



GRAYSCALE MODELING SYSTEM FOR ORGANIC JEWELRY DESIGN

Richard Gretz
Founder

Richard Gretz Goldsmiths
Corvallis, OR, USA

INTRODUCTION

This paper focuses on grayscale modeling, a technique based on creating grayscale images (referred to as Alpha maps) that are transformed into 3D models using height field technology. Height field modeling has been widely used in topography since the 1970s and is commonly employed in the gaming industry to create environments such as mountains and terrains.

Over the past decade, I have developed and refined my grayscale modeling techniques which I now use exclusively for creating jewelry designs destined for 3D printing and five-axis CNC machining. Unlike models produced by CAD software (e.g., Rhino, SolidWorks, Fusion 360), which often yield rigid, mechanically precise designs, grayscale modeling allows for intricate, natural details—such as scrollwork and organic leaves—resulting in more artistic and fluid design.

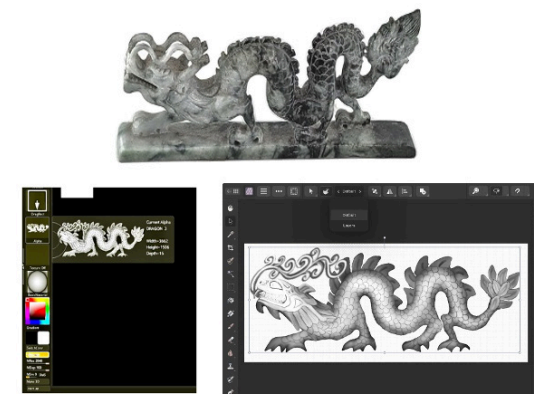


Figure 1: Grayscale modeling allows for fluid design

HERE IS THE WORKFLOW TO CREATING A PIECE OF JEWELRY USING THIS PROCESS

Step 1: Define the Design Purpose

The first step is to clearly define the purpose of the piece. This includes understanding the style of jewelry, selecting appropriate stones, and gathering specific client requirements. Considerations may include:

- The type of occasion or message the jewelry is meant to convey.
- Preferred design aesthetics, such as Art Nouveau or organic forms.
- The desired finish, including metals, textures, and final look.

Step 2: Ideation & Concept Sketches

With the design purpose established, begin the ideation phase by:

- Collecting reference materials, including photographs, found objects, or inspirational images.
- Creating quick sketches or drawings to capture initial ideas.

This step helps to visualize the concept before committing to detailed design work.

Step 3: Create the Grayscale Design Template

Start creating a precise grayscale gradient scale drawing. This step is critical as the grayscale drawing will later be converted into a 3D Alpha for modeling. Key actions include:

- Ensuring accurate measurements and proportions of each design element.
- Using gradients to denote depth—darker areas represent lower points, and lighter areas represent raised sections.
- Drawing a 2D layout to scale, reflecting the intended size and shape of the final piece.

Step 4: Export the Grayscale Drawing to ZBrush

Once the grayscale design is finalized, export it as an Alpha into ZBrush for height field generation. This step involves:

- Converting the 2D grayscale drawing into a 3D surface.
- Ensuring that the Alpha accurately represents depth variations.

Step 5: Build the 3D Model in ZBrush

In ZBrush, the imported Alpha becomes a 3D object. The following tasks are performed:

- Manipulating the 3D model by bending or shaping it to create rings, pendants, or other jewelry forms.
- Refining the form to achieve a pleasing, balanced design.

Step 6: Add Details & Check Engineering Aspects

At this stage, focus on fine-tuning the design and ensure it is ready for production. Key tasks include:

- Adding intricate details, such as scrollwork, patterns, or textures.
- Verifying stone sizes, placements, and other mechanical aspects.
- Ensuring structural strength for wearability and durability.
- Checking that the model can be successfully printed using a 3D printer or machined using a five-axis CNC.

Step 7: Refine the Design in Affinity Photo

Export screenshots of the 3D model back into Affinity Photo for further refinement. This allows for:

- Adding additional design elements, such as galleries or more intricate scrollwork.
- Enhancing the visual presentation by creating a new grayscale drawing in perfect proportion to the finished product.
- Re-exporting the refined drawing back into ZBrush for precise placement of details.

