Chaos: Crucible of Creation

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Since Galileo and Newton first opened the heavens to our understanding in the 16th and 17th centuries, science has become one of the cornerstones of Western thought. Today, most educated people assume that the physical universe is governed by laws that are absolute and unambiguous. And though these laws may seem as remote as the stars themselves to the average citizen, many people believe that the laws regulate a kind of "clockwork universe" in which design and order prevail. To many, this is a comforting thought. But if 20th century science has taught us anything, it is that this model of reality is far from accurate. For in addition to the order that we so love to find in nature, we also find chaos.[1]

As a Christian, I treasure the elegant designs of the Creator wherever I find them, for they remind me that He was here. And is still here. And that He still has much to teach me. But what am I to make of chaos? From ancient times, the notion of chaos has been used as the antithesis of everything good and constant and reliable. And from the core of my being, something in me abhors the notion of chaos. Rejecting the notion of a probabilistic universe, Albert Einstein asserted that God does not play dice.[2] My sentiment, exactly. But Einstein was wrong. And so was I, for it now appears that chaotic processes are the very crucible in which the most sublime designs of nature are forged.

This article begins by developing a mathematical metaphor for creative, chaotic processes. The metaphor is then extended to address questions of a theological and spiritual nature. This is not to say that theological issues may now be resolved with mathematical certainty. Just as any analogy can be pushed too far, the metaphor presented in this article has limited value. On the other hand, sometimes a good metaphor is just what is needed to help us conceptualize a complex issue. It is with this goal in mind that these thoughts are offered.

Complex Objects From Simple Rules

The first order of business is to demonstrate an important mathematical principle: Using a simple starting shape and a single rule governing change called an iterated function, it is possible to create complex mathematical objects that are highly reminiscent of the elegant designs found in nature. For example, consider the following situation:[3] Beginning with an equilateral triangle, remove the center third of each side of the triangle and replace it with a smaller equilateral "bump-out." (See Figure 1.) This produces a six-pointed star.

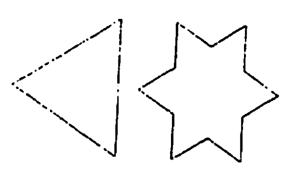


Figure 1

Now repeat the procedure by removing the middle third of each segment of the star and replacing it with a smaller equilateral bump-out (See Figure 2). Continue iterating (repeating) this procedure.

The snowflake design generated by this process is an example of a class of objects called fractals. One of the distinguishing features of fractals is that they repeat the same theme on different scales. In this case, that means "bump-outs on top of bump-outs on top of bump-outs...."

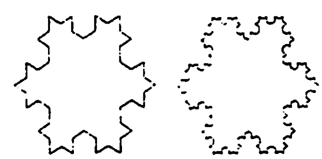
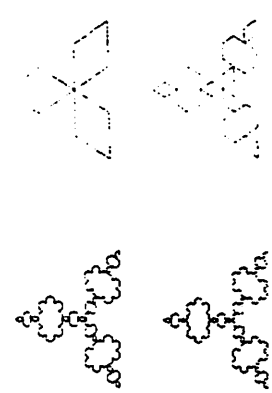


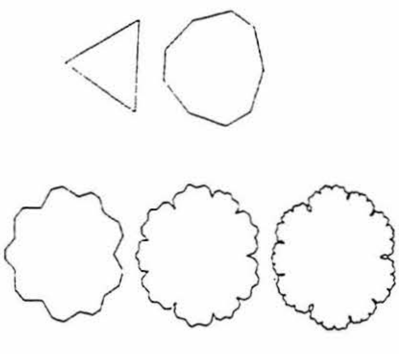
Figure 2

An elegant modification of this fractal may be obtained by changing the rule so that every time a middle third of a segment is removed, it is replaced by an equilateral "bump-in" as shown in Figures 3 and 4.



Figures 3 and 4

In the next example, we once again begin with an equilateral triangle. This time, however, we replace each side of the triangle with a trapezoidal bump-out as shown in Figure 5. Continuing this process produces the flower-like object shown in Figure 6.



Figures 5 and 6

Iterated Function Systems

A second important mathematical principle is that, by adding additional rules governing change, it is possible to create more intricate objects, some of which are highly reminiscent of objects in the natural world. The mathematical name for such a set of rules is an iterated function system, or IFS.

To illustrate this concept, we begin with a square and three rules. Each rule shrinks the square to one-half its original dimensions then shifts it in one of three directions. Rule No.1 shrinks the square, then shifts it in the direction of the upper-left hand corner of Figure 7. Rule No.2 does the same thing in the direction of the upper right-hand corner. Rule No.3 shrinks the square in the direction of the bottom of Figure 7. So, regardless of which rule is applied to the original square, the result is one of the three small squares shown in Figure 7. The shaded portions of this figure represent the possible outcomes of randomly selecting one of the three rules and applying it to the original square. That random selection and subsequent action constitutes one iteration of the iterated function system (IFS) defined by the three rules.

