3D Printing Instructions for Petroglyph Tactiles

Thank you for your interest in 3D printing these free tactile resources!

We are happy to provide these instructions to document our creative process and allow others to re-create our products for educational and outreach purposes.

We invite you to share how you're using these tactiles or to ask us questions by emailing us at punchoutreach@gmail.com. We look forward to hearing from you!

Original Chaco Canyon Petroglyphs

- The petroglyphs that our 3D models are based on are located in Chaco Canyon, New Mexico.
- These petroglyphs have been theorized to be related to ancient heliophysics and sun-watching done by the Ancestral Pueblo peoples.
- Our 3D models are exaggerated, artistic depictions of these carvings created for educational purposes.
- To learn more about these petroglyphs, watch this short video: https://www.youtube.com/watch?v=Rxku0l5e8NQ

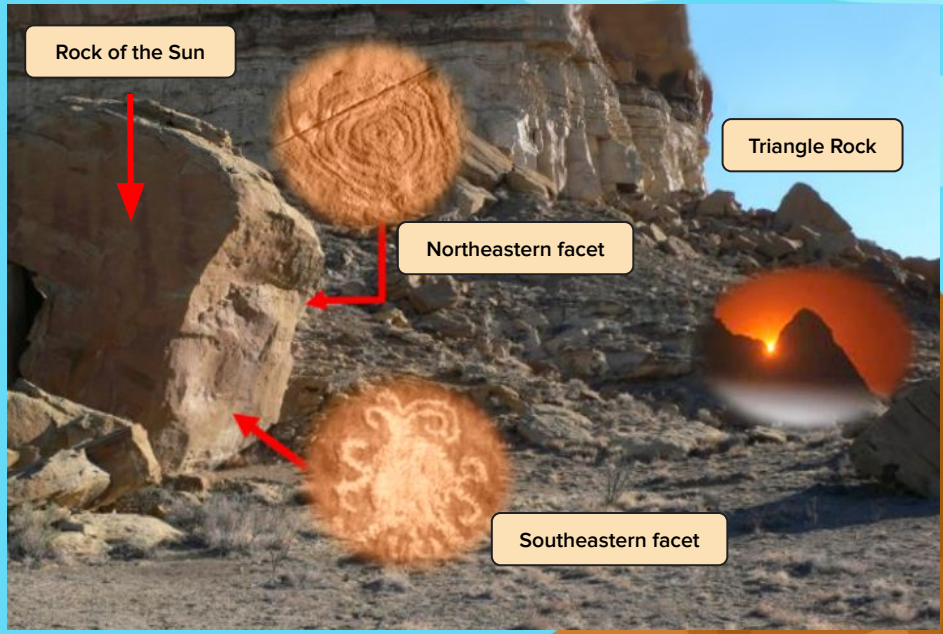


Diagram of the "Spiral" and "Curlicue" petroglyphs found on the Rock of the Sun, in relation to the Triangle Rock.

3D Printing Instructions for Petroglyph Tactiles

Two Methods for 3D Printing

Outsource the 3D printing:

- You may be able to send the 3D model file(s) to a 3D printing shop, makerspace, or college in your area.
- Some places may charge a fee for 3D printing services, such as time, materials, and delivery. Be sure to check with these facilities for their rules and requirements beforehand.
- Make sure you specify what size you would like the model to be printed at.
  - These models are large, and they may need to scaled down to fit the print area of certain 3D printers.

If you have access to a 3D printer:

- You can 3D print these models yourself with the STL file(s) provided.
- You will need a program called a *slicer*, which converts 3D model files into code for the 3D printer to print with.
  - PrusaSlicer is a free, open-source slicing software compatible with most 3D printers.
- You will also need *filament*, which is the plastic material used to create the model.
- Continue using this instructional packet to learn how to 3D print on your own.