Step 8: Finalize & Export the Model

With the design complete, perform final checks in ZBrush, including:

- Verifying the size of stones, ring dimensions, and overall scale.
 - Ensuring all elements are properly aligned and proportioned.
- Once verified, export the model as an STL or OBJ file, ready for 3D printing or CNC tool path creation.

Step 9: Cast & Finish

The final step involves turning the digital model into a physical piece through casting. This process includes:

- Producing a wax or printed model using a 3D printer or CNC machine.
- Casting the model in the desired metal
- Finishing the piece by hand, including polishing and stone setting, performed by skilled goldsmith.

SOFTWARE WORKFLOW

1. Affinity Photo – Creating the Alpha Maps

The process begins with creating grayscale drawings in Affinity Photo. These drawings are set up in millimeters to ensure precise scaling during the modeling process. It's crucial to maintain a high resolution—at least 1200 DPI or higher—to produce smooth, well-defined designs.



Figure 2: Alpha maps using shades of gray

The grayscale drawings (or Alpha maps) use different shades of gray to define height levels:

- White represents the highest point.
- Black represents the lowest point (or no depth).
- Intermediate shades represent varying heights, with up to 255 levels of detail available.

2. ZBrush – Generating 3D Models

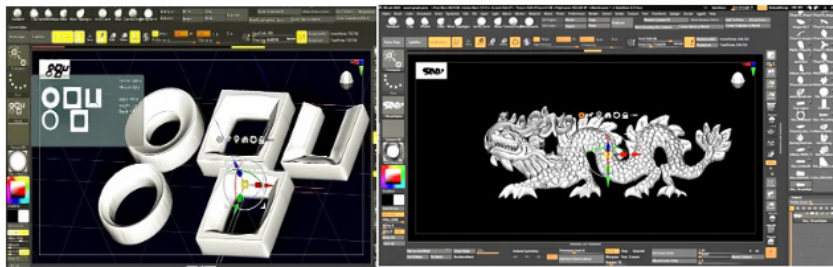


Figure 3: ZBrush allows for precise dimensions in stone settings

After creating the Alpha map, I import it into ZBrush. My custom UI in ZBrush is specifically designed for working with height fields and Alpha maps. This setup incorporates various tools and plug-ins that allow precise control over dimensions, including ring sizes and stone settings.

A key advantage of my ZBrush-based workflow is its flexibility. I can quickly and accurately modify design elements, which significantly reduces design time—by over 70% compared to using traditional CAD tools like Rhino.



Figure 4: A finished model that was made in ZBrush, and 3D printed and cast in gold

3. Height Field Technology

A height field is a grid-based representation in which each point on a 2D grid is associated with a height value, creating a 3D surface when visualized. Height fields are efficient for representing and manipulating complex surfaces, making them ideal for organic modeling in jewelry design. They allow smooth, sloping transitions, which are difficult to achieve with traditional CAD-CAM algorithms.

Key points about height fields in this context:

- Grayscale gradients directly influence the resulting 3D surface.
- Up to 255 shades of gray can be used to define varying heights, allowing for highly detailed organic models.
- Unlike CAD-CAM models, which are based on NURBS and tend to produce hard-edged designs, height fields produce smooth, natural curves and transitions.

