

# Layering Fractal Elements to Create Works of Art

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## Abstract

Recent advances in fractal generation software allow the user to create multiple layers of fractal elements that may then be combined to create a composite work of fractal imagery. As an example of how this technique can be used to create art, this paper describes the process I used in creating "The Moirai," a series of three images depicting the three "Fates" from Greek mythology who personify the inescapable destiny of man.

## 1. Introduction

My art is created solely within Ultra Fractal [1], a shareware fractal generator for the Windows platform. This state-of-the-art fractal plotter is a sophisticated graphics program with masking and layering capabilities that give the user unprecedented artistic control over the image. Ultra Fractal also provides a built-in formula editor and compiler with which users can write calculation formulas, coloring algorithms, and geometric transformations. These formula plug-ins are written by users all over the world and shared through an online database [2]. In my discussion of the software and my creative process, I will proceed with the assumption that the reader has some knowledge of Mandelbrot and Julia sets and how they are generated.

There are two kinds of coloring algorithms used in the works discussed in this paper. One is *Fractional Brownian Motion*, a fractal algorithm built on Perlin's noise function [3]. It provides bumpy coloring that can be rendered at high resolution. The other coloring algorithms discussed fall into the category of orbit traps. They monitor the orbit (the sequence of complex iterates) and color the fractal according to how close the orbit comes to the specified shape.

## 2. The Creative Process

The creative process of using fractal elements to create a composite work of art has many similarities to some of the more traditional methods used by painters and photographers. The process for each artist often begins with selecting a location as the subject of the artwork. Just as a traditional artist may select the Grand Canyon from among many scenic possibilities, my first step as a fractal artist is to select a calculation formula that provides the "landscape" for my work. The selection of this broad area immediately places limits on the subject matter. The imagery of the Grand Canyon could include rocks, cliffs, canyons, valleys, streams, and desert flora and fauna, but not snow-covered mountains, ocean coastlines, or tropical forests and creatures. Each fractal calculation formula places similar restrictions on the kinds and shapes of structures that may be found in its fractal landscape.

Next, the artist might choose to zoom into a specific area of the landscape in order to observe details that cannot be seen from a distance. The miles-wide field of vision of the Grand Canyon may be narrowed

to a few feet, or even a few inches. Because fractal structure is infinite, this zooming-in process is limited only by the computational capabilities of the software and computer.

After a location is chosen, the artist selects a medium in which to work and chooses the necessary tools and materials: paper, canvas, film, charcoal, pastel, watercolor, acrylic, oil, brush, lens, filter, etc. The inherent qualities and capabilities of each of these choices further define the outcome of the work. A black and white photograph, a watercolor, and an oil painting — each depicting exactly the same location of the Grand Canyon — would have different artistic qualities and properties based on the nature of the medium and the specific tools with which they were created.

The formula plug-ins available for Ultra Fractal — a vast collection of coloring algorithms and geometric transformations that each have unique characteristics — provide a similar toolbox and these formulas become the fractal artist's paints and brushes. And, just as a painter chooses a palette of colors with which to work, Ultra Fractal provides the user with a gradient editor to select and limit the colors used.

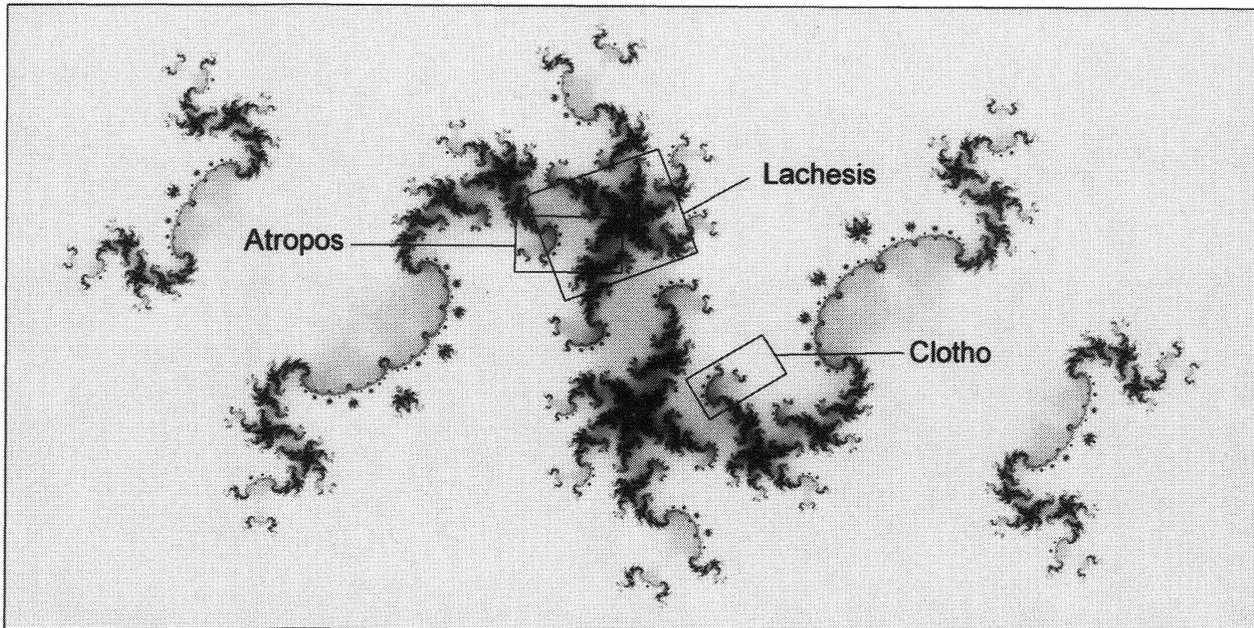
Rarely, except in "paint-by-number" kits, is art painted in just one layer. Rather, many layers of strokes combine and interact to create the final effect. Depending on the medium chosen, this interaction can vary in transparency, allowing deeper layers to be somewhat visible. Layers of watercolor, for instance, are more transparent than those painted with oil or acrylic. Ultra Fractal allows me to designate specific areas of a layer's fractal structure, certain points in the gradient, or the entire layer as partially or completely transparent. I can also use the Red-Green-Blue or Hue-Saturation-Luminosity values of each pixel to react to or combine with corresponding pixels in other layers by selecting a merge mode that multiplies, subtracts, adds to, or otherwise manipulates the color values of the pixels.