Step 1: Understanding How 3D Printing Works

- 3D printers heat up and extrude multiple thin layers of plastic to gradually build up the shape of a 3D object.
  - Though other types of 3D printers exist, the most common type of 3D printer is a FDM (Fused Deposition Modeling) 3D printer, which is what we'll be using here.
- Much like regular printers, you must first tell the 3D printer how you want something to be printed. This is done with a program called a *slicer*, which converts a 3D model file into code containing instructions on how an object should be printed. Once you 'slice' a file, your 3D printer can read this code and print it correctly.
- Your 3D printer may mess up! 3D prints can sometimes take a few tries before you end up with the desired product. They build up in layers, so it's similar to how in a brick wall, if even one brick is shifted, the whole thing could be thrown off.

Step 2: Selecting a Slicing Program

- To prepare your 3D model for printing, you'll need to import it into a slicing software.
- Many general slicing programs (such as PrusaSlicer or Ultimaker Cura) can be downloaded for free and are compatible with most 3D printers, as long as the program recognizes which printer you're using.
  - We'll be using PrusaSlicer for this demonstration.
- Depending on your 3D printer, you may have to use a specific slicing program to prepare your 3D model file. Usually, your 3D printer will indicate if a specific software needs to be used.
  - When in doubt, you can search the internet for recommendations on what slicing programs are compatible with your 3D printer.

Step 3: Sizing the 3D Model

- 3D printers can only print out an object that is smaller than its *build plate*, which is the surface that it extrudes plastic onto to build the 3D print.
  - For example, if your printer has a 7” build plate, you cannot print an 8” or 14” model on it.
- If a 3D model is too large for your 3D printer, you can either find a 3D printer with a larger build plate, re-size the model, or digitally cut the model into pieces to be assembled later.
  - Most slicers have a tool that can cut a model into pieces, though these cut lines are often visible on the final product.

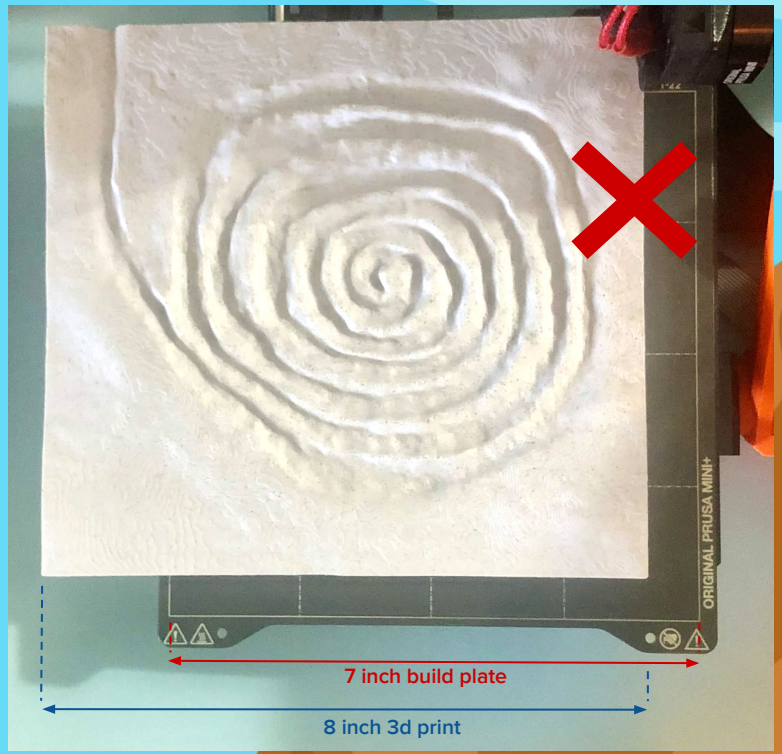
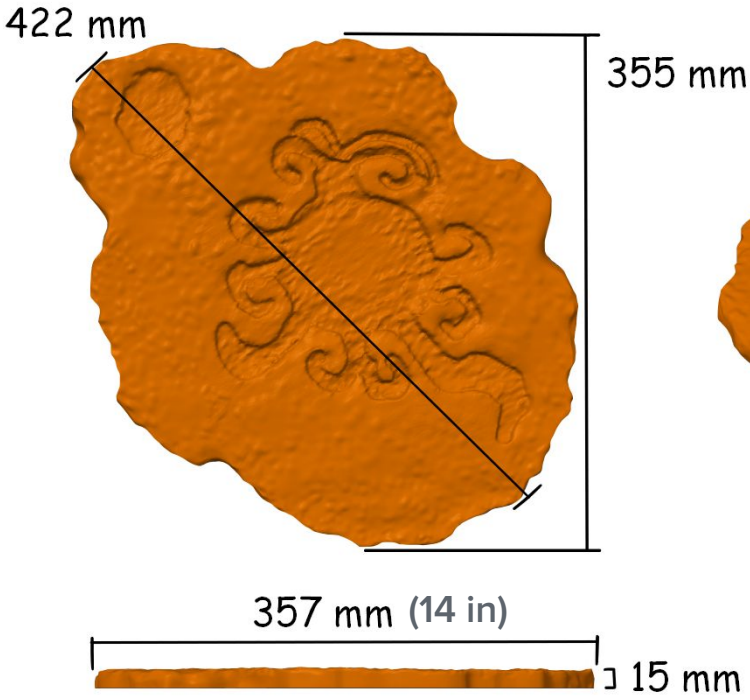


