Pictorial Abstractions
/
Visualizing Space in the Eras of Modernism and Information

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The appropriation and individual interpretation of scientific discoveries have led to new visual definitions of space, especially during the periods of scientific paradigm shifts.

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The problem of the relation between art and science was the focus of research by Martin Kemp, Linda Dalrymple Henderson, Stephen Wilson, Tony Robbins etc.

Representations of space in art history reflected philosophical as well as scientific tendencies of any given historical period. Artists invented models that corresponded to their own understanding of the world, and though they mostly did it intuitively, it was sometimes done consciously by applying their knowledge of the physical and mathematical laws governing the empirical world. A significant corpus of contemporary research in the history and theory of art focuses on the problem of scientific ideas influencing both representations of space and strategies of constructing space in the works of visual arts.[1] The appropriation and individual interpretation of scientific discoveries have led to new visual definitions of space, especially during the periods of scientific paradigm shifts. For example, the rise of abstract art and of the various modes of avant-garde transformations of space has been closely connected to the introduction of the theory of relativity, as well as to the new concept of the time-space continuum which substituted Euclidean geometry and Newton's substantivalistic ontology of space. In the post-war works of abstract expressionism, especially in their decentralized gravity-defying space defined as a field, one can see traces of quantum mechanics and its idea of reality as an invisible elastic matrix, i.e. an energy field. On the other hand, the basis for the experimentation with light and space which appeared in the works of California based artists in the 1960s (Light and Space Art) was undoubtedly their understanding of the phenomenology of human perception and particularly the conception of space as materialized light, which implied a specific tactile dimension of light. In their work, they explicitly drew on the findings of experimental psychology and phenomenology in two ways, by developing the idea of the subjective space of perception and by structuring the 'position of the viewer' in the open form of the artwork. At the same time they showed a particular interest in technological aspects of their work by introducing new materials and industrial processes. At present, with the growth of information technologies, abstract painting conforms to the development of digital media, fractal geometry, and nonlinear dynamics with the theory of complexity and chaos theory.

Contemporary abstract art creates its images of space also under the influence of a technologically expanded reality using various

imaginaries of reality fed by medicine, biology, physics and optics. Contemporary art also evokes images of space as a fluid, malleable or curved entity that is essentially arranged by the principle of coincidence. By understanding the changes in scientific models of space, we can begin to understand the basic difference between modernist and postmodern models of abstract painting. The former are rooted in reductionist strategies of simplifying space by focusing on what seems to be elementary and universal, while the latter—with their geometric and formal clarity—stem from an awareness of global complexity, and the interdependent and dynamic relations of reality.

IMAGELESS SPACE AND MULTIDIMENSIONALITY

The beginning of the 20th century bore witness to a radical change in the understanding of space in physical science. In 1905, Albert Einstein formulated his theory of special relativity. Einstein's idea of space-time subverted the traditional representation of space based on Isaac Newton's theories defining space as an absolute and a passive container of matter. Einstein's conception of the constant speed of light and of the relative nature of time and space also subverted the traditional belief in the existence of objective reality, independent of human consciousness, as his theory postulates that reality depends on the perception of the observer. The theory of relativity presupposes a "plasticity" of the world in which shapes change their color and size according to the position from which they are observed. Only the speed of light is invariable in such a system, i.e., independent of the observer's speed and direction.

The theory of special relativity alters the relations between the four basic concepts of Newtonian physics, i.e., mass, energy, space and time, reformulating them into two binary entities, namely the entity of energy-mass and the distorted continuum of time-space. They are connected by the energy of light. In 1907, Einstein suggested the reciprocal agency of both entities, but did not manage to offer any mathematical proof of their interconnection until 1915 when he proposed his theory of general relativity. Using the Riemann curvature tensor, he defined the speed of light as an element that binds these two entities. Einstein's theories enabled further research on space, e.g., the understanding of the principle of black holes, the illusory nature of gravity and especially the specific curvature of time-space. The concepts of the theory of relativity and its models of reality (according to which reality is defined by the curvature of time-space) extend far beyond any common experience and understanding of reality, and can be precisely defined only in the language of mathematical symbols.

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For descriptions of the geometric nature of space, which was defined by masses in motion, Euclidean tools had become inadequate.

When the scientific community appealed to Einstein to provide a visual metaphor or at least a verbal explanation of his findings that would be comprehensible to common people, he responded that he could offer neither. (Baldwin 1962, 32) The failure of language to explain the new physical paradigm of reality coincided with the appearance of the first abstract, non-representational forms of art. The painters of the early avant-garde art strived to express visual equivalents to the intelligible ideas of nature, space and time; some of them tried to come up with a visual representation of abstract ideas of infinity, emptiness and non-objective reality (K. Malevich, El Lissitzky), others created geometric models in pictorial space (Mondrian), the Cubists and Futurists designed structures in space that simultaneously expressed the temporal dimension, while Gabo, Pevsner and Rodchenko constructed dematerialized spatial volumes where mass reflected forms of energy states.

The discovery of non-Euclidean geometry and the multidimensionality of space, i.e. its fourth dimension, was based on the insight that Euclidean axiomatisation, with its rational derivatives, was nothing more than an abstract premise which did not refer to reality. Einstein's continuum of time-space, which depends on the position of the observer, cannot be adequately described by Euclidean perpendicular coordinate systems. The notion of curved space abolished the Renaissance linear perspective based on straight lines, and consequently also abolished the manner in which objects had been depicted, since the theory of relativity subjected shape to constant deformations depending on the position of observation.

The non-Euclidean concept of the constantly shifting appearance of an object moving within a curved time-space stimulated the imagination of modern artists, inspiring them to form alternative, imaginary conceptions of 'reality' (Henderson 1983). It was precisely this 'new ability to make imaginative assumptions about other realities that ended the hegemony of Euclidean geometry and Renaissance perspective in painting.' (Dunning 1991, 152) Modernist painters focused on the ideas and structures of space, and by investigating new spatial relations they created alternatives to existing reality. They drew upon the notion of time-dependent space (the Cubist simultaneity of gaze), creating illusions of movement (Futurism) or using kinetic elements in three-dimensional works (Constructivism); they also suggested ideas of a moving space-time infinity (Suprematism).

The thought of intelligible, multidimensional and non-objective moving space inspired Suprematist compositions by Kasimir Malevich.