Working in this particular digital medium gives me several advantages over traditional art forms, particularly the ability to see the results of each parameter or gradient change with an immediate redraw of the image on screen, and the advantages of unlimited "undo" and "redo." These capabilities allow me to experiment freely, creating and re-creating, often over an extended period of time, until I am satisfied with the work.

Using mathematical formulas is, perhaps, a strangely left-brained means of creating art. My background as a dancer and choreographer has given me ample opportunity to develop and explore creative expression through movement; but I have always been unable to express myself in the more traditional forms of visual art because I cannot draw, paint, or sculpt. When I discovered the creative potential of fractal art, I found that I could use my artistic instincts to add shape, color, lighting, texture and movement to the structures created by the fractal formulas without actually needing to draw the shapes myself. So although I am working with complex numbers and trigonometric functions, I find working in this medium to be quite a spiritual and passionate process.

### 3. Clotho

I've selected the Fates from Greek mythology who are responsible for spinning, weaving and cutting the thread of destiny as the subject of "The Moirai." For this series of three images, I chose to use the *Celtic Julia* calculation formula written by Kerry Mitchell [4] to provide my initial fractal landscape structure (Figure 1).



**Figure 1:** The entire Celtic Julia structure from which the locations for the three individual images are taken.

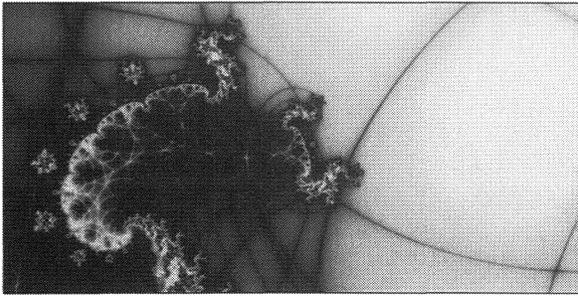
The first image in the series depicts “Clotho,” who spins the thread of destiny. In this image, I wanted to depict a queue of souls waiting to receive their thread of destiny, marking their birth into human life. From the entire structure of Figure 1, I zoomed in and selected the shape for this image (Figure 2) because I saw in it a framework for a sort of assembly line of souls and an opening from which the spun thread would appear.



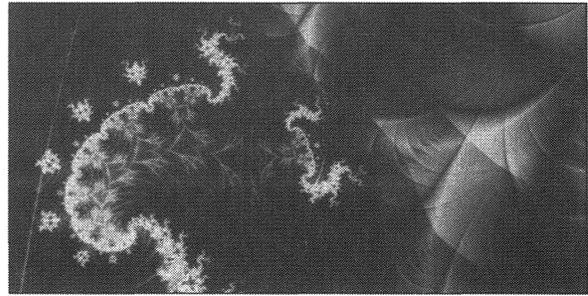
**Figure 2:** This zoom into the original Celtic Julia provides the base structure for “Clotho.”

I applied Samuel Monnier’s *Thin Orbit Traps* coloring algorithm [2] to this base structure and selected the “Lemniscate Curve” trap shape (Figure 3). I created two more layers, each using the base *Celtic Julia* structure. To one, I again applied Monnier’s *Thin Orbit Traps* — this time with the “Tangent” trap shape (Figure 4). To the other, I applied Mitchell’s *5 Point Star* coloring algorithm [2] (Figure 5). I chose this algorithm because the star shape added a magical feel to the mythological theme of the series. It also worked perfectly for my purposes because the only star in the queue that exhibits a complete 5-point shape is the largest one positioned at what will become the opening point for the thread. That complete star represents a ready-to-be-born soul, while the other incomplete forms in the queue are souls in-the-making.