Image of the 8” Spiral 3D print on top of a 7” 3D printer build plate.

Large Scale Curlicue Dimensions

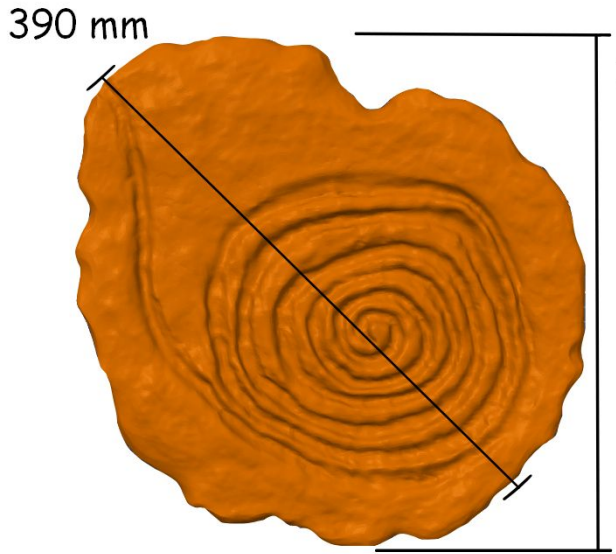


Large Scale Curlicue Petroglyph

The Curlicue model is near life-size to the real petroglyph it is based off of in Chaco Canyon.

Important Note:
This model is large and may not fit on the average 3D printer. You will need a printer with a print area of *at least 14" x 14"* to print this model in one piece.