In a series of flat, but dynamic abstract compositions, Malevich attempted to save art from the "tyranny of objects" in order to enter a reality of "sensing rhythmic vibrations and movements". By veering away from objective representation, Malevich left behind the idea of the relations between objects as the cornerstone of spatial dimensions. "When objects got substituted by non-objective forms, space surrounding them lost its finiteness, as it could no longer be subjected to measuring. Nonetheless, this space—as the surrounding of non-objects—kept its identity like the sea which surrounds an island and clearly differs from it. The thus defined space can extend either in front of the pictorial plane or lies behind it. Space is therefore infinite, but maintains the distinction between the figure and the background." (Ženko 2000, 103)

In Malevich's 'supremats' series (1915 – 1925), the figure of a black square in the painting 'The Black Square on White Background' (1915) is probably the most famous one. Due to its formal, geometric reductionism and its allusion to the iconography of absence, the painting is often understood as emblematic in the context of avant-garde modernism. The absorbing power of black color in the figure of a square renders the absence of light through suspension of the gaze, thus suggesting the interpretation of space as negative space, i.e. emptiness. Gerard Wajcman reads Malevich's Square as a result of his attempt to approach the world without using images: as an attempt "to aim at the world, at the real, without putting a surface in front of it, a screen of representation in between /…/ The Square aims at a particular type of object, it actually aims at a totally new object which I call Absence." The square may be compared to an optical instrument that makes absence visible; in the same way as all 20th-century landmark works, the Square attempts to "inscribe lack into the absolute core of the work, to reveal an emptiness, an absence, to reveal a hole". (Wajcman, 147 -148)

Eugene Thatcher interprets the black color of Malevich's Square as an icon of the invisible and the infinite, putting it in close connection with alchemical texts and illustrations from the past. He draws our attention to the richly illustrated books of the occult philosopher Robert Fludd;[2] in Fludd's work we can find a diagram of eternity in the shape of a black square, with a side annotation *'Et sic in infinitum...'* (and so on infinitely). Commenting on his picture, Fludd explained that the square represented a speculation of a spatial dimension as extant prior to the birth of Cosmos, depicting 'pure voidness, pure nothing', a kind of 'pre-universe', a 'non-space'. According to Thatcher, Malevich's image of a black square is created at a point when the individual becomes aware of their limited ability of perception, as well as their limited ability of representation. In this context, it is interesting

Robert Fludd (1574 –1637) lived in the age of the Renaissance, he was Paracelsus' student, a scientist, mathematician, physician, astrologist, but also a connoisseur of the occult and esoteric practices. His most widely known work is the 'Utriusque Cosmi maioris salicet et minoris metaphysica, physica atque technica historia (The Metaphysical, Physical, and Technical History of the Two Worlds, the Major as well as the Minor (1617–1619)), a summary of his philosophy of nature and cosmology which was evidently influenced by mystical practices.

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Proun is the title given by Lissitzky to a series of works created in the years after 1919 (mostly in the early 1920s). Proun consists of objects, lithographies, and a later spatial intervention which includes paintings and three-dimensional objects; the latter is often defined as a proto-installation (see e.g. Claire Bishop or Brian O'Doherty). Combining two-dimensional and three-dimensional geometric bodies, Lissitzky merged painting and architecure to create a new sense of space.

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See his article Proun, published in 1922 in the 6th number of the magazine De Stijl.

1   Robert Fludd, an illustration of a black square with the annotation *'Et sic in infinitum...'* from the work Utriusque cosmi maioris scilicet et minoris metaphysica, ... (1617)

2   Kasimir Malevich, The Black Square on White Background, 1915

"that only a self-negating form of representation would be able to suggest the nothingness prior to all existence, an un-creation prior to all creation." (Thatcher, 2015) From the recipient's point of view, such an understanding of the Black Square requires a substantial cognitive and perceptual investment, since in the form of the square the viewer is supposed to see a "shapeless shape", and in the black color they should perceive neither fullness nor voidness. (Ibid.) [1-2]

El Lissitzky addressed the question of representing the Suprematist multidimensional continuum in his series Proun.[3] Proun is an acronym that supposedly stands for the Russian '*proekt utverzhdenya novogo*', 'a project for the affirmation of the new', and can thus be interpreted as 'a project of progress'. As a combination of geometric bodies and flat surfaces, it merges architecture and painting, which creates a new sense of space. In his own essay (in 1922), Lissitzky defined Proun as a turn from painting to architecture:[4] indeed, Proun surpasses the limits and the static nature of painting with its progressive spatial and temporal conception that includes movement. The creative process becomes an art of mastering space, a process of "transforming emptiness into space. The observer is thus included in the process, as he observes the given forms from various points of view and is consequently overtaken by a sense of movement. This is why Lissitzky decided to abandon the two-dimensional space in favour of a truly physical space created with Prouns." (Vrečko 2009, 80) [3] Paintings in Lissitzky's Proun seem fluid, non-material; the presented geometric shapes, circles and parallelograms give appearance of rectangles sloping in space. It seems as if shapes were floating in a vague space that is itself defined by the circling spatial axes. The use of axonometric projection makes the diminishing and the deepening of perspective impossible, and the position of forms in space is ambivalent. Size and shape themselves become relative due to transparent and interpenetrating planes that do not allow for the distinction between the foreground and the background plane.

In his essays as well as his praxis, Lissitzky explored the idea of 'pangeometry', a kind of an alternative system of spatial relations that substituted the notion of linear perspective. Distinguishing between the planimetric space based on perspective and the irrational, i.e., imaginary (Suprematist) space, he articulated a dynamic expansive space whose main constituent is precisely the notion of movement. As Vrečko puts it: "It is a dynamic space which includes an element of time and thus adds a fourth dimension. Lissitzky differentiates between the three-dimensional physical space and the multidimensional mathematical space." (Vrečko 2009, 81)
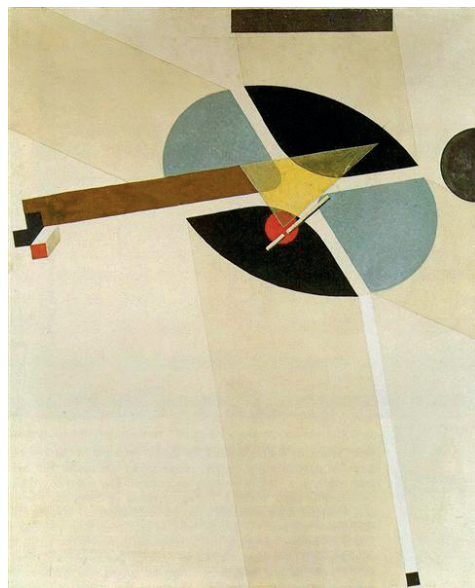
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Proun Room/ Prounenraum was originally created for the Grosse Berliner Kunstausstellung (1923) and was later reconstructed in the Hannover Museum (Room of the Abstracts/ Prouns, Hannover 1927/28). The reconstruction was commissioned by the manager of the museum who saw the earlier installation in Dresden (1926). Proun Room was also reconstructed after the 2nd World War, in the Van Abbemuseum in Eindhoven (1965). The installation consisted of a space in the form of a cube into which light entered through a semitransparent window on the ceiling. The walls of the cube were covered with two- and three-dimensional geometric elements: horizontal and vertical rectangles, sticks crossing each other, a small sphere etc., which occupied the whole surface of the walls. A mirror was included to reflect and double the view. Two black lines were marked on the transparent part of the ceiling in order to unify the space into a whole.

