Geometry as a Source of Inspiration in Contemporary Art

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Abstract

As is well known a strong interaction exists between Geometry & Art since the antiquity. This interaction has been revitalized by the developments of new artistic sensibilities in XX Century up to the turn of the third Millennium. Starting from the revolutions of Impressionism, Cubism and Futurism we discuss the role that Mathematics, Science and Technology had in inspiring some artistic movements: more specifically Geometric Abstractism, Constructivism, Kinetic Art and Optical Art. Particular attention will be given to the work of Vasily Kandinskii, Max Bill, Alexander Calder and Milan Dobes; we shall shortly mention also the role that Relativity, Quantum Mechanics and Gestalttherie have played in early XX Century in forming these new sensibilities on perceiving and representing "reality". In this way we shall emphasize that to understand most of the new forms of Art developed in the past Century one needs to understand (or at least grasp) their mathematical and technological roots.

1 Art & Geometry: a Long-Lasting Interaction

It is well known that Geometry was born out of much older knowledge as that part of Mathematics explicitly devoted to investigate shapes in Space and measure their "extension"; developed as a practical discipline since the Paleolithic age ([1]) during the Greek age it became a formalized elegant tool of theoretical though. The concept of "geometric form" did in fact slowly arise from the observation of forms already existing in Nature and more or less hidden in the structures through which the human mind tends to perceive the "Order of Nature". Starting from the Pythagorean doctrines, passing through Renaissance (we mention Perspective and Projective Geometry, developed on purpose with the aim of treating points at infinity as ordinary points and at the same time to "paint what the eyes see") and going well beyond, Geometry was assumed to be a common language for understanding the structure of the "Kosmos" that surrounds us. It is emblematic to quote what in 1623 Galileo wrote in his celebrated treatise "Il Saggiatore": *"this huge book that stands open in front of us (say the Universe) cannot be understood if we do not learn before the language and characters with which he is written. He is written in mathematical language and the characters are triangles, circles and other geometric figures"*.
The language that we use to understand "Kosmos" is indeed formed by a subtle intertwining of Numbers (the act of "counting", i.e. "Arithmetic") and Forms (the core of Geometry; [2]). All the primordial forms of "Geometric Art" did involve explicitly "basic forms" that were later encoded in Euclid's book on "Elements of Geometry": straight lines, triangles, squares, regular polygons and regular polyhedrons, also known as "Platonic Solids" (that account for the linear and affine structure of Euclidean Space); as well as circles and spheres (that account for the metric structure of Euclidean Space). These "primordial forms" do constitute the building blocks of Euclidean Geometry, together with the more complicated shapes ensuing from them with nice properties for the eye, such as: "conical sections" (ellipses, parabolas and hyperbolas); ovals; algebraic curves; knots; cusps; catenaries and catenoids; less regular polyhedrons ("Leonardian Solids"); cylinders, cones and other revolution surfaces; helicoids; and so on. An infinite family of "geometrical shapes" that we like to call "forms without an age" since they have crossed the ages, from Prehistory to now, giving rise to what we call the "persistence of forms" [3].
During XIX Century the insofar "static" Geometry of Euclid underwent a great evolution: on one side the older knowledge about the "stratified" structures of Euclidean Space was embedded into the new vision

of Felix Klein's "Erlangen Program", aimed at understanding all possible "geometries" as being encoded in groups of transformations that leave basic structures invariant. On the other side Euclidean Geometry was realized to be a particular case of "Riemannian Geometry". After the pioneering work of Karl Friedrich Gauss (1777-1885) on the properties of surfaces embedded into standard 3-dimensional Euclidean Space through the subsequent work of Bernhard Riemann (1826-1866) revolutionary ideas in the Physics and in the Mathematics of XIX Century eventually replaced the "rigid" and "static" (flat) paradigms of Euclid and imposed the predominant role of non-linearity and higher dimensionality. The abrupt transition from Newton's Physics to Einstein's Theory of Relativity accompanied the renounce to the predominance of staticity, locality and flatness (proper of Euclid's Geometry) in favor of dynamism, globality and curvature. These new scientific views had a parallel in Art, whereby Impressionism first, Cubism and Futurism later, aimed at "painting how the brain perceives" and to understanding a 4-dimensional world in which Space and Time mingle into a single entity. The rigidity of "metrical forms" was eventually replaced by the plasticity of "topological forms" [4],[5].