Now let's iterate this system a second time, shrinking the shaded

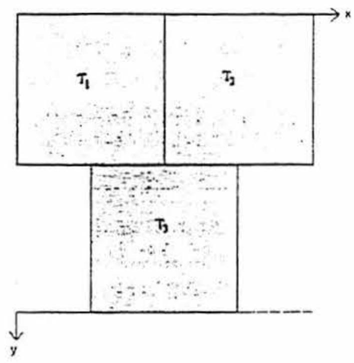
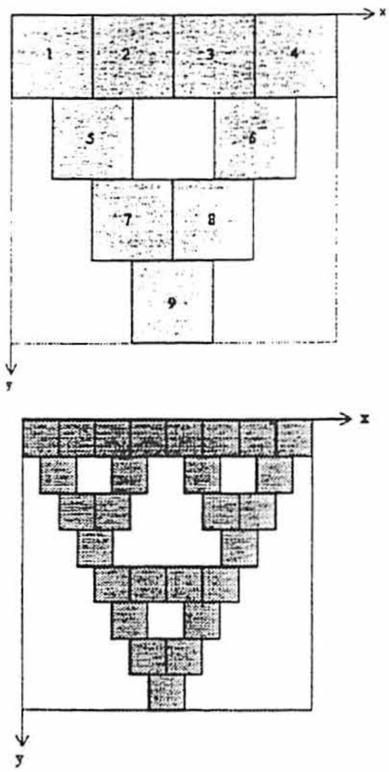


Figure 7

portions of Figure 7 and shifting them in each of the three directions listed above. The shaded portions of Figure 8 represent the possible outcomes of iterating the system twice. Figure 9 shows the possible outcomes after three iterations.



Figures 8 and 9

After repeating this process many more times (see Figure 10), we can see that this procedure also produces a fractal. Unlike the first three examples—which developed one-dimensional fractal boundaries— this iterated function system develops a two-dimensional fractal interior.

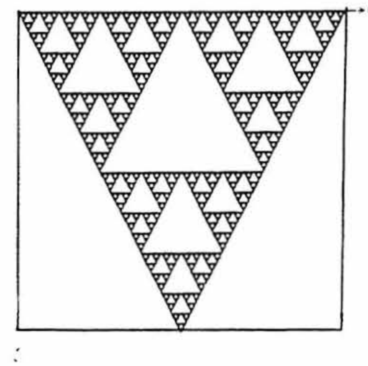


Figure 10

Each of the objects in Figures 11 to 13 was created using a similar approach. Conceptually, the procedure for generating such objects is quite simple. First, a point is selected as a "seed" from which the object will grow. Next, one of the rules of the IFS is selected at random and applied to the seed point. The rule generates a second point, which is then plotted. All sub-

Figure 11

sequent points are produced in the same manner. Every time a rule is selected at random from the IFS, it is applied to the last point plotted in order to generate the next point.

Figures 12 and 13

If the entire process is repeated from the beginning and the same set of rules is applied in a different sequence, a different set of points is obtained. The startling thing is that, no matter how many times this procedure is tried, the overall impression will always be the same, even though the specific points plotted may be different. This situation is entirely counter intuitive, a chaotic (unpredictable) process that consistently produces elegant, well-defined results. Because this thought is central to the purpose of this article, I'll state it another way. Some chaotic processes produce highly ordered, utterly reliable results. The mathematical term for that inescapable result is the "strange attractor" of the iterated function system.

Plotting strange attractors is like growing pea plants from seeds taken from the same pod. They may differ in a few details, but given basically the same sun, water, and soil, they will turn out remarkably similar. The strange attractor of an IFS corresponds to the pea plant you'd get if it had the ideal amount of sun and water and a perfect soil in which to grow.

Here is a mathematical metaphor of growth in the natural world. You too, are an approximation of the strange attractor determined by the rules for growth encoded in your DNA! Every day of your life, your cells repeat the same set of operations. Sure, if you'd had more vitamins, you might have grown taller. And if you'd never had that childhood disease, you might have been stronger. But you would still be *you*, only better.

A Metaphor of Destruction

On the basis of the preceding discussion, the reader could easily draw the mistaken conclusion that every set of geometrical transformations defines a unique strange attractor. In fact, that is not the case. For an IFS to have a strange attractor, each rule in the IFS must possess a specific mathematical attribute: it must move points closer together. If even one of the rules of an IFS fails to possess that attribute, the IFS is incapable of generating any well-defined result. Indeed, most simply "blow up" on the screen. This suggests several parallels to life on a sinful planet.