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Due to the incorporation of geometric shapes into spatial relations and due to a variety of perspectives used by Lissitzky, one can see the Prouns as a contrast to the Suprematist use of two-dimensionality and the Suprematist idea of simplifying shapes. The Proun projects seem to be a research into the Suprematist visual language, yet with an emphasized spatiality. In Suprematism, one cannot find circling spatial axes, the use of diagonals or multi-perspectivity. Suprematism was at the time limited almost exclusively to flatness, i.e. to two-dimensional shapes. With his taste for architecture and fresh three-dimensional concepts, El Lissitzky wanted to expand Suprematism beyond the edges of the plane. (Bishop 2005)

The construction of Proun Room shows the transition of the ideas concerning Proun into the actual three-dimensional space.[5] A spatial installation required the viewer to move around, since there was no intended ideal position of observation. In designing the exhibition space, Lissitzky exploited the basic elements of architecture: space, mass, color, and rhythm; compared to Malevich's Suprematist ideas, all these elements were redeveloped.[6] With the installation of Proun Room, Lissitzky completed his turn from Suprematism to Constructivism. The whole of his Proun projects thus surpasses the pictorial medium; due to Lissitzky's use of new spatial and temporal representations, the Prouns became a "station where painting changed to architecture". (Lissitzky, in Vrečko 2009, 78). Lissitzky was inspired by the idea of combining art and science (of contributing to scientific research by means of art), and by Einstein's theory of relativity, according to which measures of space and time depend on the movement of the given system. Correspondingly, Lissitzky used paintings as a building material for his constructions, beside concrete elements installed in space, and the resulting moving, dynamic, open structure implied spatial and temporal multidimensionality. The abstract art of the early historic avant-garde created new geometric and spatial compositions, consciously or subconsciously reflecting Einstein's idea that void space is not emptiness, but rather shows all of the characteristics of something real; yet these characteristics could only be defined by a new, non-Euclidean geometry. The idea of associating space with geometry and the concept of gravitational attraction as a result of the time-space interaction echoed in a series of modernist paintings treating space as a geometry invested with qualities of a tensor field.

The pioneers of abstract painting in the first decades of the 20th century came from various philosophical and theoretical backgrounds, yet they all shared a reductionist paradigm. Reductionism expressed itself either in spatial abstractions that strove to render the simplified aspects of the phenomenal world using basic geometric structures, or in the desire to create visual correspondences with intelligible principles, but in both cases it acted as the basis of modernist abstraction. To give but a few examples: Kandinsky spoke of a microscopic analysis of the basic elements of painting, such as shape, point, line and plane; Mondrian's ascetic language consisted merely of lines and three basic colors; František Kupka and Robert Delaunay used exclusively dynamic circular compositions and spectral colors. Methods of reduction, transposition of rational concepts into art, and the prevalence of geometric shapes in fine arts corresponded to the era's dominant scientific paradigm as incorporated into the various fields of science. The splitting

of inorganic nature into molecules, atoms and subatomic particles, the discovery of cells and chromosomes as the basic particles of the body, and defining indivisible sensory elements of perception in the then experimental psychology all determined creative methods employed by the artists. It was especially the latter that influenced some of the early avant-garde artists, as it used pictorial diagrams including geometric shapes and primary colors to explain the psychology of visual perception, i.e. the laws of perceiving colors, shapes, space and movement.[7]

THE NON-MATERIALITY OF THE FIELD

The peaks of non-representational post-war painting can be seen in American abstract expressionism with its various currents, namely Color Field painting, Post-painterly abstraction and minimalism. Within the dynamics of political and social changes, science put forward new perspectives and models of reality, inspired by the already decade-long unifying of the theory of relativity and quantum mechanics. The idea of the field as an energy foundation of reality determining the movement of particles reoriented the focus of the social imagination away from material reality (i.e. particles) to the more fundamental non-material, energy dimension. The model of reality in which matter is understood as merely a 'perturbation' in the perfect state of the field draws attention away from objects or the material towards the underlying non-material energy matrix that determines the appearance and the arrangement of the phenomenal. Time-space and energy-mass are subjected to the field of light or energy oscillations defining the appearance of the material already in Einstein's theory. The field as a non-material energy sphere cannot be an object of qualitative measurement, but is rather an invisible intelligible 'imageless' reality, a tensor that reveals itself only through the effects of energy on matter.

Abstract expressionists, who focused on 'images of the invisible' or created 'imageless art', reflected the idea of the intelligible dimension of reality that determines visual phenomena. The conception of space which is not defined by object relations, but which manifests instead as a field of energy oscillations, led painting away from depicting objects and into the search for new artistic—formal, conceptual and aesthetic—strategies for capturing and registering the invisible ordering spatial matrix.

Jackson Pollock subjects pictorial procedures to the invisible gravity force and leaves the shaping of the form to the 'order' of coincidence. His non-object compositions created with the dripping technique (drip paintings) suggest the invisible tension which permeates the painter's body in motion and which structures the abstract pictorial image. The

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See Paul Vitz and Arnold Glimcher. 1984. Modern Art and Modern Science: The Parallel Analysis of Vision. New York: Praeger Publishers.

dripping technique puts forward the application of colors in the wet on wet manner, lines of color merge creating "cellular structures, labyrinths, webbings, nets, and membranes, thus losing their autonomous separateness. This complex use of line strengthened the shallowness of the sensation and created a unified single image." (Dunning 1991, 180) Lines do not appear like outlines of objects or edges of shapes, they seem to have a mass of their own and are creating an interwoven mesh as a visualization of the invisible force field. The color structures of Pollock's compositions take shape as the trace of the painter's movement above the horizontally lying canvas, presenting an abstract, non-material imprint of his corporality and simultaneously revealing the effects of the energy field permeating matter. The paintings are decentered, spatial hierarchies between the foreground and the background, below and above they are suspended, the grids of lines convey the energies and tensions of the field limitlessly expanding in space. According to his painter colleague Robert Morris (Anti-form, 1968), Pollock is one of the few painters who considered the work's autonomous creation process and the movement of material in the work's final form, by which he showed an understanding of the truly fluid nature of painting.