In my work, I often use layers of mottled color such as this one created with Damien M. Jones’ *Fractional Brownian Motion (fBm)* coloring [2] to create shadows and variance in color (Figure 6).



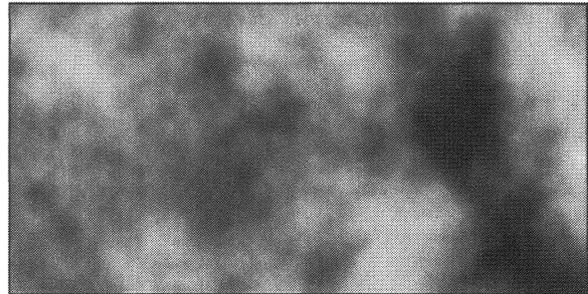
**Figure 3:** Lemniscate curve orbit trap coloring applied to the base layer.



**Figure 4:** New layer with Tangent orbit trap coloring applied to the base structure.

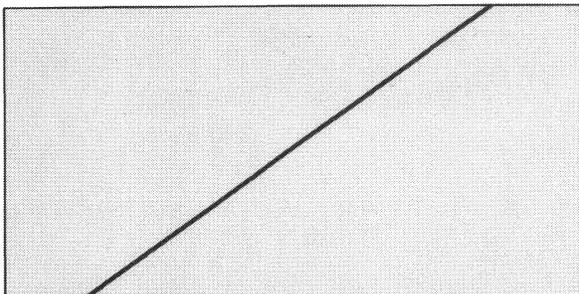


**Figure 5:** Another new layer, this time with 5 Point Star coloring.

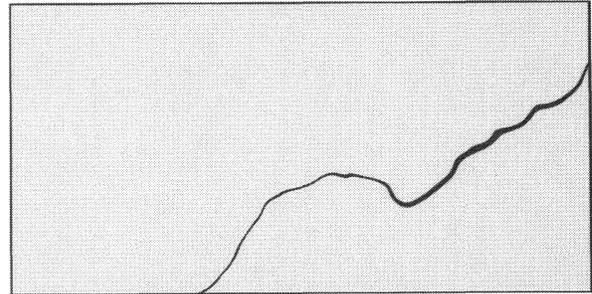


**Figure 6:** A single layer with Fractional Brownian Motion coloring.

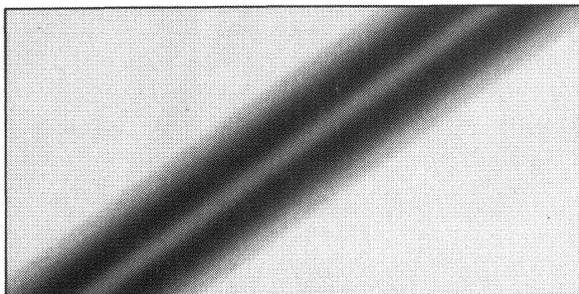
To create the thread of destiny, I used Jones' *Orbit Traps* algorithm [2] set to draw only the trap shape of a line (Figure 7). I then altered this shape to resemble a relaxed thread by applying Mark Townsend's *Turbulence* transformation [2] (Figure 8). I followed the same process in another layer using a different gradient to create a fuzzy shadow effect (Figures 9 and 10).



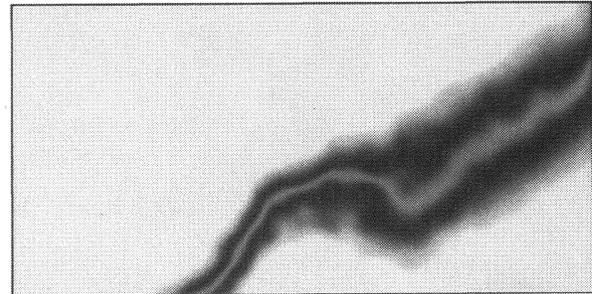
**Figure 7:** The Line orbit trap draws a straight line.



