TOPOLOGIES OF THE FOLD

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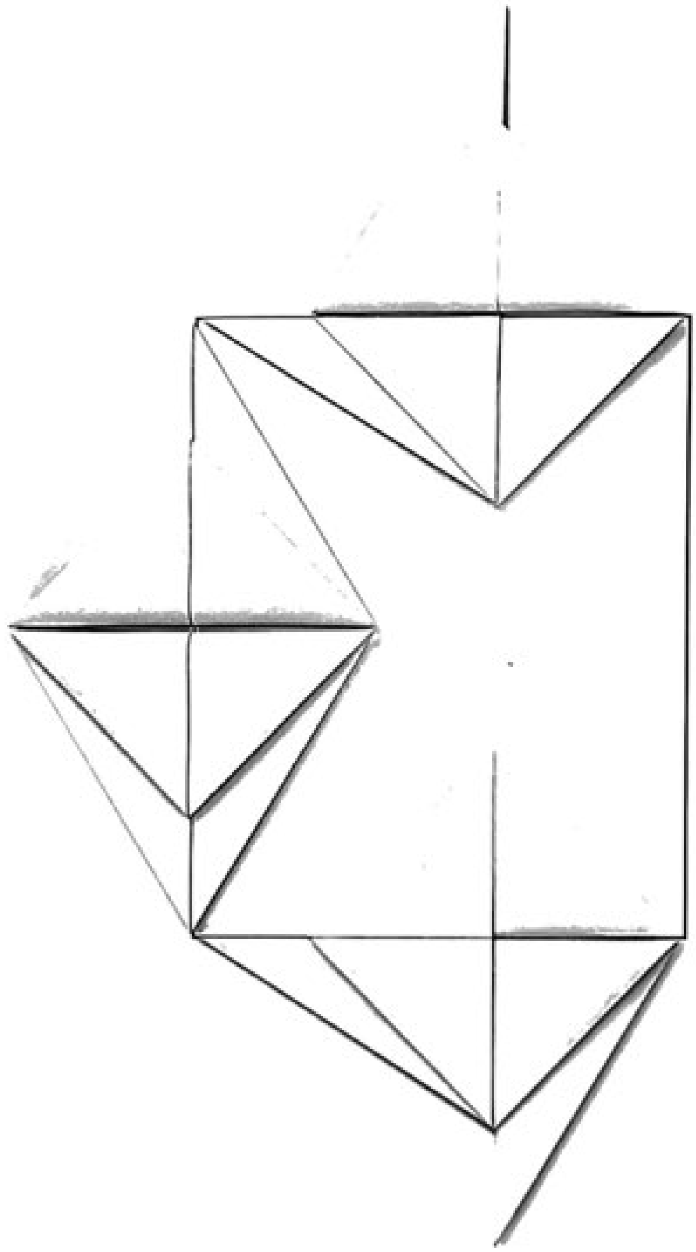
I was determined to make a painting that looked through itself at itself, as space does when it's folded.
DOROTHEA ROCKBURNE, 1977

1.
"What does it look like? What materials does it employ? How is it made?"

I used to think these were *the* essential questions in the study of visual art, and I have frequently asked my students to reflect on them when describing what they experience: the "visual appearance / material constitution" lines of inquiry.

Yet these questions scarcely hint at the observational skills necessary for describing a work by Dorothea Rockburne. There is simply too much hidden. Appearance is often a metric of relationships between distances on a flat plane or objects in space, whereas in her works surfaces are pliable, bending to create involutions that are fundamentally difficult to see without considering the act of their making as a time-based procedure. The spatial markers of back and front, above and below, right and left, and so on are relative aspects of continuous planes folded into forms; only fragments of those surfaces are ever visible at one time.[1] The works exist tucked among complex understandings of dimensionality that refer to hyperspatial surfaces, aspiring to an entirely "different kind of perspective," as Rockburne has phrased it.[2]

Let us investigate this dynamic, abstract, and at times supravisual quality of Rockburne's work through a close study of the *Egyptian Paintings* (see fig. 24), initiated in 1979 in anticipation of her first visit to Egypt.[3] On initial inspection, Rockburne's *Egyptian Painting: Stele*



(1980; p. 74) appears to be among the most simply arranged of the series: it is organized as a vertically oriented rectangular shape, whereas the other works in the series sometimes incorporate more complex geometric forms, such as pentagons and hexagons. However, *Stele* is stealthily enigmatic. The work is approximately four feet high by three feet wide and placed about two and half feet above the floor, though it appears larger by annexing the surrounding area with drawn components. Its top, bottom, and left sides are composed of three groups of folded pieces of gessoed linen that are attached by Velcro to the wall, forming slightly puffy objects. The work is overwhelmingly white but with precise thick black lines in Conté crayon marked in certain sections, including the right side, which consists of a vertical line drawn directly on the wall.

Stele is therefore simultaneously a drawing, a painting, a sculpture, and an installation like the Egyptian reliefs that are its precursors.[4] The intricacies of the arrangements of these linen objects on the wall and the way they are created by procedures of folding and layering make describing the work a tricky process of *un*folding. The left-side group initially appears to be one form subdivided on the horizontal, but it is actually two separate pieces: adjacent isosceles triangular objects with bases nearly touching as they mirror one another. These two forms are made up of two triangles each—a larger triangle and a smaller triangle on top. One can detect that the large-small triangle pairs were formerly a tall asymmetrical lozenge shape that has been bent at its wide waist, and the smaller section folded atop the larger triangle. A lightly rendered line vertically bisects these triangles, and this stripe atop the linen fabric sketches the left side of the overall rectangular form that is the work's unifying shape. Due to their pairing and the further bifurcation of this vertical line, the two original lozenges present the viewer with a total of eight triangles, and the group is fashioned from at least three layers of folded material.

While the left section is organized by the placement of these two symmetrical sculptural linen triangles, the remainder of the work is assembled from two additional asymmetrical, folded linen objects affixed to the wall, their east-west axes creating the shorter top and bottom perimeter of the overall rectangle. These forms have longer triangular sections jutting above and below, and these wings initially appear to exist in some sort of chiral relationship, as hands are nonsuperimposable mirror images to one another. But when I revolved them in my mind, moving them into place as doubles, I realized that they are flipped, the north-south wings emerging from the longer east-west portion in the top form and from the shorter one in the bottom. (To understand the work, I had to carefully sketch both top and bottom forms, attending to the triangles' sizes, markings, and their placements front to back, and then physically rotate my drawings to discover how exactly they differed.)

Rockburne has said that the linen that makes up each triangular portion of an *Egyptian Painting* (1979–81; see fig. 24) can be up to forty feet long.[5] The bulkier top and bottom forms in *Stele* each seem to be four layers deep as the result of many yards of fabric folded upon itself.[6] Like her *Golden Section Paintings* (1974–76; see fig. 24), the structures of these works are based on strips of material demarcated by sections of the so-called golden mean, which are then folded, cut, and ironed into the various arrangements that are seen. Yet what the viewer experiences is remote from the original, scroll-like rectangular plane; the surfaces of the visible parts of the triangular volumes are often the reverse sides of the material as it is rearranged into a closely pleated packet of linen. Points one might have charted on the long length of the previously unfolded linen are now compacted and proximate, nestled close to one another in a much more contained, and more complicated, topological volume.

2.

Rockburne's *Egyptian Paintings* and *Golden Section Paintings*, with their elaborate schemas of folding and pleating, use two dimensions to push the wall-bound into a third, sculptural dimension. The artist has accomplished this by using complex notions of dimensionality that can only be understood topologically, not according to traditional metrics of space visualized in and measured by grids. The folds contain dense relationships between material and space, inventing situations that demand new considerations of size and scale, surface and interiority, and, ultimately, time and proximity. The various series leading up to and including the *Egyptian Paintings* engage topological theories around set and group theory and dimensionality, as well as broader arguments about the importance of topology as a generative model for understanding language, subjectivity, architecture, and anatomy, thereby reformulating relationships among space, site, body, and matter. Here, her explorations are philosophical and mathematical even though they concern the aesthetics of materiality and space.

