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# The Fourth Dimension and Non-Euclidean Geometry in Modern Art: Conclusion

Linda Dalrymple Henderson

## THE NEW GEOMETRIES IN ART AND THEORY 1900-1930

During the first three decades of the twentieth century, the fourth dimension was a concern common to artists in nearly every major modern movement: Analytical and Synthetic Cubists (as well as Duchamp, Picabia, and Kupka), Italian Futurists, Russian Futurists, Suprematists, and Constructivists, American modernists in the Stieglitz and Arensberg circles, Dadaists, and members of De Stijl. While the rise of Fauvism and German Expressionism preceded the first artistic application of higher dimensions by the Cubists, Matisse himself later demonstrated a passing interest in the subject. And, even though the German Bauhaus was not an active center of interest in the fourth dimension, it, too, was touched by the idea through the propagandizing of Van Doesburg, Kandinsky's own awareness of the idea, and the growing interest in Germany in the space-time world of Einstein.

Although by the end of the 1920s the temporal fourth dimension of Einsteinian Relativity Theory had largely displaced the popular fourth dimension of space in the public mind, one further movement was to explore a fourth spatial dimension (and non-Euclidean geometry): French Surrealism. While acknowledging Einstein's theories, André Breton and various Surrealist painters during the 1930s and 1940s retained many of the pre-Einsteinian implications of 'the fourth dimension' and non-Euclidean geometry.

Non-Euclidean geometry never achieved the widespread popularity of the fourth dimension, which possessed many more nongeometric associations. As a result, the list of artists and critics actively interested in non-Euclidean geometry was considerably smaller. In addition to Duchamp and the Cubists Metzinger and Gleizes, the main advocates of non-

Euclidean geometry were the Russian poet Khlebnikov and the painter El Lissitzky, and rebel spirits such as Benjamin de Casseres, Dada founder Tristan Tzara, and, later, the Surrealists. For all of these individuals, whether they explored its principles or not, non-Euclidean geometry signified a new freedom from the tyranny of established laws. Codified in Poincaré's philosophy of conventionalism, this recognition of the relativity of knowledge was a powerful influence on early twentieth-century thought. Thus, even artists who concentrated on the fourth dimension alone owed something to the non-Euclidean geometries that had prepared the way for the acceptance of alternative kinds of space.

Like non-Euclidean geometry, the fourth dimension was primarily a symbol of liberation for artists. However, the notion of a higher dimension lent itself to painterly applications far more easily than did the principles of non-Euclidean geometry. Specifically, belief in a fourth dimension encouraged artists to depart from visual reality and to reject completely the one-point perspective system that for centuries had portrayed the world as three-dimensional. The late nineteenth-century resurgence of idealist philosophy provided further support for painters to proclaim the existence of a higher, four-dimensional reality, which artists alone could intuit and reveal.

Among those who subscribed to this view of the fourth dimension were the Cubists, Kupka, the Futurists Boccioni and Severini, Max Weber, Malevich and his Russian colleagues, and Mondrian and Van Doesburg. For the artists of this group whose distrust of visual reality was most deep-seated, belief in a fourth dimension was an important impetus to create a totally abstract art. Malevich's 'objectless' style was the most directly indebted to the fourth dimension, but both Kupka and Mondrian accepted the idea as a supplement to their Theosophical beliefs. And, even though the term *the fourth dimension* does not figure in Kandinsky's early writings, the belief of his era in the possibility of higher dimensions stands, along with Steiner's Christian Theosophy, behind his

antimaterialist philosophy. Two last figures who were less inclined toward otherworldly beliefs, Picabia and Larionov, also identified total abstraction in art with the fourth dimension.

The fourth dimension also supported bold experimentation by those painters who did not reject visual experience entirely. Associated initially with the geometry of Cubism's faceted forms and multiple views, the fourth dimension was also variously identified with gravity (Duchamp, Schamberg) as well as antigravity (Malevich, Lissitzky, Van Doesburg), spirals (Boccioni, Severini), the airless Platonic realm of Synthetic Cubism, and, in America, with tactility and 'significant form' in the art of Cézanne. Because of the time element in hyperspace philosophy, motion also became an important attribute of the fourth dimension—in the motion studies of Kupka, Duchamp, and Boccioni, and in the abstract art of Malevich, Lissitzky, and Van Doesburg, as well as in architecture (Van Doesburg, Fuller) and film (Bruguière, Eisenstein).

