TreeSoft FlutePlus

FlutePlus was written by Paul Rowntree, based on information and sample source codes provided by Vectric and other 'gadgeteers'. I believe it works well, but no guarantees are given for its use in any application. **FlutePlus** works with Aspire 4.0 (or greater) and VCP 7.0 (or greater). **It will not work with previous versions of either program.** Although Rowntree retains copyright, you are free to use **FlutePlus** in any way you wish, including personal and commercial applications, with no requirement to pay anything, to anyone, ever. You are not permitted to redistribute the files, nor remove the copyright information that they contain, without written permission.

Software development is time-consuming. If you feel that you have derived significant benefit from **FlutePlus**, contributions to its continued development at **PaulRowntree.weebly.com** would be greatly appreciated. This also lets me know which types of software are most useful to the Vectric community, and to target future projects better.

Change Log

Feb 8, 2014	- Add Profile vs. Pocket controls to front panel
Feb 7, 2014	- Fixed end behavior following Euan Hanchard's error report - Added 'Rail flipping' to reduce rapid motions above material - Added continuous vector coupling to avoid unneeded Z lifts - Added flat-bottomed roughing to reduce Z motion, accelerate toolpath - Removed initial tool movement to bottom-left corner of material
Jan 20, 2014	- Added SkipCount to reduce number of rails used on roughing passes
Jan 17, 2014	- Added avoidance code to prevent overcutting by finite size of cutter - Added 'Make roughing passes..' control to front panel
Jan 14, 2014	- Repaired & simplified handling of closed Profile vectors
Jan 13, 2014	- First version written and working

Disclaimer

By downloading, installing and using this program you are accepting full responsibility for any and all consequences. CNC machinery is potentially dangerous, and the user is 100% responsible for ensuring that the output of **FlutePlus** is safe to use, and that it will have the desired effects.

As always with CNC equipment, think many times before running code, and doing air cuts is often a good idea with new files. Verify the Z limits of the loaded files before cutting to ensure that you are not going to destroy your table top, spindle, or both. I use the free (and excellent) gcode simulator 'NCSim' by Gershon Elber to preview files.

Work and Play safely.

What is FlutePlus ?

FlutePlus is a 'gadget' for Vectric's Aspire 4.0 (and higher) and V-Carve Pro 7.0 (and higher) CAD/CAM tools. It builds 'fluting' toolpaths with 'Profiles' that you control using the standard Vectric vector manipulation tools. It then projects a profile onto one (or more) 'Rails' that extend in the X-Y plane of the material. The Profile controls the depth of the toolpath, while the Rail(s) control where toolpath is on the material. The key difference from the built-in flute tool is that Profiles can be any shape, with multiple sections, rising and falling regions, etc. The gadget lets you control how the length of the Profile should be adapted to the length of the Rail(s). **FlutePlus** can automatically create roughing paths. **FlutePlus** can optionally toolpath a reduced number of the selected Rails, which reduces roughing times where you are using cutters much larger than required for the finishing passes. **FlutePlus** uses the 3D shape of the selected cutting tool to avoid over-cutting 3D profiles.

FlutePlus works with Aspire and VCP in exactly the same way.

Unpacking FlutePlus

If using a Vectric installer, the files are already in their correct locations and are ready to run. Alternatively, the archive can be opened with Windows, WinZip, Z-zip, or any other standard unzipping program. Extract the files to any directory, then move the individual components in the directories shown below. Aspire or VCP will find the gadgets and show them in the Gadgets menu lists.