Topology above all is a concern with the shapes of spaces and their relative position and connections, unlike the measures of geometries that emphasize angles, distances, and areas. Topologies are frequently examined by transforming or deforming surfaces using techniques of folding, creasing, rolling, bending, or stretching to find so-called homeomorphisms, or continuities among topological classes and similarities found (most often) without employing operations of breaking or cutting.[7]

For Rockburne, key topologists and mathematicians include Georg Cantor, Henri Poincaré, Bernhard Riemann, and especially Max Dehn, who was her teacher at Black Mountain College, near Asheville, North Carolina, in the early 1950s.[8] It is also necessary to position Rockburne's work in dialogue with various theoretical projects of understanding the aesthetic, epistemological, and ontological stakes of topology. Such exploration preoccupies much of twentieth- and twenty-first-century philosophy, as elaborated in Gaston Bachelard's theories of "topology of the problematic" (as opposed to polemical reason); Maurice Merleau-Ponty's notion of anti-Cartesian, nondualistic physical proximity; Michel Serres's arguments about topology as tactility and interrelationality; and Deconstructionists Jacques Derrida's and Gilles Deleuze's discussions on the ontology of the fold, interiority, and the structure of knowledge. Rockburne's work reflects, too, Timothy Morton's more recent theorizations of hyperobjects as manifoldlike concepts whose seemingly atemporal and asynchronous scale exceed our present space-time.[9] Rockburne has often situated her work amid both phenomenological and topological concepts, citing for example Merleau-Ponty's *The Primacy of Perception* (1964): "We must go back to the working, actual body—not the body as a chunk of space or a bundle of functions but that body which is an intertwining of vision and movement."[10]

The very act of working topologically becomes a consideration of the self-reflexive folds of thought in the mind and the creases and mysterious interiority of the body. These are explorations of connections that are not linear or metrically near but ones that jump distances with new kinds of associations and relationships.[11] Likewise, in Rockburne's practice, the work is imagined as an artifact of spatial thinking and develops its own "material imagination," to borrow Bachelard's concept, as a product of procedures that have transmuted their identities between spaces and dimensions.[12] The folded artwork becomes a complex archive of topologically informed gestures by collapsing mundane experiences of material and dimensionality into densely constructed spaces that are sometimes beyond visual apperception. Put another way, according to Rockburne, "The work and I exchange places; I no longer contain the information, the work does."[13]

3.

Prior to and including the *Egyptian Paintings*, Rockburne undertook her projects by activating materials such as carbon paper, crude oil, graphite, or tar to explore relationships of *phi* (interchangeably known as the golden mean, ratio, or section) to set theory, the latter a distinct but not unrelated methodology of topological studies. In 1973 she made a series of irregularly shaped, unframed wall-bound works using linen folded according to this research in math, and then debuted these *Golden Section Paintings* in the 1974 exhibition *Eight Contemporary Artists* at the Museum of Modern Art in New York.[14] Throughout the mid- to late 1970s, Rockburne produced further-shaped pieces in several related bodies of work, some more painterly, as the *Copal* works (1976–77; see fig. 22), made of butcher paper varnished in copal oil while others

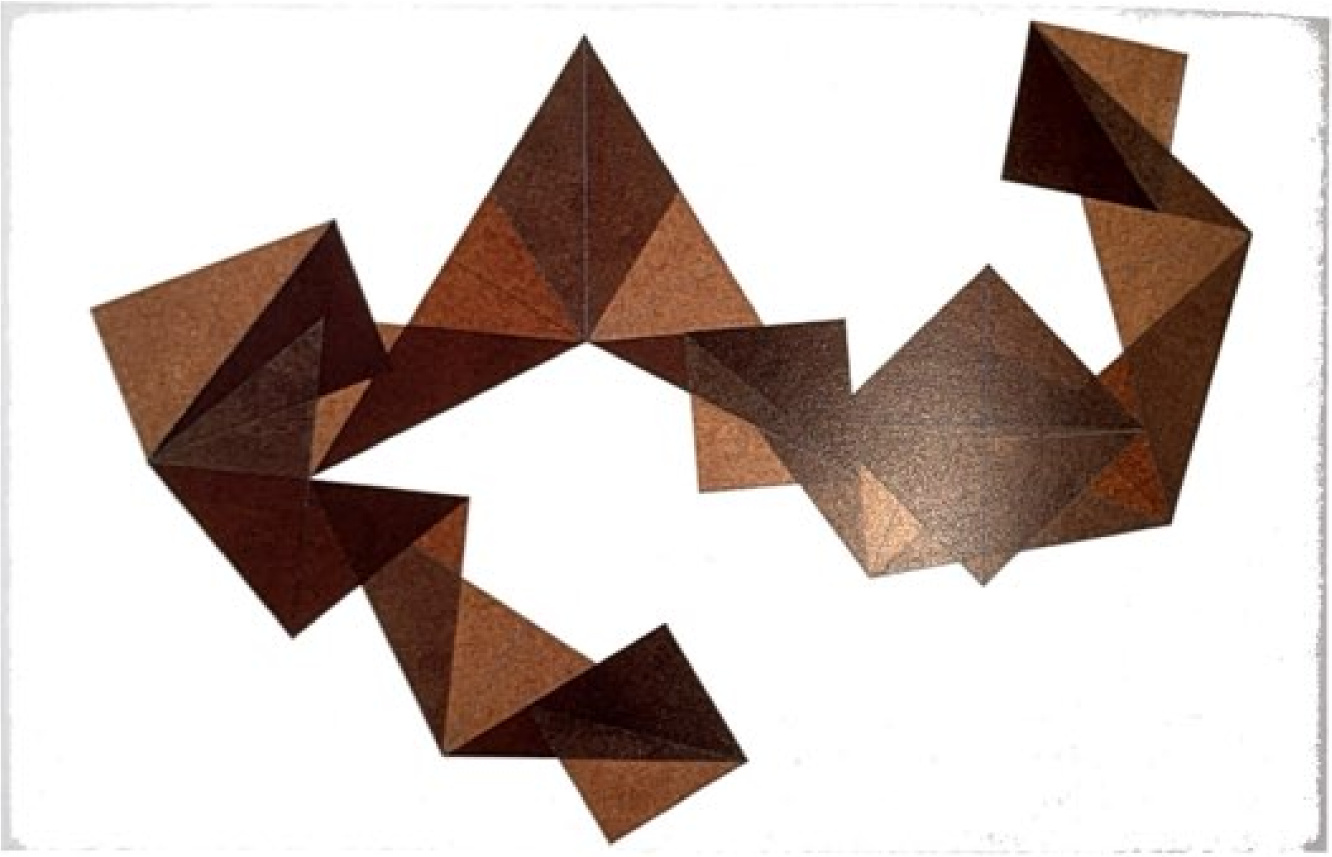


Fig. 22 *Copal VIII*, 1977. Kraft paper, copal oil varnish, colored pencil, Mylar tape, and glue on ragboard, 46½ × 82⅝ inches (118.1 × 209.9 cm). Private collection, New York