Shadows, mirrors, and virtual images were added to the four-dimensional vocabulary of the artist by Duchamp, whose approach to the subject was unique in this period. If Duchamp at first shared his Cubist colleagues' idealist belief in the fourth dimension, his attitude quickly became more analytical. For Duchamp the *n*-dimensional and non-Euclidean geometries were a stimulus to go beyond traditional oil painting to explore the interrelationship of dimensions and even to reexamine the nature of three-dimensional perspective. Like Jarry before him, Duchamp also found something deliciously subversive about the new geometries with their challenge to so many long-standing 'truths'. The motives behind Duchamp's interest in the fourth dimension in fact represent an alternative strain to the idealist visions of a higher reality that supported the birth of abstract art.

This revolutionary aim was often combined with the more utopian, idealist view of the fourth dimension in the calls for a new 'language' that were widespread in this era. One or the other goal was usually dominant, however, according to

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the degree of the author's distaste for the three-dimensional world and the status quo. Thus, when Kupka, Weber, or even Pawlowski talked of a new language for the future, their criticisms of three-dimensional reality were benign in comparison to Ouspensky's arguments against current logic and reason. A similar militantly antirational intent was behind the advocacy of the new geometries by Kruchenykh, the Dadaists, and the Surrealists. Whether overtly subversive or an idyllic vision of higher truth, 'the fourth dimension' as a rationale for exploring new kinds of language in art, literature, and music justified some of the most advanced experimentation of the era. The rediscovery of 'the fourth dimension' thus provides specific links between the artistic avant-garde and pioneers such as Gertrude Stein and Varèse.

Ranging from a geometric, purely spatial concept in the hands of Poincaré to a mystical vision provisionally incorporating time in the hyperspace philosophy of Hinton, Bragdon, and Ouspensky, 'the fourth dimension' offered the possibility of a variety of artistic interpretations. Always signifying a higher dimension of space, 'the fourth dimension' nevertheless accommodated differing proportions of geometry and mysticism as well as space and time. As in the case of Van Doesburg, in the end it was hyperspace philosophy, with its temporal element as a means to higher space, which blended more easily with Einsteinian Relativity. When the popularization of Relativity Theory in the 1920s enthroned time as the fourth dimension and Einstein as supreme scientist and philosopher, both Poincaré and a purely geometric fourth dimension were soon largely forgotten by the public and artists alike. Generally, during the 1930s and 1940s only artists of a somewhat mystical nature or, as in the case of the Surrealists, an antirational attitude would continue to see validity in discussing a spatial fourth dimension in the face of Relativity Theory.

Yet, if by 1930 the widespread 'romance of many dimensions' between the public and the fourth dimension was over, this notion, along with non-Euclidean geometry, had played a vital role in the development of modern art and theory. By rediscovering the contemporary sources on the subject and, particularly, by restoring figures such as Poincaré and Hinton to their rightful prominence, our view of early twentieth-century thought is considerably enriched. More importantly, once the artistic impact of the new geometries is under-

stood, the art and critical literature of the early modern era regain a unity and a level of meaning that has long been lost.

#### THE FOURTH DIMENSION AND NON-EUCLIDEAN GEOMETRY IN ART AND THEORY SINCE 1930

By the 1930s at least two factors militated against artistic interest in the spatial interpretation of the fourth dimension. Besides the redefinition of the fourth dimension as time in Relativity Theory, formalist art theory increasingly discouraged the presence of deep space in modern painting. Even Van Doesburg, the last major advocate of the fourth dimension, had carefully avoided violating the two-dimensional surface of his canvases and had found other means, such as the diagonal, to allude to higher dimensions. Thus, when the *Manifeste Dimensioniste* was published in Paris in 1936, over a collection of signatures ranging from Joan Miró and Hans Arp to Moholy-Nagy, Duchamp, Picabia, and Kandinsky, it was simply a generalized echo of earlier beliefs, recast in the terminology of space-time.

Written by the painter Charles Sirato, the *Manifeste Dimensioniste* was published by the *Revue N + 1* in 1936. After citing the theories of Einstein as one of the impetuses for "Dimensionisme", the manifesto declares,

"Animated by a new conception of the world, the arts in a collective fermentation (Interpenetration of the Arts) have begun to stir. And each of them has evolved with a new dimension. Each of them has found a form of expression inherent in the next higher dimension, objectifying the weighty spiritual consequences of this fundamental change. Thus, the constructivist tendency compels:

- I. Literature to depart from the line and move in the plane . . .
- II. Painting to leave the plane and occupy space: Painting in space, Constructivism, Spatial Constructions, Multimedia Compositions.
- III. Sculpture to abandon closed, immobile, and dead space, that is to say, the three-dimensional space of Euclid, in order to conquer for artistic expression the four-dimensional space of Minkovsky.

At first 'solid' sculpture (classical sculpture) broke open and, in introducing into itself the 'void' sculpted and determined from the interior space—and then movement—transformed itself: hollowed out sculpture, open sculpture, mobile sculpture, motorized objects.

