TreeSoft : StandingWave

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Updated February 6, 2013

Change Log

Date	Change
2013-02-06	• Added progressive/curved wobbly shifts to wobbles • Added additional lines below and above panel dimensions to ensure wobbles cover all of cut area
2013-01-08	• clipped EPS output to Y≥0 to always maintain registration
2013-01-06	• added 'Wobbles' option to code and front panel • added negative Wobbles per line to reverse evolution top to bottom • added xxx_All.EPS file that contains all vectors, registration and profile marks
2013-01-05	• removed comma decimal separators from EPS files • modified front panel defaults and limits
2013-01-04	• added rectangular vector to Layer 1 EPS file that shows material outline • added millimeter units to EPS file generation • cleaned up EPS file structure, corrected /RL bug, added arbitrary scaling • added more comments to EPS file output • added mm=TRUE command line option to boot with reasonable defaults in mm • corrected values entry fields to use regional formatting (e.g. ',' vs '.')
2012-09-04	• First distributed version finished

What is StandingWave?

StandingWave is a program that designs 'Wavy Panels'. If you Google this term you will find 4'x8' panels sold on EBay for $400-$800, even though they are often just machined pieces of MDF. These panels are often designed to be 'periodic' in both the horizontal and vertical directions, so the wave patterns appear to be continuous on large walls. Although the commercial products mostly use MDF type materials, real wood with the grain running parallel to the final grooves (i.e. parallel to X) makes for more interesting patterns, as long as the grain patterns do not overwhelm the imposed patterns.

StandingWave takes care of all the nasty details to produce panels that are intended to look like the sandy-bottom of a clean lake, where the incoming and outgoing waves interfere to make patterns in the sand. It takes ~1 second to generate a pattern. Once you have a pattern that you want to work up, it takes about 2-5 minutes to produce toolpaths in V-Carve Pro and to see the Previews. Typical cut depths are ~0.25". For a given pattern, using a larger cutting tool will lead to the same set of final structures, but with shallower relief.

StandingWave patterns are completely reproducible, even though the program uses a lot of random numbers to generate them. When you make a pattern, the program provides a list of all the information used to reproduce the panel, exactly. If you use this to make panels for a paying customer, you can provide exactly the same panel design as often as you wish, whenever you wish. This is different from the built in textures of VCP. By changing a random-number 'seed' (geek-talk for the key that defines the random number sequence), you can produce an endless number of panels that are all different, but share the same trends and characteristics. Also, once you specify some of the major parameters, you can tweak the minor parameters to tweak the final appearance 'just a bit'. You can stretch and distort the patterns using graphics and design programs.

Output of the program is either by way of standard black & white windows bitmap file (*filename.bmp*) with a resolution of 100 points per inch, or by Encapsulated PostScript files (*filename.EPS*) with resolution of 0.001 inches or mm. ***Use the EPS files if you can, as they are more precise and they make the panels much easier to construct with the Vectric products.*** You can choose to use two or three interleaved sets of vectors to define your waves; I think three looks better. **StandingWave** produces image and EPS files for each layer, as well as a composite EPS file that contains all of the vector information. Normally, this composite file is the only one you need, but if you want to work with the individual components, they are all available.

StandingWave's EPS files are created using millimeter or inch units, and you can view the contents with an ASCII editor like Notepad or PFE if you want. Files created in one of these units can load into a VCP or Aspire project with materials defined in the other units; Vectric programs take care of the conversions for you.

StandingWave respects the regional settings for decimal separators that you have set up for your Windows machine. Regardless of your regional settings, EPS files always use the '.' as the decimal separator.

Versions

StandingWave is available free of charge, and can be used for anything you wish. The fully-functional program is available for download at http://PaulRowntree.weebly.com. Donations (via PayPal at the download site) gives you a way to bypass the nag-screen that appears on program run, and supports continued development of these programs. If you are using this program to make commercial panels, please consider how much you are selling these panels for, and make an appropriate contribution.

Warning

The bitmap output is getting hard to support, because of the wobbles. In this version the sausages are not always fully blackened near the top/bottom of the images, although they will probably trace properly. This may be the last version that supports the bitmap file creation, unless users can give me some really good reasons to keep it in. Plus, the *xxx_All.eps* file output really is the easiest, more precise, and fastest way to define the vectors.