Large Scale Spiral Dimensions



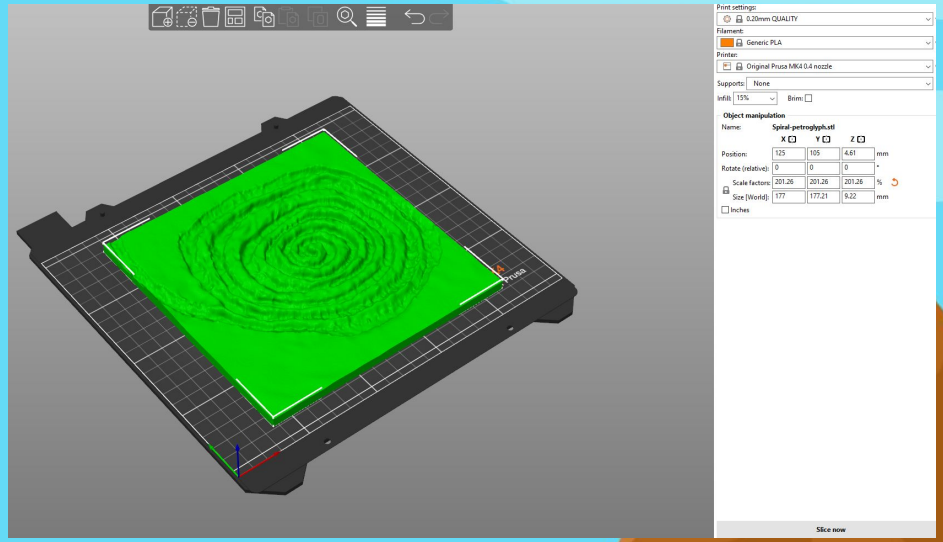
Large Scale Spiral Petroglyph

The Spiral model is **NOT** life-size to the carving it is based off of in Chaco Canyon.

Important Note:
This model is large and may not fit on the average 3D printer. You will need a printer with a print area of *at least 14" x 14"* to print this model in one piece.

Step 4: Slicing the Print

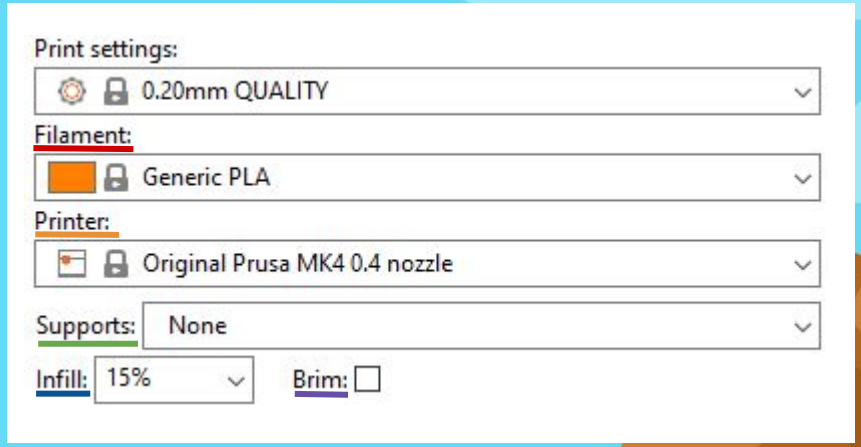
- ❑ Select which printer you're using in your slicing program.
- ❑ Import the STL file.
- ❑ The program will visualize what the object will look like on the printer's build plate. Move around and scale the object as needed.
  - ❑ Verify that the 8" and 14" files are the correct size.
  - ❑ If you want to change the size, the slicer will have options to automatically or manually re-scale the model.



Screenshot of the 8" Spiral model loaded into the PrusaSlicer program.

Step 4: Slicing the Print (cont).

- ❑ Verify you have selected the correct *filament* and *printer*.
  - ❑ Different filaments require specific temperatures to print at. Double check your roll of filament to ensure you've chosen the right settings.
- ❑ None of the petroglyph files require *supports*, as there are no overhanging parts.
- ❑ *Infill* is the percentage of the inside of the object filled in with solid plastic. 15 - 20% infill is standard.
  - ❑ More infill may increase durability by adding more internal plastic, but it takes longer to print and uses more material.
- ❑ A *brim* will create a thin puddle of plastic around the base of the print to increase build plate adhesion. This can be peeled off later.



Screenshot of the PrusaSlicer program's printing menu with adjustable settings.

Step 5: Exporting the Print

- Once you've confirmed your settings, you can slice your print. The slicer software will generate a preview that typically includes the amount of time it will take to print the object as well as how much filament will be used.
- Most programs will typically generate a *.Gcode* file, but depending on your slicer and printer, it may accept other file types. Once you've transferred this file to the 3D printer, it will read this file and begin printing.
  - Though many 3D printers require a cable or an external memory drive (such as a USB flash drive, a MicroSD card, a SD card, etc.) to transfer files, some 3D printers can connect to a computer via Bluetooth to print wirelessly. Check your specific printer for these options.

Step 6: Print!