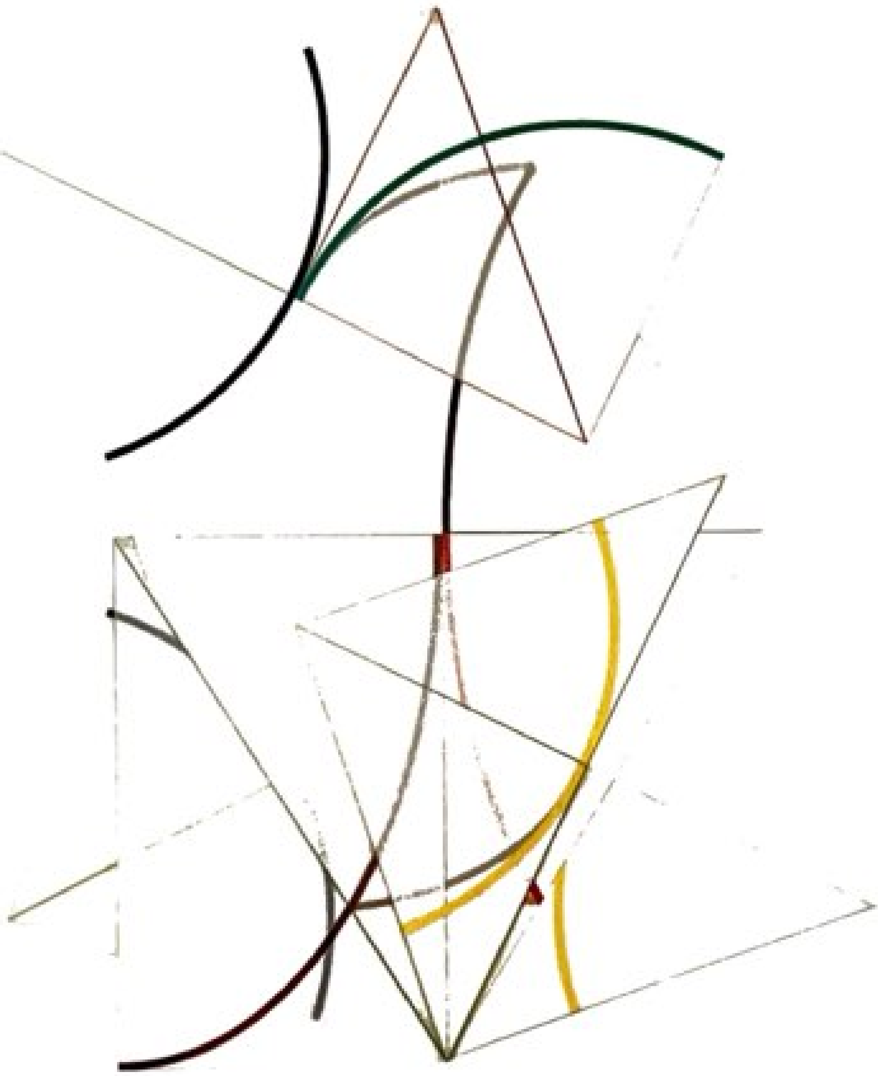
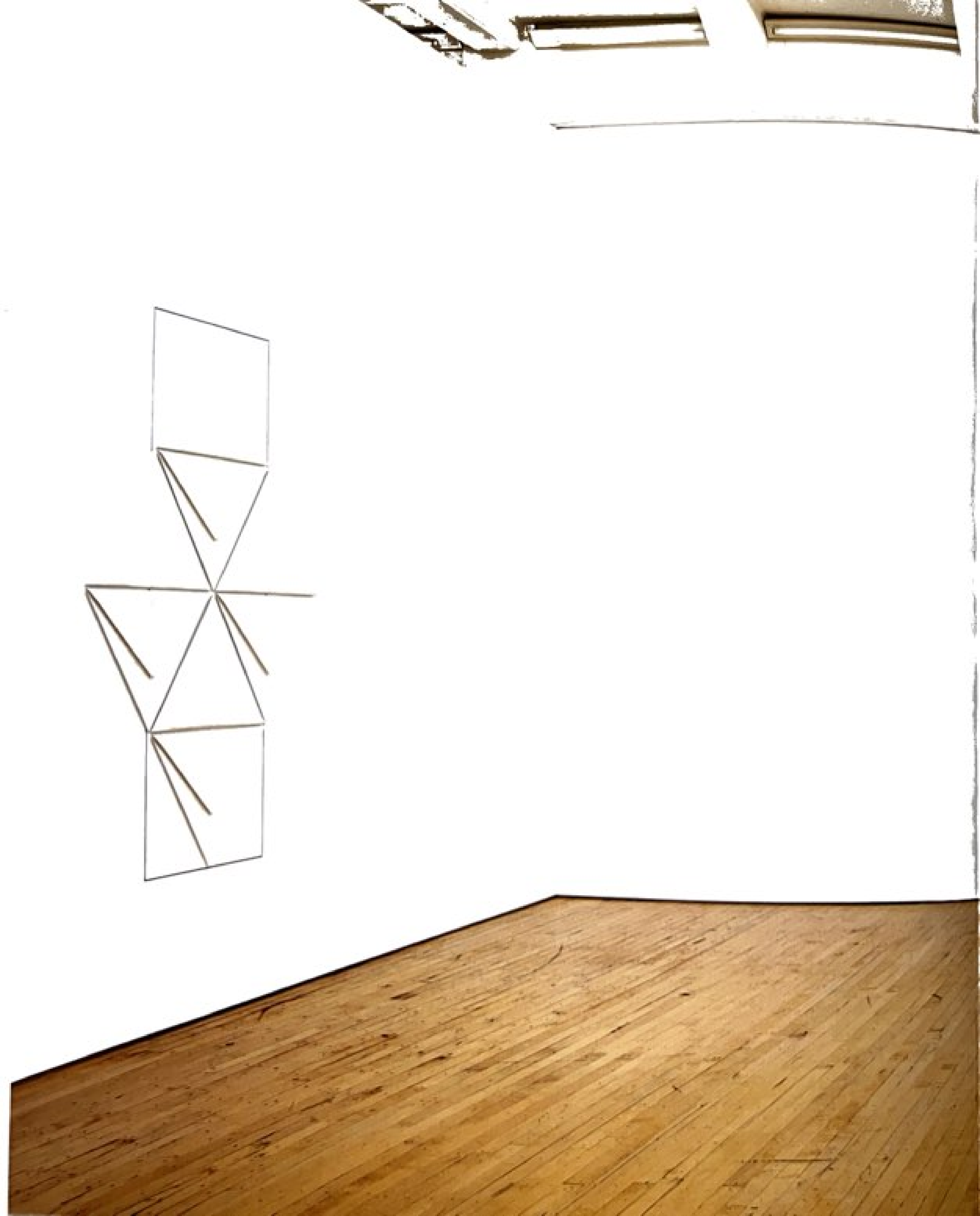
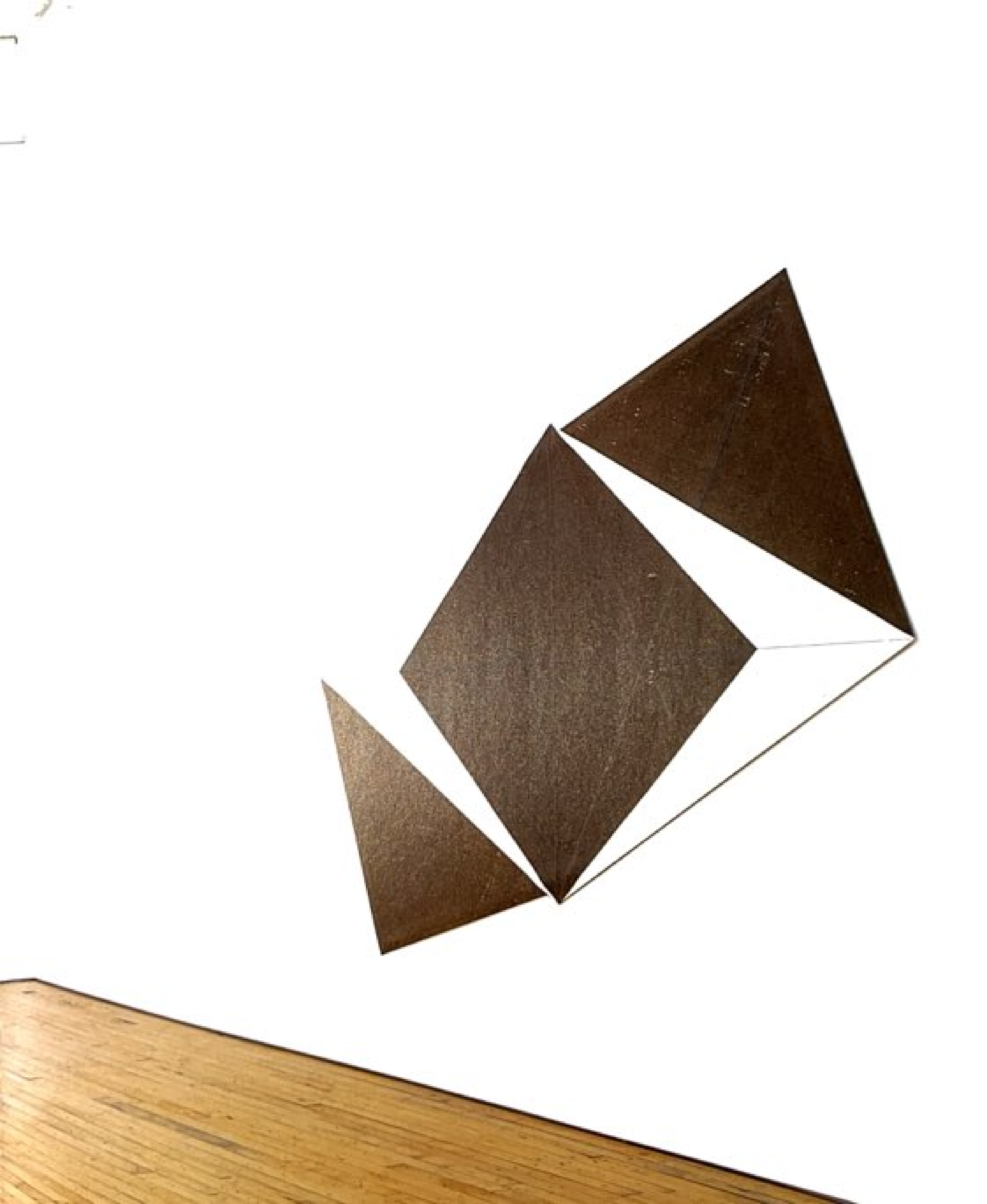


Fig. 23 *Arena III* (from the *Arena* series), 1978. Vellum, Mylar tape, varnish, and colored pencil on ragboard, 54½ × 47 inches (138.4 × 119.4 cm). Cranbrook Art Museum, Bloomfield Hills, Michigan, gift of Rose M. Shuey, from the Collection of Dr. John and Rose M. Shuey

Following pages:

Fig. 24 Installation view, Dia Beacon, New York, 2018–22. From left to right: *Egyptian Painting: Scribe*, 1979; *Egyptian Painting: Basalt*, 1981; *Golden Section Painting: Square Separated by Parallelogram with Diamond*, 1974–76



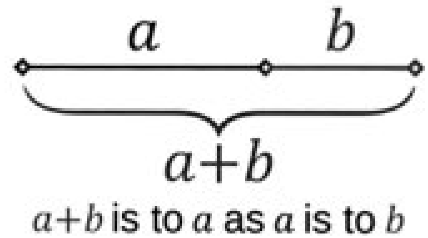


investigated aspects of drawing, including the *Arena* series (1978; see fig. 23), which were composed of colored pencil and pleated, translucent vellum. Though they use eclectic materials and take a variety of forms, nearly every series that Rockburne has undertaken in her long career derives in some way from this study of the shapes and proportions of *phi*.