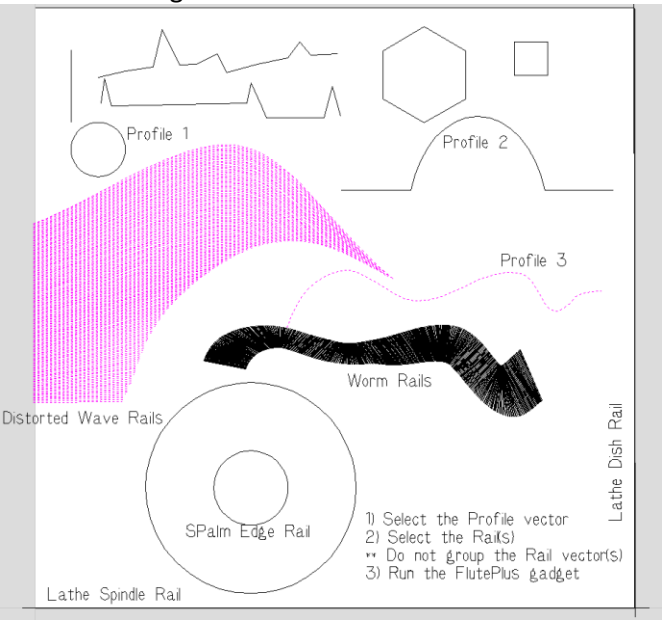
Windows Path	Contents
Aspire and VCP User Gadget directories, created during Aspire or VCP installation **C:\Users\Public\Public Documents\Vectric Files\Gadgets\Aspire Vx.y** or **C:\Users\Public\Public Documents\Vectric Files\Gadgets\VCarve Pro x.y**	**FlutePlus.lua** **FlutePlus.html** If you want, you can create a subdirectory and place these files inside it. This unclutters the Gadgets menu of Aspire and VCP.
Anywhere you want	**FlutePlus.pdf** (this file) ***.crv3d, *.crv**

Using FlutePlus

The following numerical values describe a **FlutePlus's** tool trajectory within Aspire/VCP:

Data Field	Meaning	Values
Start Depth	The depth below the material surface where the top of the fluting toolpath will be found; all other portions are below this. Normally this is 0.0, unless you are putting a **FlutePlus** toolpath at the bottom of a pre-existing pocket.	>0
Flute Depth	Depth of the **FlutePlus** patterns, measured from the deepest region of the cut to the top of the profile, which is at Start Depth.	>0
Steps	The number of steps that the gadget will take in trying to map out the Profile vector. More complicated or structured Profiles need more steps to be described accurately. Usually this is between 20 and 1000, but up to 10,000 is accepted. Higher values give better accuracy, but at the expense of slower processing time and higher memory usage. This is important when generating roughing paths and/or making **FlutePlus** toolpaths on many Rails at one time to carve out a 3D object.	0 to 10,000

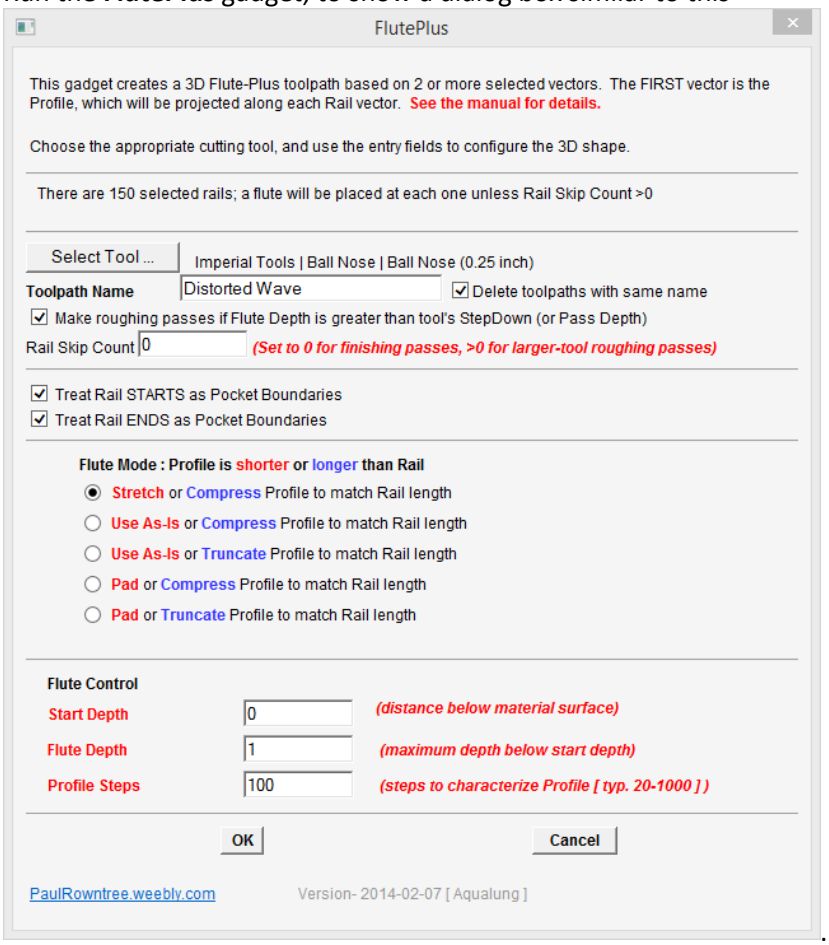
1. After installing the files, restart Aspire or VCP, and verify that it has found the FlutePlus.lua file by checking the Menu>Gadgets listing.
2. Before running the gadget, create a project and create one of more circular, curved or straight vectors on the 2D presentation. These examples are from the FlutePlus Sandbox file that is included in the gadget package.
3. Select the vector you want to use as a Profile, then the vector(s) to be used as Rail(s), ***but do not group them***. This image is a screen-shot from the FlutePlus Sandbox file.



