuration in order to have optimum results when generating instructions. The settings for your XZ stage might be different from your settings on the spindle (C-axis), so both must be set. Once set, these preferences are saved for later use each time you open the software.

- **Stepper Motor:** Stepper motors are generally either 200 steps per rotation (1.8 degree per step) or 400 steps per rotation (0.9 degree per step).
- **MicroStepping:** Stepper motor drives often allow the ability to micro-step which gives greater resolution. If your stepper driver does not have this option, select "1 step". Otherwise, select the appropriate micro-stepping value.
- **Small Gear:** Typically you will want to have a pulley on the spindle stepper motor with fewer teeth than on the spindle. This gives you more torque on the spindle and greater resolution. Enter the number of teeth on the small pulley on the stepper motor.
- **Large Gear:** Enter the number of teeth on the large pulley on the spindle.
- **Lead Screw:** Enter the number of turns per inch on the lead screw on the X and Z stages. For metric, enter the pitch in mm. Note that this might not be the same as the number of threads per inch in the event that your lead screw has multiple starts.
- **TPI/mm:** Select if the pitch is TPI or mmm.

Location and name of g-code output file

The default location for the generated g-code file is in the same directory as the .xml file. The name is the same as the .xml file, but will have an extension of .ngc (which is the standard for LinuxCNC software).

You have the option of selecting a single file that will always be used with the same name each time. For example, this might be on a different computer on the network which is running the LinuxCNC software. This makes it easy to simply re-load the file each time something is changed. Note that with this option, you will not be asked prior to over-writing the file.

You can set the maximum number of g-code instructions that can be executed per second. In reality, LinuxCNC can only compute a trajectory at some maximum number of points per second

which is a function of the speed of the CPU and other factors. This generally will come into play when cutting from rosettes at the maximum precision where a g-code instruction is generated for each micro-step of the spindle (C-axis). You can determine how fast your LinuxCNC machine can execute commands by setting this parameter to some high number (like 500) and then cutting a single rotation of a rosette with maximum resolution at a high rpm (like 10RPM). Note how many seconds it actually takes to cut the rotation. The number of g-code instructions per second that your system is capable of handling is the number of micro-steps per revolution of the spindle (C-axis) divided by the number of seconds to do the cut.

LinuxCNC IP address

If you wish to probe points from the actual position of your XZ stage, check the "Connect to LinuxCNC" box. Then enter the IP address of your LinuxCNC computer. Note that some routers may assign a different IP address every time the system is turned on. You can change that in your router setup so that it always assigns a given IP address to each machine.

GCode Output

There are 3 options for writing g-code. The first (and most commonly used) is cutting patterns from rosettes. You can also cut the contour of a shape, or cut threads.

Important! Since this software has no knowledge of the actual position of the stages, the user must assure that the stages are positioned so that the first g-code command executed (going to the first CutPoint) will not cause the cutter to interfere with the work.

To write the g-code file, press the "Write G-Code" button in the GCode Control Window. The file will have the same name as your .xml file, but will have the suffix ".ngc". Alternately, you can always write to a specific file on a networked LinuxCNC computer (see Hardware Preferences above). Most of the g-code instructions use inverse time mode (g93) to assure that both the maximum rpm and the maximum velocities are not exceeded. When the spindle turns a full rotation, it is set to zero (without turning back) by the use of the g92 offset command. At the end of the file, a g92.1 command is given to clear any offsets that have been accumulated. The user needs to be aware of how these commands operate.

Feed Rates

When generating g-code, the software needs to know the maximum feed rate on both the linear stages (X-axis and Z-axis) and on the spindle (C-axis). Values can be entered by moving the slider with the mouse, selecting the text in the display field and typing in a new value, or placing the cursor in the display field and rotating the mouse scroll wheel.

- **RPM:** Enter the desired maximum rpm on the spindle (C-axis).
- **Velocity:** Enter the desired maximum velocity on the X-axis and Z-axis (inches per minute).

Note that this software is set up with a maximum spindle speed of 10 rpm, and a maximum linear stage speed of 15 inches per minute.

Cutting Rosettes

When cutting from the rosettes, it is generally best to make multiple coarse cuts followed by a final fine cut. You can enter the depth of the coarse cuts and the depth of the final cut. Note that the final depth of the cut is specified on each CutPoint and the final depth will be broken down into the appropriate number of coarse and fine cuts. You also have the option to specify the number of stepper motor micro-steps for each generated g-code command. You might use a larger value for the coarse cuts and a smaller value for the final cut. You can choose to have all the cuts in the same direction, or to have the last cut in the opposite direction.