Phi is an irrational number (that is to say, a never-repeating infinite decimal expansion),[15] defined by Euclid around 300 BCE, as evidenced in a line cut in a "ratio when, as the whole line is to the greater segment, so is the greater to the lesser" (fig. 25).[16]

The calculation that defines *phi* is commonly referred to as the golden mean, ratio, or section, and this ratio appears in nature and math in unusual ways: from the pattern of sunflower seeds arranged in the flower, the arcs that peregrine falcons employ to dive for prey, or the recursions of the Fibonacci sequence to the branching structures of fractals.[17] In a golden rectangle, the two lengths of its four sides are determined by the golden ratio. It can be subdivided into three components: two squares and a daughter golden rectangle, whose proportion is smaller than the mother's by a factor of *phi*.[18] This daughter rectangle can be similarly subdivided, as can all of her daughters, forming a series of continuously diminishing golden rectangles with each of the diagonals connecting these nestled mother-daughter rectangle pairs converging into an ever-receding point, the so-called eye of God (fig. 26).

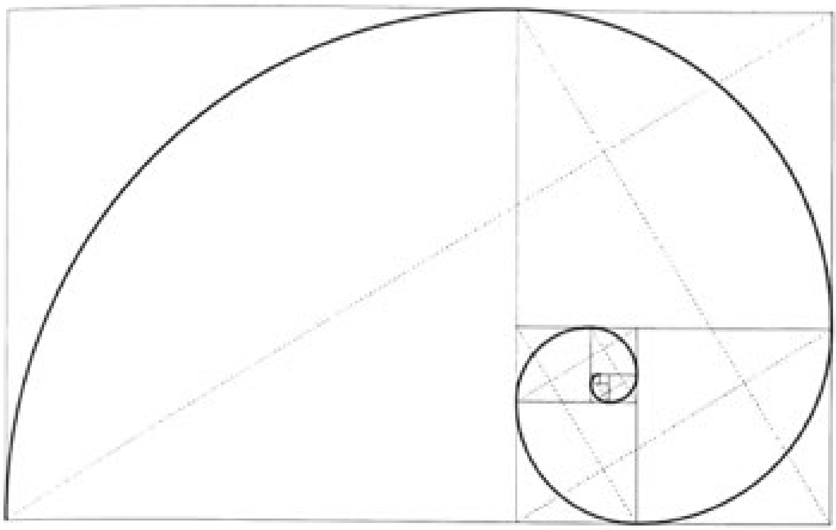
Motivated by the generative possibilities of how these ratios and interactions could expand the work into the surrounding walls, Rockburne pushed her study of the golden section beyond the base rectangle and its diagonals. Beginning in 1972–73, particularly through the series *Drawing Which Makes Itself* (1973; see fig. 27), Rockburne began investigating the lines emerging from the squares and triangles implied by the golden rectangle's proportions, marking and scoring folded parts of her pieces according to the many potential vectors of interrelated and often embedded shapes. To help determine her arrangements and placement of lines, she used the notion of a set as defined by mathematician Felix Hausdorff in the early twentieth century: "A set is formed by the grouping together



of single objects into a whole. A set is a plurality thought of as a unit."[19] Rockburne credits Dehn with introducing her to set theory while she was at Black Mountain College; his pioneering papers in geometry, topology, and combinatorial group theory from 1910–20 made him one of the highest-regarded practitioners in this branch of mathematical logic concerned with the collections of objects. Rockburne later reflected: "Set/group theory provided me with a new and unique way of understanding different kinds of interactions among group relationships, including spatial relationships."[20]

Regarding these interactions that Rockburne describes, Dehn questions how to account for sets of infinite numbers, particularly those that Cantor, the inventor of modern set theory, called transfinite sets.[21] In the early 1870s Cantor was engrossed in a seemingly baffling question: "How many points are there in a line?"[22] Superseding the prior Aristotelian concept of numerable, finite sets pitted against a philosophical category called "the infinite," Cantor proposed that there are different sizes for infinite sets that are nonetheless comparable.[23] Cantor argued that while an infinite series of odd numbers might be seen as differently sized than an infinite series of natural numbers (0, 1, 2, 3, . . . *n*), then a "one-one correspondence" is possible. Every odd number can be paired with a natural number, thus foreclosing the tendency to view the infinite as a refusal of numerability. However, certain infinite sets are larger than others, and therefore correspondence cannot be established; for example, the set of real numbers (every number on a number line) would be larger than those of natural numbers. Discussing Cantor's importance to her

Fig. 25 Line segments in the golden ratio



breakthrough works from the late 1960s and early 1970s, Rockburne stated:

> The construct he invented is a way to define groups of numbers, which can represent anything, including themselves, although they might have different elements or characteristics when bunched together. Each specific number group, in turn, becomes a specific set. This brilliant work provided a kind of "open sesame" into number theory, allowing . . . access to a kind of thinking previously undefined.[24]

Following Cantor, Dehn additionally elaborated on the notion of infinite groups (a group in set theory is a set subject to an operation with certain conditions: taking a set of integers— . . . -2, -1, 0, 1, 2 . . ., for example—together with an additive operation, establishes a group).[25] He began to study groups related to knots, a topic Rockburne also investigated through her work.[26] The knot complement—the complex space around the knot that the knot carves into space—was, to Dehn and most

Fig. 26 Golden rectangle or "eye of God" other topologists, of greater interest than the knot itself because it allows for complex understandings of 3- and higher-dimensional manifolds.[27]

For Rockburne, how a work is experienced dimensionally is of key importance, and the notion of a manifold is central to this experience. Take, for example, a sphere: it is a 2-manifold in that at any point on its (finite) surface *appears* 2D (flat) to a tiny enough observer.[28] Each point on a 2-manifold contains a disk (a continuous and connected portion—a neighborhood), not necessarily flat, of points likewise in the 2-manifold. Rockburne employs the mathematical concept of a neighborhood with regularity to indicate an area around a point, where there's movement without leaving the set. For example, a closed square does not have a neighborhood in its corners or boundaries because then the edge would cross into a different neighborhood. But a bounded set (a house) within the square (the blocks that define a neighborhood) is in a neighborhood. (Except if your house is on one of the perimeter streets, then it may be on the edge of two neighborhoods and not securely in either one of them.)

Following the definition of an *n*-manifold and the prior case of a 2-manifold, every point of a 3-manifold must also have a ball of points around it that is in a 3-manifold.[29] A 3-manifold is a space whose every point locally appears like Euclidian 3-space, which is the 3-manifold space of general human awareness. But "just as there are many different possible two-manifolds [spheres, toruses, etc.], there are many possible three manifolds": 3-spheres, 3-toruses, hyperbolic 3-space, and so on. Euclidian 3-space may only be one of them, and it is certainly not the only one that math can describe.[30]

While a 2-manifold sphere is a hemisphere in 3D space, 3-manifolds exists in 4D space, making them extremely difficult to visualize. (It must be noted that 4D space as described here refers to Euclidian 4D [*xyzw* coordinate] space, which can be considered one of several hyperspaces in which successive coordinates can be added to make more dimensions [the 5D, 6D, and so on]).[31] This is not a description of the so-called (Hermann) Minkowski coordinate space (*xyzt* coordinates, with *t* as a time coordinate) that Albert Einstein expanded upon as "space-time," a related

