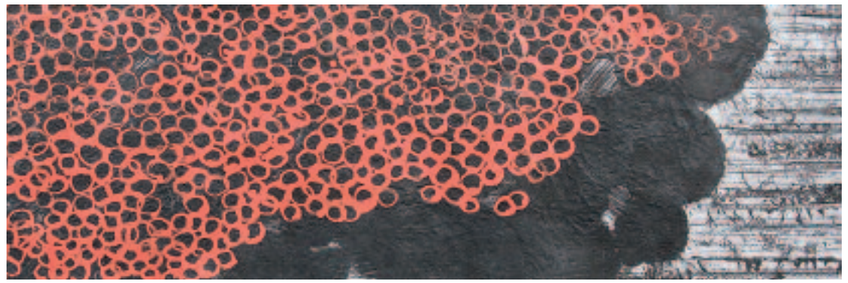
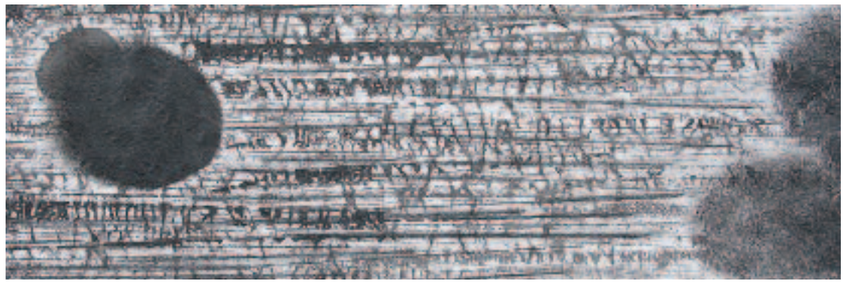




CREATIVE TRINITY

TEXT BY NANCY ZIMMERMAN

It would seem, on the surface at least, that art and science have little in common. The first deals with unquantifiable, subjective concepts like beauty and emotion; the latter is absorbed by observable, measurable phenomena. But while they may appear to be opposites, art and science share a fundamental characteristic that binds them inseparably: Both are, at heart, nothing more than a search for truth. The avenues of approach to this truth are necessarily different, of course, but each seeks to express the verities and intangibles of life on this planet and beyond. Whether via a mathematical formula or a painting of exquisite beauty, reality is explored and explained by practitioners who pair empirical observation with imagination to achieve a synthesis that resonates as *true*.

Somewhere along the line in Western culture, however, the idea that these endeavors were complementary was lost, and they came to be perceived as separate and unrelated. This separation reached an apogee of absurdity in the early 20th century; around the same time Albert Einstein was astounding the scientific world with his imaginative new ideas, artists were being marginalized as impractical dreamers or eccentrics whose creative output was deemed a luxury or mere frivolity in terms of its social utility. Scientists, on the other hand, garnered a reputation as rigidly disciplined, practical people performing work essential to human progress.

This gulf between the two pursuits didn't always exist. In earlier eras, art and science were viewed as closely associated fields of inquiry into the nature of life and the physical world. A prime example of this fusion is the work of Leonardo da Vinci, which encompassed not only drawing and painting but also mathematics, engineering, and architecture. Leonardo is known for his use of perspective in painting, employing a sophisticated understanding of geometry and mathematics to elevate art to a new level. But he also put forth theories that, had they been published in his lifetime, might have revolutionized the science of his era. He studied such concepts as the circulation of the blood and the effect of the moon on the tides, and hypothesized about subjects as diverse as the nature of fossil shells and the process of continent formation. As an inventor he designed an underwater diving suit, is thought to have devised the hydrometer, and drew up plans for flying machines that, while not fully successful, incorporated sound principles of aerodynamics.