Installation

Download the **StandingWave** ZIP file archive into a directory of your choice. There is no Windows installation, and the program does not use the registry or leave any junk scattered around in your

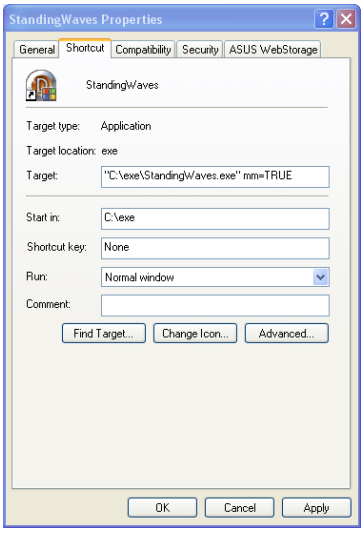
computer. When you are done with the program, just erase the unzipped files, and you are clear and clean.

Using StandingWave

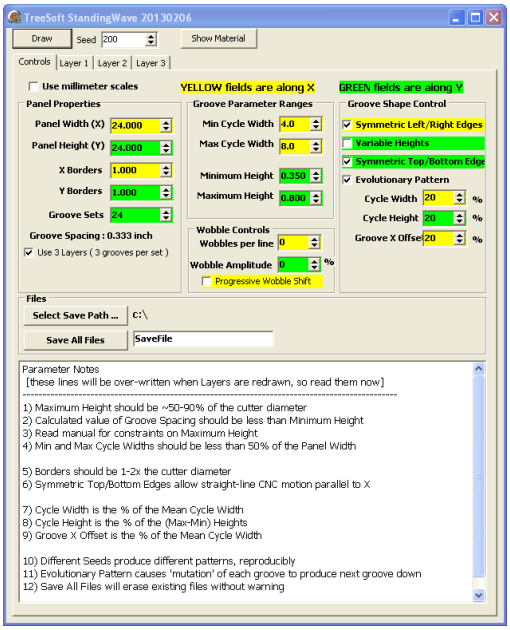
If you run **StandingWave** by clicking on the program icon, it will use inches as the default unit. You can change to millimeters with a front panel control, and this will convert all control values to the new units. If you use millimeters on a regular basis, you can create a shortcut to the program, and add 'mm=TRUE' to the command line. This has to be outside the quotes surrounding the program path, and it is case sensitive. Using this command line option also installs reasonable default values at startup, instead of the converted Imperial values that are used with the 'Use millimeter scales' option on the front panel. Using this command line option also sets this checkbox.

Please read all of these instructions before making designs, toolpaths and panels.

I recommend that you go through the process of creating the EPS files and toolpaths using **StandingWave's** default parameters before you start designing your own panels. To do this, run **StandingWave**, press the 'Draw' button on the front panel, then press 'Save All Files'. This will create the files in the c:\ directory. Then re-read the instructions on ToolPath generation below. Once you have the mechanics of the process figured out, come back and re-read the following detailed instructions on how to tweak the panels.



When you run **StandingWave**, it will show a window shown below. It is probably a good idea to maximize the window so you can see the patterns on the Layer 1 … Layer 3 tabs better.



Across the top there are three controls that drive pattern generation.

Draw : regenerates the patterns based on the front-panel control values. If you keep pressing the Draw button without changing the parameters you will keep regenerating the same patterns.

Seed : this integer value kicks off the random number generator. The value of 'Seed' has no meaning, but it is the fingerprint of the resulting pattern. Changing this value triggers a generation of the new patterns that are similar to previous patterns.

Show Material : is a visual tool to show a white rectangle of the desired panel dimensions overtop of the wave patterns. Redraw the graphics without the Material showing before saving the results if you are using the bitmaps instead of the EPS files.

Just below the buttons there is a tabbed sheet. The 'Controls' tab contains all of the numerical values used to define the wavy patterns. Yellow controls refer to the X direction, and Green is for Y. The waves are always parallel to the X axis. 'Layer 1', 'Layer 2' and 'Layer 3' are image displays that show you the current wavy pattern; black areas will be machined.