The selected Profile vector is the single wave with two maxima running from near the middle of the workspace to the right edge. The Start of the Profile is at the left-end. The cluster of selected vectors on the left were generated by making an array of straight lines, then distorting to the desired shape and Baking the Distortion. It is not apparent from this image, but these vectors run from left to right, with the Start point on the left. **They are not grouped.**

4. **REALLY IMPORTANT : The Start point for the Profile will be placed at the Start point of the Rail, so you must pay attention to this when creating and selecting vectors. Editing vectors can change the 'Start' point of the vector without warning. If you need to manipulate or coordinate the directions of many vectors at once, the GreenSquares gadget may be useful.**

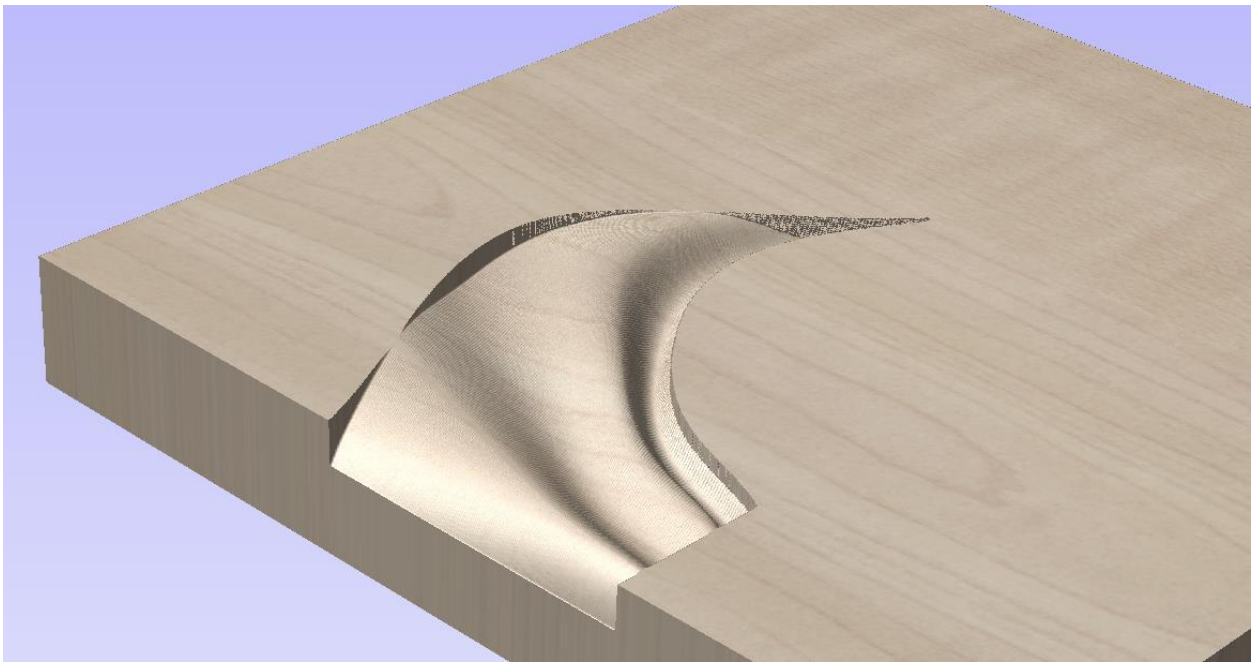
5. Run the **FlutePlus** gadget, to show a dialog box similar to this