Metaphors from physics are also evoked by the abstract compositions of Barnett Newman; the large color surfaces act as a tensor field uncontrollably expanding outside the confines of the painting's material medium. It is broken off by vertical lines, the so called 'zips', which simultaneously demarcate and link color fields: "Zip prevents routine perception as it cannot be spatially located, due to the constant exchange with the color tissue: both elements support each other and work simultaneously and inseparably, thus the zip is read as a positive and a negative, surface and depth, a cut and a seam, where the effect of the sublime, which the painter aims at, is implemented with invisible, but intuitively felt pulsation, expansion and condensation, in the uncontrollability of the pictorial space." (Gnamuš 2008: 285) It seems that Newman's paintings depict the expansibility of space as the light waves of energetically charged quantum particles; they suggest a sense of an elastic field connecting pictorial space with the immediate space of the viewer. Newman claims that he has come to understand the value of zip gradually, through emptying the space instead of filling it: "The streak was always going through an atmosphere. I kept trying to create a world around it … Suddenly I realized … that I had been emptying space instead of filling it and that now my line made the whole area come to life." (Auping, 2007: 146). Newman's 'spatial emptying' suggests the imagination of non-space and the original emptiness the moment before the creation of time and space, energy and matter. His works are new renditions of the sublime, which

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See: Newman Barnett, The Sublime is Now (1948), where Newman claimed that European art was not capable of reaching the sublime, as it had remained 'inside the reality of sensation (the objective world rather distorted or pure) /…/ and was unable to move away from /…/ an empty world of geometric formalism - a pure rhetoric of abstract mathematical relationships, became enmeshed in a struggle over the nature of beauty.' New American art, on the other hand, was free of the weight of European culture, and was the only one which could create sublime art at that moment, as American artists used their 'own feelings' in their work…' (Excerpt from 'The Ideas of Art, Six Opinions on What is Sublime in Art?, *Tiger's Eye* (New York), No.6 (15 December 1948), pp. 52-53.).

now does not refer to nature but to the heroic sublimity of the moment, a manifestation of the consciousness of pure presence and the present.[8]

The dematerialized 'color field' of Mark Rothko offers a sense of the sublime and the metaphysical. Although Rothko was aware of the metaphysical and spiritual aspects of his atmospheric color abstractions, he emphasized his primary interest in creation of space. He was conscious of the fact that art does not merely reflect the perception and conception of spatial relations, but is also, above all, creating space. He distinguished between painting that enacts tactile space and one based on images of a space of illusory plasticity, and just as many contemporary abstract painters, he tried to connect illusionist pictorial space with the actual space of the viewer. His paintings composed of softly intermingling color spatial forms evoke associations of the transcendental nature of space, as found in the tradition of the sublime—the landscape-related sublime—belonging to romantic painting (Caspar David Friedrich, Frederic Church, William Turner), but Rothko creates the sense of the exalted using abstract means and by forming dematerialized and immeasurable spatial dimensions, which absorb the self-consciousness of the perceiver and bring about a sense of fusion with the universal and the absolute.

In the analysis of pictorial space, Rothko distinguishes between representations of space and things which suggest the sense of touch on the one hand and those which are perceived solely though the eyes on the other: "Tactile space, or, for the sake of simplicity, let us call it air, which exists between objects or shapes in the picture, is painted so that it gives the sensation of a solid. That is, air in a tactile painting is represented as an actual substance rather than as an emptiness." (Rothko, Space (1947) in Auping 2007, 21) He illustrates tactile space with an image of the volume of jelly objects are submerged into?, presenting the idea that the otherwise invisible or barely perceptible volume of air gets some 'weight and presence'. Rothko warns about neglecting this 'airy' dimension in the case of illusory space that focuses only on the illusion of appearance and creates a feeling of things moving within emptiness. The means employed by illusionist painters in the past to move past the conception of space as an empty container of things used to be representations of clouds, smoke and haze (in landscape painting) or the use of atmospheric perspective.

Rothko subjected his own pictorial procedures to the idea of representing spatial tactility. He strove towards the abstract, more accomplished ethereal image and considering possibilities of remodeling and expanding the tactile pictorial space into the immediate physical space, in which both the painting and the observer are placed. (Auping 2007, 141) In 1949 he created his first 'color field', a pictorial space based on the virtual exchange between hazy rectangular shapes or color 'clouds',

which are suspended in the field of another hue. The spatial relation between the 'figure' and the background as an undefined spatial field became ambivalent. Rothko created atmospheres that evoke a sense of the emanation of gas. He thus suggested a dissolution of the material pictorial medium and at the same time illusionistically connected the virtual pictorial space with the perceptual, physical space of the viewer.

Rothko did not consider himself a colorist, as he was not primarily interested in the intrinsic value of color, but in creating various kinds of spaces. His paintings were often based on darker and muted color values, chromatic dimness is particularly characteristic of his late works, whose culmination was the cycle of fourteen murals created for a chapel in Houston, Texas, which was later dubbed The Rothko Chapel. The spatial arrangement of these paintings indicates an extraordinary harmoniza- tion of painting, architecture and space, while the linking element of this constellation is light. Rothko, who normally paid attention to the contrast between light and dark as well as the perceptual conditions of experiencing paintings that depended on ambient light in a space (he recommended subdued and diffuse lighting of the exhibition space), in- sisted on the presence of natural light in the case of the Chapel. Daylight is supposed to dynamize space and sensitize the viewer's perception, as it is perpetually shifting due to weather changes and temporal cycles of day and night; the space is supposed to be 'breathing' with light and 'living' in the heightened perceptual states of the viewer's self-consciousness. [4]

The works of post-painting abstraction, deconstruction, hard-edge painting and minimalism in the nineteen-sixties represent an extreme form of reductive procedures of abstract painting; these works deal with exclusively formal questions both in theory and practice. The famous tautology by Frank Stella "What you see is what you see" expresses the understanding of painting corresponding to an extremely materialist, objectivized approach; painting is identified with the pictorial medium and does not refer to anything external. The extreme form of non-refer- ential art appears as a 'pure signifier', which does not open up transcen- dent spatiality, but evokes its own immanence, the presence of 'things among things'. Formal reduction corresponds to reduction in meaning; this is the painting of painting, which does not express social, political or philosophical meanings, but rather addresses the propositions or the deconstruction of its own practice. These are rational and controlled pictorial procedures, where the blurredness of the visible strokes of the hand abolishes the presence of the 'subject', attention is drawn to the minimal differences among hues, and the effects of simultaneous color contrasts, suggested by the sharply delineated color shapes; attention is drawn to a painting covered in colors, where—in the ideal form—the

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4   Mark Rothko, No. 61 (Rust and Blue), 1953

distinction between the medium and the image is negated. Works that are exemplary in this aspect are the shaped canvases of Ellsworth Kelly or Frank Stella. With regard to minimalist reduction and 'primary or analytical painting', we need to mention the geometrically conceived works by painters such as Brice Marden, Robert Mangold, Robert Ryman, Jo Baer, Agnes Martin or works of the art group BMPT (Buren, Mosset, Parmentie and Torroni). The group Support-Surface (Devade, Cane, Pincemin, Viallat, Bioules) undertook the structuralist deconstruction of painting to the medium – canvas, color and the frame, where the painting's status is reduced to the signifier of the painters' practice.