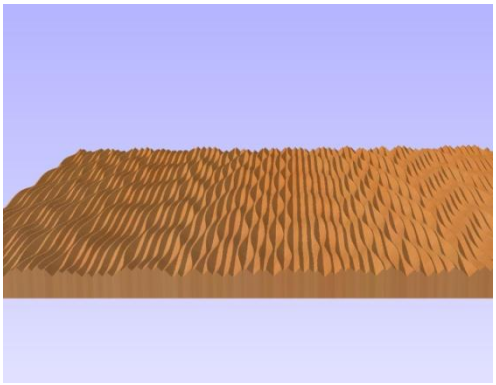
Start with the 'Controls' tab, where most of the action is.

Use millimeter scales : This toggles the use of millimeter units for the output of the program. When you change the scales the program recalculates the front-panel control values to produce the same patterns either way. Some round-off does occur, but it is negligible.

Panel Properties : These set the dimensions of the material that you will be using, as well as the border size around the panel. They must agree with how you set up your CAM program and your CNC table bed.

> **Borders** should be about 1" (25 mm), and must be at least as wide as the tool that you will be using to carve the panel. Normally you would use a ball-nosed cutter. **Groove Sets** controls the number of pairs (or trios) of sausages will make up the panel height. The centre-lines of the sausages are separated by a distance (Groove Spacing) that is shown below the Groove Sets

control, and this is recalculated whenever a relevant parameter is changed. V-bits will work but they create very angular structures; unless you have unchecked the 'Symmetric Top/Bottom Edges' the bottom of the bit carves a line at the bottom of each sausage, which is usually unwanted.



Groove Parameter Ranges : These define the shapes of the sausages. Each sausage will extend completely across the panel, and into the left and right borders. Each sausage is composed of bumps within the specified width range. The program will randomly pick widths (X) for each 'bump' subject to the limits on the Control panel. The full height (Y) of each bump is more than the 'Minimum Height' and less than the 'Maximum Height'. To avoid having regions of the panel that are not machined, the 'Minimum Height' should be greater than or equal to the 'Groove Spacing' value described above. This makes good sense, but it is not enforced by **StandingWave**.

***** The cutting tool diameter MUST be greater than the 'Maximum Height'; in practice, it should be ~25% larger to avoid deep gouges. Toolpath generation could fail in V-Carve Pro or Aspire if the tool is too small, and it seems like VCP will only sink a ball-nosed bit into the work as deep as the tool radius anyway, so wider sausages with narrow tools would end up being flat bottomed.**

***** The Maximum Height must be less than the separation between sausages on any layer or else they will overlap on a layer (which is easily seen on the bitmaps). When using three layers, Maximum Height should be less than 3x Groove Spacing, and with two layers, less than 2x Groove Spacing.**

This sounds more complicated than it is. In practice, set Maximum Height to be ~75% of the cutter diameter, then adjust Groove Sets until 2x the Groove Spacing (or 3x if 3 layers are used) is slightly greater than the Maximum Height, then set Minimum Height to be slightly larger than the Groove Spacing. The default values seen when you run **StandingWave** are workable for a 1" (~25 mm) diameter cutting tool or larger. Larger tools produce shallower features with the same pattern.

If the program finds potential problems, it will show a message on the text display after regeneration. If adjacent black sausages on a bitmap preview are touching, it might be the limited resolution of the images, but you might want to decrease the Maximum Height a bit or decrease the 'Groove Sets'.

Wobbles Controls (New for 2013) : Wobbles add variety to the patterns, while maintaining the periodic properties. Without Wobbles, the centre-line of each sausage is pretty much a straight line going across the panel, and in simple patterns this could be seen for several adjacent sausages. Wobbles make these centerlines rise-and-fall along the Y direction of the panel as you look across the panel 'X'. The wobbles can be made to progressively shift from sausage-to-sausage, or the shift can start at zero, reach a maximum mid-panel height, then return to zero at the top edge. Wobbles can make a world of improvement towards the look of underwater sandy waves. To get a clear view of what the wobbles are doing, try setting the Groove Parameters 'Maximum Height' to be equal to the 'Minimum Height', which

will make the sausages all look the same, and the cuts would just be horizontal bands. Now set 'Wobbles per Line' to 2, and wobble Amplitude to 100%, and press Draw. Play with the wobble controls until you get a feel for how they work.