Today we find the compartmentalization of modern life that has relegated art and science to separate corners has become not only unsatisfying from an intellectual standpoint, but also unworkable from a practical one. Increasingly, the need to integrate the knowledge and applications of seemingly discrete disciplines is asserting itself. In medicine, for example, where overspecialization has led to a vision of the body as a set of distinct systems, each to be managed apart from the others, we've found ourselves in many cases overmedicated, taking pills to counteract the ill effects on one organ of the medicine prescribed to benefit another. A more holistic approach to health is currently emerging to counter this approach, one that sees the body's different functions as components of a smoothly working whole whose individual parts all affect one another.

In the worlds of science and art, a similar awareness is taking shape, spurred in part by the explosion of technological advances that are, themselves, a fusion of creative thinking and science. Santa Fe's artistic and scientific communities are at the forefront of this growing awareness, with good reason. In addition to being a renowned center for the arts, the area is also home to some of the finest scientific minds in the world. The Los Alamos National Laboratory performs cutting-edge research in applied science; the Santa Fe Institute, whose president, theoretical physicist Geoffrey West, was just named by *Time* magazine as one of the world's 100 most influential and powerful people, is a think tank that explores key questions of existence across a variety of scientific disciplines. Over the past ten years, a number of symposia and panel discussions on the connection between art and science, cosponsored by SITE Santa Fe and the Santa Fe Institute, have attracted large audiences, attesting to the high level of local interest in the subject.

Jean Constant is a Los Alamos–based artist who works with mathematicians to beta-test software by rendering their formulas as artistic representations. Using a sophisticated computer program, he applies imagination to the computations in such a way as to demonstrate their physical manifestations and, in the process, highlight any

"Cosmic spiritual feeling is the strongest and noblest incitement to scientific research. The most important function of art and science is to awaken it and keep it alive."

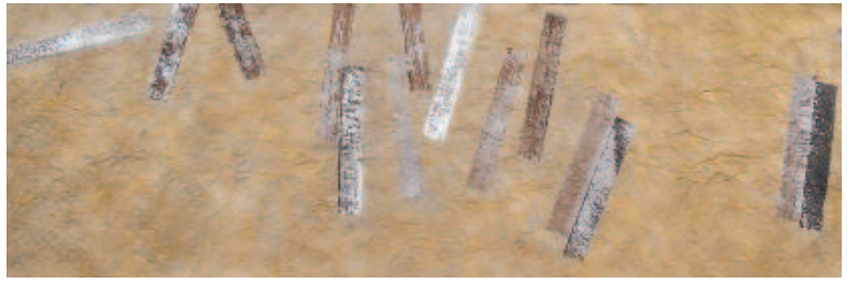
—Albert Einstein

Scroll by Signe Stuart, *Symptoms*, 2004, sumi ink and acrylic on mulberry paper, 11" x 60' (this page through page 87). The scroll can be viewed in its entirety, or rolled out in segments to be studied like a book. "Patterns and structures that emerge in my work allude to atomic and subatomic fields of energy and matter," says Stuart.

PHOTOS OF SCROLL DETAILS ©ROBERT MILLER

PHOTO BY JAMES HART, COURTESY OF ZANE BENNETT GALLERY

***Synapscape #6*, 2005, by Paul Shapiro; acrylic, oil, and collage on masonite, 35.5'' x 24''**


errors in logic. He also creates artwork on his own—in oils, acrylics, digital media—that's inspired by and adheres to the principles of these formulas. "My work is a poetic visualization of mathematical algorithms," the artist says. "A mathematician's aim is to understand and define the world as it is. As an artist, I use the tools of mathematics to create new perspectives."

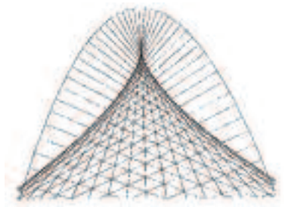
Constant is involved with a number of organizations that promote interaction and collaboration between artists and scientists, and he believes that bringing these groups together is an important next step in our social evolution. "Society has tried to push artists into a corner," he says. "The 'crazy artist' is a convenient image, but it's never really been accurate. These days, science is bringing art back to where it belongs, a partner in the act of discovery of the world around us. Today the computer is as powerful a technology as advances in painting were in the Middle Ages. Painting was once done on walls, primarily in churches," Constant recounts. "Then, the Dutch masters began to work in oil and on canvas—a scientific advancement for that era which, though controversial at the time, allowed art to travel. You couldn't take a church with you, but you could now transport a painting on canvas from Amsterdam to Venice. This kind of work wasn't accepted as 'art' at first, but you hear the same arguments today about art made with the help of a computer."