Then must come the creation of an absolutely new art: cosmic art (Vaporization of sculpture, 'Syno-Sense' theater—provisional designations). The total conquest of the art of four-dimensional space (a 'Vacuum Artis' until now). Rigid material is abolished and replaced by gaseous materials" [1].

The manifesto was signed by Ben Nicholson, Alexander Calder, Vincent Huidobro, Kakabadzé, Kobro, Joan Miró, Moholy-Nagy, Antonio Pedro, Arp, P. A. Birot, Camille Bryen, Robert Delaunay, César Domela, Marcel Duchamp, Kandinsky, Fred Kann, Kotchar, Nina Negri, Mario Nissim, Fr. Picabia, Prampolini, Prinner, Rathamann, Ch. Sirato, Sonia Delaunay, and Sophie Taeuber Arp.

Sirato's text was vague enough in its references to both the fourth dimension and non-Euclidean geometry to be acceptable to the manifesto's wide range of signatories. Members of the Abstraction-Création group were satisfied, since the manifesto did not advocate space in painting, but rather that painting should move into three-dimensional space in the form of constructions [2]. It was sculpture that was to incorporate the fourth dimension—but initially, at least, in the form of motion, in line with Moholy-Nagy's interpretation of 'space-time' as well as with the 'Precision Optics' of Duchamp, who at that time was producing his *Rotoreliefs*. And for the more mystical or adventuresome members of the group, there was the prospect of the ultimate 'cosmic art', in which sculpture would be vaporized and consist entirely of gaseous materials. Kandinsky and others grounded in Symbolist thinking would certainly have responded to Sirato's evocation of a 'Syno-Sense' theater with possible affinities to earlier experiments in color music.

Although Sirato's prediction of a new, cosmic art produced few results at the time, the mystical component of the *Manifeste Dimensioniste* reflected what was to become the main thread of continuity with past thinking about the fourth dimension. Apart from the Surrealists, painters working in the other dominant mode of the 1930s, geometric abstraction, rarely demonstrated an interest in a fourth spatial dimension unless their personal philosophies inclined toward the spiritual or mystical.

A number of relevant sources published in the late 1920s and early 1930s reinterpreted hyperspace philosophy in the light of Relativity Theory [3]. The most important of these texts was the Symbolist Maurice Maeterlinck's *La Vie*

de l'espace, a remarkable résumé of the early twentieth-century literature on the fourth dimension. Maeterlinck's lengthy section of *La Vie de l'espace* entitled "La Quatrième Dimension" deals with nearly all the major figures who wrote on the subject, including Hinton, Pawlowski, and Ouspensky, as well as Jouffret, Poincaré, and Boucher. Although Maeterlinck refers to Einstein's new theories and even quotes from A. S. Eddington's *Space, Time and Gravitation*, he considered Relativity Theory to be only one aspect of 'the fourth dimension'. Like Pawlowski before him, Maeterlinck refused to sacrifice the idealist and even mystical associations of a spatial fourth dimension in favor of time as the fourth dimension [4].

The American painter I. Rice Pereira, who matured in the 1920s, may well have read Maeterlinck's book or another of the contemporary reappraisals of hyperspace philosophy. Whatever the manner in which she was introduced to Hinton's writings, however, his books became a crucial source for her own double-edged investigation of the fourth dimension [5]. Sensitive to the mystical and intuitive aspects of the fourth dimension, Pereira also studied the physics of Einsteinian Relativity during the 1930s. The result was what she termed a "pure scientific or geometric system of esthetics", which sought "to find plastic equivalents for the revolutionary discoveries in mathematics, physics, biochemistry and radioactivity" [6]. Within this highly scientific-sounding philosophy of art, however, Pereira also incorporated elements of hyperspace philosophy.

*Oblique Progression* of 1948 illustrates the type of spatially complex works Pereira created in the 1940s, relying both upon spatial clues and upon various patterns of reflecting light. Light, space, and time were consistent themes in the philosophical texts Pereira subsequently published, along with a belief in the evolution of consciousness based on hyperspace philosophy. In *The Nature of Space* of 1956 she would write,

"The apprehension of space and the development of human consciousness are parallel. The more energy that is illuminated and redeemed from the substance of matter, the more fluid the perceptions become and the more the mind sums up into abstraction. The mind's capacity for dimensionality and the structure of consciousness become available through experiencing one's own action. . . . One cannot explore a dimension unless the constellation of one's own

consciousness is prepared to apprehend it" [7].

As late as 1966, in *The Transcendental Formal Logic of the Infinite: The Evolution of Cultural Forms*, Pereira still sounded much like one of the devotees of evolving consciousness and dimensional awareness in the Stieglitz circle in 1913 [8].