- ❑ Turn on your printer. Ensure that the filament is properly fed into the nozzle and that the build plate is clean.
- ❑ Verify the printer has received the 3D printing file, either by manually inserting the memory card into the printer or transferring the file via Bluetooth. Find the file in the print menu and begin printing.
- ❑ Most 3D prints take a long time to print. Depending on the printer, model size, and infill settings, the petroglyphs may take anywhere between 4 and 30 hours to print.
- ❑ You'll likely want to watch the printer print the first layer or so to ensure that everything is printing properly.
  - ❑ The most likely time for the printer to mess up is during the first layer, often due to poor build plate adhesion. If this happens, stop the print, clean off the build plate, and try again.
  - ❑ If the print continues to fail, this likely indicates an issue with the printer itself or an improperly sliced file. There are many online resources available for troubleshooting, including forums, videos, and direct support from the 3D printer manufacturer.

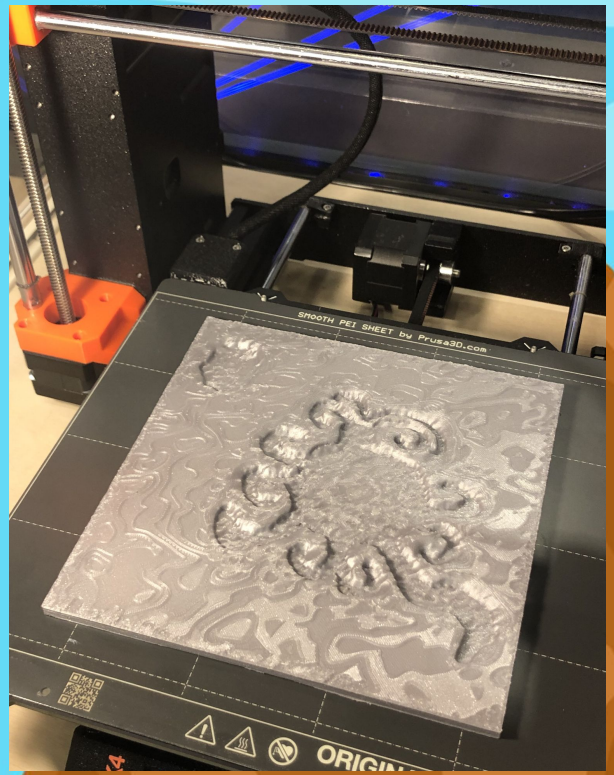
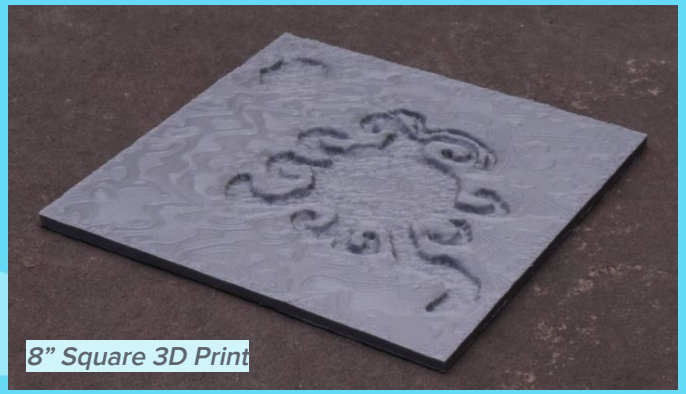