6. Select a tool from the standard Vectric Tool database. **FlutePlus** will accept end-mills, ball-nosed bits, radiused end-mills, and V-bits (radiused cutters are treated as end-mills for now). **FlutePlus** uses the shape of the tool to avoid overcutting each vector along its trajectory, but it does not avoid overcutting material off to the side of the current Rail. You can mix metric and imperial units for the current project and tools.
7. Enter a name for the toolpath. If 'Delete toolpaths with same name' is checked, all existing toolpaths with exactly the same name (case-sensitive) will be deleted before creating the replacement. This makes iterative designing of the toolpaths very rapid. Don't forget to uncheck it (or entering another name) before moving on to another **FlutePlus** toolpath design.
8. Check the "Make roughing passes…" if required. Normally this is checked, unless you have already made the roughing passes with a previous run of the gadget, perhaps with a more robust hogging out cutting tool.
9. If Rail Skip Count is > 0, **FlutePlus** will skip over this many Rails before doing the next one. This is useful if you are using many Rail vectors to machine a 3D shape, and these Rails must be closely spaced to get a smooth finishing pass. When roughing with a larger diameter tool, you may not have to run the cutter over each vector. This option can speed up roughing process by a factor of 2-20, depending on the bits you are using. Set Rail Skip Count to 0 for the final finish pass for smoothness.
10. Don't worry about the two checkboxes that control end-behaviour for now.
11. There are 5 different 'Flute Modes' available. These control how to deal with unequal Profile vs. Rail vector lengths. In this example, the Rails at the top of the cluster are longer than the Profile, while the bottom Rails are shorter. The first option will Stretch or Compress the Profile so that it is exactly the same length of each Rail.

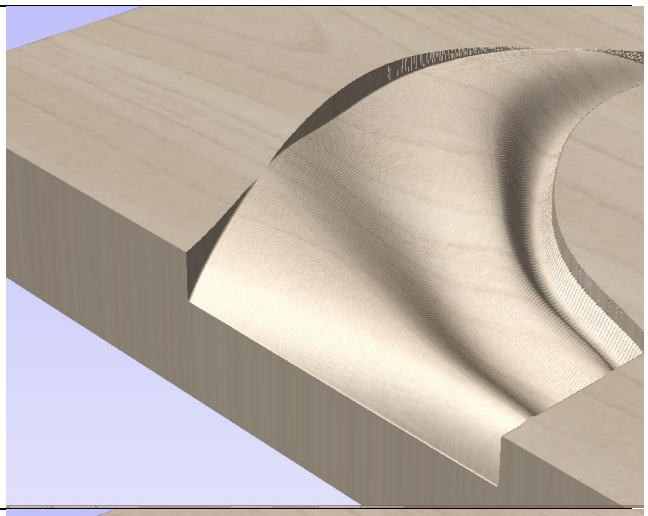
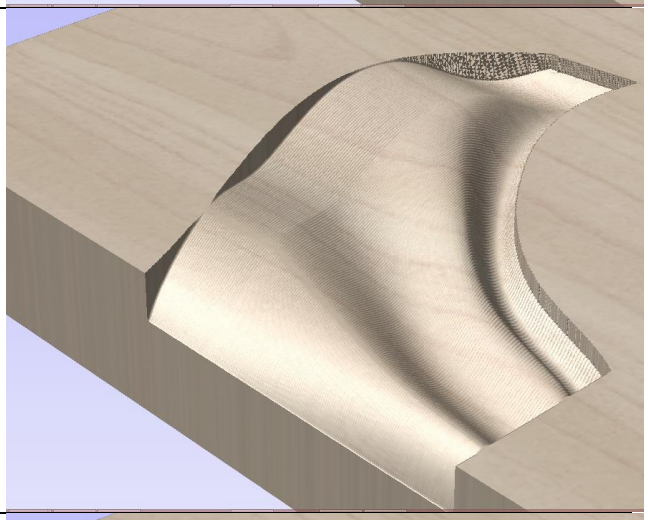
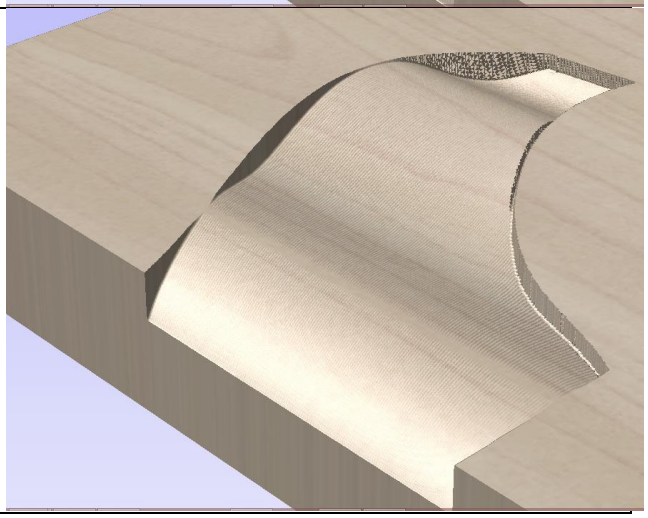
The effects of each option are shown in a Table following these instructions. Stretch and Compress is probably the most commonly used mode.