Of course, art need not be computer-generated to exhibit a kinship with science. The creative process itself, wherein stimuli from the physical world are rearranged and expressed in an imaginative way, is largely the same for both scientist and artist. "We have a lot in common with scientists," agrees Santa Fe artist Signe Stuart. "We like to fiddle around with nature on many levels, generating and solving problems posed by simple questions like, 'What does it mean?' 'How does it work?' 'What happens if?'.

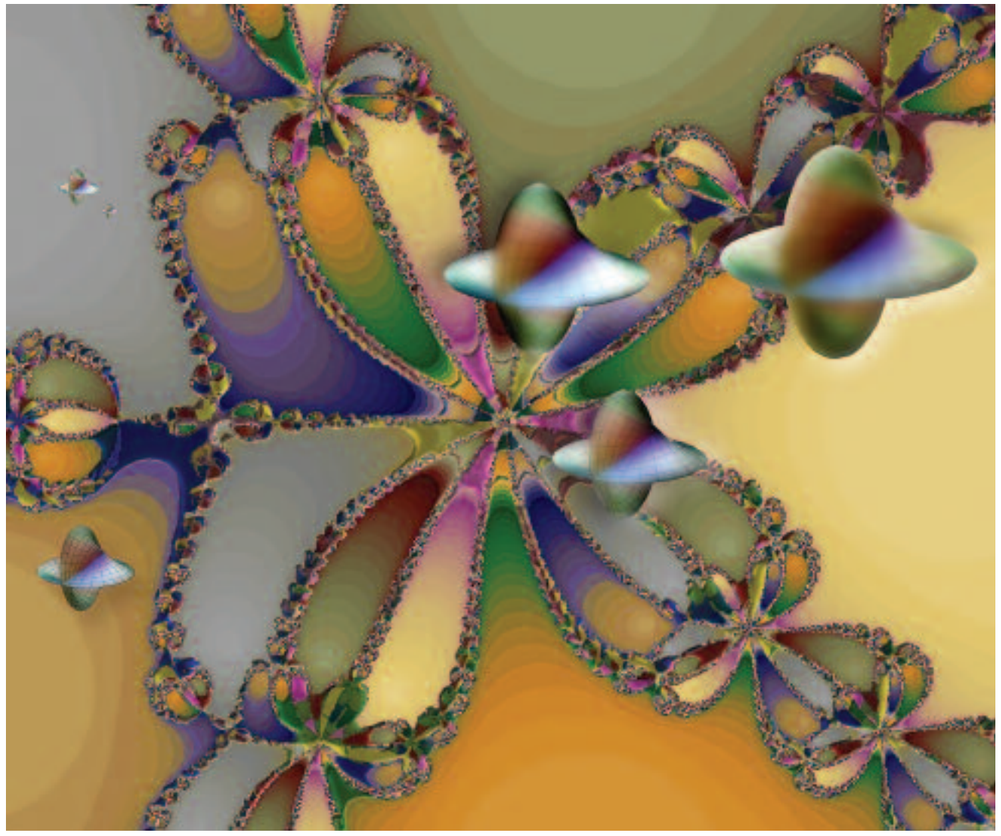
"Artists and scientists are involved in works of transformation," Stuart continues, "transforming materials, ways of thinking, or being. And fundamentally, all transformations are those of matter or energy. As a painter, my work in the studio parallels work in a laboratory—it's research. I explore and develop visual images as metaphors for my ideas, I test and manipulate various materials to express those ideas."