First, in its present form, my body isn't going to last forever. The IFS of my genetic code is flawed. It includes genes that control aging. It may even include genes that will eventually turn my body against itself in the form of a cancer or an autoimmune disease. But I know that one day I will receive a new body from God. That new body will be free from flaws. Then, at last, I will be free to become the healthiest person imaginable. I will become the unique, ideal me that God had in mind from the beginning. Like a pea growing up in a perfect environment, my new body will be perfectly realized in my next iteration.

Second, just as my body may be thought of as a strange attractor associated with my genetic code, the invisible me, my character, might be thought of as a different kind of strange attractor arising from the dynamic, occasionally random interactions of my knowledge, my values, my beliefs, my feelings, and my actions. I believe that, in terms of the great controversy between Christ and Satan, this is the me that matters. It is the invisible me that Satan would poison with his lies. But, by God's grace, it is also the place where the Holy Spirit will eventually restore the image of God without obliterating my individuality. In this way, I envision Christ fashioning in each of His children a unique expression of His love. In such a model, just as in the case of a computer-generated graphic, the important thing would not be the specific points generated by my life, but the overall pattern of my life. There is something about that thought that rings true for me because it places individual actions in the proper perspective.

Third, the metaphor enables me to appreciate the subtlety of Satan's strategy in planning the fall and destruction of humanity. All he had to do was to add a few "bad" rules to human belief system in order to "blow up" the strange attractor of our first sinless state. Each of Satan's rules have this attribute in common: they separate us from God.

A Metaphor of Redemption

Among the great stories of the Bible, one in particular stands out as a beacon of hope for lost sinners. It is the story of the thief on the cross.[4] The thief went to the cross with nothing, but died with the assurance of eternal life. I realize that some Christians are troubled by that story because it appears to overlook the significance of years of Christian service. But to me, it is the clearest possible proof of God's love and power to save. I believe that the thief truly repented of his sins and accepted Jesus as the Lord of His life.

To the thief, the knowledge that God loved him and had forgiven him brought more than release from guilt. It opened the way for the Holy Spirit to restore the love of God in the bruised and dying man's spirit. And of all the "rules" in all the IFS systems in the universe, that is the most powerful. As surely as Adam's life started to fail the instant he lost track of that truth, the thief's eternal life was guaranteed the instant he gave his heart to the Saviour.

Now for one last fact about strange attractors. As they grow from a seed point to thousands of points, the general form of the strange attractor is gradually revealed. If you interrupt the process after several thousand points have been plotted, erase the work that has been done so far, and then continue as before, the image is gradually redrawn in full. Any number of points can be lost in this manner without affecting the long-term outcome, for the ultimate result depends not upon the first few points but upon the rule system producing the points. Furthermore, the selection of the seed point is completely arbitrary. That's how I view the Christian life. We can come to Christ from any background and be assured of salvation. We may live another day or another 50 years. Our part is to love Him and give Him a free hand to make of us what He will in eternity.

A Final Speculation

The issue of free-will versus determinism, i.e., my free choice versus God's foreknowledge, has challenged my thinking for decades. It's one of those topics that I return to periodically, even though I don't expect to achieve a major breakthrough on the issue this side of heaven. On the other hand, I believe that the metaphor developed in this article has helped me to see the problem in a new light: that is, a certain amount of random activity on my part and God's understanding of the strange attractor of my life are not inherently inconsistent. That is, at the same time, I can be free to make choices and He can know where my life is leading. I like that!

Creation and Chaos

It is clear now why, for so long, I was certain that God would never have anything to do with chaos. For me chaos was synonymous with destruction and loss. Since God is a creator, not a destroyer, it never occurred to me that He might use chaotic processes to bring beauty and order to the universe. I now understand that, like many other things, chaos itself may be used creatively or destructively. And it appears that I have barely begun to understand the creative resources and strategies available to God.

NOTES

1. See Kevin C. de Berg, "A Random Universe? Order and Chance in Nature and Scripture," *College and University Dialogue*, 2:3 (1990), pp. 10-12.

2. R. Clark, *Einstein: The Life and Times* (New York: World Publishing, 1971), pp. 340-345.

3. David A. Thomas, "Investigating Fractal Geometry Using LOGO." *The Journal of Computers in Mathematics and Science Teaching*, 8:3 (Spring 1989), pp. 25-31.

4. Luke 23:39-43.

Suggested Reading

1. J. Gleick, *Chaos, Making a New Science* (New York: Viking, 1987).

2. B. Mandelbrot, *The Fractal Geometry of Nature* (San Francisco: W. H. Freeman & Co., 1982).

3. H. O.-Peitgen and P. Richter, *The Beauty of Fractals* (New York: Springer-Verlag, 1986).

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