**Figure 8:** The Turbulence transform distorts the line into a thread-like shape.

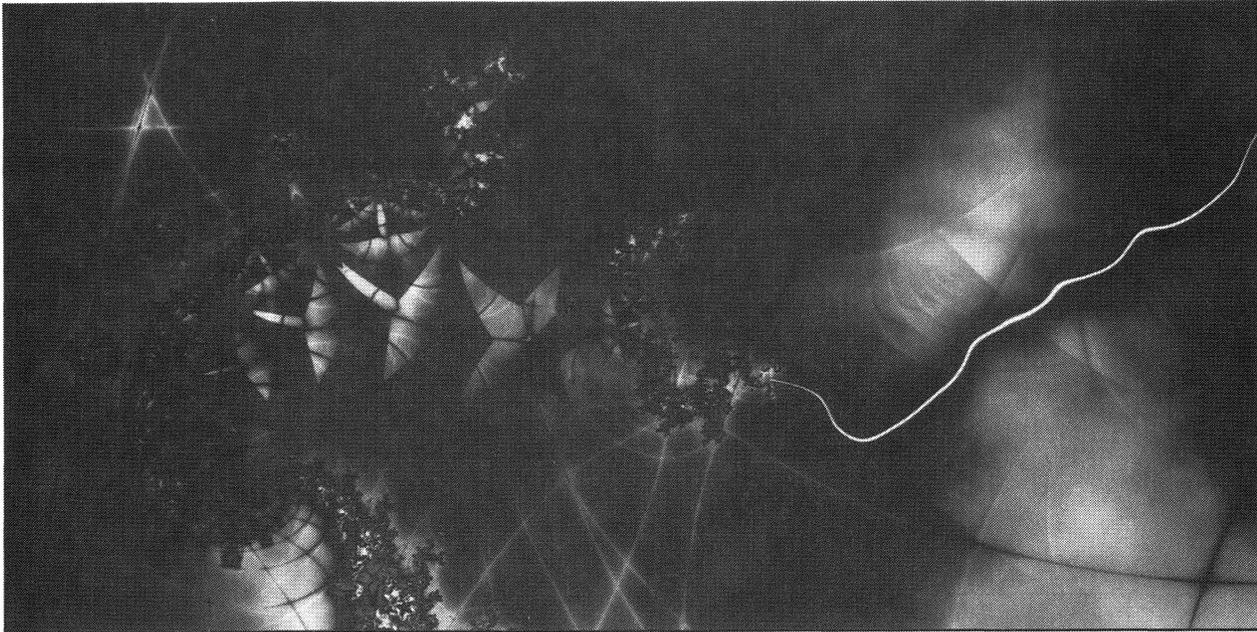


**Figure 9:** A new layer with the line trap, using a different gradient, creates a shadow.



**Figure 10:** The Turbulence transform distorts the shadow to match the thread's shape.

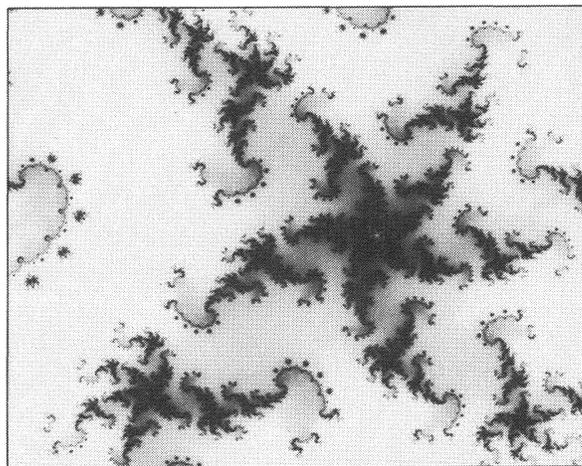
After positioning these two layers so that the thread appears to emanate from the tip of the spiral structure, I added masks to each layer to make the thread appear at the right location in the image and hide the unwanted areas. Merged together, the six layers form the completed work (Figure 11).



**Figure 11:** "Clotho" (2001) by Janet Parke.

#### 4. Lachesis

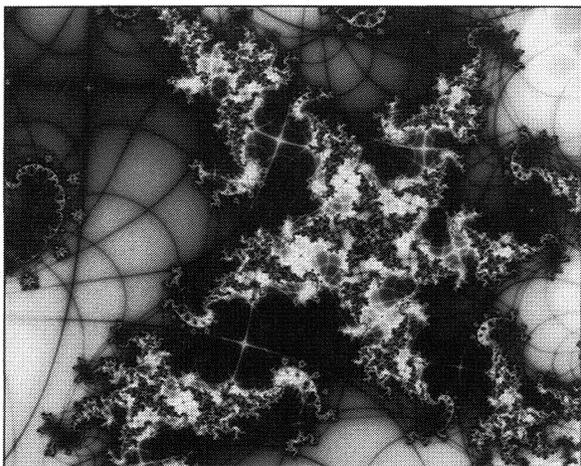
The second image in the series represents "Lachesis," the fate responsible for weaving the thread of destiny into the fabric of one's actions. To set the scene for this image, I envisioned creating a cloth-like background against which the central figure would lie. From the original *Celtic Julia* structure, I selected a new location — one of the largest starlike shapes — into which to zoom (Figure 12).



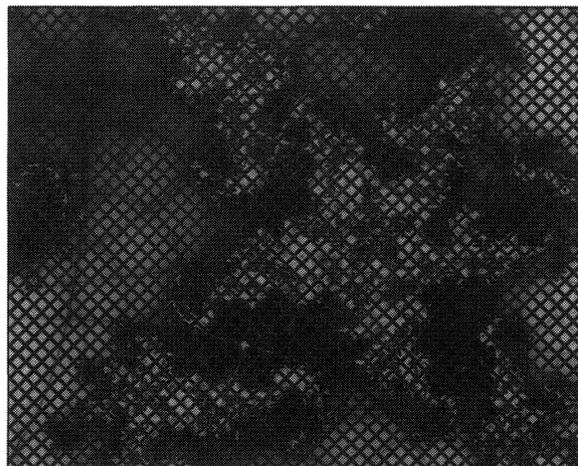
**Figure 12:** This zoom into the original *Celtic Julia* provides a base structure for "Lachesis."