A closer examination of the writings of several abstract artists in the 1930s and 1940s may in the future reveal additional artists aware of the traditional 'fourth dimension'. The names of at least three such artists, all affected by the mystical possibilities of higher dimensions, can already be noted: the Russian-born painter Maurice Golubov, Mark Tobey, and Louise Nevelson, also of Russian birth [9]. The fourth dimension was also an element in the early art theory of Hans Hofmann, whose own artistic education had begun in pre-World War I Paris. Hofmann's familiarity with the ideas of Apollinaire and the Cubists is apparent in a 1930 *Art Digest* article, where he writes, "All profound content in life originates from the highest phenomenon of the soul: from intuition, and thereby is found the fourth dimension. Art is the expression of this dimension realized through the other dimensions" [10].

Typically, however, the fourth dimension did not continue as a major feature of Hofmann's thinking. While its spiritual implications were suited to Hofmann's aesthetic philosophy, the fourth dimension as a spatial phenomenon was in direct conflict with his dedication to the integrity of the picture plane. Indeed, in the face of the growing surface orientation of modern art, only one movement, Surrealism, openly declared an interest in deep space. As a result, it was through the Surrealists that the fourth dimension and non-Euclidean geometry had their last broad impact on early modern art.

In the tradition of Jarry and Duchamp, André Breton found the new geometries ideally suited to his arguments for a new 'surreality'. The advent of Einstein and Relativity did not negate for Breton the earlier significance of the new geometries. Instead, Relativity simply added a second, temporal definition to the fourth dimension and, in his view, further undermined accepted ideas about the nature of reality. Like the early twentieth-century advocates of the fourth dimension, Breton had inherited the Symbolist generation's distrust of the exterior world [11]. Although the major source for Breton's Surrealist theory was Freud's analysis of the unconscious mind, much of his thinking reflects earlier themes associated with higher dimensions as well

as non-Euclidean geometry. Breton carried on the Dada attack on logic and reason in a manner much like that of Ouspensky's arguments for a new four-dimensional antilogic. Furthermore, he was actively interested in spiritualism and mysticism as means for communication with the unconscious. As early as 1922 Breton and several colleagues had experimented with spiritualist trances as an alternative to dreams and automatic writing for escaping the control of reason [12].

Non-Euclidean geometry and Lobachevsky himself were officially incorporated into the Surrealist attack on reason and logic in 1936. In that year Gaston Bachelard's essay "Surrationalism" was published in the first and only number of the periodical *Inquisitions*, edited by, among others, the former Dadaist Tzara. Arguing that human reason must be restored to its function of turbulent aggression [13], Bachelard cited Lobachevsky's non-Euclidean geometry as one of the sources for "surrationalism". Breton and a number of the Surrealist painters shared Bachelard's view. Their enthusiasm for non-Euclidean geometry as another support for rejecting established laws is reflected in the titles of works such as Yves Tanguy's *The Meeting of Parallels* of 1935 (Kunstmuseum, Basel) and Max Ernst's *Young Man Intrigued by the Flight of a Non-Euclidean Fly*, begun in 1942 (Private Collection, Zurich) [14]. Even Salvador Dalí's famous limp watches in *The Persistence of Memory* of 1931 have non-Euclidean overtones. In his 1935 book *The Conquest of the Irrational* Dalí discussed the watches in the context of his comments on non-Euclidean versus Euclidean geometry and the theories of Einstein. Noting their immediate visual source in a plate of Camembert cheese, Dalí described the melted watches as "the extravagant and solitary Camembert of time and space" [15].

In his own writings Breton dealt more specifically with the presence of higher spatial dimensions in Surrealist painting. In the 1939 essay "Des tendances les plus récentes de la peinture surréaliste", Breton noted a new current in painting that combined a renewed interest in automatism with the larger problem of depicting higher dimensions of space. Of these younger artists, Breton wrote,

"If, when they venture into the scientific realm, the precision of their language is somewhat unreliable, it cannot be denied that their common, fundamental aspiration is to move beyond the universe of three dimensions. Although that was one

of the leitmotifs of Cubism in its heroic period, it must be admitted that this question poses itself in a much more pointed manner since Einstein's introduction of the notion of *space-time* into physics. The necessity of a suggestive representation of the four-dimensional universe asserts itself particularly in Matta (landscapes with several horizons) and in Onslow Ford. Dominguez, motivated by similar preoccupations, now bases all of his researches in the domain of sculpture on obtaining *lithochronic surfaces*.<sup>\*\*\*</sup>

Breton's reference to Cubism's fourth dimension, paired with his quotation from Oscar Dominguez's 1942 text "La Pétrification du temps", confirms the dual definition of the fourth dimension accepted by the Surrealists. The tradition of a spatial 'fourth dimension' possessed mystical and even irrational associations that supported the Surrealist outlook. Thus, in the face of the temporal fourth dimension of Relativity Theory, interested painters simply continued to treat the space-time continuum as if it possessed four spatial dimensions, as Van Doesburg and, for a time, El Lissitzky had done. Oscar Dominguez, on the other hand, working in sculpture, was fascinated by the life of objects in time.

