4-D and I

I am no longer inclined to write about what four-dimensional geometry is and how it has influenced early modern art. I've done that; it's in print, and Linda Henderson has written reams about it. Four-dimensional geometry, in all its various costumes, has danced with just about every important artist of the last hundred years. These are historical facts; you can look them up. However, by extending my scope to writers and filmmakers, I can try to show how four-dimensional space is deeply imbedded in current works of art, something that has not been fully articulated. Through this four-dimensional art, we can see in a new way. We can lose the sense of being tied to a particular location and see in a more overall way.

In 1979 I saw a work of art that gave the viewer the sense of seeing from many locations at once when Sol LeWitt, Lucinda Child, and Philip Glass collaborated on a dance piece at the Brooklyn Academy of Music. Dancers appeared behind a scrim on which was projected a film of the same dancers doing the same dance. From many seats in the theater, the "real" and the "film" dancers overlapped exactly. Then the two sets of dancers diverged and recombined, like melodic lines in a fugue, which is the way I often describe the space in my painting. The film also cuts to views to the left and the right, in effect sliding me around the auditorium as it kept another part of my mind center stage. As a Minimalist, LeWitt missed some of the opportunities presented by this arrangement. I remember feeling at the time that most of these dislocations were slight. The scale relationships could have been reversed, so that the real dancers behind the scrim could have been seen larger and thus in front of the scrim. The camera could have rotated up to 90 degrees so that we saw the dance in floor plan at the same time we saw it frontally. He could have expanded the use of mirror reflection—the two groups of dancers split left to right—but true mirror reflection could have been used either in film processing or, now much more easily, in video. I think I remember that the camera took the point of view of one of the dancers for a while—that was daring: immobile in my seat, I was moved to be on the stage and in the dance, while at the same time I had a frontal view of the presidium stage.

Those were early days: among artists *ambiguity* was fighting with *objecthood* to be the contemporary aesthetic goal. In spite of all the complexity and multiplicity in the world around them, most artists remained true to the taste for Minimalism that was the establishment style. Fifteen years later, artists, writers, and filmmakers had a much more daring confrontation with the fourth dimension.

In Kazuo Ishiguro's 1995 novel *The Unconsoled*, the internationally known pianist Ryder returns to his small, Bavarian home town to judge a piano contest, one of whose contestants is Ryder himself as a very young man. The younger Ryder hopes his parents will attend his performance; the older Ryder mourns that his parents died long ago. The town has wormholes—spaces are multiply connected—so that leaving through the door of a house could put one at the far end of town rather than in the neighborhood where the house is located. Youthful crushes, old lovers, ex-wives—it is never really clear who the women in the book are.

In Ishiguro's book, four-dimensional geometry is the armature for our subjective, psychological reality, as well as our objective, physical reality. The town is in a state of bereavement because its beloved music master has died. The piano contest has been held in order to choose the next master, and the most illustrious native son has been asked to return to serve as judge. In the meantime, the citizens are in an acute crisis, for they have no guide to music; they do not know what music they like; indeed, they cannot even experience the culture that was the mainstay of their lives. Ishiguro's point is that we carry our parents' voices in our heads all our lives and do not feel comfortable without some super-presence channeling our actions and consciousness. Beyond that, he demonstrates that it is inaccurate to consider a person as located at a single spot in three-dimensional space and moving always forward in time.

The Mike Figgis 2000 film *Time Code* tests the limits of omniattentiveness. On screen are four films; that is, the movie screen is divided into four parts, and each quadrant has a different film playing. The four films (actually high-capacity video) were shot in real time with one take and no edits. Each of the cameras follows a separate set of actors, who are doing different things at the same time in different parts of Los Angeles and who sometimes come together to interact. At those moments, two or more quadrants show the same scene, but the cameras are at right angles to each other. The only

concession to traditional movies is that the four different sound tracks accompanying the four different films are mixed sound up or sound down to make one quadrant dominant for a period.

I saw the film twice, and the most amazing thing was its coherence. It is true that the narrative dominated my second viewing, but even during the first, I could let go of my anxiety about not understanding everything and flit back and forth between the screens and become captivated by the story. It is said that Goethe could write two different documents at once, one with each hand, while reading a third. Even the staid BBC-TV news can run banner text of a different story than that in the main picture in order not to bore younger viewers. It seems that humans can be mentally in more than one place at the same time without a loss to the quality of our perception.