As we said in [6] *"The turn of the XX Century saw great revolutions in thought, related to new understandings of the physical world, of Technology, of the Psychology of perception, along with the artistic sensibility that refers to these new issues. The theory of Electromagnetism was formulated in 1864 by James Clerk Maxwell (1831-1879), who died at the age of 48 in the same year in which Albert Einstein (1879-1955) was born in Ulm: light became afterwards the measure of all things. Relativity Theories (the "Special" in 1905 and the "General" in 1915-1916) changed our way of understanding Space and Time. In parallel, the studies of Sigmund Freud (1856-1939) culminated in 1895 with Psychoanalysis, while the Gestalttheorie (the "Psychology of Forms") was born in Germany around the turn of XX Century, starting from earlier work by Ernst Mach (1838-1916) and Edmund Husserl (1859-1938). Photography (born at the beginning of XIX Century) became well structured only in the last decades of the Century, while its dynamical evolution known as Cinema can be set back to 1895, when Auguste (1862-1954) and Louis Lumière (1864-1948) projected their first movie at the Grand Café des Capucines."*

The new age that emerged from the beginning of XX Century was thence the "Age of Motion, Light, Dynamism, Perception and Visualization". These new paradigms become central themes of Science and Technology, so that Art begun not surprisingly to parallel developing new expressionistic ways aimed at putting them in relation with the way in which brain reacts to external stimuli. Art eventually transformed from an exhibition of static objects (paintings or sculptures) to a search for "dynamical and/or interactive artworks" that entangle reality with illusion, dynamically interfering with the perception of the spectator and/or the ambient in which they are embedded. So-called "Kinetic Art" was born. In parallel, a new idea of Space and a new idea of Time had finally become arena and subject at the same time for artistic creations, that generalized from rigid and immutable pieces to dynamical and ever changing ones, extending their own structure and essence to become "Installations", often formed by moving objects that can sit everywhere and allow interactions with onlookers, often entangling Science with Art. Along with these frenetic developments that are still under their way, for many artists of XX Century the simple forms of Geometry – and more generally, the entire field of Mathematics - have again become a fresh source of inspiration for Art, in a kind of "travel backward in time", towards a renewed aesthetics of "simple forms": circles, straight lines, triangles *("without which we cannot intend human words"* as Galileo said), as well as squares and other geometric constructions.

A further important domain of intersection between Art and Science in the XX Century is related with the artistic and scientific researches that mix up the theory of colors, the properties of light and the problems related with the "Theory of Perception". This mainstream, suitably conjugated with the stream of "Kinetic Art", takes the more appropriate name of "Optical Art" and is rooted in the work of Victor Vasarely (1906-1997), who *"begun to use programmed painting systems, based on permuting geometrical models and variations of sharp colors until luminescence; what he added to traditional Concretism was the aspect of optical tension*" ([7], pages 92-94). The term "Optical Art" was coined in 1964 by the sculptor George Rickey (1897-2002) who spoke of *"artworks being designed by concentrating onto optical effects such as consecutive images, illusions, inversions in the ratio between figure and background"* so that with respect to "pure" Kinetic Art *"Op artworks set movement in the observer himself rather than in the*

observed object. The visual apparatus of the onlooker is obliged to perform continuous adjustments to overcome the ambiguities that are presented to it" ([7], page 96).