Dominguez's writings on the fourth dimension may have been the most scientific of any of the Surrealists. His introduction to the idea of 'lithochronic surfaces' in "La Pétrification du temps" demonstrates a rather solid grounding in Relativity physics, as well as an awareness of the two-dimensional analogy that had been a frequent component of earlier discussions of a fourth dimension of space. By 1942, however, Dominguez was more interested in the 'lithochronic surface' itself, which he explained as follows:

"Let us imagine for a minute any three-dimensional body, an African lion for example, between any two moments of his existence. Between the lion  $L_0$ , or lion at the moment  $t = 0$ , and the lion  $L_1$  or final lion, is located an infinity of African lions, of diverse aspects and forms. Now if we consider the ensemble formed by all the points of lion to all its instants and in all its positions, and then if we trace the enveloping surface, we will obtain an *enveloping super-lion* endowed with extremely delicate and nuanced morpho-

logical characteristics. It is to such such surfaces that we give the name *lithochronic*" [17].

While Dominguez recognized time as the primary definition of the fourth dimension, ideas closer to those of hyperspace philosophy's combination of time and space underlie his notion of the lithochronic surface. In the end, Dominguez's description seems more applicable to works such as Boccioni's *Unique Forms of Continuity in Space* than to Dominguez's Surrealist objects [18].

In addition to his creation of Surrealist objects and his experiments with the technique of decalomania, during 1938 and 1939 Dominguez had produced a series of highly spatial 'cosmic' paintings, as he termed them. The polyhedral forms present in works such as *Nostalgia of Space* of 1939 have been connected to the geometrical models at the Institut Henri Poincaré, which were photographed by Man Ray for the 1936 exhibition of Surrealist objects [19]. If interest in the Institut Poincaré suggests one link to the 'heroic period' of the fourth dimension, Duchamp himself was another. A friend of the Surrealists in Paris during the 1930s, Duchamp became particularly close to the Chilean-born painter Matta Echaurren during the Surrealists' World War II 'exile' in New York. Matta collaborated with Katherine Dreier to write the essay *Duchamp's Glass: An Analytical Reflection*, published by the Société Anonyme in 1944, and in February 1948 Matta published Duchamp's *Large Glass* note "Cast Shadows" in his magazine *Instead* [20]. However, as Breton documents in "Des tendances les plus récentes de la peinture surréaliste," Matta's interest in the fourth dimension dated back at least to the late 1930s.

Matta had joined the Surrealist movement in 1937, after working for several years in the architectural office of Le Corbusier. Sharing with his friend Gordon Onslow-Ford a desire to discover an inner world, Matta (and Onslow-Ford) responded to Surrealism's Freudian orientation as well as to 'the fourth dimension' in both its mystical and scientific forms [21]. Matta soon began to explore the world of higher dimensions in a lush, organic style influenced by the biomorphic abstraction of Tanguy and, in part, by the 'cosmic' paintings of Dominguez.

By the early 1940s, Matta's depictions of a nebulous spatial realm also began to incorporate a number of angular, linear elements, as in *The Vertigo of Eros* of 1944. The lines in this painting are

actually reminiscent of the maze of string Duchamp created in 1942 for the New York exhibition *First Papers of Surrealism* in one of his own latter-day experiments in dimensionality and curvature [22]. Indeed, Matta's friendship with Duchamp in the 1940s was an important stimulus for the Chilean painter to persist in painting infinite space and to ignore the modernist preference for flatness.

Breton could have included one other painter in his 1939 discussion of the fourth dimension, had it not been for the ideological break between Dali and himself in the later 1930s [23]. In *The Conquest of the Irrational* Dali had also reflected a concern with higher spatial dimensions. Although this notion never dominated his art in the way it guided Matta, Dali, like Matta, was attracted by both the mystical and the scientific sides of 'the fourth dimension'. Dali's painting *Crucifixion (Corpus Hypercubicus)* of 1954 was actually inspired by the ideas of the twelfth-century Catalanian mystic Raimondo Lulio, as well as the sixteenth-century architect Juan de Herrera. In Dali's mind, his work with the hypercube was the culmination of Lulio's manipulation of two-dimensional forms and the three-dimensional researches Herrera presented in his manuscript treatise "Discurso de la figura cúbica" [24].