TACTILITY OF LIGHT AND PHENOMENOLOGY OF PERCEPTION

Reality as described by Einstein is founded on the premise of the constant value of the speed of light and the relativity of space, time and mass. The speed of light is constant for all observers regardless of the velocity and direction of their movement. At the same time Einstein's theory postulates that the deformations in the appearance of objects in space and time, which are always the same, take place during movement at the speed of light.[9] The field of light determines the structure of space and time, actually it represents their origin, it is independent of observers and as such it has a special place in the theory of relativity. Light, with its constant speed, functions as a connective glue between the binary categories of space-time and mass-energy. The famous energy equation ($E = mc^2$) treats the relationship between mass, energy and the constant speed of light in a vacuum, explaining how mass turns to energy at the constant speed of light and vice versa. Energy contained in a sheaf of light rays can be converted into weight – we can calculate the weight of light.

   Such insights into the reality of the interconnection of light and matter are reflected in many procedures concerning light in modern painting, directed at the shifting color effects in dependence on light conditions (impressionism) or the dematerialization of form (luminism, orphism (Delaunay, Kupka, Feininger), etc.). The 20th century witnessed the blossoming of the art of light in kinetic or optic art, in the light art installations Art & Space, which made light autonomous as a concrete, real artistic medium, and veered away from the traditional pictorial 'representation' of light. Light became the central medium of expression in phenomenologically oriented artworks investigating the potential, and role of (optic and bodily), perception in the formation of a work of art. Despite the fact that art interventions bound to concrete space (location-specific installations) represent the

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See Schlain, Leonard. 1991. Pp. 119 - 137.

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A group of artists, whom we join under the name of the movement Light & Space Art, worked, though loosely connected, in the nineteen-sixties and seventies in California. In terms of ideas, their work presents a phenomenological alternative to minimalism, whose centre was in New York. Beside the pronounced focus on perception and space in relation to light effects, the Light & Space artists differ from minimalism by conceiving space in more non-material, discreet and occasionally distinctly conceptual terms. This distinction could be summarized in the difference between 'art as an object' and 'art as an experience', or, to use the words of Craig Kauffman – the first are interested in perception, while the second are more interested in material procedures. (See: Berlot Pompe, Uršula. Space and light in art installations of 20th century. / Prostor in svetloba v umetniških instalacijah 20. stoletja. Praznine 08/2015. Ljubljana: Umetniško izobraževalno društvo Praznine, 2015.)

culmination of light art, I will now limit myself to examples that expanded the concept of painting through engaging light technology and light-sensitive materials as practiced by the Californian movement L.A. Glass & Plastic and Light & Space in the nineteen-sixties.[10]

Artists who were, due to their use of glass, plastic and other (then) new industrial materials, such as fiberglass, polyester or epoxy resin, acrylic plate etc., united under the designation L.A. Glass And Plastic or also L.A. Look, Fetish Finish and L.A. Cool School, created works in which the boundaries between painting, sculpture and design became blurred. Their experiments with new materials and light technologies were not motivated by the formalist questioning of the medium, but rather by sophisticated engagements with perception, light, color and space. Glass and plastic enabled a focus on non-material optic and tactile effects of works, which induced subtler perceptual states by including light shifts, translucence, illusionist effects of depth, shadows and reflections. Nonetheless, the emphasis was not on the material, but the idea that material was only a means for achieving the goal, which was transcending the material.

Artists such as Ron Cooper, Craig Kauffman, Ed Moses, Helen Pashgian, Peter Alexander, Larry Bell, Robert Irwin, DeWain Valentine, Doug Wheeler and Larry Bell, created sculptural, pictorial and spatial works which were, due to specific materiality, sensitive to the environment and light in space. Due to effects of dematerialization, generated by smooth and light-responsive surfaces, these works stressed the reciprocity between light, matter and shape, and established new forms of phenomenological relations with the viewer.

The artistic appropriation of design procedures from the aeronautical and automobile industry, and the introduction of light technologies and new techniques of processing materials (vacuum treatment, dyeing and sterile chambers, mechanical cuts, bending etc.) led to connecting art with science and technology. Artists participated in inter-institutional projects, art residences and research platforms that connected artists with scientists and engineers. We need to point out that creative exchanges between art and industry were not directed towards examining pragmatic functional solutions or toying with technology *per se*, but rather involved subtle explorations of the range of artistic experience, established via the relation between object and perceiver.

Paintings created by Craig Kauffman, Helen Pashgian, Peter Alexander or De Wain Valentine, may elicit associations to nature due to special atmospheric effects, though the resemblance with the materiality of water, air, clouds, vapors, the vastness of the sky or the remoteness of the ocean horizon was mediated in the abstract, purified form in an

entirely artificial medium. One of the first artists to use plastic and its industrial treatment was Craig Kauffman, who tested the boundaries of the pictorial after 1963 with a series of paintings presenting abstract, biomechanical forms on Plexiglas. He became famous especially for his hybrid painting-objects in bubbly shapes, which he produced with the vacuum treatment of plastic and the layered sprinkling of the deposit. When explaining the motive for creating these works, he said that he was looking to create a sense of 'a bubble sculpture as "art you can ride in" and as a "hover form which moves around [the) room and bumps into walls." (Kauffman in Clark 2011, 57) The soaring and ethereal 'capsules' of various pastel tones were attached horizontally to the wall; due to optical effects of shining through, reflecting color and glimmering, effects which were changing according to the observer's position, these works produced a floating and immaterial impression. The artist experimented with materials and light with the intention of incorporating the effects of ambiental phenomena into the perception of form, while the viewer's experience became the work's basic element. [5]

The light-responsive works of Peter Alexander are distinctly associative, as they resemble the depth of water, the softness of clouds, haze and similar ethereal atmospheric phenomena, due to transparency and color gradations. Formally educated as an architect, he transferred his pronounced feeling for space and ambience into sculptures and paintings he made in the 60s and 70s by casting artificial resins. (What followed was a period of returning to more traditional painting techniques and, a decade ago, to the use of acrylic materials.) His first works were abstract landscapes made of plaster set in Plexiglas boxes. In 1971, he commented: "The idea was that you would project yourself into these landscapes by looking into the box. ... It never worked in plaster so the extension of that was to try to work it out in some other medium." (Alexander in Clark 2011, 59-61). The works he created by molding polyester resin (1965 - 72) produced a sense of minimalist reduction and formal homogeneity. The central event is created by light refracting and passing through a translucent material; it seems that these works materialize light or some other 'vaporous' substance; the object manifests as an optic, changeable and mutable natural phenomenon.

Simultaneously ethereal and sensual, the works of Peter Alexander function as a metaphor for the momentary suspension in time, or images of 'a wave caught in a moment'. The later works made of polyurethane resin are mood affecting and associative as spilt fields of color; it seems that they represent a state when the water reaches the shore and disappears in the sand. They suggest a sense of soft transition of the substance of water into the air, and,

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5   Craig Kauffman, Untitled, 1968

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In Stuck Red and Stuck Blue, rectangular apertures are cut out of additional walls, which are covering the room's real walls. Fluorescent colour light bulbs are hidden in the slits behind these temporary walls. Due to the intense colour glow of rectangular shapes in an otherwise dimmed space, negative spaces of apertures seem full or material, while the walls seem to dematerialize. Emptiness and fullness are optically subverted; the colour gains a sense of weight, and the painting represents the materialization of light in a tactile manner.