2 From Impressionism, Cubism and Futurism to "Geometric Abstractionism"

Cubism operated a cut in our way of representing reality in Painting, interpreting it as the superimposition of multiple views from different viewpoints rather than the effect of a single glance; paintings of XX Century become "manifolds" and, in a sense, they were also able to embed a fourth spatial dimension into two-dimensional canvases. A similar revolution towards artistic multi-dimensionality was operated also in Architecture at the turn of the Century: Gaudì's innovation [8] can be considered as examples (Gaudì, 1852-1926), but also the work of Le Corbusier (Charles-Edouard Jeanneret-Gris, 1887-1965), Iannis Xenakis (1922-2001), Santiago Calatrava (1951), just to mention a few.

Figure 1: *"La Sagrada Familia" by Gaudì (left) - a"mobile" of Calder, UNESCO in Paris (right) – photo © by Marcella Giulia Lorenzi*

The introduction of Time as a fourth dimension of SpaceTime was pursued in Art through the "purely perceptive solutions" of the artistic movement known as "Futurism" which also profited of the new ideas and technologies of XX Century had through new forms of Art related with the development of Photography and Cinematography; the "photographic counterpart" of Futurism was christened as "photodynamism", at the bases of which were lying the famous studies of Eadweard Muybridge (1830-1904) – that did in fact inspire many other artists of the XX Century. For example, Francis Bacon (1910-1992) who is considered one of the greatest post-war painter, about whom we read: *"The artist worked by getting often inspiration from photographical images […] In particular he was attracted by the famous treatise […] of Eadweard Muybridge, in which one could find several sequences of naked men and animals portrayed in various phases of their motion"*; [7], p. 80. The French painter George Mathieu (1921) has in fact written in 1959: *"Introducing rapidity in western aesthetics seems to be a particularly important phenomenon."* As early as 1859 Alphonse de Lamartine (1790-1869) wrote: *"Photography is an Art. Photography is more than an Art. It is a solar phenomenon, where the artist collaborates with the Sun"* while in 1923 the famous movie director Dziga Vertov (1896-1954) declared: *"I'm an eye; a mechanical eye [...] freed from the boundaries of Time and Space, I co-ordinate any and all points of the Universe, wherever I want them to be. My way leads towards the creation of a fresh perception of the world. Thus I explain in a new way the world unknown to you."* Photography has later evolved into "Digital Photography" and allowed even more powerful artistic expression [9]. The American master of Digital Photography Rick Doble said once that: *"Digital Photography could be a major Art form in the next century. It may be the culmination of the development of Photography. Digital cameras may give us the power to set Photography loose"*; as we said in [5] Digital Photography allows indeed new forms of Art than can be ascribed to the framework of "Generative Art" in the sense of Galanter.

Along with Impressionism, Cubism and Futurism the evolution of artistic research for innovative expressions generated a kind of "reverse process". As said in [6] *"in its continuous struggle for ways to represent reality in an as faithful as possible manner, Art had generated investigations about the best way to reproduce the "seen" (Perspective), about the ways to transfigure reality under the guidance of "impressions" and "deformations" (Impressionism), about the very nature of our vision of colors ("Pointillisme")*. Parallel to the understanding that our Universe is not "simple" but largely due to a complicated fusion of simpler fragments (nowadays called "Complexity") after the XIX Century the search for "reality" in Art has therefore taken different paths. Photography and Cinema deprived of meaning the search of ways to "reproduce reality" by painting techniques, thus inducing artists to better "transfigure it": subliminal perceptions and the need of "deconstructing forms" through their reduction to "plastic models" or to "simple constituents" (to be ordered and considered as "fundamental entities") led Artists at the saddle point between XIX and XX Century to use again the "primordial forms" of Geometry as concrete sources of inspiration for artworks. A renewed attention arouse towards the evocative power of simple geometrical forms that soon became central for new researches on the "reduction of reality to its basic constituents" as well as a way to evoke the mechanisms of perception by "shape-reconstruction" and color entangling. Cubism slowly transfigured into "Geometrical Abstractionism" through the emblematic work of Vasily Kandinskii (1866-1944), who investigated also the relations between artistic expression and scientific methods; see [10]. A further contribution to this new marriage between Art & Geometry resides in the work of Piet Mondriaan (1872-1944).