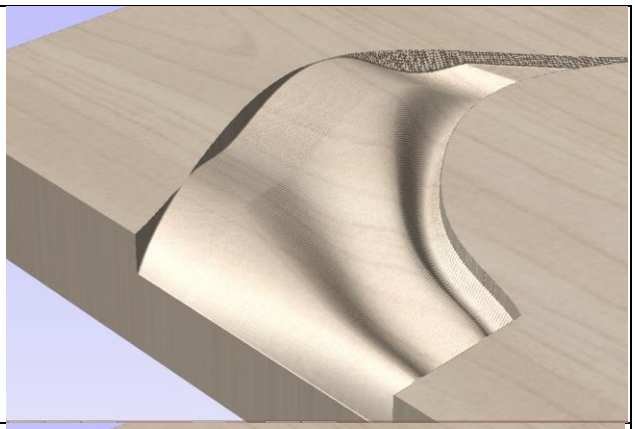
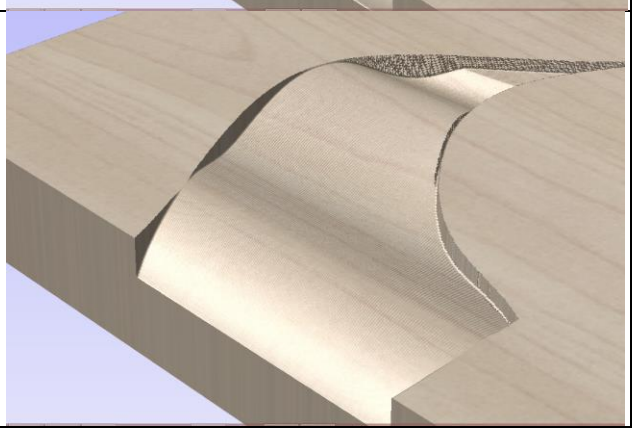
12. Enter appropriate values to describe the fluting toolpath you want in the three numerical entry fields. Units are in the current job units. Start with a Steps value of 50-200, then increase or decrease as required.
13. Verify the settings. Repeat step (13) as many times as necessary.
14. Press "Ok" to accept, or "Cancel" to reject the settings. If you accept them, the program will generate the toolpath and add it to the toolpath list so you can preview the results.
15. If you pressed "Ok", the last set of parameters will be saved for the next use of **FlutePlus**. It may take a few seconds to complete the calculations.
16. Go to the Preview mode, and see what you have made.



The Rail at the top of the cut shows the shape of the Profile clearly, with two maxima. Subsequent Rails get shorter, causing the two crests of the wave to get compressed towards the left side of the material (the Start point of the Rails). They also bend, and the **FlutePlus** toolpath follows these bends to give a graceful, natural evolution to the flutes.

The control over the shape of the **FlutePlus** toolpath comes from the choice of Flute Mode on the gadget control panel. Using the same example, here are the results. Only the Flute Mode is changing in these images. The names of the modes reflect what is done to the Profile if it is **shorter** or **longer** than the Rail.

Mode 1 : **Stretch** or **Compress** The Profile is forced to exactly match the length of the Rail. This Flute Mode ensures that the ends of the Rails are all at exactly the same depth of cut, the entire space occupied by the Rails will be machined, and that all parts of the Profile are seen.	
Mode 2 : **Use As-Is** or **Compress** Using the Profile As-Is means that the toolpath extends only as far as the profile was defined, as shown in the upper-right corner of the image; if the Profile is too long for the Rail, it is compressed to fit. This Flute Mode ensures that the ends of the Rails are all at exactly the same depth of cut, and that all parts of the Profile are seen.	
Mode 3 : **Use As-Is** or **Truncate** Using the Profile As-Is means that the toolpath extends only as far as the profile was defined, as shown in the upper-right corner of the image; if the Profile is too long for the Rail, it is chopped off at the end of the Rail. This Flute Mode imposes minimal changes on the final cuts due to changes in the Rail length.	