During the 1950s and 1960s artists such as Dali and Pereira were nearly alone in their continued interest in the traditional fourth dimension of space. Although the painters of the major movement of the 1950s, Abstract Expressionism, had learned a great deal from the Surrealists in New York during the 1940s, these lessons had little to do with the fourth dimension or non-Euclidean geometry. In fact, it was the very antipathy of the young Americans toward geometry, as represented by the art of the American disciples of Mondrian, which made Surrealist automatism attractive. Thus, Barnett Newman's 1942 painting entitled *The Death of Euclid* (Collection Betty Parsons, New York) is a generalized rejection of all geometry and not a tribute to non-Euclidean principles.

Historical distance also discouraged widespread enthusiasm for higher dimensions of space after 1940. Artists born around 1905, as were many of the Abstract Expressionists [25], had come of age as painters only in the late 1920s, at the end of an era dominated by 'the fourth dimension'. The next generation of painters, whose styles emerged in the 1960s, were so far removed from this period that they were, on the whole, totally unaware of the importance of the new geometries for early modern art. In

<sup>\*\*\*</sup>"Certain surfaces, that we call *lithochroniques*, open a window on the strange world of the fourth dimension, constituting a kind of solidification.... (Sabato and Dominguez)" [16].

addition, the modernist preoccupation with flatness continued to discourage purposeful evocations of space as a goal in painting. By the end of the 1960s, the Minimalist movement had banished spatial illusion from modern painting.

During the 1970s, however, there emerged a number of individuals, both artists and mathematicians, who share the goal of giving visual form to spatial fourth dimension. The 1978 volume *Hypergraphics: Visualizing Complex Relationships in Art, Science and Technology*, a symposium sponsored by the American Association for the Advancement of Science, presents the work of a group of these researchers, including Thomas Banchoff and Charles Strauss of the Mathematics Department of Brown University, and David Brisson of the Rhode Island School of Design [26]. . . Banchoff and Strauss . . . manipulate four-dimensional figures on the display screen of a computer. The results of this technological advance are four-dimensional images of an intricacy and accuracy never dreamed of in the early twentieth century [27].

Similarly, the articles published by the painter Tony Robbin in the later 1970s chronicle a rise of interest in spatial complexity among contemporary painters [28]. Robbin believes in the reality of four-dimensional space, and his paintings, such as 79-8 are intended as metaphors for the complexity of the space-time world of the twentieth century. While the Cubists, in their pursuit of the fourth dimension of space, had introduced multiple viewpoints, those views were nevertheless fused into unified images. Robbin's work, on the other hand, makes a definitive break with the unities of the past. Against an indefinite background made up of impossible figures such as splayed-out Necker cubes, linear grids denoting independent planes in space overlap and interpenetrate. In combination with the painting's ground, these grids provide contradictory spatial clues and establish a tension that refuses to be resolved in three-dimensional space. Further supporting this effect is the interaction of the variety of patterned surfaces and . . . the solid color grid elements, which call to mind Malevich's free-floating planes of color.

Robbin's more recent works also explore the notion of a collapsing spatial metric, a principle that is only slightly indicated in the decreasing size of the Necker cube faces toward the edges of [Robbins' 79-8]. The question of the geometrical metric of space is one of the many issues Robbins has derived from his reading in contemporary physics. Yet,

like the Cubists before him, Robbin reminds his viewer that the purpose of his art goes beyond mathematics or physics *per se*. As he has written in a recent article,

"Artists who are interested in four dimensional space are not motivated by a desire to illustrate new physical theories, nor by a desire to solve mathematical problems. We are motivated by a desire to complete our subjective experience by inventing new aesthetic and conceptual capabilities. We are not in the least surprised, however, to find physicists and mathematicians working simultaneously on a metaphor for space in which paradoxical three dimensional experiences are resolved only by a four dimensional space. Our reading of the history of culture has shown us that in the development of new metaphors for space artists, physicists, and mathematicians are usually in step [29].

Reminiscent of Matyushin's 1913 assertion that "artists have always been knights, poets, and prophets of space in all eras," Robbin's statement suggests that after a long hiatus 'the fourth dimension' may be on the verge of a new phase of influence.