In the already quoted monograph [7] Angela Vettese claims (page 7) that *"After late '900 artistic practice has been enriched by a set of technologies [...] the language of Art has been endowed with a number of expressive possibilities never seen before: Painting and Sculpture have not disappeared, but they seem to be more and more contaminated by our new ways of perceiving; even if traditional techniques do periodically live moments of rebirth, the mechanical images that we are continuously facing are persistently changing their lexicon"* and she adds that such a practice has entailed *"a progressive divorce between Art and Aesthetics"* ([7], p. 10). In our opinion, instead, one is facing a new paradigm for Aesthetics, that has in fact rapidly evolved in order to follow the change of taste generated by new scientific understandings: in a sense, passing from linearity to curvature, from staticity to dynamism, from continuity to "fractality" has in fact changed not only Mathematics but also our own way of perceiving the notion of "beauty" and "order"; as David Hume said once: *"Beauty is not an inner quality of things, it exists only in the spirit that contemplates it."* The XX Century has thus become the "Century of New Visual Art" , a form of Art "able to understand the sense of change" and to meet *"the waves of sense that walk together with History"* ([7], p. 16). Again we can quote a few examples of this new sensibility: "Surrealism" first (Salvador Dalì; 1904-1989) and "Metaphysical Painting" later, of which the Italian painters Giorgio De Chirico (1888-1978) and Renato Guttuso (1911-1987) were among the major interpreters. As well as the whole research performed on Non-Euclidean forms by "Constructivist Artists", among which we like to mention Milan Dobes (1929) [11],[12] - the famous Bratislava master among its fathers - and a large part of the artistic followers that were in exhibition at the House of Arts in Bratislava in 2010, under the emblematic title *"Borders of Geometry"* [13].

We like to quote once more from [7] (page 87): *"Geometrical Abstractionism has deep roots in the antique Pythagorean conception according to which the basis structure of Nature should have a geometrical character [...] in the artistic domain it has mainly produced the humanistic insistence on central perspective, in the XIX Century one can find its echo in Cézanne, who notoriously saw Nature as a set of geometric solids, as well as in Picasso, Braque and all cubist painters. If Cubists still maintained a strong relation with figurative painting, only the Russian Abstractionists really gave body to an absolute pictorial geometrism"*. In a famous 1913 statement the French writer (and Cubism's mentor) Guillaume Apollinaire (1880-1918) said: *"Today scientists no longer limit themselves to the three dimensions of Euclid. The painters have been led quite naturally, one might say by intuition, to preoccupy themselves with the new possibilities of spatial measurement which, in the language of modern studios, are designated by the term:* ***the fourth dimension****. Regarded from the plastic point of view, the fourth dimension appears to spring from the three known dimensions: it represents the immensity of Space*

eternalizing itself in all directions at any given moment. It is Space itself, the dimension of the Infinite", while in 1917 Theo Van Doesburg (1883-1931) published the "Manifesto of Concrete Art" that aimed at replacing "Abstract Art" (considered as vague) and soon became a synonymous of geometrical and impersonal paintings.

We should now mention the artistic work of Max Bill (1908-1994), who gained inspiration directly from Geometry: in Painting, with his important investigations on simple geometrical forms that can produce emotions by side-by-side overlapping and complementary colors; as well as in Sculpture, with his insistence on new geometrical shapes suggested in two and three dimensions by Topology, mainly related with the two-dimensional (non-orientable) surface known as "Möbius strip" [14]. In his 1949 essay [15] we read: *"By a mathematical approach to art it is necessary to say I do not mean any fanciful ideas for turning out art by some ingenious system of ready reckoning with the aid of mathematical formulas. […] Kandinsky had indicated the possibility of a new direction that […] would lead to the substitution of a mathematical approach for improvisations of the artist's imagination […] Most of the modern work which is often held to have been largely inspired by mathematical principles cannot, in point of fact, be identified with that entirely new orientation I have called the Mathematical Approach to Art […] The difference between the traditional conception of Art and that just defined is much the same as exists between the laws of Archimedes and those we owe Einstein and other outstanding modern physicists […] and despite the fact the basis of this Mathematical Approach to Art is in reason, its dynamic content is able to launch us on astral flights which soar into unknown and still uncharted regions of the imagination".*