Mode 4 : **Pad** or **Compress** If the Profile is too short, the end of the FlutePlus toolpath is padded to the end of the Rail using its last Z value, as shown in the upper-right corner of the image; if the Profile is too long for the Rail, it is compressed to make an exact fit. This Flute Mode ensures that the ends of the Rails are all at exactly the same depth of cut, and that the entire space occupied by the Rails will be machined.	
Mode 5 : **Pad** or **Truncate** If the Profile is too short, the end of the FlutePlus toolpath is padded to the end of the Rail using its last Z value, as shown in the upper-right corner of the image; if the Profile is too long for the Rail, it is chopped off at the end of the Rail. This Flute Mode ensures that the entire space occupied by the Rails will be machined, while imposing minimal changes to the shape defined by the Profile.	

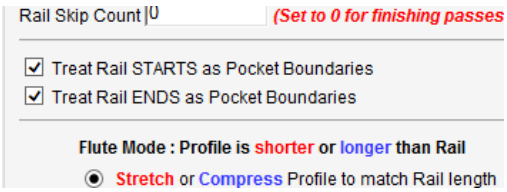
How FlutePlus Treats the Vector Ends

FlutePlus can be used to make variable-Z Profile-like toolpaths or variable-Z Pocket-like toolpaths.

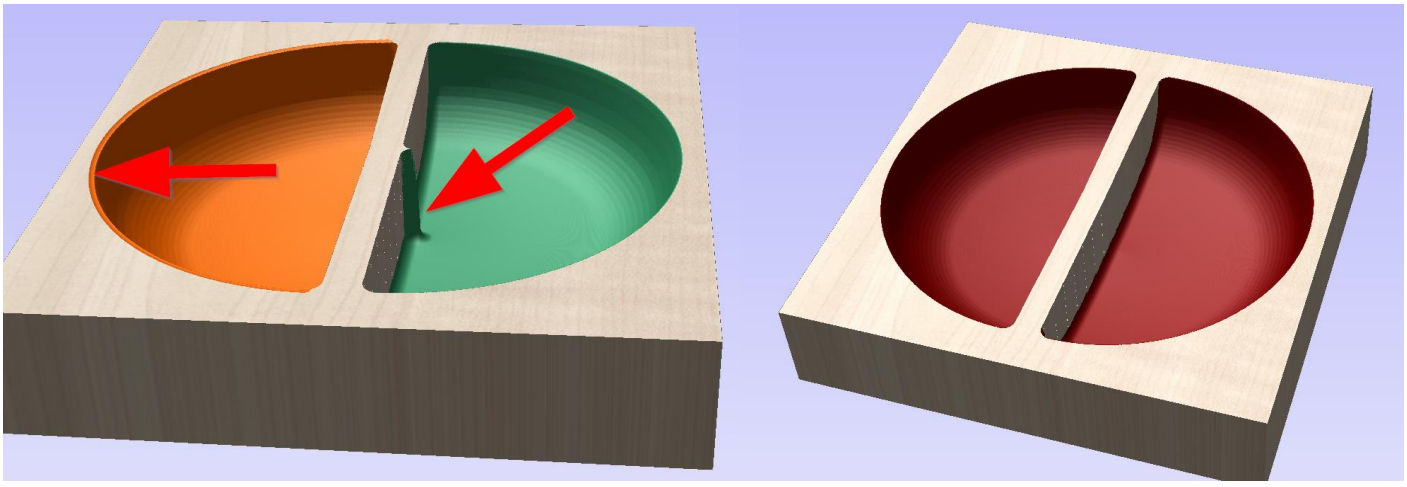
A Profile-like toolpath starts and/or ends with the centre of the tool exactly over the start and end points of the vector, just as Vectric Profiles behave; Profile toothpaths can extend beyond the vector by as much as ½ of the tool diameter, at each end. This ensures that that the cut is exactly correct over the entire length of the vector, with the risk of possible unexpected material removal beyond the vector length.

A Pocket-like toolpath treats the vector starts and/or ends as boundaries, and the cutting never removes material before or after the end of the defining vector, just as Vectric Pockets never extend outside the selected vector boundary. This could result in the centre of the cutter not moving all the way to the end of the vector because the edges of the cutting tool could have already reached the boundary. This can lead to material not being cut within the boundary (as seen at the edges of a pocket cut with a ball-nosed cutting tool).

FlutePlus lets you control how each end of each Rail is treated, individually, using dialog box Checkboxes.