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2. On the Abstraction-Création group of abstract geometric painters with which many of the manifesto's signers were associated, see Gladys C. Fabre, *Abstraction-Création 1931-1936*, ex. cat. (Westfälisches Landesmuseum für Kunst und Kulturgeschichte, Münster, and Musée d'Art Moderne de la Ville de Paris, 1978).
3. In addition to Claude Bragdon's books of the 1920s, another typical reevaluation of hyperspace philosophy in the context of Relativity Theory was Richard Eriksen's *Consciousness, Life and the Fourth Dimension: A Study in Natural Philosophy* (Copenhagen and London: Gyldendal, 1923; New York: Alfred A. Knopf, 1923). In Eriksen's work the mysterious properties of the fourth dimension of space were transferred to the new temporal fourth dimension of Relativity Theory.
4. See Maeterlinck, *La Vie de l'espace* (Paris: Eugène Fasquelle, 1928; New York: Dodd, Mead & Co., 1928).
5. See John I. H. Baur, *Loren MacIver/I. Rice Pereira*, ex. cat. (Whitney Museum of American Art, New York, 1953; New York: The Macmillan Co., 1953) p. 52.
6. Pereira, in *ibid*.
7. Pereira, *The Nature of Space* (1956; reprint ed. Washington, D.C.: The Corcoran Gallery of Art, 1968) pp.

49-50. Even though by 1956 Pereira had returned to a more rectilinear and seemingly planar mode in painting, her goals remained multidimensional. Following upon a dream in 1954, described in *The Lapis* (Washington, D.C.: The Corcoran Gallery of Art, 1959), Pereira developed a system of two-dimensional symbols with which to depict an infinite, space-time landscape free, in her view, of both Euclidean geometry and perspective.

8. See, for example, Pereira, *The Transcendental Logic of the Infinite: The Evolution of Cultural Forms* (New York: I. Rice Pereira, 1966) pp. 10, 20, 56, 57.
  9. On Golubov's continuing concern with a mystical fourth dimension, see *Maurice Golubov: Paintings 1925-1980*, ed. Daniel J. Cameron, ex. cat. (The Mint Museum of Art, Charlotte, N.C., 1980) pp. 5, 10, 11, 16. For the influence of hyperspace philosophy on Tobey, see, for example, "Mark Tobey Writes on His Painting on the Cover", *Art News*, XLIV (1-14 Jan. 1946), 22, where Tobey explains that "the multiple space bounded by involved white lines symbolizes higher states of consciousness". William Seitz discusses this statement in the context of Tobey's philosophy in *Mark Tobey*, ex. cat. (The Museum of Modern Art, New York, 1962) p. 27.
- Nevelson encountered mystical views of the fourth dimension during the 1920s at the theater art school organized by Princess Matchabelli and Frederick Kiesler in New York. Nevelson, who was also a student of Hans Hofmann, today still uses the term 'fourth dimension', if somewhat offhandedly, in her definition of art. See the essay by Lori Wilson in *Louise Nevelson: The Fourth Dimension*, ex. cat. (Phoenix Art Museum, 11 Jan.-24 Feb. 1980) p. 12.
10. Hofmann, "Review of the Field of Art Education: Art in America", *The Art Digest*, XIV (Aug. 1930), 27. For an overview of Hofmann's art and theory, see William C. Seitz, *Hans Hofmann*, ex. cat. (The Museum of Modern Art, New York, 1963).
  11. On the importance of Symbolist attitudes for Breton and his colleagues, see Anna Balakian, *Literary Origins of Surrealism: A New Mysticism in French Poetry* (New York: New York University Press, 1947). On the Surrealists' appreciation of Jarry, see, in addition to Balakian, Maurice Nadeau, *The History of Surrealism* (1945), trans. Richard Howard (New York: The MacMillan Co., 1965) pp. 72-73.
  12. Camfield, *Picabia: His Art, Life and Times*, p. 184.
  13. Bachelard, "Surrationalism", trans. in Julien Levy, *Surrealism* (New York: The Black Sun Press, 1936) p. 186. For a critique of Bachelard's text, see Gauss, *The Aesthetic Theories of French Artists*, pp. 87-88.
  14. Ernst's painting was made by letting a tin can, dripping paint, oscillate back and forth over his canvas, producing curved, but hardly non-Euclidean, tracings. See Diane Waldman, *Max Ernst: A Retrospective*, ex. cat. (The Solomon R. Guggenheim Museum, New York, 1975) pp. 54-55, Fig. 24.
  15. Dali, "Les Pleurs d'Héraclite", in *La*