I applied the same Lemniscate curve trap I used in "Clotho" to the base structure of this image (Figure 13). To create the cloth, I applied Robert Williams' *Patterns* [2], a geometric transformation that

overlays a grid on the same layer (Figure 14).



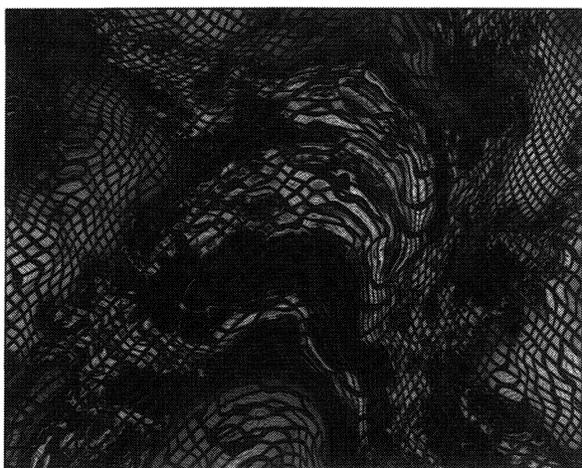
**Figure 13:** *Lemniscate curve orbit trap coloring is applied to the base structure.*



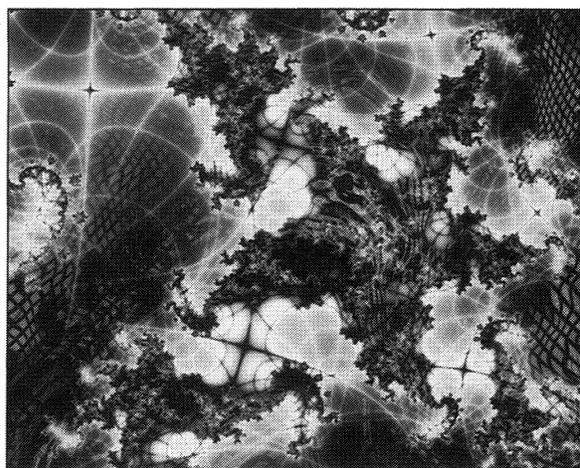
**Figure 14:** *The Patterns transformation overlays a grid on the Lemniscate curve layer.*

This effect looked too clean and organized — I wanted the cloth to reflect the struggles human life, to be worn and irregular — so I applied a second geometric transformation, Townsend’s *Turbulence*, which twisted and distorted the entire layer (Figure 15).

Because I wanted the cloth to appear only in the background, I created a second Lemniscate curve layer, identical to the one in Figure 13. By designating certain areas of this layer to be partially transparent and merging it with the cloth layer, I could control where in the image the cloth effect appeared (Figure 16).



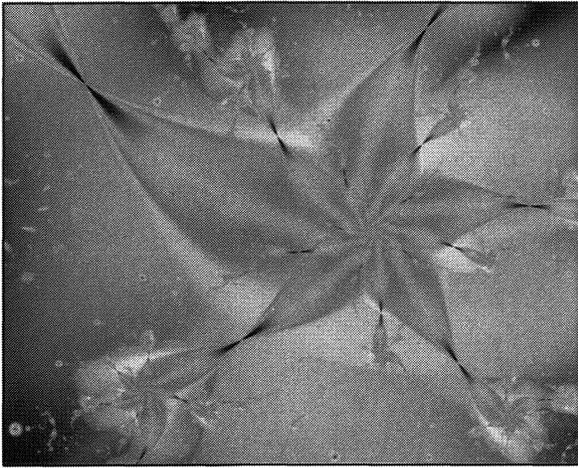
**Figure 15:** *When a Turbulence transformation is applied, the entire layer is distorted.*



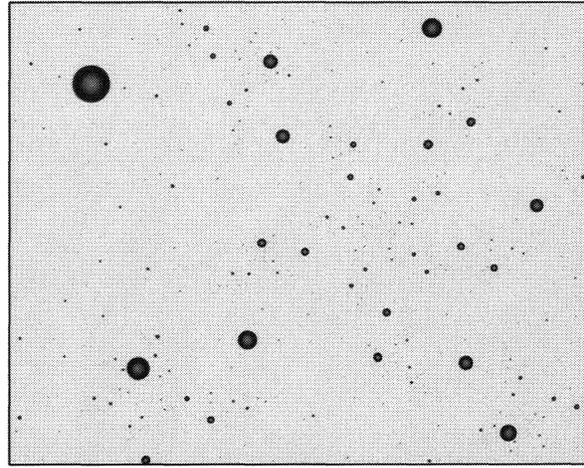
**Figure 16:** *Another Lemniscate curve layer with partial transparency, placed on top, forces the cloth effect into the background.*

Since I used the star shape in “Clotho” to represent the soul before birth, I wanted to continue that motif for the central figure in “Lachesis.” The *Harlequin* coloring by Townsend [2], applied to the *Celtic Julia* structure, created a softer, but still recognizable star shape. Where the stiff, flat star in the first image represents the unborn soul, this sculpted flower-like shape with softer coloring now represents the living soul in human form (Figure 17).