Wobbles per Line : This is an integer (-2, -1, 0, 1, 2 …) that changes the centerline for each sausage from a flat, horizontal line to a sinusoidal line, with this number of complete Wobbles across the X range of the panel dimensions. Going from the top of the panel to the bottom there is a horizontal shift of exactly one Wobble length to add additional waviness. Negative Wobbles per Line changes the direction of this horizontal evolution. The panel remains periodic in X and Y when you add Wobbles.

Wobble Amplitude : This is expressed as a percentage of the Maximum Groove Height, and sets how high (in Y) the Wobbles will be. This is currently limited to be 0-100%.

Progressive Wobble Shift : If checked, the maximum of the wobbly centreline will progressively shift farther and farther from the left edge as the sausages move from the bottom to the top of the panel. If unchecked, the maximum of the wobbly centreline will move farther from the left edge, reach a maximum shift at the mid-height of the panel, then gradually move back to the left edge.

Groove Shape Controls : These direct the way that the bumps on the sausages are shaped. Starting with the four check-boxes,

Symmetric Left/Right Edges : When Checked, each bump will have left/right symmetry.

Variable Heights : When checked, the heights of each bump are allowed to vary within the 'Minimum Height' to 'Maximum Height' window. If not checked, each bump will extend exactly from the Minimum to Maximum Heights.

Symmetric Top/Bottom Edges : When checked, the sausages will be symmetric about their horizontal centre line, and the cutting tool will move straight down the panel adjusting Z as it moves in X, but Y will be fixed (if no Wobbles!). If not checked, but Variable Heights is checked, then top/bottom edges will be different.

Evolutionary Pattern : When checked, each sausage is a 'mutated' version of the preceding sausage, with the Cycle widths, heights and horizontal offsets varying slightly from the previous set. How 'slightly' is controlled by the numerical controls below. Larger numbers give larger variability. Evolutionary mode can make more natural-looking waves, and it tends to make lower profile wave structures, with deeper, rolling tertiary structures. You will see what I mean below. These numerical controls also control the creation of sausages without Evolutionary Pattern selected, by selecting values for the width, height and offsets within the ranges allowed.

Below all of the controls is a text display. Initially it holds some reminders on the various parameters.

Each time you regenerate the pattern, this text display is cleared and replaced by a summary of the parameters used to define the current pattern, along with any error messages or warnings. You can select this text, right click to copy it to the clip board, then paste it into a text file to document your pattern. As well, the text is saved to a filename.txt file with the images and EPS files by pressing 'Save All Files'. Retyping these values into **StandingWave** at a later date will recreate this pattern exactly.

Strategies

The Layer 1-3 images give you a pretty good idea of what is being created by **StandingWave**. For each layer, the wider the sausage, the deeper the V-Carving toolpath will take the cutting tool. But the real interest in the wavy panels comes from how side-by-side cuts (i.e., sausages on adjacent layers) interfere with each other. This is where the Vectric previews are important and can save you from a lot of wasted time and material. I do not have the programming skill to create these previews, so you are going to have to go through the

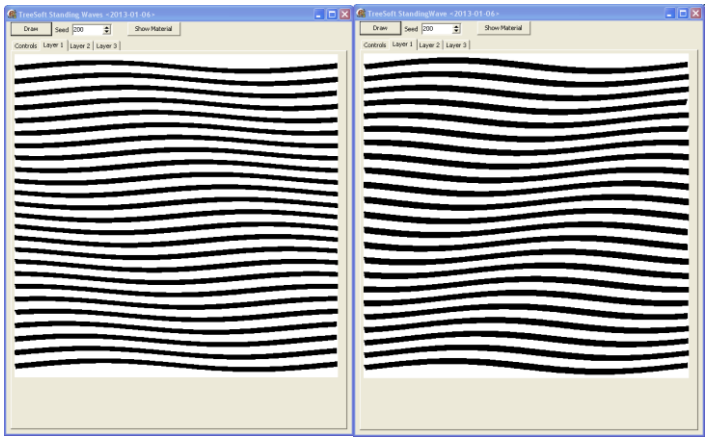
Generate pattern in **StandingWave** →Generate V-Carve toolpaths in VCP → View Preview in VCP