In Christoffer Boe's 2003 Danish film *Rekonstruction,* a middle-aged writer comes to Copenhagen with his beautiful young wife. She is left alone while he is engaged in meetings and interviews relating to his new book. The wife meets a young photographer, a brief affair ensues, and they make plans to run away together to Rome. The photographer sells his cameras to finance their elopement, but they fail to meet at the appointed hour. Each assumes the other has backed out. The wife returns with her husband to their secluded house in the country.

It would be a straightforward narrative, except for the fact that key scenes are replayed with variations: the young people's chance encounter takes place on a bus, in a restaurant, at the bar of the restaurant, no, at a table in the restaurant. The same words are spoken over and over. It is as though several scenarios (how they met, how they progressed to bed, how they planned to run away, how it happened that they failed to rendezvous) are running simultaneously, and it is mysterious which one is the "real" one. The husband talks to his wife about the new novel he is writing, and he reveals different ideas he has about the plot. We see that it is possible that that the photographer and the writer's wife are simply acting out different version of the new book. Perhaps their affair is only in the husband's imagination as he rewrites his book. That simpler view of space and time is defeated at the end of the film when the three characters meet. The photographer pulls the wife aside, tells her he has the tickets. Doesn't she still want to go? But the moment has passed; she tells her husband that the urgent young man was not

bothering her but simply mistook her for someone else. A white lie to protect her husband and her marriage? Or the truth, since the affair was a fantasy of her writer husband?

The power of the film is that several histories of the same events occur in the same place at the same time. In this quantum space, all versions of the past are equally likely to be true, and which version of history we finally find ourselves in seems more to be a matter of chance than intention.

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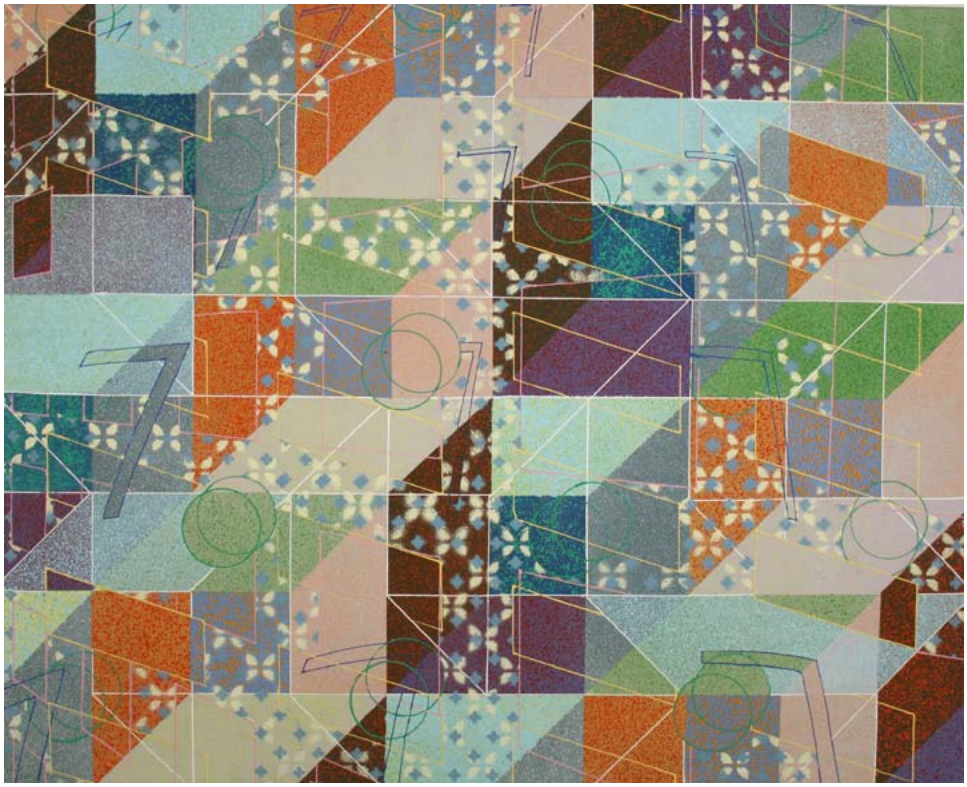
I feel at home with mathematicians, because I do not have to explain, **again,** that time is not the fourth dimension, any more than north is the second and left is the first. I do cherish the time I spent with Tom Banchoff, Nick deBruijn, Scott Carter, George Francis, and Lou Kauffman. They taught me what I wanted to know about higher-dimensional space. I think the history of art can be told as a history of the depiction of space, and that exercise alone brings art and geometry together:

Egyptian art occupies a space of known and named things. Greek art occurs in a general space where abstract ideas can be embodied in living things. Roman space is the first real—as in specifically observed—space inhabited by historical figures. Byzantium makes a space of the saints and God not contiguous with our own, and thus inaccessible to us. But Renaissance art, through great effort, defined the point of view. For fifteenth century artists Piero della Francesca and Masaccio, perspective geometry defined humanism: looking at their paintings, we stand on the same ground as Christ and Mary. Having a viewpoint toe to toe with them establishes our equality with God. The artists would have been burned at the stake if they said such a thing, but they became rich when they painted it. In Impressionist space, the individual observer is at the vortex of transient sensation. Cubist space is a space of four-dimensional objects: part of the object is observed and part intuited.

I have been following the idea of four-dimensional art, wherever it led me, since 1975, when Marcia Tucker wrote that “contradictorily visual information suggests the complexity of four-dimensional geometry” in a catalogue essay for my solo debut show at the Whitney Museum in New York. I studied the geometry by writing some of the first computer programs to visualize four-dimensional figures, and also by studying four-

dimensional geometry in its application to space-time physics. I was mindful of two great pitfalls: I did not want to make mathematical illustrations, yet I wanted the work to be steeped in the real mathematics enough to offer a new vision. Looking back on those four decades of work, I see that I passed through five periods, each with its own formal strategy and its own art form, each one based on a particular geometric lesson learned. These formal innovations bring the viewer to a new way of seeing by exploring the ways in which the fourth geometric dimension is brought to our three-dimensional world.

From studying special relativity I learned that more than one space (frame of reference) can be in the same space at the same time. Consequently, I tried to put the viewer in more than one place at one time. In these early paintings, five linear patterns are superimposed at different angles to the picture plane; the viewer is above, to the left, to the right, and so on, of a background structure that itself is made of reversing figures. Further patterns are sprayed through stencils for an additional "ground," sometimes in front of and sometimes behind the other backgrounds and figures in the painting, creating a complex space, rich in color and texture. One focuses on a pattern and senses a location in space, only to be (psychologically) displaced when focusing on a second pattern, and so on. Eventually the viewer sees two or more patterns at once. It is as if a trained listener, on hearing a fugue, keeps track of the several melodic lines running forward and backward even when the notes are presented as chords. Associated with Pattern Painting, these paintings were prized by European dealers and collectors who saw no contradiction in an art that was both geometric and lyrical.