12

Doug Wheeler was originally a painter who, after starting with the processes of formal reduction of abstract (combining biomorphic and mechanical) geometric shapes in more or less monochrome imagery (1962-63), and continuing with a series of 'chip' paintings (1964), gradually arrived at introducing real light elements into painting (fabricated pieces, 1965-68), where canvas was replaced with Plexiglas and neon light bulbs placed in the interior. What came next were 'Light encasements' (1969), which combined vacuum processed elements of Plexiglas and light technology to create softly rounded linear rectangular light shapes.

6   Peter Alexander, Royal Blue Drip, 2011

when exhibited in a gallery space, tend towards transcending the physical medium and merging with the surrounding space. [6]

Although James Turrell and Douglas Wheeler were known especially for their light and space installations, I would like to—in the context of analyzing transformations of pictorial space—highlight two types of their work which offer new pictorial spatiality. Turrell's first light works (Light Projections (Afrum), 1966-67; Stuck Red and Stuck Blue, 1970) were produced, as the painter claims, in reference to painting: "What happened then is that I got more interested in the plumbing of hypothetical space and the idea of the presence or quality of light. Afrum ... was more of a painting in the sense that you have painting on a two-dimensional surface that alludes to perhaps three dimensions or unsolvable three-dimensional things. This work was about taking three-dimensional space and making the same kind of allusions to the space beyond that-you don't need to call it fourth dimension but just one that does not solve up in three. So in that way, my work does have a lot more to do with painting than it does with sculptural or architectural senses, because the first thing that is important is that the light is used as material, and that it has a physical presence as such, and that space is solid and filled and never empty.... Let's call painting our concept of three-dimensional space ... then from that, create paintings that don't solve up in that space-rather they are that space. They become like little 'holes in reality.'" (Turrell in Butterfield 1993, 72). Regardless of dealing with the illusion of the three-dimensional volume brought about by intense light projection in a suitably deformed geometric shape (Afrum), or with shallow space constructions (Stuck Red and Stuck Blue, 1970[11]), which work in the opposite manner by flattening some parts (the actual holes in the wall) from 3D into apparent color two-dimensionality, these works revolve around the idea of light as a tactile substance which gives a feeling of being touchable. [7]

Light paintings from the series 'light encasements' (1969)[12] by Doug Wheeler stress more directly the concept of painting as the materialization of emptiness. His works— with the help of the vacuum treated acrylic light tubes that he sprinkled with lacquer—radiate in soft diffuse light and give a sense of light surrounding non-material emptiness. [8] The artist thus comments:

"I want the spectator to stand in the middle of the room and look at the painting and feel that if you walked into it, you'd be in another world."

/   Wheeler in Clark 2011, 31
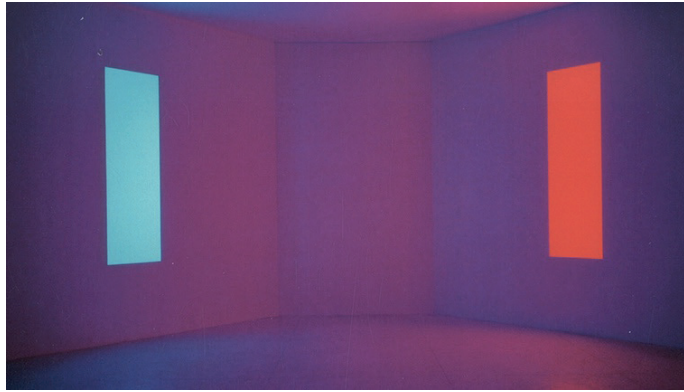
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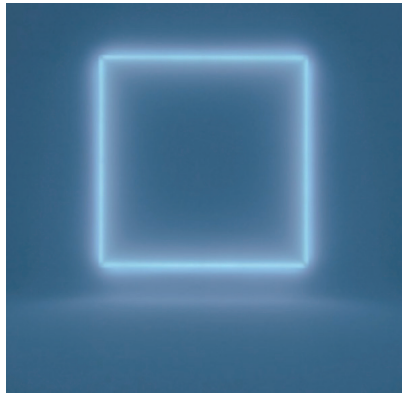
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Light paintings 'light entrapments' (1968) by Ron Cooper were created by layering artificial resin and fiberglass. Cooper produced paintings that create, on the brink of the visible, 'traps for light'; he was interested in the effect of color suspended in space. In the late 60s Helen Pashgian also made acrylic paintings and three-dimensional objects, where the key element was the interplay between light and transparency. By molding resin and inserting solid acrylic elements into simple geometric (rectangular or round) shapes, she created illusory effects, which depended primarily on the angle of observation, i.e. the position of the viewer and the shifts in ambient light. In contrast to many artists, who in the 60s began their career as painters but gradually dropped canvas and turned to the use of the light medium (D. Wheeler, R. Irwin, L. Bell and others), Mary Corse, despite her experiments with materials, kept her primary interest in painting. By mixing glass micro-grains into color surfaces, she created a dynamic sense of refraction, condensing and reflection of light in paintings (the end of 60s), while later she introduced light-electric elements to create light-boxes which gravitate towards the 'technological sublime' (Clark 2011: 55).

Despite the variety in formal expression or the philosophical background of the artists who introduced light as a medium into their works in the 1960s, they share a common emphasis on the central importance of perceptual and situational experience in a work of art. Their art experiments with new materials, light technology and industrial productions reflected their interest in the psychological and perceptual dimension of the aesthetic experience which is supposed to expand the viewer's scope of self-consciousness.

COMPLEXITY AND NON-LINEARITY IN THE ABSTRACTION OF THE INFORMATION AGE

Modern science, which established models of reality on the basis of Einstein's theory of relativity and Planck's quantum physics, also generated a particular gap between the experiential and the theoretical, mathematically described model of space. This duality was actually introduced by analytical geometry (Descartes), which was not based on the space of perception (unlike the classical Euclidean geometry), but rather on the mathematical space of algebra and arithmetic. Classical geometry reflected relations found in natural space; geometric symbolization served representation (the relation between the geometric sign and thing was based on similarity), while analytical geometry used signs *per se*, which did not mirror perceptual space, but relied on functional equations. While the 20th century physics, on the basis of unifying the theory of relativity

7   James Turrell, Stuck Red and Stuck Blue, 1970

8   Doug Wheeler, Untitled, 1969/2014

with quantum mechanics, offered a consistent explanation of physical space; mathematics established a whole specter of different geometries and multiple mathematically provable, intelligible space dimensions.