Using Mitchell's *Gaussian Integer* coloring [2] in a separate layer, I created decorative gold beads positioned at each petal's tip (Figure 18).

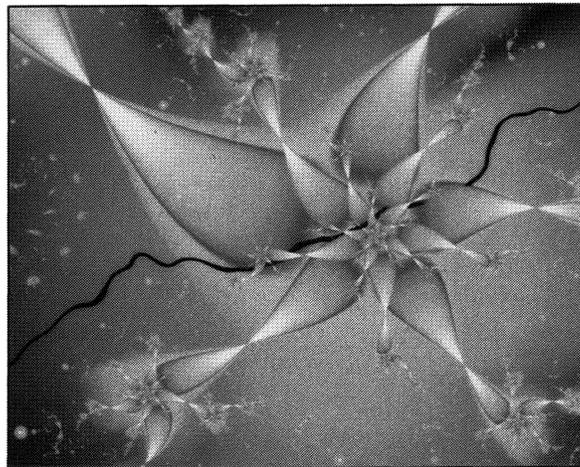


**Figure 17:** *Harlequin coloring, applied to the base structure, creates a new star-like effect.*



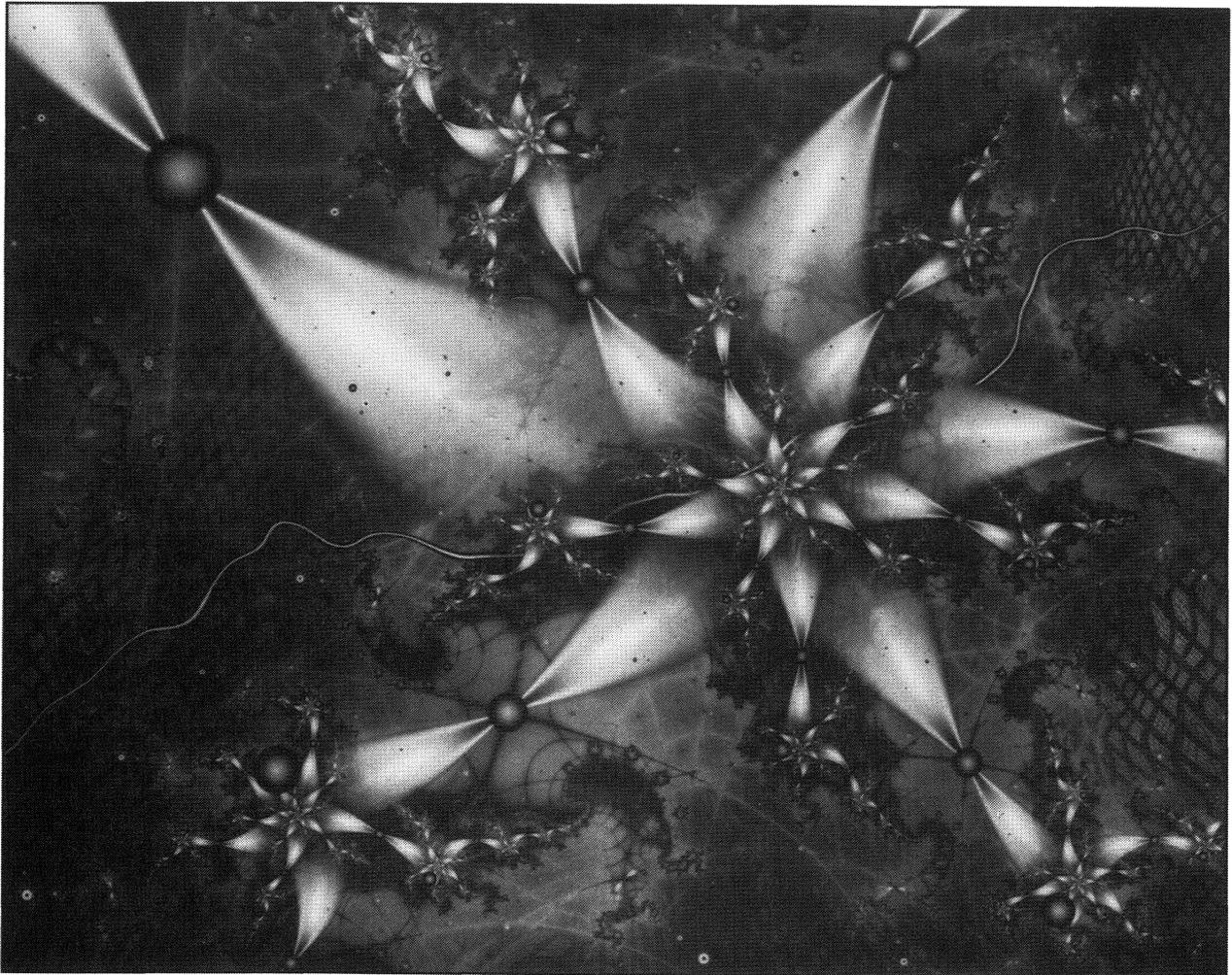
**Figure 18:** *Applying Gaussian Integer coloring creates decorative beads at key positions.*