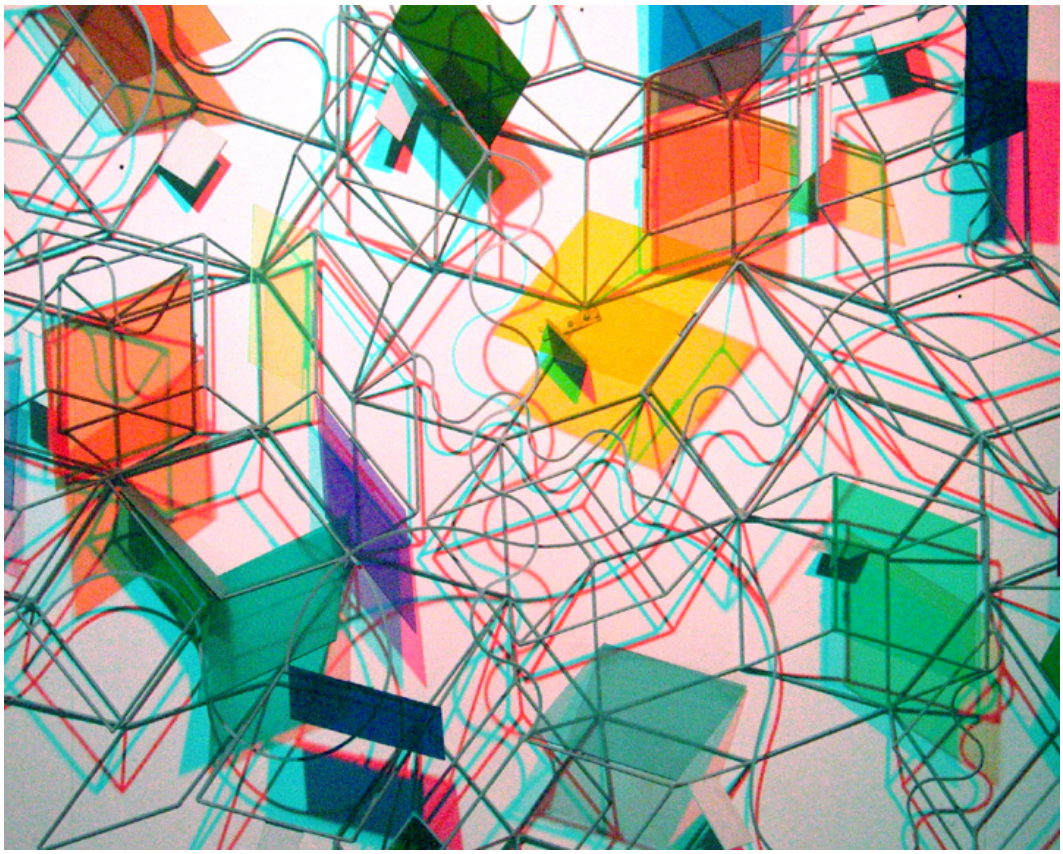


1979-7 1979, acrylic on canvas, 56 x 70 in.

From mathematician Thomas Banchoff I learned that planar rotation is a unique property of four-dimensional space and that planar rotation is essential to an understanding of that space. I first saw this quicksilver visual property of four-dimensional objects on Banchoff's computer. One can rotate a page around a pinpoint, or a box around an axle; in four dimensions one can rotate an object around a plane. Here four-dimensional rigid structures appear to flex and turn inside out in the same way that shadows of ordinary objects stretch and flex when the objects are moved. Planar rotation was brought to life in a series of relief artworks that I made between 1981 and 1989. I discovered that using two-dimensional elements, painted lines, and three-dimensional elements such as structures made of metal rods, planar rotation could be generated as the viewer passes by the artwork.

Fourfield, (detail) 1980-81, acrylic on canvas with welded steel rods, 96 x 324 x 15 in.

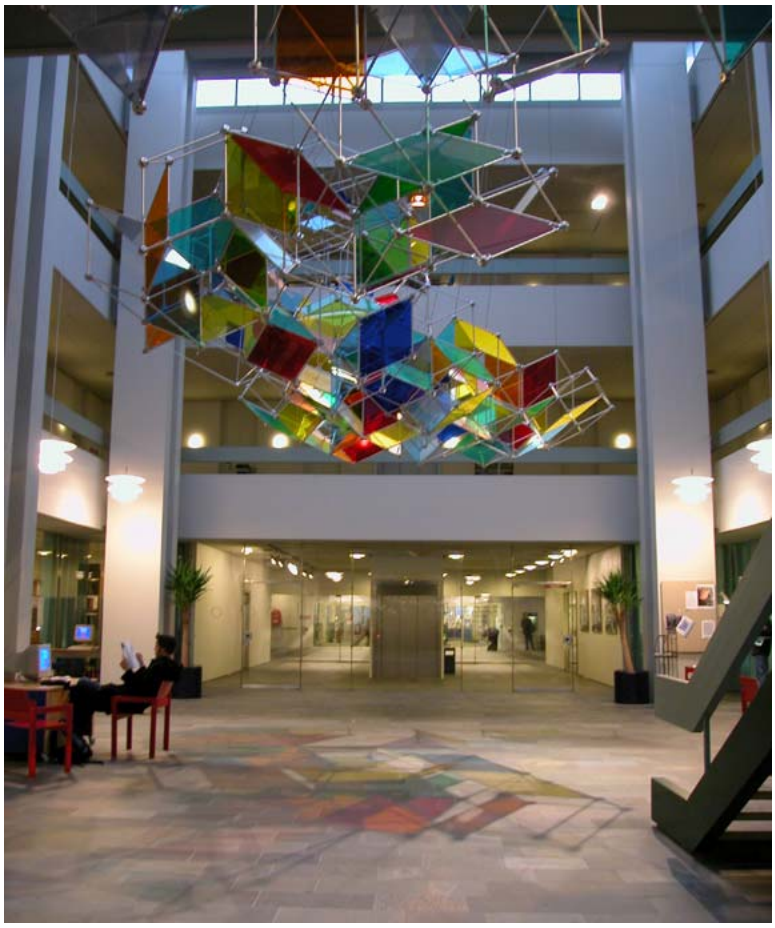
I went to a lot of trouble to make sure that the painted lines and the painted metal rods look the same to a standing viewer. But as the viewer moves, strange things happen. As in any relief, planes can be hidden behind an edge of that plane (seen exactly edge first), and in my four-dimensional works, one has the sensation that whole three-dimensional structures are hidden behind open cubes. Space spins out of space as the viewer moves. In a further development, the two-dimensional elements become the cast shadows of the three-dimensional elements: the relief structures are lit by a red light and a blue light. Where the lights shine together, there is white on the wall, but when the red light is shaded by a rod, a sharp, intensely colored blue line appears; and when that same rod shades the blue light, a sharp, intense red line appears on the wall. When anaglyphic (red and blue) 3-D glasses are worn, these separate red and blue images recombine to make an illusion of another structure. Now we have two structures, one made out of light and the other made of metal rods, occupying the same space at the same time and moving through one another as the viewer passes by, replicating planar rotation, just as we see in the computer models. If you wear the glasses as you look at the artwork, a walk in the studio makes the images move as though you were walking in the fourth dimension.