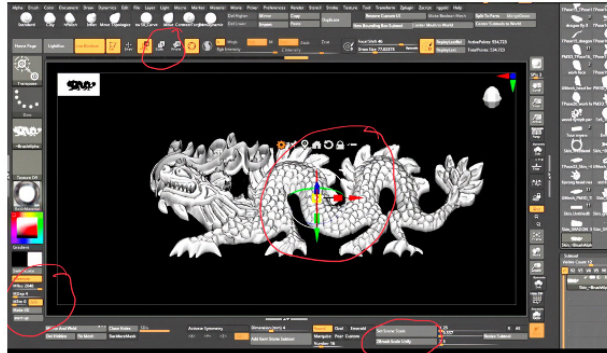
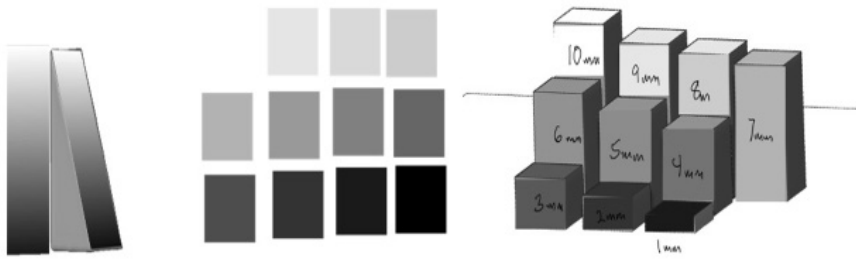
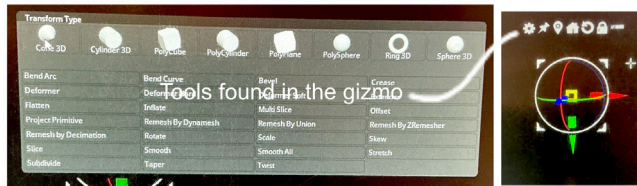


Figure 5: Examples of the power of gray CAM modeling works (top), and what a grayscale Alpha will produce when put into a height field (bottom).

Custom UI Tools in ZBrush

Here's a brief overview of key tools in my custom ZBrush UI.



Tool Name	Function
Set Scenic Scale	Ensures the object is scaled precisely to millimeter measurements.
Make 3D Tool	Converts an Alpha map into a 3D model, with sliders to control mesh fineness.
Startup Tool	Creates a black background (black = 0 depth) for starting new models.
Move Tool & Gizmo	Provides access to essential transformation tools, similar to Rhino's gizmo.

Figure 6: Most important tools found in the gizmo

There are so many tools in the UI of ZBrush, we will not have time to look at all of them. What I'm trying to show you here is that the UI in ZBrush is custom-made and very important to have these tools available in your UI so you can find the appropriate tools and models very easily. Some of these tools are not found in the default UI. They are plug-ins that have to be imported from the ZBrush website. For example, the Set Seismic Scale tool comes from a plug-in called Scale Master that has to be imported into ZBrush in order for the program to measure things accurately.

Why Grayscale Modeling Produces Superior Designs

In a paper presented by Gary Dawson at the Santa Fe Symposium®, he highlighted how CAD-CAM programs (e.g., Matrix, Rhino, SolidWorks) produce models with hard edges and lack the smoothness required for organic jewelry design. As a result, jewelry created using these systems often appears mechanical and lacks individuality. The takeaway was that these limited software systems have the capacity to create a certain range of design, so jewelry designed from these same software matrices can look the same.

In contrast, grayscale modeling produces designs with:

- Smooth, natural transitions.
- Highly detailed and intricate organic shapes.
- Artistic aesthetics that are difficult to replicate using CAD-based systems.
- Accurate settings for your stone with asymmetry shapes, using photos of organic material that you wish to create with.

In addition, you can work back and forth between your ZBrush document and an Affinity Photo, adding to your design in one and accurately transmitting your changes to successive generations of your ZBrush Alpha.

There are so many reasons that using this process is far superior to the design world of Rhino. The speed of the designing process is so much faster that have been able to cut my design time by over 60%.

This process is particularly useful to a person with the artistic skills to conceive of and draw in two-dimensions.

Examples of Alpha Maps and 3D Models

Below are examples of Alpha maps created using Affinity Photo and Procreate, which have been used to produce complex and beautiful jewelry designs. When imported into ZBrush, these Alpha

maps result in highly detailed, organic models with smooth curves and intricate surface patterns.



Figure 7: Examples of items made with the grayscale modeling system

This approach is fascinating, especially with the emphasis on organic forms and Art Nouveau aesthetics. The use of grayscale modeling in combination with Affinity Photo and ZBrush allows for an impressive level of detail and fluidity that mechanical CAD tools lack.

This next session will deal with some cool things that you can do with this system.

First, I want to show work made with stones. You photograph the stone you're going to use and you make an Alpha map of it around which you build your model. The file will retain the correct proportions between the two programs.