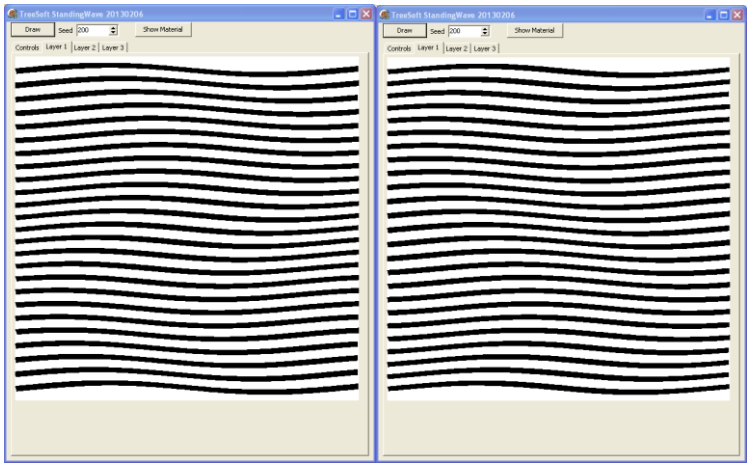
cycle a few times to start to understand how the layer images relate to the final previews. With practice, this cycle takes less than 1 minute. Remember that the final patterns seen on the material are caused by the ***interferences*** between the adjacent sausage vectors used to guide the cutter. If successive sausages were all identical, then you would end up with a series of boring straight lines on the final cut (you can force this to be the case by setting Maximum Groove Height to be equal to Minimum Groove Height, or by setting all of the 4 percent controls in the Groove Shape Control box to 0 thus eliminating the groove-to-groove variations). Wobbles would make the lines bend, but they would stay pretty boring. On closer inspection, you would see 'tertiary structure' where the bumps in the sausages are sculpted deeper into the material, but the most visible horizontal lines would not be very interesting. To create differences between adjacent sausages, and therefore make the final product more interesting, try to:

1) use as small a value for Minimum Height as you can (a few thou greater than Groove Spacing),
2) use as large a value of Maximum Height as you can (but smaller than the tool diameter), and
3) introduce variations with the controls on the right side of the Controls tab.

On the other hand, if the sausage-to-sausage variations become too large, there is no 'evolutionary' advantage. Longer Cycle Widths tend to make calmer, less structured panels.

Adding Wobbles can add a lot of variety to the panels, and removes the 'straight-line' look of the sausage centre-lines. In my opinion the Wobble Amplitude should be ~20-50%, and 1-3 Wobbles per line on a square panel. If Wobble lengths are similar to or greater than the average Cycle length of the sausages they dominate the overall appearance. Like most graphic design choices, 'more' is not necessarily 'better'. You can see the Wobbles themselves in the images by setting the Maximum Groove Height to be the same as the Minimum Groove Height. The images below shows 1 Wobble per line, Maximum Groove Amplitude =0.35", and Wobble Amplitude = 100%, with Progressive Wobble Shift. Negative Wobbles per Line (image on the right) reverses the way the Wobbles evolve from top to bottom. The next pair of images show the effect of Progressive Wobble Shift unchecked.





Files

Once you are happy with the patterns seen in **StandingWave**, you need to save the files. All are saved at once to a single directory. Press the 'Save Path …' button (near the middle of the Control tab) and navigate to where you want to save the files. Press 'Ok' on the dialog. The path that you picked will be shown beside the button, and the filename you selected is in an edit box just below the path, ***but you haven't saved anything yet.*** You can manually change the filename to remove extra characters, add stuff, etc. When you press 'Save All Files' it will append file types and layer information to these files, and shove the ASCII parameters (*filename.TXT*), all images (*filename_Ln.bmp*) and all EPS files (*filename_Ln.EPS*) to the disk at one go, where 'Ln' will be 'L1', 'L2' or 'L3' for the different layers. It also creates the file '*filename_All.EPS*', which contains all of the vector information of the two (or three) layers in one file, plus the material outline vector. **This is the easiest file to work with, since everything can be loaded into VCP or Aspire at one go.**

Pressing the 'Save All Files' button will erase any similarly-named files without warning.

Generating Toolpaths in V-Carve Pro or Aspire

Start a new project. Define the material size to be the same as you used in **StandingWave**, with the origin in the lower-left corner, offset by the X and Y borders used in **StandingWave**. The work should then be in the upper right (+,+) quadrant, with a border separating it from the (0,0) origin. A 24"x36" panel with 2" borders would require a material definition of 28"x40", with the bottom left corner at (0,0), or 24"x36" with an offset of 2" in X and 2" in Y.