Speaking of *"The Mathematical Approach in Contemporary Art"* Angela Vettese ([7], pp. 88-89) claims also that*: "here one reads that Art should not be considered as a substitute for Nature, nor a substitute of individuality and spontaneity. Art cannot rise and grow until when individual and personal expression is not subjected to the principles of order"*. Out of Max Bill's experience a whole new body of artistic expression was in fact born, that can be collectively called *"Constructed Art"*. Among his followers we should mention Richard Paul Lohse (1902-1988) who in the second half of XX Century developed a geometrical painting founded on serial permutations of colors that follow sequences that reproduce the chromatic spectrum either in horizontal or in vertical. Concerning his own methods Lohse wrote indeed: *"We can produce modular constructions through a flexible principle based on a specific law or by multiple manipulations of a basic module. The extension and the triumph of the schema give rise to a dynamical organizing principle, the first operation predetermines the last one, the largest constellation of forms contains the smaller one, both in Architecture and in Art… Behind us we have the tradition of technique, in front of us the field of an unlimited flexibility and new orderings"* ([7], p. 90). Similar geometrical constructions belong to the artistic movement known as "Hard Edge Painting", the major interpreter of which was Ellsworth Kelly (1923), who contributed to "destroy constructivist geometry" founded on orthogonality: minimal variations of the square angle characterized Kelly's paintings, who operates either by side-by-side positioning of separated surfaces, each one being painted in a single color, or by painting adjacent zones with strongly contrasting and different colors ([7], pp. 46-47).

3 From Motion to "Kinetic Art" and "Optical Art"

In order to show in a concrete way the "flowing of Time" in Art and to overcome the still "static" experiments of Futurism, by "truly inserting" motion in artworks, the simplest idea was of course to think and construct devices in 3-dimensional Space that can be animated and therefore "seen in motion". This idea inspired a new artistic form of expression initiated in the first half of XX Century and later called "Kinetic Art" (even if we would better call it "Dynamical Art", to emphasize not only its relation with "motion as it is" but also to "motion as ensuing from an external force"). From an historical viewpoint antecedents can be traced back to Marcel Duchamp (1887-1968) works, even if one can effectively speak of "Kinetic Art" only after the work of the American artist Alexander Calder (1898-1976), who conceived moving sculptures (called in fact "mobiles") deprived of any pedestal and conceived as devices formed by suspended colorful forms free to move, pushed by wind or by the hand of an observer, so "going against

any rule of monumental sculpture". The birth-year of "Kinetic Art" as a specific movement can be finally set to 1955, when the Cantonal Museum of Beaux Arts in Lausanne hosted the historical review *"Le Mouvement dans l'Art Contemporain"*. More recently, as we already mentioned, thanks to a clever mix of new technologies and an appropriate use of specific properties of light, the "primitive" forms of "Kinetic Art" eventually evolved into what can be properly called "Optical Art".

As discussed in our paper [6] Frank Popper has divided kinetic and optical artworks into four major groups: 1) Artworks that induce a psychophysical reaction in the public through instable and mutable design (e.g., those of Bridget Riley (1931) or certain pieces due to the already mentioned Milan Dobes); 2) Artworks that create a disorientation using explicitly the relative motion between the artwork and the observer; e.g., those of Jesús-Rafael Soto (1923-2005) and of Yacov Agam (1928); 3) Self-moving structures, such as the "Mobiles" of Calder; 4) Structures in which motion is induced mechanically by engines or other devices. As a part of Kinetism we should also mention the so-called "Programmed Art", that was born around the sixties in Europe. When presenting in Milano one of his first exhibitions ("Arte Programmata", 1962) the Italian semiologist Umberto Eco (1932) wrote that *"inserting in the artworks the possibility of change one was in fact allowing in it a certain degree of indetermination, in spite of the <<calculations>> that might have been useful to conceive it"* ([7], p. 96). In Programmed Art artworks (often animated by small engines) had sometime a recreational intention and sometimes a truly scientific and mathematizing intension. For example, the "Groupe de Recherche d'Art Visuel" started from premises near to the Theory of Perceptions and elaborated their interest towards a specific aspect of motion that they described as *"development that tends to organize a new visual situation"*, showing to be independent on calculations and projects about the relations between Space, Time and images.