Figure 8: Examples of items with stones

We make a bezel to go around the stone and then build a halo for it in Affinity Photo. After importing the stone into Affinity Photo, I blur it out so I can create an Alpha map out of it for the bezel.

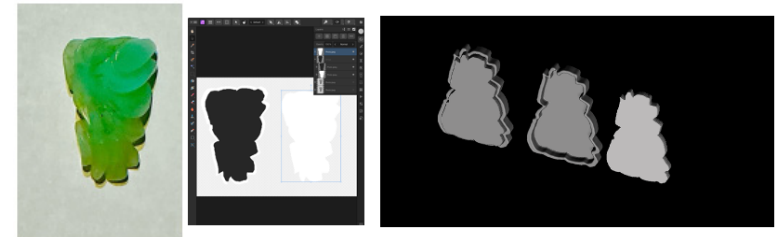


Figure 9: The stone we start with and the bezel process

In this way, it's easy to make an incredibly complex bezel to fit the stone. The measurements are exact and the stone drops right in.

Furthermore, taking a screenshot of the ZBrush object will allow it to be brought back into Affinity Photo (or other drawing program) to create a new Alpha map, which allows for fine design adjustments, such as scrollwork to fit into a gallery.

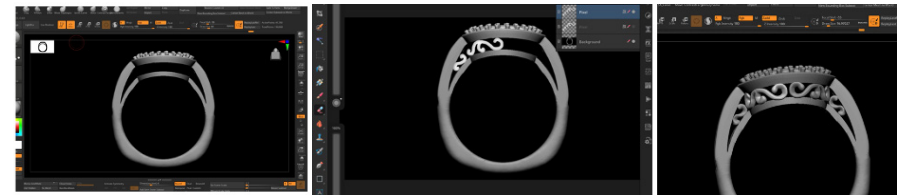


Figure 10: The Alpha in Affinity Photo

In Figure 10, the piece is imported back into Affinity Photo and the scrollwork is painted directly onto the piece. The Alpha map is transferred back into ZBrush. The scrollwork fits precisely in the proportions required by the design. This process, which would have taken hours in any other CAD program, required only minutes with grayscale modeling.

List of Tools

Here is a list of the tools that I use for this process.

- An iPad Pro with a tablet pencil to produce my Alpha in Affinity Photo and Procreate

- A Windows computer with enough power and RAM to handle ZBrush
- An X Pen drawing tablet with a large screen and a stylus for hand-drawing design work.

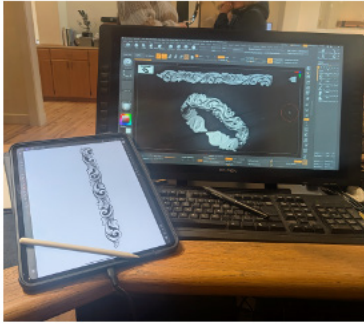


Figure 11: A computer, tablet and tablet pencil working in sync

Alternatively, a PC computer with good processing power and RAM and any brand of drawing tablet with a stylus can be used for this process, as Affinity Photo is also available on non-Apple systems.



Figure 12: This was created using using grayscale modeling

CONCLUSION

Grayscale modeling, using height fields and grayscale drawings, offers a powerful and efficient method for creating highly ornate and organic shapes that would be nearly impossible to achieve with traditional CAD programs like Matrix, Rhino, or other algorithm-driven software. This approach allows for more intricate and artistic designs, reducing the time required for modeling while producing jewelry that exudes a handcrafted, organic beauty rather than a machine-generated aesthetic.

By leveraging this process, designers can break free from the rigid structures imposed by conventional CAD workflows, resulting in unique, fluid forms that better reflect artistic intent. I hope that others in the field will recognize the potential of this method and explore its use in creating truly exceptional jewelry.

On my website, gretzdesigns.com, you can find more of my work, all created with grayscale modeling.

CREDITS

I could not have done this without the use of AI ChatGPT because I am highly dyslexic and my whole life I have not been able to write papers very well— grammar spelling, etc. Now AI allows me to freely express myself in literal language, where I used to only express myself in my artistic designs, drawings photographs, etc. Gary Dawson, paper given at the Santa Fe Symposium in 2017 paper being finding your voice, finding our voice is new tools in the box