Another Santa Fe artist whose work explores questions of matter and energy is Paul Shapiro. "My work is a metaphorical depiction of what quantum physics is looking at, a pre-matter state where energy systems are dancing," says Shapiro. His recent output, a series of acrylics on paper and masonite panels called "Quantumscapes," has been described by some as being "about quantum physics." "That's wrong," he insists. "I'm merely looking at the same phenomena that quantum physicists do, but expressing them in artistic terms." Shapiro admires these scientists, he says, because unlike those who came before, who superimposed a preconceived template on "consensual reality," the quantum researchers have proven that there's no such thing as objective reality, that all perception requires both an observer and the observed. "Human beings have disconnected from the cosmos, but quantum physics is discovering the unity of the manifest," he says. "My work is about that unity."

Jack Leibowitz, a retired professor who taught physics as well as art at Catholic University in Washington, D.C., now lives in Santa Fe, where he's taking time to pursue painting and writing. As both an artist and a scientist, Leibowitz is intrigued by the similarities between the two fields and is currently at work on a book about their intersection. "Just as only a small number of physical laws underlie some of the unimaginably diverse phenomena in our physical world," he writes, "so do only a few basic design principles and elements of art yield the virtually

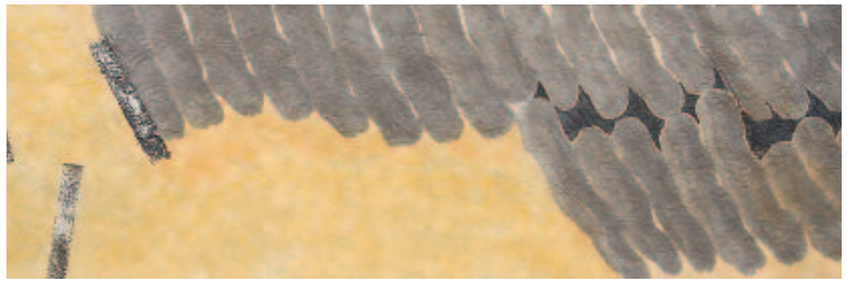
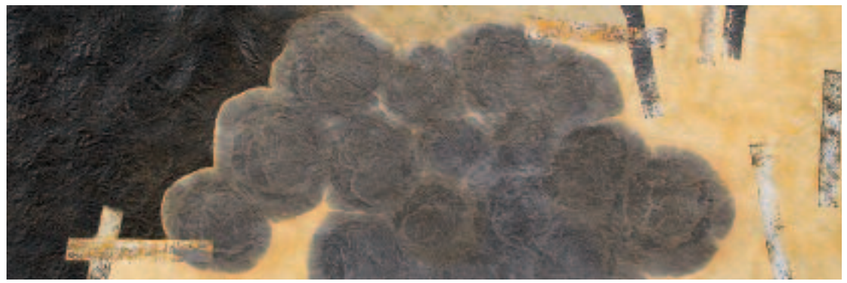
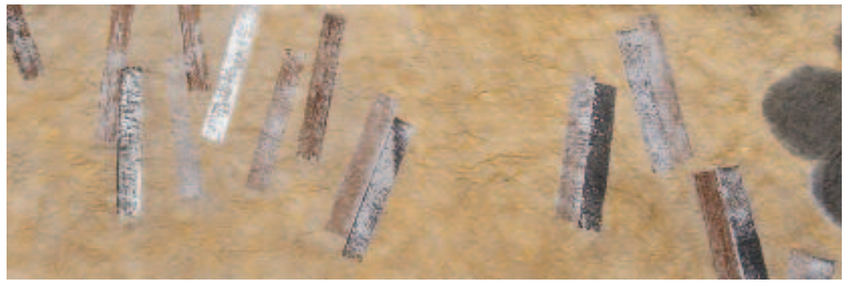

Designs for the structures at the Mathematical Park in Paris include the Seventh Temple (top), which resembles small temples of antiquity and illustrates tilings of Euclidean and hyperbolic spaces. ©Claude Bruter. Example of a Gaussian curve (center) at the Gauss Observatory, which is devoted to differential geometry. Whitney's Umbrella (bottom) is a self-intersecting rectangle in three dimensions. ©Richard Palais.