The predominant paradigm of postmodern science has been founded on the basis of chaos theory and nonlinear dynamic systems. In the nineteen-fifties and sixties, fractal geometry started to describe the reality of phenomena belonging to complex systems and nonlinear dynamics, beside which Euclidean geometry seemed useless. Euclidean space was based on the abstract geometric systems of coordinate axes, straight lines and basic geometric bodies; it treated natural phenomena (physical, biological...) in abstract terms, using reduction and specialization. It was founded on the search for linear processes in nature, i.e. the search for rules and patterns of the behavior of a particular system along the principles of cause and effect. Euclidean space was conceived in an abstract manner and did not correspond to the revelations of reality as described by chaos theory, which was founded on the finding that even the simplest systems could generate chaotic behavior. The accumulation of input information did not improve the understanding and prediction of nonlinear and chaotic dynamics, as the latter confronted us with non-periodicality and complex phenomena with which 'mistakes' tend to increase.[13] Research on the behavior of chaotic systems has revealed that reality is established through the relationship between order and disorder (chaos); it has led to the demand for new scientific methods that would be able to discover and examine the inherent order and behavior of seemingly totally chaotic and unpredictable natural or artificial structures. What is essential for studying nonlinear systems therefore is not linking causes with effects, but rather the identification of patterns and certain irregular repetitions (semblances, non-coincidental iterations). Space, which is curved, deformed, coiled, cut, undulated and dynamic is fittingly described by fractal geometry (Benoit Mandelbrot), which recognizes resemblances in the structure of fractals (not complete identity), iterated at different scales; the micro scale of the fractal structure reflects the macro structure, each minimal particle of the system reflecting the order of the whole to which it belongs. Chaos theory does not limit itself to fractals, but deals with nonlinear phenomena, which are characterized by variety, ephemerality and dynamism. Precise research on chaotic systems and nonlinear dynamics was made possible only by digital technology with algorithmically generated virtual simulations.

Modern art movements were often inspired by science; many avant-garde artists were led by the desire to use artistic means to visualize relative space, multidimensionality and other scientific visions of reality according to the new scientific paradigm. Deformed topologies,
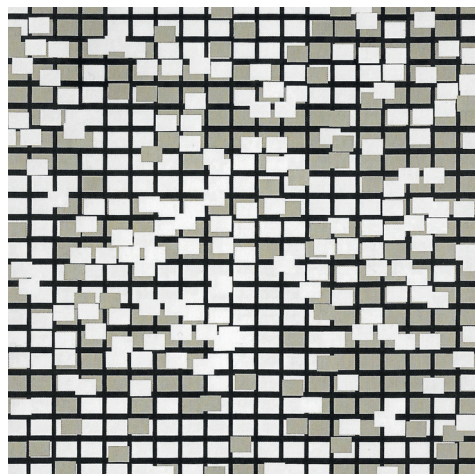
13
Nonlinearity can be illustrated by playing cards where the rules of the game would be changing on the spot, due to the process of playing, or with the example of a labyrinth, whose walls and paths would be rearranged with each step of the way.
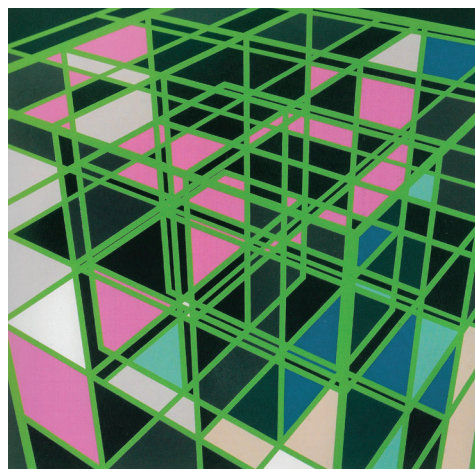
decompositions, fractured and curved spatial representations reflect broader scientific and social concepts of modernism. The pictorial procedures of rationalization, the abstraction of visible reality and the gradual formal reduction of elements of pictorial space coincide with the dominant scientific tendency to count and deconstruct reality to elementary particles or indivisible elements, which are regulated by universal laws. Just as the micro-reality of scientific world reveals the workings of energetically charged particles (physics, chemistry), cells and chromosomes (biology) or the indivisible elements of sensory perception (experimental psychology), modern art leans towards pure abstraction with painting focusing on elementary art concepts – pure colors, lines and reduced geometric shapes. The prevailing reductionist method and paradigm of understanding reality permeated both the scientific and artistic strategies of modernism. (Manovich 2007; Vitz and Glimcher 1984)

Since the 1960s, we have witnessed the emergence of a new epistemological paradigm in numerous scientific and technical fields, including chaos theory, nonlinearity and the dynamics of complex systems, self-organization and autopoiesis, research on artificial life and intelligence, mirror neuron networks and genetic algorithms. The study of nonlinear dynamics of complex systems sheds light on the articulation of spontaneous order, which is not determined by the characteristics of the system's elements, but rather the emerging and unpredictable features that appear from chaos and coincidence in the process of simple interaction between elements. The paradigm of complexity, which has come to replace linear reductionist models of reality, does not merely reflect the new scientific and social reality, but can be traced also into the field of contemporary art production.

In abstract art of the information age, the aesthetics of complexity have appeared most explicitly in digital and new media arts, computer generated 'software' abstractions or (interactive) video simulations, which often use the same algorithmic bases as scientific animations of chaos and artificial life. As noted by Manovich, software artworks (moving computer simulations) demonstrate the aesthetics of complexity in the interactive parts, where the user, with the help of a particular interface, brings to life abstract dynamic patterns. These moving visual systems no longer evoke ideas of order and simplicity, and their behavior is neither linear nor random – instead they appear to change from a state to a state, swinging between order and chaos, in a similar manner as complex systems found in nature. (Manovich 2007: 349) Manovich clarifies the aesthetics of complexity using examples of digitally generated software (interactive) abstract works[14], which show the dynamic movement of changing linear structures. He emphasizes that the line used in

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Manovich illustrates his hypothesis on the complexity aesthetics with examples of moving computer generated (software) simulations, which were – beside more traditional art forms – incorporated into the exhibition *Abstraction Now* (Kunstlerhaus Wien, 2003). When considering the works of artists such as Golan Levin, Manny Tan, James Paterson and Amit Pitaru, Peter Luining, Return and James Tindall, he notes the formal similarities between these and the tradition of modernist abstractions (composition based on the grid, combinatory aesthetics, colour and formal geometric reduction etc.). Despite this, the analyzed works express an entirely different logic: instead of the systematic play of variations of a small number of elements, these computer generated works constantly subvert possible configurations, without an inclination to discover or stabilize 'the right form' (modernism). They present a continuous process of the dynamic reshaping of forms which are not linked hierarchically. Unlike the works described here, which render complexity through the dynamic behaviour of considerably minimalist linear patterns, some artists use algorithmic processes for creating dense and complex fields which are often covering the whole screen (Glen Murphy, Casey Reas, Dexto, Meta, Ed Burton and others).