All that remained was to add the thread of destiny, created using the same techniques I used for "Clotho." This time, however, I wanted to "weave" it into the central star/flower figure. To achieve this look, I created and applied a flower-shaped mask to this layer using the *Harlequin* coloring, which caused the thread to disappear and reappear among the petals (Figure 19).



**Figure 19:** *The thread of destiny, woven through a flower-shaped mask created with Harlequin coloring.*

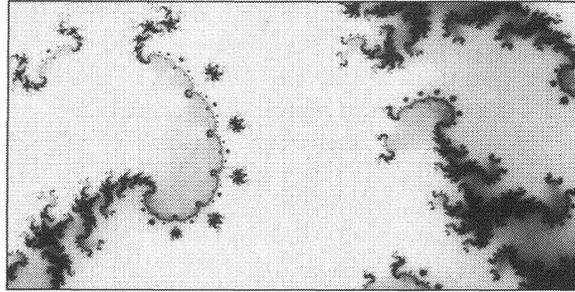
The completed image (Figure 20) shows that with careful use of transparency and masking, the busyness and complexity of the individual layers can be merged into a seamless blend of background texture and foreground figures. There is a sense of depth that comes from both the use of shadow and highlight, and from the overlapping of the background textures. The flower shape of the soul has a sensual beauty; but the life the soul has led, represented by the surrounding texture, has clearly not been without challenge or obstacle.



**Figure 20:** "*Lachesis*" (2001) by Janet Parke.

### 5. Atropos

The last image in the series depicts "Atropos," the fate who cuts the thread of destiny. I included elements from the first two images — the star/flower figure, the thread, and the woven fabric — but I also wanted to convey in this final image the feeling that the soul is nearing the end of its human life. I began with a third zoom into the original *Celtic Julia* structure. Very similar to the location chosen for "Clotho," this hook-like shape (flipped vertically from its original orientation) provided the necessary structure upon which to build the final image (Figure 21).

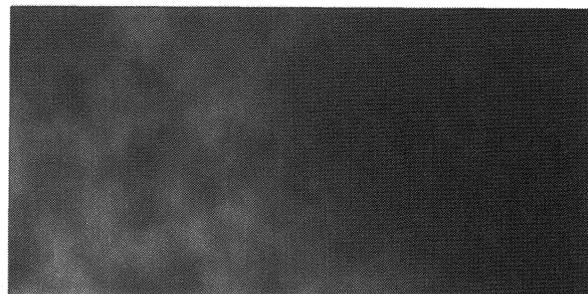


**Figure 21:** This zoom into the original Celtic Julia provides the base structure for "Atropos."

Once again, I used the same Lemniscate curve trap and the *Patterns* and *Turbulence* transformations to create the cloth-like effect. I wanted the fabric of the soul's life to appear even more tattered as it nears death; so I applied one more effect to this layer — Jones' *fBm Clipping* [2] — a transformation that created big holes in the fabric (Figure 22). A graduated mask applied to the right side of the image allows the cloth to disappear into nothingness. And as in "Clotho," I used a layer of *Fractional Brownian Motion* to create a mysterious, mottled look (Figure 23).



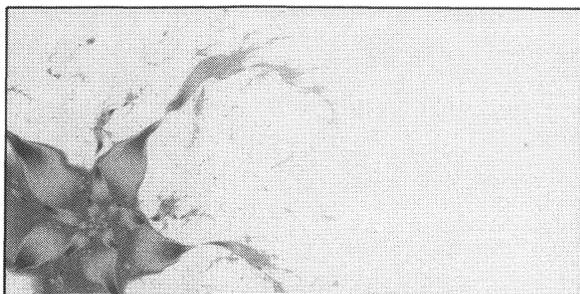
**Figure 22:** Base layer with Lemniscate coloring; and *Patterns*, *Turbulence*, and *fBm Clipping* transforms.



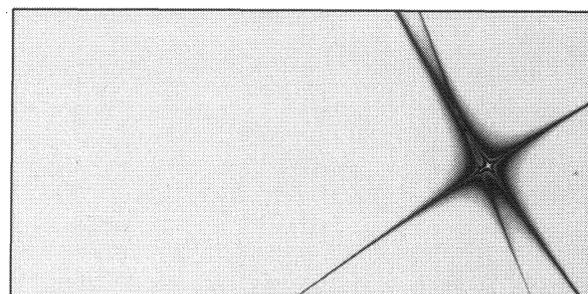
**Figure 23:** A layer of Fractional Brownian Motion coloring to provide shading.