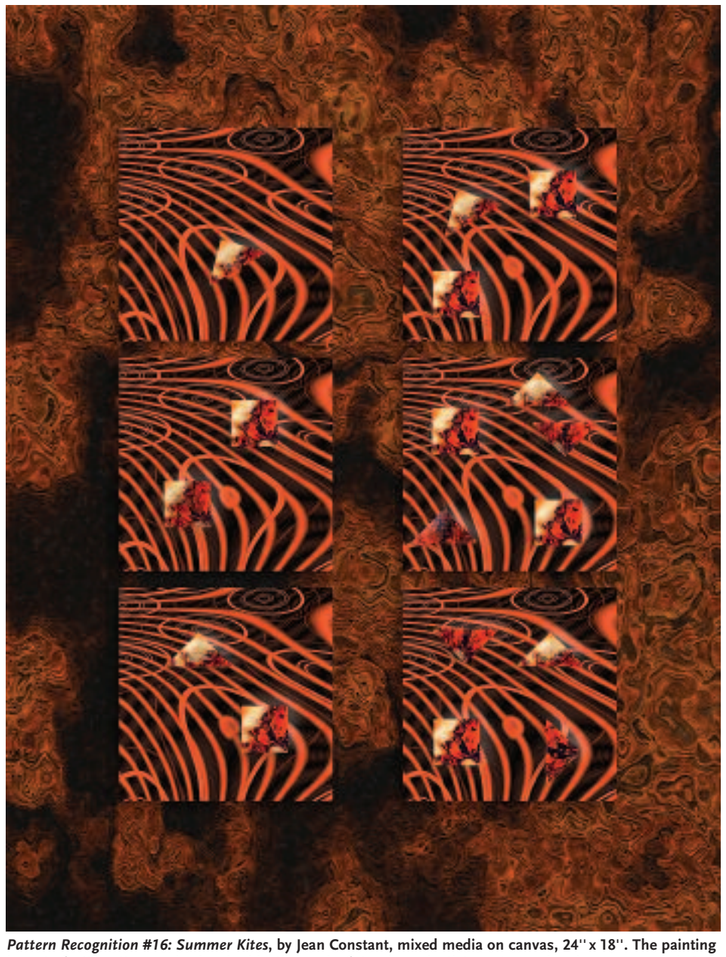


***Newton Polynomial Transgression*, 2000, by Jean Constant, mixed media on canvas, 18" x 16". The shapes are interpolation polynomials for a given set of data points, integrated into a fractal background. Courtesy of the artist.**

"Scientific rigor without the creative guidance and inspiration of the artistic impulse becomes rigor mortis."

—Laurence Campbell, theoretical physicist



***Pattern Recognition #16: Summer Kites*, by Jean Constant, mixed media on canvas, 24'' x 18''. The painting is part of a 22-pattern series inspired by the work of Russian scientist M. Bongard and was presented at the National Center for Genome Resources in Santa Fe. Courtesy of the artist.**

limitless means of artistic expression. A painter, for example, starts with the blank canvas as the 'ground of symmetry' and, informed by his aesthetic sensibilities, arranges artistic elements so as to create an artistic dialogue that expresses coherence. He captures an organic unity in the fully realized composition, thereby introducing a new balance."