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See: Rossalind Krauss, Grids (1979) in The Originality of the Avant-Garde and Other Modernist Myths.

the context of modernist abstraction presents the basic visual element of the abstract structure of the world, while in the context of the moving virtual abstract composition it evokes the richness and complexity of reality: "In other words, if modernist abstraction assumes that behind the sensorial richness of the world there are simple abstract structures that generate this richness, such a separation of levels is absent from software abstractions. Instead, we see a dynamic interaction of elements that periodically leads to certain orderly configurations." (Manovich 2007: 348)

A significant portion of the production of contemporary abstract painting is based on the processual logic and formal aesthetics of complexity. We can observe pictorial strategies of direct appropriation of algorithmic processes, ideas and techniques of visualizing complexity, or less direct references to the dynamism and nonlinearity of abstract structures that reveal—in seeming chaos—a certain sense of order. In the context of the so-called contemporary 'post-media' art production, paintings are created through processes of passing between digital tools and analogue techniques, while the resulting spatial structures include the experience of both media.

The line of contemporary abstract painting explores the visual potential of a grid with contemporary means of visualization and creation, thus reinterpreting the grid as an emblematic compositional principle of the modernist abstract painting.[15] Works of Esther Stocker construct variations of the grid linear orthogonal structures, where the abstract semantic content (the event of painting) is developing in the field of distinctions between order and deviations from order. Although the paintings suggest comparison with the modernist tradition of abstract painting (or centripetally and centrifugally directed compositions of grid), in this case the perception of singular formal units (color, line etc.) is not highlighted, but instead we are dealing with turning away from 'objects of perception' to 'perception itself' (Röbel 2004: 79). In the same vane the abstractions of Günther Selichar or Doris Marten express the aesthetics of digital visuality, which is determined by the reality of screens, pixels, dots, lines and the logic of binary numerical relations. The grid constructions of Sarah Morris, which refer to the transformation of modernist architecture, appear more spatial. [9-10]

Contemporary abstract pictorial representations seldom stress the notions of emptiness, absence and the depiction of the undepictable, which were characteristic of modernism. More often they are created on the bases of the scientific imaginaries of contemporary, technologically expanded reality: seemingly abstract organic (biomorphic) or geometric structures originate from the phenomenal but until now invisible dimension of reality, which has become accessible

9 Esther Stocker, Untitled, 2001-2003

10 Sarah Morris, National Archive, 2002

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with the help of various contemporary medical technologies (X-ray, ultrasound and magnetic resonance), microscopic or telescopic instruments, nanotechnology etc. For example, the pictorial abstractions of Ross Bleckner incorporate the experience of the technologically revealed complexity, which points to the invisible bodily geometry; the invisible realms of bodily, cellular and organic structures create bodily topologies, visualized in an utterly abstract manner. [11-12]

While the technologization of nature characterizes the works of Ross Bleckner, the abstract works of Fiona Ray or Tomma Abts are marked by greater fusion between technology and nature, which is described by Paul Crowther with the term *'techno-nature'*. Crowther believes that "the relation between contemporary sensibility and the natural world, in general, is thoroughly mediated by technology. (...) We have, then, three vectors—the naturalization of technology, the technologization of nature, and the continuum wherein these tendencies intermingle in a very close way" (Crowther, 2012: 219). The 'floral' motifs in Fiona Ray's paintings give an impression of vegetative growth creating new, unprecedented, nature-like vegetative forms, while the works of Tomma Abts produce a technological hybrid between the natural and the artificial through intense trompe *l'oeil* effects of simulation: orbital, curvilinear and sharp angular forms are seemingly superimposed and perforating undifferentiated backgrounds. [13-14]

Such pictorial images question blurred distinctions between the real, virtual and abstract, visible and invisible, natural and artificial in the contemporary world; they open up a complex field of questions, which, in abstract painting, highlight the delicate and constantly changing relations between reality and (its) representation in art. The appropriation of scientific and technological images of the natural in artistic abstraction is leading us to reflect on the epistemological dimensions of scientific visualizations developed by Horst Bredekamp. Bredekamp emphasizes that scientific and technological images do not function merely as passive illustrations, but in fact actively participate in the epistemological production of knowledge. (Bredekamp, 2015: 1-5). This raises the question to what extent do artistic (abstract) images, created on the basis of appropriating and intertwining technological, scientific and aesthetic aspects of imaging the real (natural), also possess the generative and transformative epistemological power in art research, and in what ways does such artistic production contribute to the expansion of knowledge with its means and methods.

11   Ross Bleckner
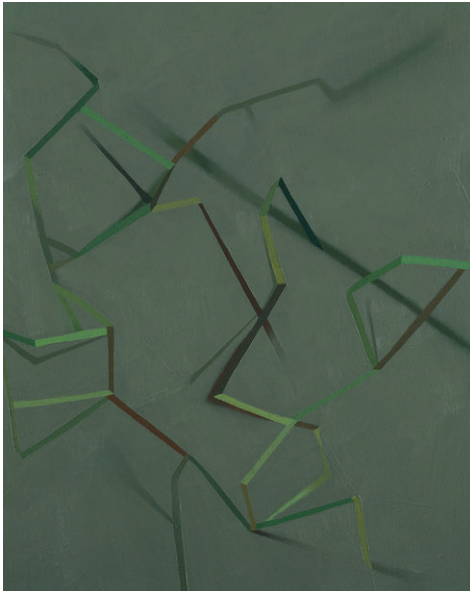
12   Ross Bleckner

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Modernist abstraction related to the scientific and technological paradigm of understanding the then reality and used its own, artistic medium, to reflect the cognitive, epistemological and aesthetic values of the broader social sphere. The abstract art of the information (postmodern) era, which is affected by contemporary scientific models of reality, communication technologies, social networks and the digitally expanded concept of the everyday, is likewise a reflection of the world which is based on a more complex, virtually connected and dynamic mesh of relations. Contemporary abstract images rarely invoke notions of void, absence or non-objectness, since their geometric or biomorphic constellations reflect the symbolic forms of contemporary social, technological and virtual complexity, which generates a fragile and dynamic oscillation between order and disorder.

Regardless of the formal and content-related variety of contemporary pictorial abstraction, the strength of contemporary abstract or non-objective pictorial forms can be seen in providing a form of art that encourages, in a particular manner, the viewer's freedom of interpretation. Studies of the sensory and cognitive dimensions of aesthetic experience in contemporary neuroscience show that the observation of the visually undefined, ambivalent or abstract forms and patterns, or those indeterminate in terms of meaning, intensify imagination and intuitive (pre-cerebral) dimensions of aesthetic experience, due to the lack of a coherent semantic (narrative or figurative) expression. The vital force of abstract art stems from its ability to trigger an individual sensory and emotional experience before the cerebral (rational) response; it can thus in a unique way inspire the viewer's creativity and imagination in experiencing art and reality.

13   Fiona Rae, Don't make skies fall down!!!, 2007

14   Tomma Abts, Stilf, 1999

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