Using the SymmetryWorks Software—A Quick Guide

Open-source software by Son Ngo and Bridget Went, based on code by Cameron Wong and improved by Jay Ladhad
Algorithms and documentation by Frank A. Farris

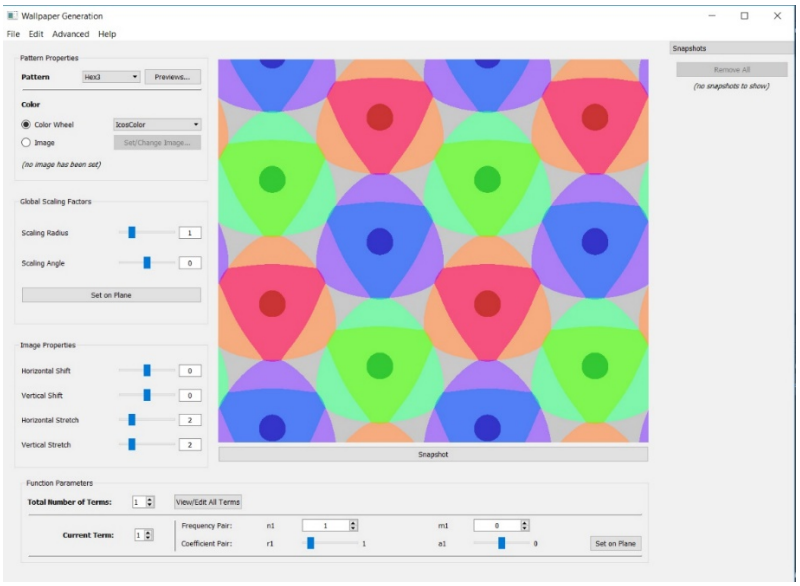
Download and Install

Find our public Github site https://github.com/jrnladhad/symmetryworks-research-bowdoin . There are folders for Wallpaper Generation and Sphere Skins. This document is about Wallpaper Generation, so open that folder. Mac users can download **wallgen.dmg** (for OS X), but this version is not the most recent update. Windows users can use the latest version by downloading **SymmetryWorksWindows7-2018.zip.** Unzip the file to your PC and in the resulting folder you will find an executable file **wallgen.exe**. When you run this software, you may have to override error messages, warning you not to download unsafe software.

If you wish to modify the software, then use the "Clone or Download" button and save the entire project to a folder on your computer. Download and install the full version of QtCreator (you must include QtCharts) and configure it correctly on your machine. Then open the project file, wallgen.pro and Qt should take you through a process to configure the project on your system.

Using the Software

When you open the program, you will see something like this. It may be necessary to resize your screen to see the colored preview window at its normal size.



After an overview we'll travel counter-clockwise around the window, explaining the meaning of each feature.

Overview

The SymmetryWorks software implements algorithms to create wallpaper patterns, either from one of several given color schemes or from any image file. You don't need to understand the underlying mathematics (outlined in Farris's book, *Creating Symmetry: The Artful Mathematics of Wallpaper Patterns*), but you do need a bit of vocabulary.

Patterns are created by a superposition of wave functions. These functions determine a pixel in a source image, or a color from a color wheel, to place at each point in the pattern. The default window shows a pattern made from a single wave, with a correspondingly simple pattern. It is colored with a particular color wheel, not a source photo.

Superimposing many waves can make more interesting patterns. The default wave has the lowest possible frequency; additional waves vary more rapidly, according to numbers we call *frequency numbers*, labelled *n* and *m* in the software, one for each spatial direction. Higher numbers correspond to faster spatial vibrations. A wave with both frequencies 0 can be useful to move waves off-center in the source image.

Top menu bar: Use **File** to save your workspace and export patterns as JPG files. One easy way to learn how to use the software is to open a file that someone else has provided. The file type is **.wpr**. **Edit** allows you to undo (Ctrl-Z / Cmd-Z) or redo (Ctrl-Y/ Cmd-Shft-Z) a step. **Advanced** allows you to set an overflow color; you can also see which pixels of a photo are called by your function.

Pattern: The drop-down box lets you select among the 17 possible wallpaper pattern types. Push the **Previews** button to see a sample of each type. A new pattern type comes with a single default wave.

Color: You can select from several available color wheels (default setting) to color your pattern, or upload your own photograph, the **Image** button. In the rest of these instructions, we assume that you are using images.

Global scaling: These parameters scale the current function, to adjust how it calls up pixels in the source image. The **Scaling radius** increases or decreases the amount of the source image targeted by the wallpaper function, like a camera iris. The **Scaling angle** turns the entire photograph, bringing different features into different parts of the pattern. The **Set on plane** button calls up a display where you can drag a single point to vary both parameters and see how that affects your pattern. This might be a good time to open the **Show Image Data Points** display from the **Advanced** menu. Dots in the display show which areas of the photo are being called by your current function. Vary the scaling parameters while looking at this display to see what they do. If the scaling radius is too large, the overflow color appears.

Image properties: The default display shows a 2 by 2 swatch of the plane, with its corner at the point (0,0). If you want to see more cycles of your pattern on the screen, increase the **Horizontal stretch** and **Vertical stretch.** Some patterns are very sensitive to changes in aspect ratio, so keep these two locked together if you want to preserve the pattern type. If you aren't happy with where the corner of your pattern starts, change the **Horizontal shift** or **Vertical shift** or just drag inside the preview window.

Function properties: To increase the number of terms, click the elevator button. Try adding one term at a time. To build a pattern from scratch, leave the default wave, where *n* is 1 and *m* is 0, and click the **Current term** button to edit a 2nd wave. Try changing the frequencies and see how they affect the pattern. The **Coefficient pair** sliders allow you to adjust the radius and angle of the term you are working on: A higher radius means more of that wave; the angle parameter turns the direction of the wave on the source image. The **Set on plane** feature allows you to see what happens when you vary both of those at once. If you are happy with your 2-term pattern, try adding a 3rd. General rule: Use less of higher-frequency waves to make a more pleasing pattern.

Snapshot: Whenever you like what you see, push the Snapshot button (Ctrl-D/Cmd-D). If your later choices cause you to wander away into something you don't like, you can return to where you were. Searching for a great pattern really can feel like wandering in a maze. This drops a breadcrumb. To save a high-resolution version, select **Export** from the File menu. Beginners should use an aspect ratio of 1:1.

Overall: Finding a great pattern is a matter of luck and experience. Get to know the pattern types by trying to make a beautiful example of each. We hope you enjoy our mathematical kaleidoscope!