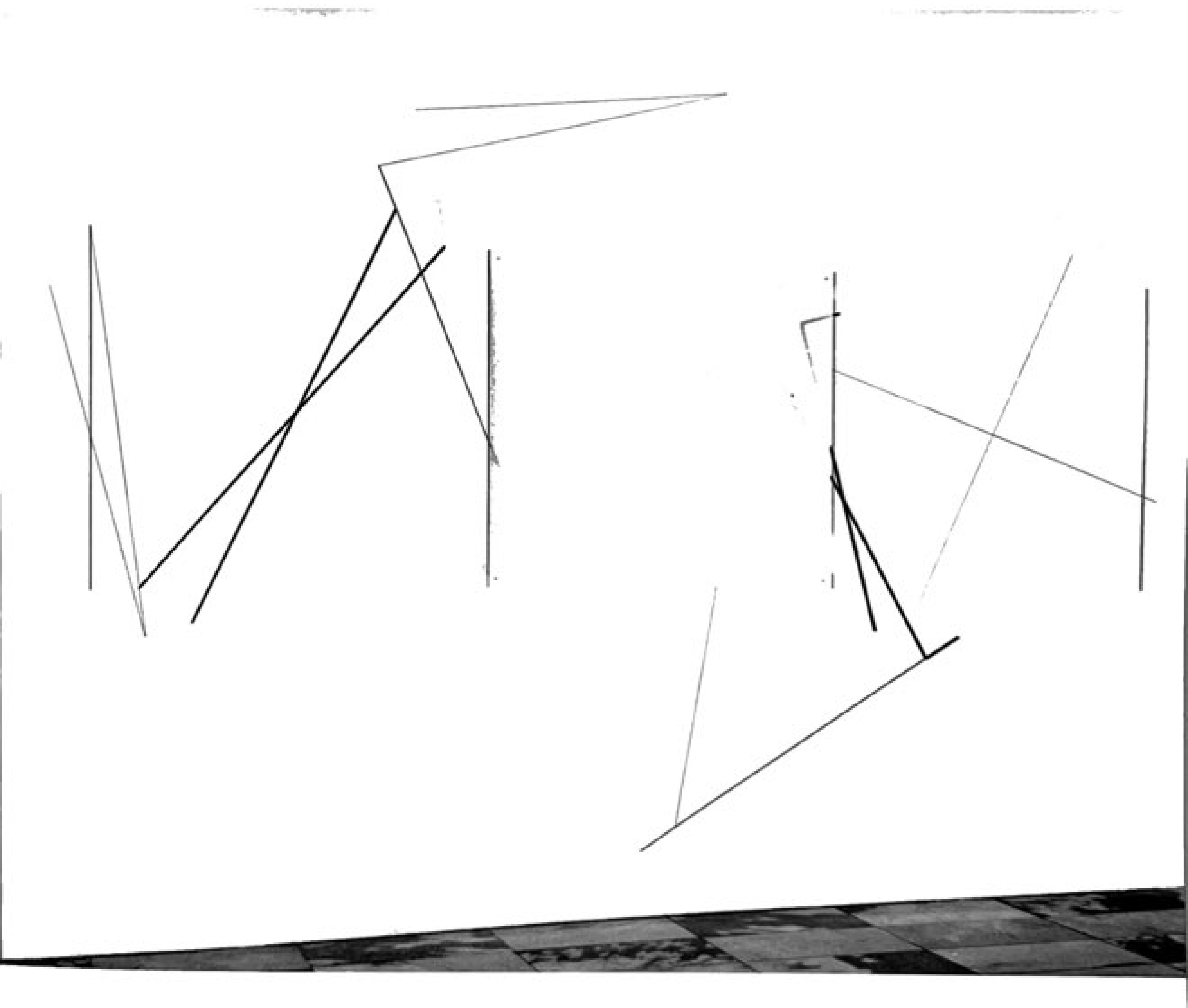


Fig. 27 *Drawing Which Makes Itself: Neighborhood*, 1973. Wall drawing, graphite, colored pencil, and vellum, 107 × 150 inches (271.8 × 381 cm). The Museum of Modern Art, New York, gift of J. Frederic Byers III

but different consideration of time as the fourth dimension.) Referring to this difficulty of visualization, Rockburne has noted, "When utilizing topology, it's always a matter of trying to put a four-dimensional construct on a two-dimensional surface, and that's very hard to do."[32]

There are geometries, Plato wrote, "which can be seen only with the eye of the mind."[33]

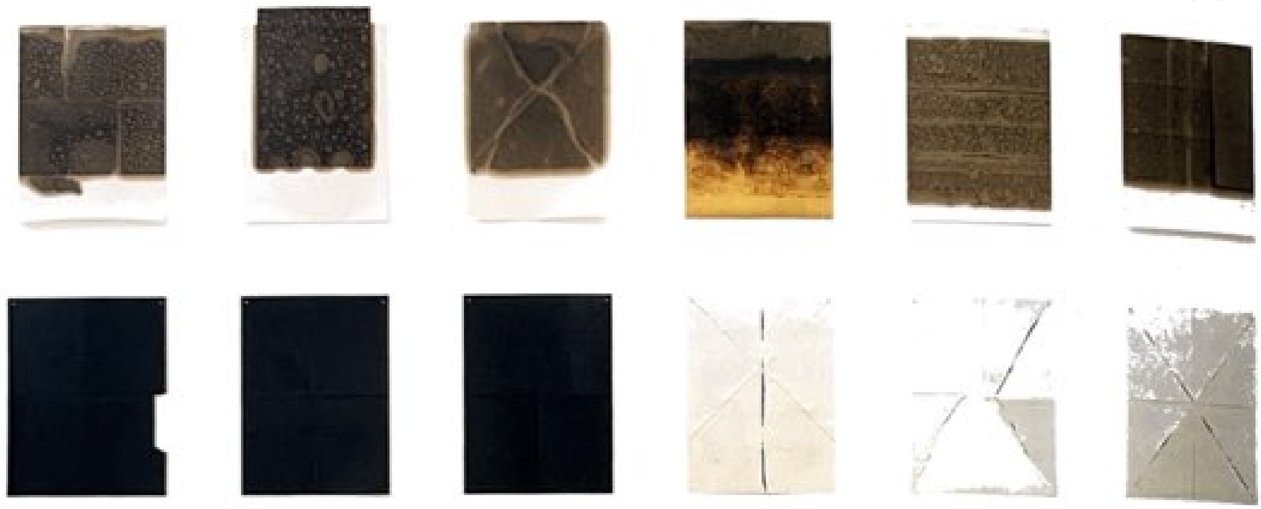
4.

Employing set theory, Rockburne executed her works using the concept of an open set, which provides a sense of nearness that metric sets cannot do with their measured distances. For example, if two dots are marked on opposite places on a piece of paper, they are a set. If the paper is then folded in half to overlap the two dots, the two dots are very near each other topologically, whereas they were and remain metrically very far away on a flat paper plane. These spaces, the folded paper and the paper in a flat plane, remain homeomorphic and share characteristics as a 2D surface in 3D space.

To undertake her explorations of the topological continuity of sets, during the late 1960s and 1970s Rockburne initially employed paper, since it was the medium most associated with the act of folding (think of books, envelopes, letters, boxes, and so on to conjure the pervasiveness of folded paper in our lives). Manipulating paper not only by folding but also by scoring and soaking it, Rockburne made *Ineinander Series* (1972; fig. 28) with creases as points of contact in which layers of paper exchange materials that are painted on them, namely tar and crude oil (the title refers to the German word meaning "into each other"). For works such as *Locus* (1972; fig. 29), she subjected paper to various folds that additionally explore the layering and multidimensionality of *Ineinander Series*. *Locus*, which appears at first to be a monochromatic image, is gallingly complex. It is a group of six forty-by-thirty-inch folded rag-paper sheets hung side by side, each in portrait orientation and similar to a giant paper airplane unfolded. Yet each crease emerges from an intricate process of impressions, layering, and spatial marking by the artist: the graphite lines drawn on the paper; the spines and indentions embossed around those graphite marks when the folded works went through a printing press; the aquatinted resin and titanium paint then applied to folded sections with a copper printing plate; and finally, the lines that form the edges of the paper itself. What appears to be a governing orthogonal principle dictated by the paper's edge begins to break down as the vectors mapping subdivisions of the paper lead to crooked angles and shardlike fragments.

In the half-decade between the *Golden Section Paintings* and the production of the *Egyptian Paintings*, Rockburne inaugurated an even more radical shift in topological exploration, additionally implicating the work more with dimension and shape studies and less with group and set. She did this by removing a stage in the sequence of production that had distinguished her work previously: the act of *un*folding. All her prior work had folded paper, now only to return to a creased version of its original rectilinear, mostly flat shape. Works such as *Intersection* (1971/2018; fig. 30) and *Scalar* (1971; fig. 31) may have accelerated this change of retaining the dimensions of the fold; both implement rolled material to build volume. In *Scalar* a section of paper doubled on itself in anticipation of a crease is instead arrested as a hump protruding from the rest of the work, in the same way as a fold in the landscape. In *Intersection*, rolled plastic covered in crude oil forms a bolt of material unfurling across the floor.