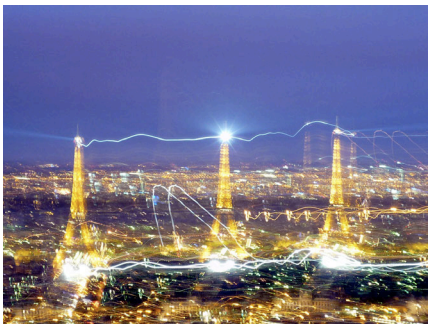

Figure 2: *Time, Light and Motion in Digital Photograpy: "Multiple Tour Eiffel"– photo © by Marcella Giulia Lorenzi*

One of the most ambitious installations ever constructed in the framework of Kinetic Art was done in Liége in 1961 by Nicolas Schöffer (1912-1992), who constructed a "cybernetic tower" of 52 meters of height, with the insertion of surprising effects of optical nature, so experimenting the addition of sounds and artificial illumination to movement. The framework of Optical Art was rooted in much older prescriptions having as a common background the skillful repeated use of color decomposition and visual microstructures: first the technique of "Pointillisme" of Georges Seurat (1859-1991) and Paul Signac (1863-1935), between XIX and XX Century; but also Futurist works (e.g., *"Compenetrazioni Iridescenti"* by Giacomo Balla; 1871-1958). Older antecedents can be traced back to studies by Johann Wolfgang Goethe (1749-1832) on the nature of colors and in the attention that Turner and Impressionists gave to light effects, as well as in the experiments about abstract compositions of colors that were at the bases of the colorful paintings of Sonia Delaunay (1885-1979) and Robert Delaunay (1885-1941). One should also recall the important contributions of the Hungarian artist Laszló Moholy-Nagy (1895-1946) who among 1922 and 1930 elaborated a series of artworks known as "space-luminous modulators".

As we remarked before, the progressive diffusion of Gestalttheorie was crucial for this new form of Art. In the words of Vasarely we read in fact: *"The basic notion of Kinetism […] is the very idea of movement. […] one speaks of Kinetism also for works in motion […] Not! For me Kinetism is what happens in the*

spirit of the viewer when his eye is obliged to organize a perceptive field that is obliged to be unstable. In other words, the reality that is shown to him is not a given one, which would be the "good" vision of the artwork; there are on the contrary multiple realities that are interchanged according mechanisms strictly related with Psychology. It is here that we meet Gestalttheorie, founded on the fact that the eye is by no means a passive receptor for visual information… What astonishes me in this change of perspective is that, alike in Renaissance, Art and Science … rejoin together to promote a new vision of the World". Gestalttheorie was also at the bases of Structuralism, that started from the idea that visual perception follow the rules of our sensorial apparatus, able to act at the pre-cortical level before the stimulus reaches our brain: our retina, for example, perceives a continuous line out of a discrete sequence of small segments. This mechanism of vision is also at the bases of the still unsolved dilemma whether Cinema is an "illusion of movement" (motion is continuous while a film is formed by a sequence of static frames) or, rather, motion is a stepwise process as in D'Alembert's principle of Lagrangian Mechanics, while the "apparent continuity of motion" is nothing but the way in which our brain interprets a discrete set of "quantum jumps" (see [16]). We recall here a famous debate that arouse between Einstein and Bergson about the very nature of Time. The transfer of the new ideas of Gestalttheorie to Art was certainly favored by the publication of the studies of Rudolf Arnheim (1904-2007) on the relations existing between Art and visual perception, while the book "*Inner Vision*" by Semir Zeki (see [12]) proceeds in exactly the same direction.