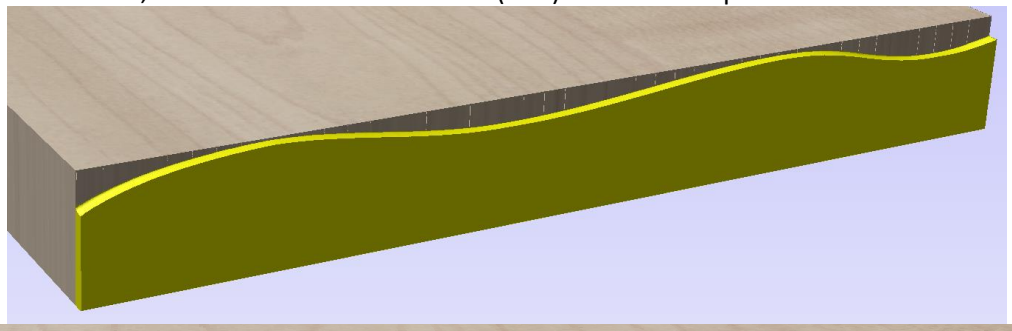


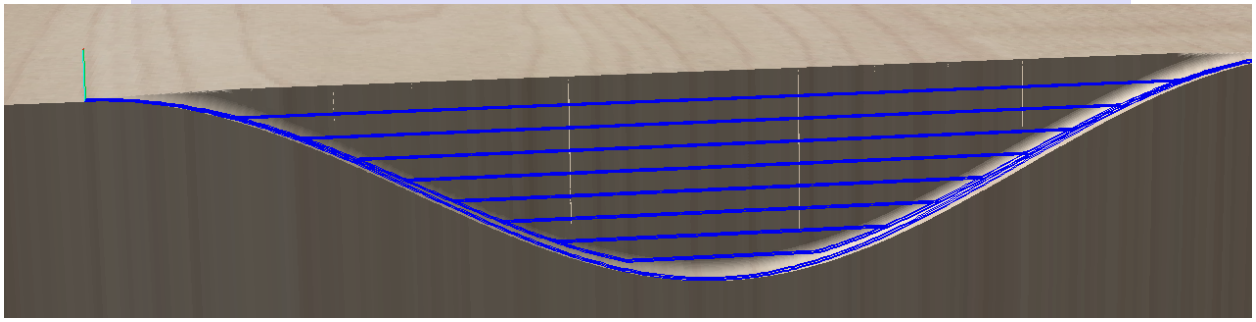
The End_Behaviour_Demo.crv and SplitBowl.crv files let you explore the possible cases. As an example, the left-hand image shows bowl sides designed with radial vectors, start points in the centre. The left section treats both ends of the vectors as Profile-like, the right section treats both ends as Pocket-like. Both sides have drawbacks; the best approach on this design would be to treat the starts as Profile-like, and the ends as Pocket-like, as shown on the right-hand image.



Tips for Using FlutePlus

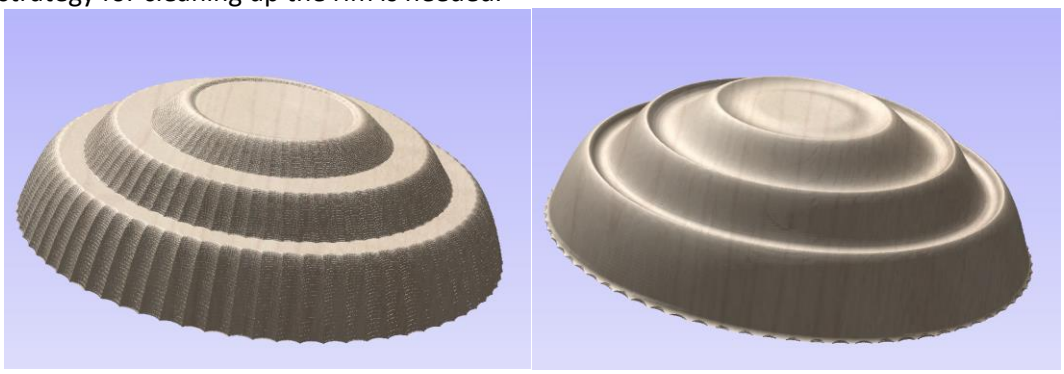
1) Although **FlutePlus** can be used to create single flutes on individual vectors, arrays of Rail vectors can be used to create novel 3D structures in the material. Unlike the stock Flute toolpath, **FlutePlus** can be used to make convex and concave shapes like bowls.
2) The units associated with the tools and jobs can be freely mixed; use millimeter or inch unit systems as you see fit.
3) After construction, you can edit the Start Depth and the tool parameters of **FlutePlus** toolpaths; toolpaths can be easily recreated for more extensive changes.
4) It is possible to make toolpaths suitable for a lathe. Simply make your design and project it onto a straight line parallel to the X or Y axis, depending on how your lathe is configured. The flute will then represent your desired shape as the Z coordinate, and the tool translation as X (or Y). These examples are in the Flute Plus Sandbox file.