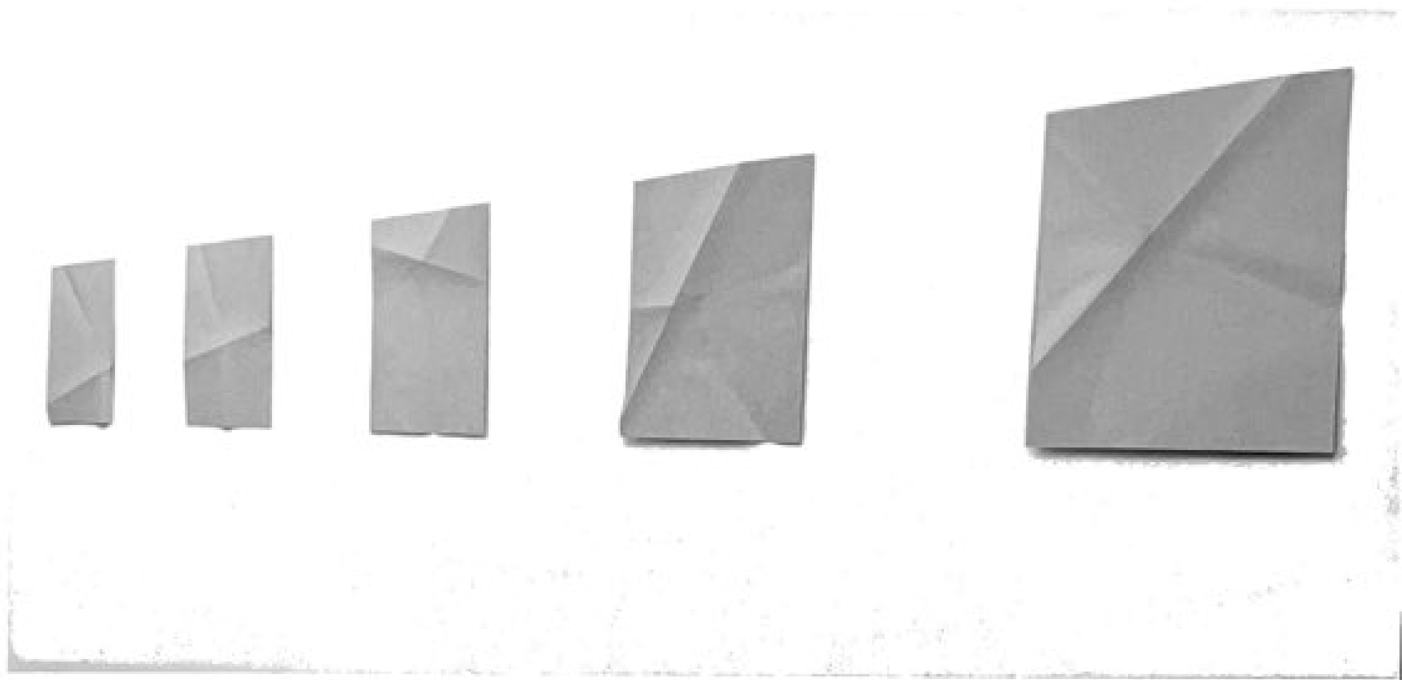
Folding is not merely the domain of paper; it characterizes the manipulation of many other objects and materials: fabrics (clothes, towels, and bed linens), industrial materials (metal and rubber), household furniture (chairs and futons), as well as sundry things, including cake batter and poker hands. And of course, the fold is a constitutive element of living things. Leaves unfold, human bodies bend and unbend at their many joints, and people fold and unfold their arms and legs. The inside of the body is likewise composed of countless folds. Rockburne's investigations of the dimensional properties of vellum and linen overturn the historic instrumentalization of those materials as support for the pictorial



effects of painting or drawing. The work is no longer merely looked at but rather its structure is imagined in its folds. The repetitions that produced it become a seductive comingling of space and time, particularly in works such as the *Arena* series (1978; see fig. 23) that use the transparency of vellum to make the layers a visible record of past gestures.

Folding is a multifarious act: the doubling over creates a duplication (a folded page has four surfaces, not the two previous ventral and dorsal faces) as well as a reduction (those surfaces have as little as half the area). In a fold, sections overlap, and many parts are not visible. In considering Rockburne's work, one is tempted to refer to Derrida's sense of the fold as a "multi-*pli*-cation," among his many puns on the French word *pli*, to fold.[34] In Derrida's case, the consideration of folding was part of his larger argument about dissemination, as opposed to unification and mastery, and he couched this discussion in shared characteristics between

Fig. 28 *Ineinander Series*, 1972. Crude oil and tar on folded paper, 12 parts, each sheet: 40 × 30 inches (101.6 × 76.2 cm). Collection of the artist



the fold and the interiority of the female body, in particular the hymen. To Derrida the hymen, a fold that is both inside and outside, is a threshold space that is constitutively a fold; there is no secondary adoption of folding because it is by definition a fold.[35] There is certainly a skinlike quality to Rockburne's layered works, folds defining the body's intricate surfaces and invisible interior tissues. Skin is a topological surface, able to be stretched and contracted, made visible and secreted by the extra folds of clothing. According to Serres, the sensate awareness of the "self touching itself" is a vastly overlooked form of knowledge and experience:

> I touch one of my lips with my middle finger. Consciousness resides in this contact. I begin to examine it. It is often hidden in a fold of tissue, lip against lip, tongue against palate, teeth touching teeth . . . skin tissue folds in on itself. Skin on skin becomes conscious. . . .

Fig. 29 Detail of *Locus*, 1972. Double-sided aquatint etching; graphite and white oil paint on Strathmore rag paper, 6 parts, each sheet: 40 × 30 inches (101.6 × 76.2 cm). Dia Art Foundation, gift of Dorothea Rockburne Foundation

Fig. 30 *Intersection*, 1971/2018. No. 4 heating oil, plastic, paper, chipboard, and charcoal, 12 x 88 x 98 inches (30.5 x 223.5 x 248.9 cm). Edition 2/3. Dia Art Foundation

Without this folding, without this contact of the self on itself, there would truly be no internal sense, no body properly speaking.[36]

In contrast, Deleuze's argument of the fold emerges from the late seventeenth-century mathematician and philosopher Gottfried Leibniz's concept of the monad, a microcosmos in which each part bears an almost homeopathic relationship to the whole. "Each particle involved is defined by a micro interfold of pleated matter and folded spirit."[37] And here we arrive at a central concern of Rockburne's practice: how the topological spaces of the fold refer to the interiority of her subjective procedures of creativity and how those processes engender and externalize a work becoming a "subject-object."[38]

5.

Rockburne's topologies emerge from contradictory definitions of the abstract thinking of math: it is a true and accurate reflection of the phenomena of the world, or it represents a model of human thought and experience. She has stated, following the seventeenth-century mathematician and physicist Blaise Pascal, that "the logic of the mind is mathematical," yet in a non-self-expressive way, she believes that an artist nonetheless "works within a narrow margin that is emotional."[39] Artist Mel Bochner posed a similar but related question when he introduced Rockburne's work for a feature article in *Artforum* magazine in 1972: "Are such systems of thought an interior reflection of the mechanisms of an objective reality separate from us, or is there a tie between these external structures and the minds that determine the manifestations of our actions?"[40]

How do we reconcile Rockburne's sense of a mind structured by mathematical truths with what she calls "body thinking," a performative, haptic practice also characterized by "very deep and basic emotions—[the] levels of existence."[41] In the math mind, considerations of universal and cosmological truths are requirements of mathematical proof.[42] The materiality of her works and their relationship to tactility, physical

Fig. 31 *Scalar*, 1971. Chipboard, crude oil, paper, and nails, overall: 80 × 114½ × 3½ inches (203.2 × 290.8 × 8.9 cm). The Museum of Modern Art, New York, gift of Jo Carole and Ronald S. Lauder and Estée Lauder, Inc., in honor of J. Frederic Byers III

movement, bodily manipulation, and the specificity of the artists' embodied subjectivity made of and by nature relate to what she terms "a larger collective memory": of human consciousness generally and of art production more particularly.[43]

Serres has written that "topology is tactile," whereas literary scholar and philosopher Steven Connor states that "topography is visual."[44] In Rockburne's work, a topological conception of space allows for the interpenetration of all manner of relationships previously understood dualistically, especially those of subject/maker and object, object and site, and site and subject/viewer. According to Connor, "Topology marks and maintains the meeting of abstract and concrete, the activities of analysis and the primary operations of touch and molding."[45] Rockburne's pleating of matter therefore represents a radical countermodel not merely to contemporaneous works of Minimalist art, motivated as they were by the subdivision of planar surfaces and the motif of the 3D space Euclidian grid, but also to Land artists' and Postminimalists' explorations of entropy and gravity that, with some exceptions, remained couched in the realm of metric understandings of space. Rockburne's shaped drawings and canvases differ radically from those created by artists Ellsworth Kelly, Frank Stella, Richard Tuttle, and others during the 1950s and 1960s in how they engage this folded dimensionality, beyond what critic Lucy Lippard terms the "one-sided continuous surface" that is the typically shaped canvas.[46] According to Rockburne, she is instead employing the "body to make a topological drawing in motion and therefore in time."[47] In Serres's words, "Neglecting point of view and representation," Rockburne's practice "favors mountains, straits, footpaths, Klein bottles, and chance borders that are formed through the contingencies of contact."[48]

Epigraph: Alicia G. Longwell and Kate Bellin, "Selected Chronology of Life and Work with Artist's Statements," *Dorothea Rockburne: In My Mind's Eye*, ed. Alicia G. Longwell (Water Mill, NY: Parrish Art Museum, 2011), p. 148.