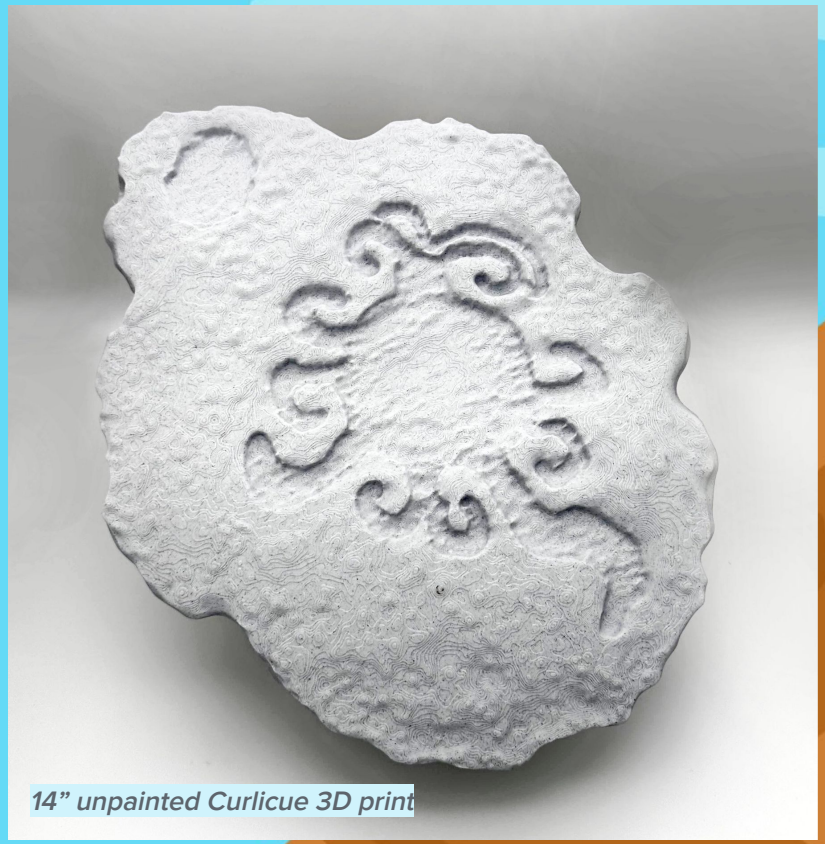
Image of the 8" Curlicue 3D print on a 3D printer.

Product Images

14” Large Scale 3D Print (painted), showcased during the NASA launch broadcast by Craig Deforest, the PUNCH mission leader

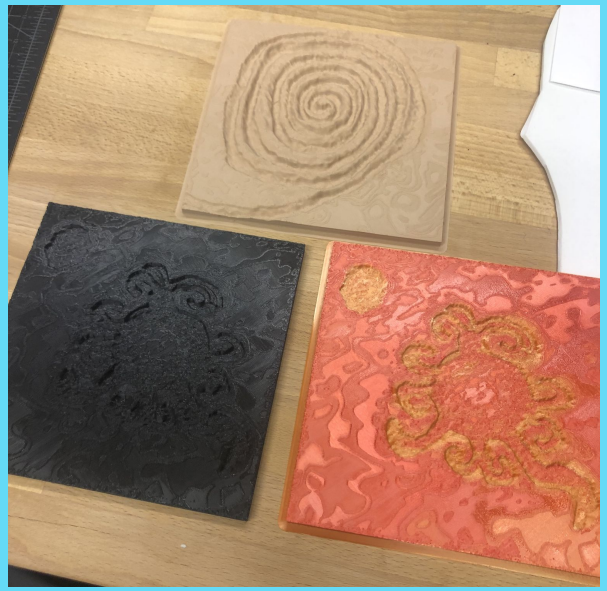


8” Square 3D Print



14” unpainted Curlicue 3D print

Product Images (cont.)



3D prints using Tan, Black, and Red/Gold Dual-Tone filament

3D prints using Cyan and Blue / Green Duo Tone filament.

Credits

- 3D Petroglyph Tactile STL files created by **Caileigh Hudson**, **Chris Gaines**, **Will Harris**, and **Kai Hughes**.
- Written instructions by **Kai Hughes**.
- Presentation background created by **Kai Hughes**, inspired by a photo of Chaco Canyon taken by **J. Ninneman**.
- All photo images taken by **Kai Hughes**. Slide 13 photos courtesy of NASA PUNCH Outreach. Digital screenshots are from the PrusaSlicer program.
- Special thanks to **Cherilynn Morrow** and the PUNCH Outreach team for their assistance with this project.