If you are using EPS files to represent the patterns (and you should) then you can Import the *filename_All.EPS* file. It should automatically align itself with the lower left corner at (0,0). To verify this, you can zoom in on the origin and you should see a small 90° pie in the (+,+) quadrant, and the tip of the pie exactly at (0,0). You can erase this pie section if you want, but it won't harm anything.

(new for 2013) The *filename_All.EPS* file also contains a rectangle that shows the material position that you setup in **StandingWave**; you can ignore the rectangle if you have positioned your material exactly on the cutting table with the bottom left corner of the material offset from (0,0) of the CNC by the border dimensions. Alternatively, you can create an Outside Cut profile with this rectangle vector to cut away the unwanted material from the desired panel**. Only the portion of the panel that is within the rectangle is periodic in the X and Y directions.**

Group the set of 'sausage' vectors, excluding the material rectangle. It is easiest to find the rectangle in looking for the vertical edges on the left or right sides. Switch to the toolpath generation screen, and create the V-carve paths using the tool of your choice.

Alternatively, you can import the two (or three) *filename_Ln.EPS* files separately into VCP or Aspire, and go from there. If you start with Layer 1 then the toolpath names will match the layer contents. You should be able to do all of this without having to reposition or rescale any vectors. Check out the results in the Preview, and define the cutout profile if you want, using an outside cut. *Filename_L1.EPS* also contains the material rectangle. This approach may be required if VCP or Aspire complains about overlapping vectors. In some cases, Vectric programs complaints of this type can be silenced by making the material larger.

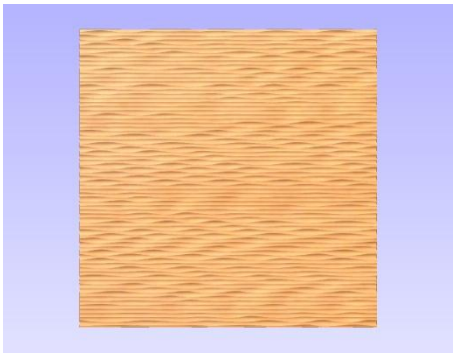
> **If you are using the images** : Import them one-by-one into separate layers of VCP. You will have to move the bottom corner of the image to (0,0) if it is not there, and then adjust the size of the bitmap to be exactly the (panel width+2x border), (panel height + 2x border) dimensions that were used in **StandingWave**. There are no registration marks in the bitmap files. Now trace the bitmaps to generate a set of vectors, and group each layer's vectors into its own object to keep them distinct. Select each grouping and make V-Carving toolpaths. This really is much messier and error prone than using EPS files. Any errors on the positioning and scaling will make it difficult to reproduce the panels exactly at a later date.

If you are *not* going to cut out the panel using the rectangular material vector shape that is included in the EPS file, then position the material on the CNC bed such that it is offset by the borders from whatever point your machine considers to be (0,0). Ensure that your tool is free to move to and cut air all the way around the panel including the borders on all sides.

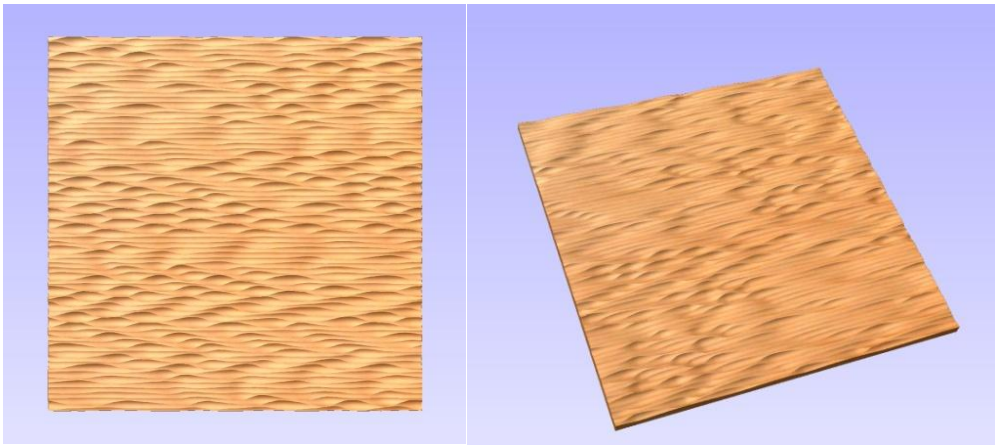
Some Examples

Here is a sample set of parameters, along with the resulting preview images from VCP rendered for a 1.0" diameter ball-nose bit on 'Dark Beech'. You should be able to regenerate these patterns exactly with the following parameters. For what it is worth, these images don't do justice to the full-screen versions made by Vectric.