1 I had previously written about how the reverse sides of Josef Albers's canvases contained textual recipes about the paints and varnishes he used, yet it is fascinating to consider that in Rockburne's work the back is a *constitutive*, not supplemental, pedagogical element. The vectors of artistic exploration coming in and out of Black Mountain College, where Albers taught from 1933 to 1949 and where Rockburne was a student from 1950 to 1952, are varied and meet sometimes only tangentially. Though Rockburne was attracted by the Bauhaus legacy of Black Mountain and hoped to study with the Alberses, when she arrived there in 1950 they had already departed. For more on Albers's instructional notations, see "Josef Albers and the Ethics of Perception," in Eva Díaz, *The Experimenters: Chance and Design at Black Mountain College* (Chicago: University of Chicago Press, 2014), pp. 15–52.

2 Dorothea Rockburne, "In Conversation: Dorothea Rockburne with David Levi Strauss and Christopher Bamford," interview by David Levi Strauss and Christopher Bamford, *The Brooklyn Rail*, June 19–August 14, 2011, p. 3. Here Rockburne is referring to the three-point perspective she trained in during the 1940s at the École des Beaux-Arts de Montréal, as well as the Montreal Museum School.

3 Dorothea Rockburne was long interested in Egyptian wall reliefs and indicated her desire to complete her own series before seeing the originals: "I had to get those paintings out of my head and into the world before I went there, because after visiting Egypt I would never have the nerve to walk in the ancient footsteps." As she reflected, "When I finally did see them, they were exactly as I had envisioned. The light fell on the linear element of the bas-reliefs, of Ramses and the interior of the Temple of Luxor. The way the Egyptian light illuminates the curved surfaces touched my innermost being." Quoted in Longwell and Bellin, "Selected Chronology," p. 148. Both sunk and bas-relief techniques emerged out of a linear style that was combined with carved hieroglyphs, and sunk reliefs (a technique that forms figures from cuts into a flat surface) in particular require strong light in order to define their shadows.

4 Rockburne has described being fascinated with the dynamic spatial qualities of Egyptian bas-relief (a carving technique that removes the background around the figures) and sunk relief. Egyptian reliefs were always painted, making them paintings, sculptures, and architectural installations all at once.

5 Rockburne, in conversation with the author, October 14, 2022.

6 Rockburne, in an online conversation with Joachim Homann and Jennifer Taback, April 27, 2021, organized by the Harvard University Museums (transcription by the author).

7 A volume, such as a sphere, is topologically homeomorphic to a cube, a pyramid, and a dodecohedron—all solid polyhedra. Puff out those edges and there is still a single volume. These forms are said to be simply connected: that is, they have no holes in any dimension. In contrast, a torus (a donut shape) is not homeomorphic to a sphere, but it is to a coffee cup with a handle. Swell the cavity of the cup and the handle becomes the hole in the torus.

My gratitude extends to mathematician Ricardo Gonzalez for his helpful clarifications about details concerning the concept of homeomorphism in this section. He notes that a continuous map between topological spaces is termed a "homology isomorphism." Gonzalez points out, "Operations of puncturing or cutting may change the homology of a topological space by introducing 'holes' or 'handles' in some dimensions. If two spaces are homeomorphic then the two spaces must have isomorphic homology groups." According to Gonzalez, homology is important because "the [fundamental homeomorphism] theorem [published by Emmy Noether in 1927] states 'If two topological spaces are homeomorphic then they have isomorphic homology groups,' but if we use the contrapositive of this statement, which is 'If two topological spaces have non-isomorphic homology groups, then they are not homeomorphic,' then we can see if the spaces have a different number of *n*-dimensional holes or handles for some *n*, then we can show that they cannot be homeomorphic, and thus some puncturing or cutting must be used to get from one to another." Gonzalez, email correspondence with the author, November 7, 2022.

8 Rockburne also cites Edwin A. Abbott's influential book, originally published in 1884, *Flatland: A Romance of Many Dimensions* (New York: Dover Publications, 1992), as a key reference point. Abbott's work convincingly imagined the appearance and qualities of different *n*-manifolds in various dimensions: for example, a sphere only ever seen as a disk of different widths as it passes through a plane, from the perspective of "flatlanders" living on the plane.

9 Jacques Derrida, Gilles Deleuze, and Michel Serres are discussed later in this essay. For more on Gaston Bachelard's topological thinking, see Mario Castellana, "Topological Reason in Bachelard and Surroundings: Kurt Godel," *Orbis Idearum* 8, no. 2 (2020), pp. 11–35. Michel Serres, *The Five Senses: A Philosophy of Mingled Bodies* (London: Bloomsbury Academic, an imprint of Bloomsbury Publishing, 2016), pp. 25–26. For more on Serres and topology, see Steven Connor, "Topologies: Michel Serres and the Shapes of Thought," *Anglistik* 15 (2004), pp. 105–17, and Steven Connor, "Michel Serres's Five Senses," in *Empire of the Senses: The Sensual Culture Reader*, ed. David Howes (Oxford: Berg, 2005), p. 319. Timothy Morton, *Hyperobjects: Philosophy and Ecology after the End of the World* (Minneapolis: University of Minnesota Press, 2013).

10 Dorothea Rockburne, "Moveable Feast," *Artforum*, November 2011, pp. 218–19.

11 Anna Lovatt has written of this relationship, "Rather than deploying self-generating procedures to eliminate subjective impulses, Rockburne regarded their reflexive structure as a metaphor for the formation of the subject . . . an investigation of selfhood through a series of reflexive, nonreferential procedures." Anna Lovatt, "Dorothea Rockburne: Intersection," *October* 122 (Fall 2007), p. 42.

12 Gaston Bachelard, *Earth and Reveries of Repose: An Essay on Images of Interiority*, trans. Mary McAllester Jones (Dallas: Dallas Institute Publications, 2011), p. 17.

13 Dorothea Rockburne, "An Interview with Dorothea Rockburne," interview by Jennifer Licht, *Artforum*, March 1972, p. 34.

14 The Museum of Modern Art show was curated by Jennifer Licht, who had earlier interviewed Rockburne for the artist's 1972 *Artforum* feature story. The exhibition was panned by critics such as Thomas Hess, Robert Hughes, and Tom Wolfe in his 1975 book *The Painted Word*. In addition to Rockburne, the exhibition included works by Vito Acconci, Alighiero e Boetti, Daniel Buren, Hanne Darboven, Jan Dibbets, Robert Hunter, and Brice Marden.

15 Like the more familiar irrational number *pi* (3.14159 . . .), which is the ratio of the circumference of a circle to its diameter, one might think *phi* (1.61803 . . .) is a never-ending number. But according to Gonzalez, "Use of the phrase 'never-ending' may not be exact, as this idea refers to the notion of having no limit, yet the number itself is finite." One can instead think of it as having "infinite decimal expansion, or that the decimal expansion is never ending." Gonzalez, email correspondence with the author, November 7, 2022.

16 Euclid called the golden ratio an "extreme and mean ratio." Euclid, *Elements*, book VI, proposition 2, http://alepho.clarku.edu/~djoyce/java/elements/bookVI/bookVI.html.

17 See Mario Livio, *The Golden Ratio: The Story of Phi, The World's Most Astonishing Number* (New York: Broadway Books, 2002), pp. 109–23.

18 For more about the properties of the golden rectangle, see ibid., pp. 62–91.

19 Felix Hausdorff quoted in Mary Tiles, *The Philosophy of Set Theory: An Historical Introduction to Cantor's Paradise* (Mineola, NY: Dover Publications, 1989), p. 99.