5) **FlutePlus** will make roughing passes if the Flute Depth is greater than the Stepdown of the tool and "Make roughing passes…" is checked. Unchecking this option will speed up the calculation and rendering times during design refinements; turn it back on when needed. Since **FlutePlus** uses the shape of the cutter to avoid overcutting, you can calculate roughing passes with a large robust cutter, then calculate a single finish pass with a smaller tool that will get in where the larger cutter could not. To avoid doing a lot of air-cutting on this finishing pass, un-check the "Make roughing passes…". You can use a slightly shallower Flute Depth for the roughing passes (~95% of the true final depth) to keep a thin skin of material everywhere for the finishing pass with the smaller tool. The roughing paths are designed to reduce Z motion as much as possible by using flat-bottomed motion, but the final path will remove material everywhere to avoid touch-down marks, even when using the same tool for the roughing and final passes.
6) Setting Rail Skip Count >0 can save a lot of roughing time if your Rail vectors are closely spaced. This is a preview of a stepped elliptical bowl exterior, first with 0.5" End mill roughing passes with Rail Skip Count=15, then a single pass with a 0.25" Ball-Nosed mill; both were calculated with the same Profile and Rail vectors, although the roughing pass only used ~6% of them. Depending on your machine and material, this is possibly too high a SkipCount, since there is very little overlap at the far ends of adjacent Rails in the Roughing process. Some

strategy for cleaning up the rim is needed.



7) **FlutePlus** moves the cutter over all of the Rails for each of the Roughing Passes before moving down to the next depth. To avoid a lot of motion above the material as it moves to the next rail, **FlutePlus** will go 'backwards' over some vectors, creating a back-and-forth motion for closely spaced Rails. This is done automatically, and is not affected by the true 'Start' point of the Rail. If the Rails are widely spaced across the material, it may be more efficient to run the gadget several times, one for each region.
8) If the end of one vector is very close to the start of the next cut (see above concerning direction of cutting) then **FlutePlus** will proceed smoothly from one to the next, without raising the tool between Rails. Since Z motion is relatively slow on most machines, this should save machining time. Turn on the Animation options of the Previews to see what is really taking place.
9) Closed paths can be used as Profiles and Rails. If you use a circle with the Start point at 12:00 for a Profile, the shape is a concave cosine curve, with a smooth entry and finish at the surface of the material, as shown in the 'Lathe Dish' example on the right-edge of the FlutePlus Sandbox image. Start point at 6:00 gives a sine wave, looking like a slow-starting convex bump. Polygons give stranger, segmented waves (probably less useful). Using a circular Profile on a circular or elliptical Rail gives an interesting profile, like an edge design on one of SPalms' boxes; this is shown in the Sandbox file.
10) If using a ball-nosed cutter it may not be able to go down to the anticipated depths at the start or end of the Rail. This may prevent the toolpath from completing a full cutout of the shape from the material. The solution could be to use a smaller diameter tool, or you can add a horizontal line to the end of the profile, which gives the tool enough space to fully descend to the anticipated depth before reaching the end of the Rail. Both strategies are shown in the Heart.crv example file.
11) If using **FlutePlus** to carve out 3D shapes, you may be interested in the **GreenSquares** and **Cookie Cutter** gadgets; both are free. **GreenSquares** makes it easy to arrange the start points of groups of vectors, and **Cookie Cutter** makes it easy to trim Rail vectors to vector outlines to make complex shaped bowls etc.

If you use **FlutePlus** to produce something interesting, please consider posting photos on the Vectric forums. If you have any questions, I am frequently on the Vectric and CNCZone forums as PaulRowntree, or you can reach me via the PaulRowntree.weebly.com website.

Again, if you feel that **FlutePlus** has improved your toolset or assisted your CNC work for pleasure or profit, please consider making an appropriate contribution to support its continued development, at **PaulRowntree.weebly.com**.

Cheers!

PR

Sample Images

From heart.crv

From End_Behaviour_Demo.crv