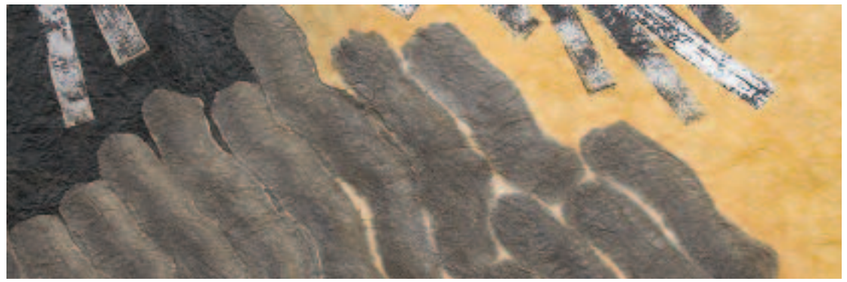
These words—*symmetry*, *balance*, *coherence*, *unity*—tend to pop up when describing the products and the processes of both artistic creation and scientific discovery. And, increasingly, scientists and artists are teaming up to produce projects that foster greater understanding of these overlapping worlds. Constant has been involved in an effort by ARPAM (Association pour la Réalisation et la Gestion du Parc de Promenade et d'Activités Mathématiques, or "Association for the Realization and the Management of a Mathematical Park"), a group of noted French physicists, mathematicians, and other scientists, to build a "mathematical park" near Paris. The idea is to erect ten small structures whose architecture, form, and decoration would demonstrate particularly significant mathematical concepts and facts. The exhibition is intended to underscore the bond linking intellectually based art—as practiced by mathematicians—with art that has a more sensory expression. Among the proposed features is the Knotted Stained Glass, a building to be made entirely with transparent material that's illuminated from the inside to illustrate differential topology. Another is the Luminous Torus, which will be constructed partly of glass so observers can see the effects produced by light beams projected on a suitable transparent object with a variable refraction index.

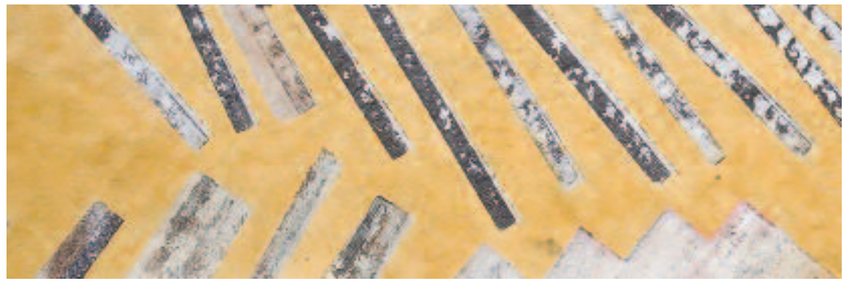
As an offshoot of this project, a presentation of the exhibit and lecture series "Mathématiques et Arts" was held last year at France's Henri Poincaré Institute and École Polytechnique. Constant participated in this program, which featured talks by a variety of scientists from around the world, including the United States, as well as works from an international assemblage of artists. Constant reports that the project will travel to Thessaloniki, Greece, in October, where it will be part of the International Science and Technology Fair.

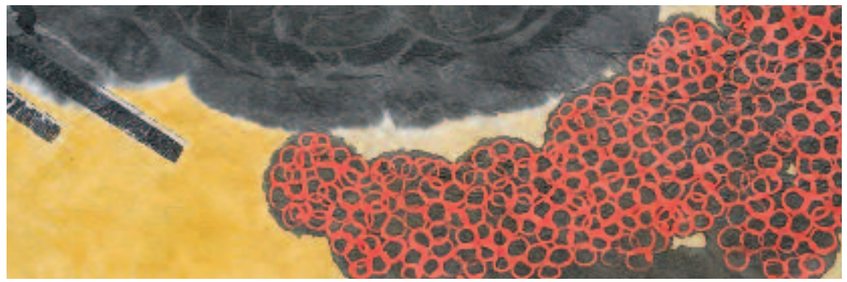
Closer to home, Constant is active in the Forum for Science and Art, a Santa Fe–based organization whose purpose is to provide a context for members to share inspiration and understanding stemming from the close relationship of science and art. Toward that end, the group, which counts among its members physicists, artists, mathematicians, and "anyone intrigued by the concept," compiles and disseminates information relevant to science and art, and meets monthly for informal discussions of related topics. Forum founder Susan Latham, a sculptor and occupational therapist who has worked with school systems to provide art-based models for teaching mathematics, is convinced that an awareness of the "oneness" of these disciplines is essential to understanding our world and learning to respect nature. "Our mission is to develop a sense of community among individuals who delight in exploring new possibilities and integrating perceived opposites," says Latham.