- **Depth per Pass:** The depth of each coarse cut. Typical values are often in the range of 0.020 to 0.030 inch.
- **Micro-Steps per instruction:** The number of stepper micro-steps per each generated instruction. The equivalent number of "Degrees per step" is displayed. A value that gives about 0.15 degrees per step might be good for coarse cuts.
- **Final Cut Depth:** This is the depth of the final fine cut. Note that this is not the total cut depth (which is specified for each CutPoint). A typical value is 0.005 inch.
- **Micro-Steps per instruction:** The number of stepper micro-steps per each generated instruction. The equivalent number of "Degrees per step" is displayed. For best resolution, you would set this to "1".
- **Soft Lift:** (optional) Gradually lift the cutter the specified distance over some number of degrees rotation. This can be used with a fixed cutter to avoid a line when the cutter is withdrawn.
- **Soft Lift Height:** The distance to lift the cutter.
- **Soft Lift Rotation:** The cutter is gradually lifted over the specified degrees rotation.
- **Direction of Rotation:** The rotation can be always positive (counterclockwise), always negative (clockwise) or positive on roughing cuts and negative on the final and cleanup cuts.

Important! When cutting on a convex surface, you MUST provide a safe path for the cutter to go from one CutPoint to the next! Otherwise, after making the a cut, the cutter might run into the surface of your shape! "GoToPoints" are entered in the Outline Editor in the "Edit CutPoint" mode by right clicking. These "GoToPoints" are displayed in red and are numbered. Since CutPoints are cut in the order they are entered, any "GoToPoints" you enter will provide a path when going from one CutPoint to the next.

Cutting Contours

This is useful when you want to rough out a shape and use the ornamental lathe to complete the final shape. It is also useful when making closely nested shapes. The user can specify how coarse of a step to take (which is independent of the display resolution used in the Outline Editor window). At each point on the curve, one complete turn is made at the specified rpm.

- **Step Size:** The approximate distance moved on the outline for each cut. Typical values are often in the range of 0.020 to 0.100 inch.
- **Backoff:** How far to back away (from the final surface) when making the first cut. For example, if you have roughed out the shape to within about 0.1" of the final contour, you may want to backoff 0.100" on the first cut.
- **Direction of cut:** Either "First to Last" or "Last to First". Note that this refers to the order that points are entered in the outline. You can view the order of the points in the DataNavigator window.
- **Number of coarse cuts:** The number of coarse cut passes (which can be zero).
- **Depth of coarse cuts:** The incremental depth of each coarse cut pass (which can be zero).
- **Number of fine cuts:** The number of fine cut passes (which can be zero).
- **Depth of fine cuts:** The incremental depth of each fine cut pass (which can be zero).

Note that you need at least one coarse or fine cut (or nothing will be cut). You might only have one cut of zero depth with no back-off, which will cut the surface as drawn. The total number of passes (with the total cut depth relative to the drawn surface) is displayed.

Important! When cutting on a convex surface, you MUST provide a safe path for the cutter to go from the end back to the beginning when taking multiple passes! Otherwise, after making the first path, the cutter might run into the surface of your shape! Safe paths are entered in the Outline Editor in the "Edit Outline" mode by right clicking. These "safe path" points are displayed in red.

Cutting Threads

Threads may only be cut on a vertical surface (i.e. two points in the outline with the same X-coordinate). Threads are conveniently cut by the use of a thread cutter or 60 degree angle cutter in a drilling frame.

- **Threads per Inch:** The number of threads per inch. The pitch is displayed for convenience (but the pitch field cannot be manually changed).
- **Starts:** The number of starts for the threads. This is usually "1", but if you want faster threads (such as on the lid of a box), you can set this to a higher value. Note that the "turns per inch" will be the "Threads per Inch" divided by the number of starts.
- **%:** The percentage of engagement in the threads. A typical number would be 60%. See the figure below for more information and a description of the other dimensions displayed.
- **Female ID:** Enter a number here for the inside dimension of the female recess, and the outside dimensions of the male tenon will be calculated and displayed.
- **Male OD:** Enter a number here for the outside dimension of the male tenon, and the inside dimensions of the female recess will be calculated and displayed

LinuxCNC Connection

If you have set up your preferences to allow probing the actual position of the XZ stage, then this panel will show that the connection is active. When you press the "Probe" button, the actual position of the XZ stage is read and used as the coordinate for adding an outline point (if the EditorWindow is in "Edit Outline" mode) or used as the coordinate for adding a CutPoint (if the Editor Window is in the "Edit CutPoints" mode). The probed position is shown in the panel for convenience.