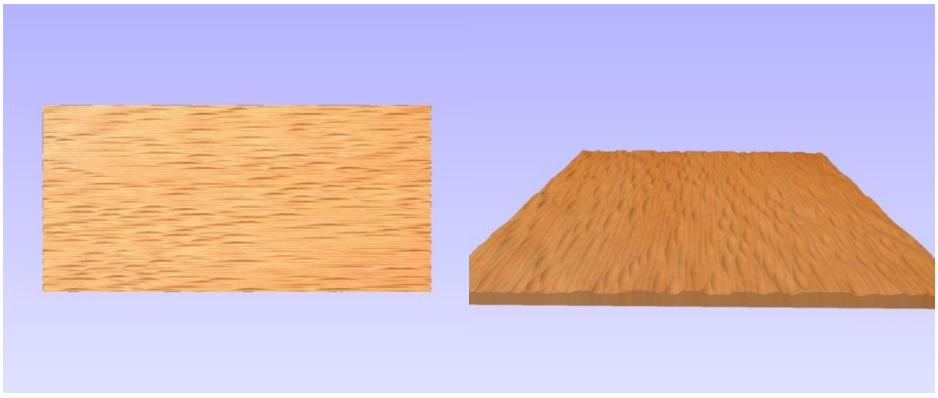
```
Random Seed : 200

Panel Parameters < all in inch >
   Panel Width, Height : 24.000  24.000
   L/R and T/B Borders : 1.000  1.000
   Groove Sets : 24 <this gives Groove Space = 0.333 inch>
   Three Layers is CHECKED

Groove Parameters < all in inch >
   Minimum & Maximum Groove Height : 0.350  0.600
   Minimum & Maximum Cycle Widths : 4.000   8.000

Checkbox Controls
   Left / Right Symmetric is CHECKED
   Top Bottom Symmetric is CHECKED
   Variable Heights is UN-CHECKED
   Evolutionary is CHECKED

Variability Controls
   Cycle Width : 20 %
   Cycle Height : 20 %
   Groove X Offset : 20 %

Wobble Controls
   Number of Wobbles/line : 0
   Wobble Amplitude : 0 % of the MaxGrooveHeight
```



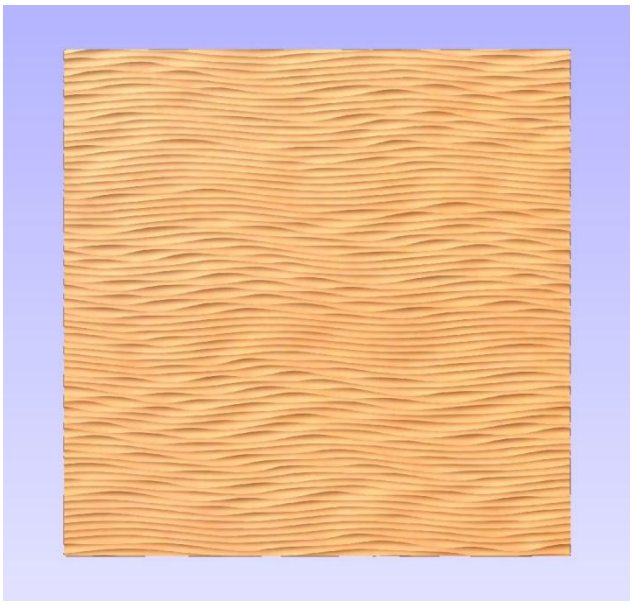
Increasing the Maximum Groove Height to 0.800” increases the contrast, and makes it less likely to find long bands extending across the entire panel.