In another layer, I again created the central figure of the soul with the *Harlequin* coloring. By applying Townsend's *Turbulence* and Jones' *fBm Glass 1* transformations [2] to the entire layer, these distortions made the soul appear to be losing strength and shape (Figure 24).

Figuring out how to actually cut the thread and portray the moment of death proved to be one of the biggest challenges in the entire process. I wanted to simulate scissors, but didn't know exactly how to create that effect. Then, as I looked back over the first two images, I noticed that intersecting lines of the Lemniscate curve in the first layer of the "Clotho" image formed a fantastical scissor-like shape — exactly the effect for which I was looking. I placed this new element in the right half of a new layer (Figure 25).

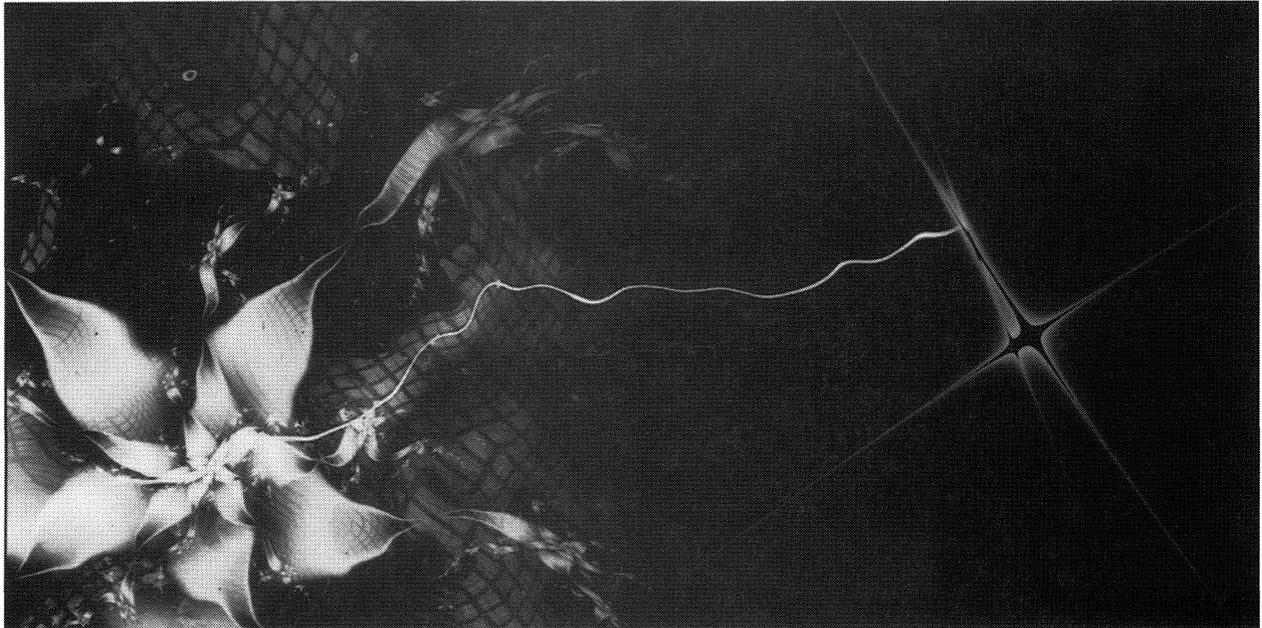


**Figure 24:** Harlequin coloring applied to the base layer, distorted by *Turbulence* and *fBm Glass 1*.



**Figure 25:** Scissors, created with Lemniscate curve coloring.

All layers combined, the final image of the series attempts to portray the disintegration of a human life, the moment of death, and an indication of the void thereafter (Figure 26). When placed side-by-side, the three images of this series tell the story of the birth, life, and death of the human soul.



**Figure 26:** "Atropos" (2001) by Janet Parke.

## 6. From Computer Screen to Finished Artwork

Although many digital artists must create their finished work at a fixed size, fractals can be regenerated at any resolution without loss of detail. In fact, the larger a fractal is rendered, the greater the visible detail. So while I create the image at a size convenient to my screen resolution and work space, once the image is complete, I can render it at a suitable size for printing (often 200 pixels per inch). The final render is then saved as a graphic file and sent to a photographic lab to be printed on photographic paper.

### Acknowledgments

Ultra Fractal, the software used in the creation of these works, was written by Frederik Slijkerman. The formulas used were written by fellow fractal artists, teachers, mentors, and friends: Damien M. Jones, Kerry Mitchell, Samuel Monnier, Mark Townsend, and Robert D. Williams.

### References

- [1] Ultra Fractal software [Online], available from <http://www.ultrafractal.com/>.
- [2] Ultra Fractal Formula Database [Online], available from <http://formulas.ultrafractal.com/>.
- [3] Perlin, Ken, Hoffert, Eric, *Hypertexture*, Computer Graphics (proceedings of ACM SIGGRAPH Conference), Vol. 22, No. 3, 1989.
- [4] Mitchell, Kerry, private communication, 2000.