- Conquête de l'irrationnel* (Paris: Editions Surréalistes, 1935) p. 25.
16. In Breton, *Le Surréalisme et la peinture* (New York: Brentano's, 1945) p. 152.
  17. Dominguez, "La Pétrification du temps", in *La Conquête du monde par l'image* (Paris: Editions de la Main à Plume, 1942); trans. in Lucy R. Lippard, ed., *Surrealists on Art* (Englewood Cliffs, N.J.: Prentice-Hall, 1970) p. 109.
  18. A selection of Surrealist objects by Dominguez is illustrated in Marcel Jean, *Histoire de la peinture surréaliste* (Paris: Editions du Seuil, 1959) pp. 245–48.
  19. Jean, *Histoire de la peinture surréaliste*, p. 269.
  20. For this note, discussed in Chapter 3 above in connection with *Tu m'*, see Duchamp, "Cast Shadows", in *Salt Seller*, pp. 72–73.
  21. Gordon Onslow-Ford described his and Matta's goals in this period, as well as Matta's mystical leanings, in a 1969 interview with Irene Clurman, which formed the basis for her essay *Surrealism and the Painting of Matta and Magritte*, Stanford Honors Essay in the Humanities, no. 14 (Stanford: Stanford University, 1970) pp. 17–27.
  22. Matta's paintings since the mid-1940s have usually included monsterlike personages, which often reduce the overwhelming spatial effects of his works of the early 1940s. See William Rubin, *Matta*, ex. cat. (The Museum of Modern Art, New York, 10 Sept.–20 Oct. 1957). For Duchamp's installation and Rubin's suggestion of this connection, see Rubin, *Dada, Surrealism, and Their Heritage*, ex. cat. (The Museum of Modern Art, New York, 27 Mar.–9 June 1968) pp. 160, 164.
  23. On the differences between Breton and Dali which began with a left/right political split, see, for example, Nadeau, *The History of Surrealism*, p. 215.
  24. Dali mentions both of these figures in his *Diary of a Genius*, trans. Richard Howard (Garden City, N.Y.: Doubleday & Co., 1965). Dali's vision of himself as the third inspired Catalanian in this developing dimensional line was explained by Dali to Professor Thomas Banchoff of Brown University. A recent painting by Dali, *A la recherche de la quatrième dimension* (Private Collection), demonstrates that Dali, like Duchamp, has found stereoscopy a useful means for exploring dimensionality. For this work, and a discussion of Dali's recent perceptual experiments, see the essay by Robert Descharnes, "Dali, l'image de l'espace", in *Salvador Dali: Retrospective 1920–1980*, ex. cat. (Musée National d'Art Moderne, Centre National d'Art et de Culture Georges Pompidou, Paris, 18 Dec. 1979–14 Apr. 1980) pp. 390–402.
  25. Although Dali was also born in 1905 and Pereira as late as 1907, by the end of the 1920s both of these figures were already closely in touch with older artists in the avant-garde. Except for Hofmann, this was not the case with the majority of the Abstract Expressionists.
  26. See Brisson, ed., *Hypergraphics: Visualizing Complex Relationships in Art, Science and Technology*, AAAS Selected Symposium 24 (Boulder: Westview Press, 1978). This renewed interest in a spatial fourth dimension has been supported by new and more complex theories of cosmology in physics, as reported in such recent sources as Rudolf v. B. Rucker, *Geometry, Relativity and the Fourth Dimension* (New York: Dover, 1977) chs. 1–3, and Martin Gardner, *The Relativity Explosion* (New York: Random House, 1976) chs. 10–12.
  27. See Banchoff and Strauss, "Real-Time Computer Graphics Analysis of Figures in Four-Space", in *Hypergraphics*, ed. Brisson, pp. 159–67. See also Kenneth Engel, "Shadows of the Fourth Dimension", *Science* 80, no. 5 (July–Aug. 1980) pp. 68–73. Banchoff and Strauss's work is a major step forward in a field pioneered by A. Michael Noll, who produced the first computerized films of four-dimensional figures at Bell Laboratories in the mid-1960s. See the 1967 article by Noll, "Displaying *n*-Dimensional Hyperobjects by Computer", reprinted in *Hypergraphics*, ed. Brisson, pp. 147–58.
  28. See, e.g. Robbin, "The New Art of 4-Dimensional Space: Spatial Complexity in Recent New York Work", *Artscribe* (London), No. 9 (1977), pp. 19–22. See also the essay by Ellen Schwarz for the exhibition *Subject: Space* (Pratt Institute Gallery, New York, 27 Nov.–20 Dec. 1979).
- Perceptual illusion had also functioned in the mainstream of modern painting to reopen the exploration of space. Al Held was among the first artists in the later 1960s to reintroduce definite spatial cues and even multiple viewpoints into avant-garde painting. It is thus no coincidence his pupils, such as Robbin, have been at the forefront of interest in spatial complexity and particularly four-dimensional space. On Held's spatial paintings from 1967 onward, see Marcia Tucker, *Al Held*, ex. cat. (Whitney Museum of American Art, New York, 1974). In her concluding remarks Tucker compares Held's space to the four-dimensional, non-Euclidean space-time of Relativity Theory, although, in fact, these ideas were not a conscious motivating force for Held.
29. Robbin, "The New Art of 4-Dimensional Space", p. 20.