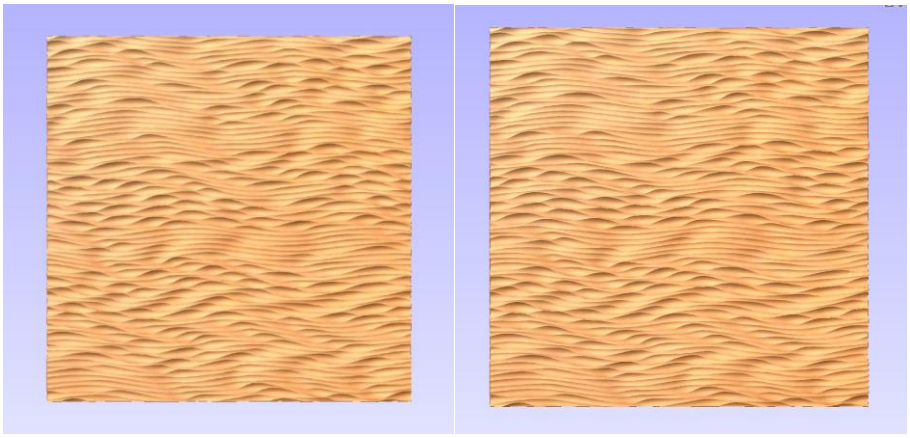
The tilted image on the right shows the underlying ‘tertiary’ structure that looks like slow rolling waves underneath the horizontal ripples. They are most visible when adjacent sausages are similar and wide in some region. Of course, since these patterns are all based on vectors, you can also stretch and distort them in VCP. Here is the same pattern, stretched out by 100% along X but keeping Y the same to avoid problems with tool widths. Complex distortions may make it impossible to stack panels, since the periodicity may be lost.



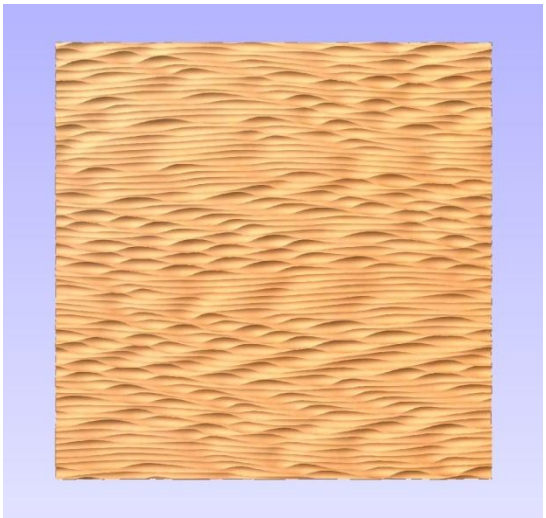
The original parameters, now with 2 Wobbles per line, and an amplitude of 30%.



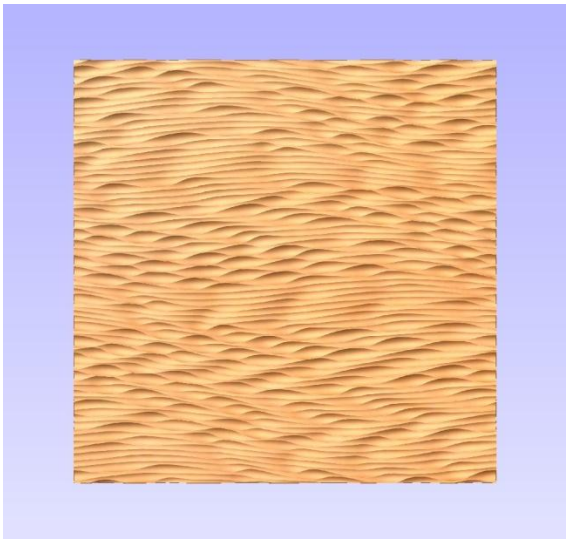
The images below show Maximum Groove Height = 0.800”, 2 Wobbles per Line, Amplitude=30%, Progressive Wobble Shift checked (left) and un-checked (right).



The following image shows 1 Wobble per line, still 0.800” Maximum Groove Height, and the Wobble Amplitude = 30%



The following image shows the effect of increasing the Wobble Amplitude to 50%. In this case, the Layer 3 sausages went below Y=0, so I increased the Y borders by 1.0" (top and bottom) in **StandingWave**, and increased the material height in VCP by 2.0".



Have fun! Please post anything interesting that you make!