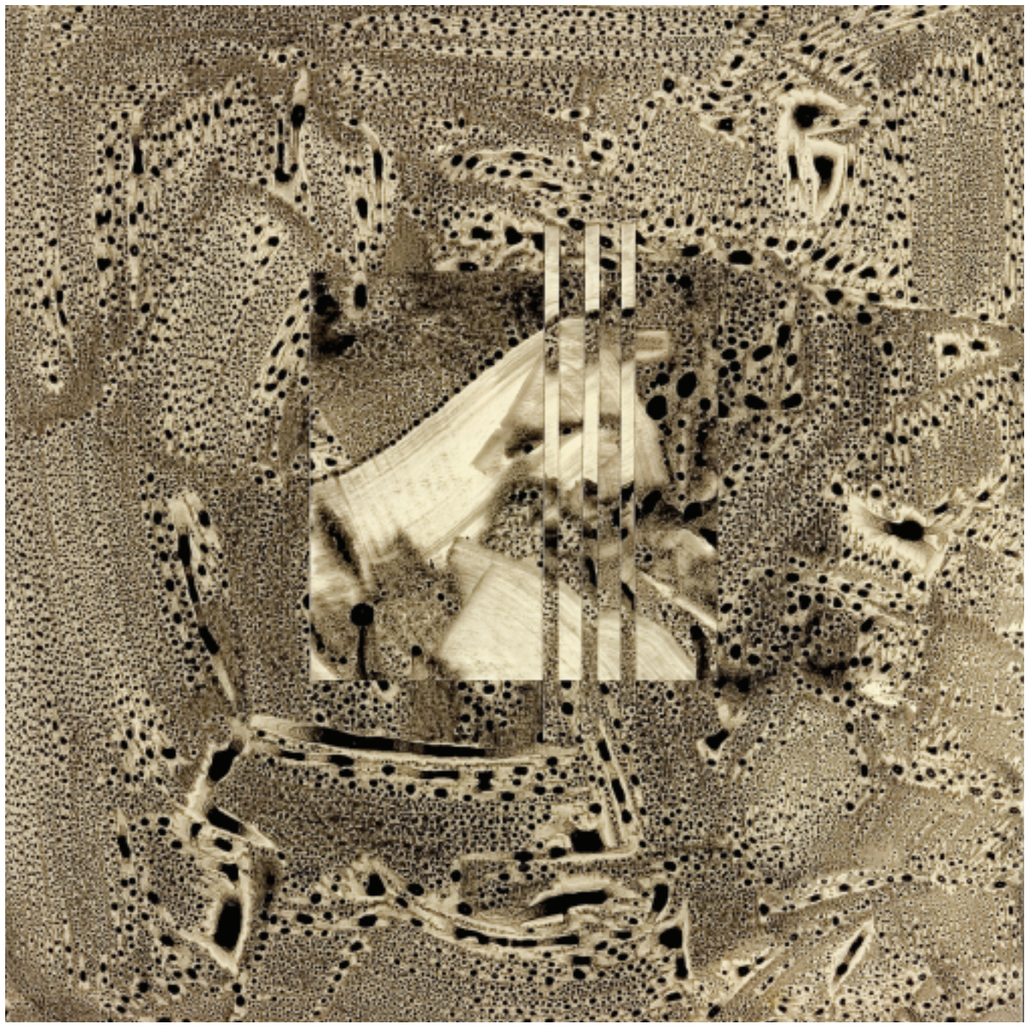
Leibowitz, too, in his experience as a physicist has found the congruence of art and science to be a useful departure point for exploring reality from all perspectives. "In