20 Rockburne, "Selected Chronology," p. 140.

21 Dehn's papers "On the Topology of Three-Dimensional Space" (1910) and "On Infinite Discontinuous Groups" (1911) garnered him great acclaim in the math community. For more on Dehn's theories and career, see David Peifer, "Max Dehn and the Origins of Topology and Infinite Group Theory," *The American Mathematical Monthly* 122, no. 3 (March 2015), pp. 217–33. For a discussion of what Dehn might have taught Rockburne at Black Mountain, see David Peifer, "Dorothea Rockburne and Max Dehn at Black Mountain College," *Notices of the American Mathematical Society* 64, no. 11 (December 2017), pp. 1313–18.

22 Tiles, *The Philosophy of Set Theory*, p. 3.

23 Recent reconstructions of the palimpsests that make up the so-called Archimedes codex have revealed that, working about one hundred years after Aristotle in the mid-third century BCE, Archimedes "knew of an *actual* infinity . . . the contemplation of an actual infinite set of objects,"

something Gottfried Leibniz and Isaac Newton could not resolve: "The underlying logic of handling potential infinities was not clearly worked out by the inventors of the calculus." Reviel Netz and William Noel, *The Archimedes Codex: How a Medieval Prayer Book Is Revealing the True Genius of Antiquity's Greatest Scientist* (Philadelphia: Da Capo Press, 2007), p. 52.

24 Rockburne quoted in "Selected Chronology," pp. 141–42. "Cantor's paradise," to use mathematician David Hilbert's memorable 1926 phrase, helps describe the importance to math of Rockburne's "open sesame" revelation about the comparability of the infinite classes as discrete sets.

25 "One has to be careful with definition of group," Gonzalez warns, "since not any set with an operation defines a group. A group is a set *G*, with an operation * (the star is a placeholder for the operation), such that

1) the operation * is associative
2) the set is closed under *
3) there exists an identity element
4) inverses exist based on the identity element and the operation." Gonzalez, email correspondence with the author, November 7, 2022.

26 Topologically any knot is homeomorphic to a circle, meaning that any "experience" of, for example, an ant traveling on that line appears to follow a continuous, connected curve. Gonzalez mentions that it is always necessary to clarify "what state these objects are 'in,'" that is, the dimensionality in which they exist. For example, "A knot is an embedding of S^1 (or a circle) into R^3" (R^3 is one way in math to notate a 3-manifold). Gonzalez, email correspondence with the author, November 7, 2022.

27 Dehn's study of knots resulted in several topological innovations still employed today, including the so-called Dehn's Surgery, in which a twisted knot (essentially a solid torus) is embedded in a 3-manifold to create a new 3-manifold. For more on Dehn and the topology of knot complements, see Colin C. Adams, *The Knot Book: An Elementary Introduction to the Mathematical Theory of Knots* (Providence, RI: American Mathematical Society, 2004), pp. 259–60.

28 In technical terms, an *n*-manifold is a topological space with the property that each point has a neighborhood that is homeomorphic to an open subset (here, a continuous portion) of *n*-dimensional Euclidean space. As Ricardo Gonzalez explains, "Funny enough, this is the reason why when we look off into the distance, say while standing on a beach, the horizon looks like a flat line. Locally the ground—the surface of the Earth, which is a 2-manifold—appears like subset R^2, or as you said, a flat disk, when in fact the ground (i.e., the Earth) sits in R^3." Gonzalez, email correspondence with the author, November 7, 2022.

29 The study of 3-manifold objects is surprisingly complex, due to the long unsolved proposition posed in 1904 by Henri Poincaré that suggested the only 3-manifold in which every loop can be shrunk to a point is the 3-sphere. Note that a 3-sphere, as Richard Earl puts it, "Does not mean a solid ball in 3D, but rather a 3D spherical shell that sits naturally in 4D." Richard Earl, *Topology: A Very Short Introduction* (Oxford: Oxford University Press, 2019), p. 114. The Poincaré conjecture was considered by many to be the most pressing mathematical problem of the twentieth century. The reclusive Russian mathematician Grigori Perelman proved Poincaré's conjecture in a series of three papers published in 2003.

30 Adams, *Knot Book*, p. 244.

31 For a discussion of the nonvisual nature of 4D geometry, see Morris Kline, *Mathematics for the Nonmathematician* (New York: Dover Publications, 1967), pp. 275–77.

32 Dorothea Rockburne, "Interviews: Dorothea Rockburne Talks about Her Retrospective," interview by Lauren O'Neill-Butler, *Artforum.com*, July 6, 2011.

33 Plato, *The Republic*, book VI, trans. Benjamin Jowett, http://classics.mit.edu/Plato/republic.7.vi.html.

34 Jacques Derrida, "The Double Session," in *Dissemination*, trans. Barbara Johnson (Chicago: University of Chicago Press, 1983), p. 270. Original publication in French in 1972.

35 This text contains dozens of references to the hymen, its penetration and "violation" as a loss of virginity, positioning the female body as a vulnerable one separate from (but ultimately

constituted and dominated by) the mastery of culture, textuality, etc. In other texts he considers the foreskin, and in particular the "violence" of circumcision, "the first event to write itself" on the body. Jacques Derrida quoted in Geoffrey Bennington and Jacques Derrida, "Circumfession," in *Jacques Derrida*, trans. Bennington (Chicago: University of Chicago Press, 1993), pp. 120–21.

36 Serres, *Five Senses*, p. 22.

37 Arkady Plotnitsky, "Algebras, Geometries, and Topologies of the Fold: Deleuze, Derrida, and Quasi-Mathematical Thinking (with Leibniz and Mallarmé)," in *Between Deleuze and Derrida*, ed. Paul Patton and John Protevi (London: Continuum, 2003), p. 106.

38 "It seems reasonable that paper acting upon itself through subject imposed translations could become a subject-object." Dorothea Rockburne, "Notes to Myself on Drawing," *Flash Art*, no. 42–43 (April–May 1974), p. 66. The same text is dated "April 1973" in Jennifer Licht's catalog for *Eight Contemporary Artists* (New York: Museum of Modern Art, 1974), p. 50. Rockburne has also implied that the site can become an almost animated subject: "The place and the work should be an integrated thing that presents a point of change. To turn the place in which I work into the object, by object I mean object as experience." Rockburne, "An Interview with Dorothea Rockburne," p. 36. In this sense Rockburne's circulation of instructional diagrams distributed on handheld placards for gallery visitors to *Dorothea Rockburne: Drawing Which Makes Itself*, her 2013–14 exhibition at MoMA, expands the notion of the object as the focus of a visual experience, instead allying the viewer with the procedures of production. According to Matthew Farina's review of the show, "The diagrams are handwritten by the artist, listing detailed steps for the installation of each piece: how to fold or score the materials, when to use an 8H pencil, how to establish a specific degree of overlap, and so on. With her instructions highlighting the role of process, one can calibrate exactly how the sheets of carbon paper were positioned as they were scored." Matthew Farina, "Dorothea Rockburne, 'Drawing Which Makes Itself,'" *The Brooklyn Rail*, November 5, 2013, unpaginated.

39 Dorothea Rockburne, "Dorothea Rockburne by Saul Ostrow," *BOMB*, October 1, 1988, pp. 31–33. In this vein, Rockburne has stated, "Because art is made by human beings and is meant to communicate, a personal and emotional content is bound to be reflected in the art object." Rockburne, "Plates with Artist's Statements," *In My Mind's Eye*, p. 64.

40 Mel Bochner, "A Note on Dorothea Rockburne," *Artforum*, March 1972, p. 28.

41 Rockburne, "Dorothea Rockburne by Saul Ostrow," pp. 31–32.

42 As Rockburne said of Dehn: "He wasn't teaching mathematics, I realized later. He was teaching cosmology." Rockburne, "In Conversation," p. 7.

43 Ibid., p. 12.

44 Serres, *Five Senses*, p. 99, and Connor, "Michel Serres's *Five Senses*," p. 319.

45 Steven Connor, "Topologies," *Anglistik* 15 (2004), pp. 105–17.

46 Lucy Lippard, reviewing the 1964 Solomon R. Guggenheim Museum, New York, exhibition *The Shaped Canvas*, curated by Lawrence Alloway, "New York Letter," *Art International* 9 (March 1965), p. 46. I would argue that an artist like Lee Bontecou, who began making shaped, sculptural, wall-bound works in 1959, could be more productively compared to Rockburne's low reliefs than the works included in Alloway's show, although Bontecou's practice did not emerge from a study of topological concerns. See Frances Colpitt, "The Shape of Painting in the 1960s," *Art Journal* 50, no. 1 (Spring 1991), pp. 52–56.

47 Rockburne, "Selected Chronology," p. 145.

48 Serres, *Five Senses*, pp. 25–26.