1987-3 (detail) 1987, welded steel, plastic, and colored lights, 84 x 84 x 8 in.

Neither crazy quilts nor regular rigid patterns, quasicrystals are non-repeating patterns with remarkable, new visual properties that were discovered by mathematicians only recently. From mathematician Nicolaas de Bruijn and physicist Paul Steinhardt I learned that quasicrystals are projections of more regular figures in higher-dimensional space. This mathematical fact became a guiding principle of my philosophy: all the intriguing, asymmetrical, aperiodic, apparently anthropomorphic qualities of quasicrystals (they seem to know where they are going as they propagate) come from regular cubes in higher-dimensional space. All these amazing properties are artifacts of being *projected* to lower-dimensional space. Large enough to be architecture, my quasicrystal sculpture for the Danish Technical University appeared to change its structure from triangles, to squares, to five-pointed stars depending on one's orientation under it, and the shadows the rigid structure cast also had two-fold, three-fold, and five-fold symmetry depending on the position of the sun. During the later 1980s and until the

Denmark structure was dedicated in 1994, I made and exhibited many quasicrystal models and temporary structures.



COAST Quasicrystal 1993-4, aluminum and plastic, 640 x 320 x300 in.
Eik Reitzel, engineer. Photo: Annette Hartung.

From topologists Scott Carter and Louis Kauffman I learned about braiding spaces. One can tie a (one-dimensional) string in a knot because it can pass through the third dimension to overlap and underlay itself: two more dimensions than the string itself possesses. To do the same with a two-dimensional object such as a sheet, one needs access to four dimensions. Especially since 2000, when I renewed my friendship with Scott Carter, I have been knotting and braiding multiple three-dimensional spaces in five-dimensional space, which resulted in paintings that superficially resemble my early work. In these new works, however, three-dimensional spaces are established by linear lattices

that flow over and under each other and, paradoxically, through each other, as what is logical in higher-dimensional space becomes paradoxical when projected to three-space. The viewer becomes comfortable with these paradoxes and uses them to see the higher-dimensional space in that same way we can see a regular cube from its distorted, rubbery and illogical two dimensional shadow. Transparencies of color help to flip the space and establish the higher-dimensional visualizations.

22005-7 2005, acrylic on canvas, 56 x 70 in.

Talking with Roger Penrose, attending his lectures, and studying his writings have taught me to take the idea of higher-dimensional projective space more seriously. I have begun a new series of works, paintings in oil with intense color and rich texture, but I have not abandoned my goals of higher-dimensional vision. The paintings focus on what the mathematicians call singularities: the locations where different spaces come together. In my computer prints, latticed spaces flow across the page and then at key places paradoxically intersect (as a function of being projected to a lower-dimensional space). These new oil paintings focus on those paradoxical intersections. In other words, the new

paintings let go, somewhat, of the identity of the lattices to focus on the singularities. The viewer does not look across the painting so much as look into the projective space.

2010-O-3 2010, oil on canvas, 56 x 70 in.

The fourth dimension has always connoted power over complexity, an architecture to house the multiplicity of spaces that increasingly are part of modern life. Both the objective space of physics (both relativity and quantum space), and the subjective space of personal experience require a richer structure than a mere three-dimensional geometry can provide. The braiding of separate three-dimensional spaces takes place in our media in ways that not even Marshall McLuhan could have foreseen. It is the intent of works of literary and dramatic art, as well as visual art. It has been a privilege to be part of this consciousness-expanding program, in my geometry research, in my writing, and in my art.

Tony Robbin, Gilboa, 2010