***Spiral Dance*, 1998, by Susan Latham, polished aluminum, 24'' x 22'' x 18''. Courtesy of the artist.**









***Cosmotex #16*, 2005, acrylic / collage on masonite, 24'' x 24''**

PHOTO BY JAMES HART, COURTESY OF ZANE BENNETT GALLERY

their quest for coherence," he observes, "artists and physicists, each from a distinct perspective, probe our inner and outer worlds and help deliver meaningful patterns out of a seemingly impenetrable forest of confusion. We often find the results profoundly rewarding, which explains why throughout history the arts and sciences have engaged humankind's aesthetic imagination. Computer scientist David Gelernter once said that 'the sense of beauty is a tuning fork in the brain that hums when we stumble on something beautiful.' Artists and scientists know and cherish the experience of that hum. Placing works of art and physics under the same lens allows a more penetrating insight into both. For example, analogous effects become evident when one sees the quantum information revealed by merely changing the symmetry of the box enclosing an electron—or when altering overall symmetry of a David Smith abstract sculpture simply by moving the position of a cylinder."

Architecture provides another example of how science and art intersect. From the pyramids of ancient Egypt to the skyscrapers of today, an understanding of the core principles of mathematics and engineering is essential to this fusion of form and function. In recent years, an interest in what's been termed "sacred geometry" and "sacred architecture" has burgeoned as people look to the perfection of the pyramids or the awe-inspiring cathedrals of Europe as models of building practices that embody the highest expression of art and science. These terms refer to the geometry employed when designing sacred buildings or works of art, and its proponents believe that the discipline's sacred ratios also underlie music, cosmology, and observable features of the natural universe.

In 1984, Cynthia Stibolt, a Santa Fe painter, commissioned local architect Ken MacKenzie to build her a studio according to the principles of sacred geometry, with stunning results. "We started with a simple square that was to be harmonized with the land and the universal whole," says MacKenzie. "We established the axis for the movement of the sun, then determined via dowsing whether there were lines of energy running within the earth that would establish an axis or a spiral. The ancient temples and cathedral sites are all conjunction points of these geodetic energies, and our building site was chosen in a similar fashion.

"In further studying the sacred architecture of Gothic cathedrals and Egyptian, Greek, and Indian temples," MacKenzie continues, "I discovered they all incorporated the same principles regarding proportion and measure. Here was something that had more to do with the inner space than with the outer form, and it transcended geography and time. The common purpose was to create an environment, a vessel, that reflected the order that exists in the universe, a material manifestation of the divine. It's actually a conscious effort to establish a link between heaven and earth, to infuse matter with spirit."

The finished studio became a place of power and heightened creativity for Stibolt, whose work began to flow effortlessly as soon as she occupied the space. "I've been more productive, more prolific than I ever could have imagined," she says. "People who visit are struck by the sense of peace and protection they feel there; it has a healing effect."

"If, as Goethe suggests, architecture is indeed 'frozen music,'" adds McKenzie, "then this viewpoint is confirmed, for architecture is to space as music is to sound." In fact, sacred geometry has long been understood as a component of music. It was Pythagoras who first found that a string, when stopped halfway along its length, produced an octave, while a ratio of two-thirds produced a fifth interval, and three-fourths produced a fourth. His followers believed that these mathematical ratios gave music healing properties, allowing it to restore harmony, literally and figuratively, to an unwell body. In nature, as well, this geometry has power, making it possible for organisms to optimize their resources: The chambers of a nautilus grow at a constant rate, for example, forming a logarithmic spiral, and bees build honeycombs that are a repeating pattern of hexagonal cells.

Also from nature comes the more recently defined fractal, a geometric shape that has symmetry of scale, such that if you were to zoom in on any part of it at various levels of magnification, it would still look the same, or nearly the same. We find this property in the branches of a tree, rugged coastlines, and planets that orbit stars that, in turn, orbit galaxies—the part is the whole, and the whole is the part. It's no accident that this definition mirrors the teachings of many religions on the concept of the oneness of the universe. A sense of that oneness finds artistic expression quite strikingly in the form of the mandala, an ancient Buddhist and Hindu graphic symbol of the universe in which a circle is divided into four sections, each bearing multiple projections of an image.

The principle at work here, then, is not so much the duality of art and science but rather the trinity of art, science, and spirit. In pursuing this tripartite truth, whatever the vehicle, we find a satisfying, scalable symmetry that is beautiful and wondrous to behold. ✿

For additional information, see page 188.