It is worth mentioning here also the work of the Italian artist Bruno Munari (1907-1998) who can be properly considered (together with other Italian artists) as a significant trait d'union between Futurism, to which he was affiliated, and the so-called "Concrete Art". His persistent and deep interest in "elementary geometrical shapes" (in particular, the square, the circle and the triangle, that he also collected into a nice series of booklets (see [12]). Among the Optical Artists we should mention Getulio Alviani (1939), who interpreted the paradox of metallic surfaces static as far as position is concerned, but seen as moving because of light vibrations on specific textures; Pol Bury (1922-2005) in whose work optical illusions are mixed with effective motion; Bridget Riley (1931) who worked on the apparent motion of painted surfaces, through serial repetitions of curved lines; Jesús-Rafael Soto who authored striped patterns on the front of which light suspended laths move and confuse the view; Luis Tomasello (1915), known for colored shades projected on white surfaces by small internally pigmented cubes aligned on their diagonals [12]. Authors of Optical Art have mainly worked on periodical geometrical structures (spirals, concentric circles, networks) mainly elaborating them as shades of black and white, their deformations giving rise to sensations of chromatic vibration. The complexity of the forms used by them is balanced by the geometric order imposed by the structure of the compositions and by the recurrence of serial patterns. When working with color, moreover, they investigated various effects of luminescence, interference and illusory depth. Most of the "optical artworks" were explicitly searched for "secondary perceptive effects" (i.e., visual effects that rise not at a first glance but only when the brain has begun to codify and decode the visual impressions), so that they can be understood only after sufficient time and a good concentration, as it usually happens when looking at "optical illusions". In a sense, an optical artwork becomes effective only when it is really perceived through an active participation of the observer; moreover, the artist's intervention is based on a sort of "absolute objectiveness" that leaves aside emotional expressions. A final quotation is deserved by the famous work that Olafur Eliasson (1967) presented at the 2003 edition of "Biennale di Venezia", into the Danish pavilion. It consisted of an installation of light (optical tubes) and colors that were able to took the spectator into a kaleidoscopic effect of reflections ([7], pp. 337-339).

4 Conclusions

We like to conclude with a few citations about the fruits of the interaction between Art & Science. We mention first what Marvin Minsky (1927) pointed out about the importance of artistic representations to better understand scientific concepts: *"No matter what one's purposes, perhaps the most powerful methods of human thought are those that help us find new kinds of representations. Why is this so important? Because each new representation suggests a new way of understanding; and if you*

understand something only one way, then you scarcely understand it at all. Perhaps this is the way the Arts so often precede the flowerings of culture". Stephen Wilson [17] pushes the concepts even further by claiming that *"the role of the artist is not only to interpret and spread scientific knowledge, but to be an active partner in determining the direction of research".* We have seen how the interrelationships between Art & Mathematics have increased across the change from the XIX to the XX Century, growing throughout the whole Century (see [18]). In spite of reductive opinions that tend sometimes to minimize these interrelationships, on the basis of a presumed and in fact meaningless separation between Art and Science as independent domains of Culture, this mutual relation is due to the undeniable fact that Science and Art evolved together "on parallel tracks". In the age of "New Science" a separation of Art from the impressive development in human scientific knowledge would have therefore been an impossible accident. New (and old) Mathematics have gradually become instruments and sources of inspiration for new forms of Art that aim to transcending the experiential world rather than trying to reproduce it in a stereotypical way - exactly as Albert Einstein once said *"The artist and the scientist each substitute a self-created world for the experiential one, with the goal of transcendence",* at the turn of the Third Millennium we cannot do anything else than waiting to see where this mutual and far-reaching synergy will bring new Art, new Science and new Mathematics towards new common goals in new Culture [19].

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