Line and Space as a New Artistic Language in Modern Sculpture[1]

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In 1912 Pablo Picasso created the *Guitar* (Fig.1), which heralded a new era in the history of modern sculpture. This was one of the first sculptures to depict an ordinary everyday object. The *Guitar*, however, was not a straightforward copy of a real guitar but an attempt to represent the concept of guitar, and, at the same time, to create a guitar as an object in itself.

A further, and no less revolutionary, innovation in the *Guitar* stemmed from the new relationship displayed between material and space. Previously, a sculpture, in the traditional sense, had constituted a solid, closed mass. Space contained it, enfolded it, and sometimes even entered into more complex relationships with it - as in the Baroque sculpture that powerfully and dynamically broke free into space, and at the same time allowed space to penetrate the form. However, until the *Guitar*, the penetrating space was always real space, even if its dimensions were exaggerated, twisted or emphasized. In Picasso's *Guitar*, for the first time, space penetrates the solid mass, functioning as a new kind of material - "Negative Space" or "Negative Void" - which has no real substance, but nevertheless creates the sculptural form.

Picasso's *Guitar* also introduced another innovation – creating a three-dimensional form out of two-dimensional materials. The flat planes that are cut, stuck together and folded into "boxes", enclose and contains negative space. It is also one of the first modern sculptures to use available, expendable industrial materials.

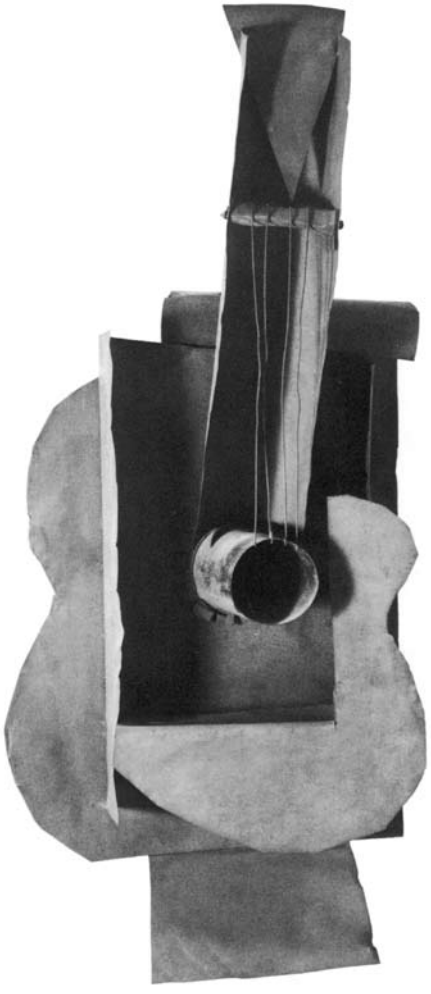

Fig. 1: Pablo Picasso, *Guitar*, 1912, Cardboard and string, 66.3x33.7x19.3 cm, MOMA, New York. © Succession Picasso 2003.

Fig. 2: Alexander Archipenko, *Walking Woman*, 1912, Bronze, H. 67 cm, Donald Karshan Collection. © 2003 Estate of Alexander Archipenko / Arists Rights Society (ARS), New York.

Not coincidentally, in the same year, 1912, Archipenko created *Walking Woman* (Fig. 2), in which the figure is actually created out of a void that is defined by the material surrounding it; and Boccioni, probably influenced by Picasso and Archipenko, created the *Development of a Bottle in Space* (Fig. 3), in which he also utilizes negative void. Hence we may say that 1912 was an important milestone in modern sculpture; instead of sculpture made out of solid masse surrounded by space – sculpture became a void surrounded by material and space became a new material, which transcended its "materiality". This was the beginning of a process during which sculpture lost its solidity, until finally the negative space was to be delineated by a mere line of material - "Linear Sculpture".

Linear sculpture is any sculpture constructed of outlines that enfold space and give it form, or of lines that design a form in space. It uses structural elements of minimal mass such as wires, metal strips, cords, wooden rods or any other material that appears as a line in space. A flat plane, viewed from the side, can also be seen as a line; hence linear sculpture includes the use of thin planes, such as sheets of paper, cardboard, metal sheeting, plywood, glass or plastic. One should note that a plane made of transparent material (like glass or plastic) can be viewed as a line not only from the side but also in frontal view, as its edge marks the line of transition from material to space.

Modern technology has contributed to the development of linear sculpture both in the creation of novel techniques and of new materials. Industrial technology has flooded the market with cheap, available materials such as paper, cardboard, wire, plywood, metal sheeting as well as Perspex and other plastic materials, which are transparent and have strength and flexibility, unlike fragile glass. These modern materials have become legitimate

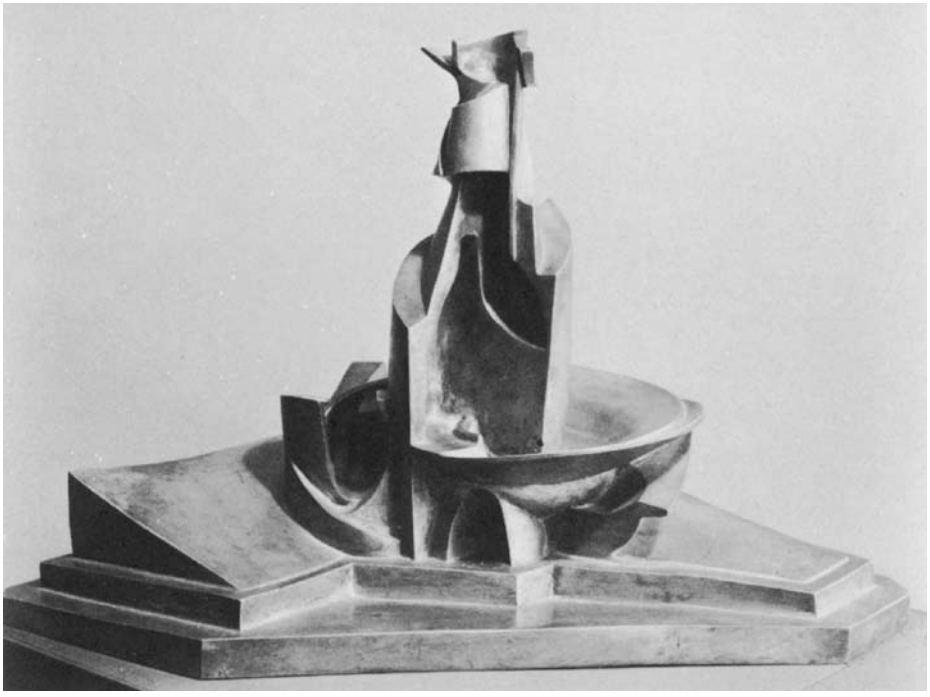

Fig. 3: Umberto Boccioni, *Development of a Bottle in Space*, 1912-13, Bronze, H. 38 cm, MOMA, New York.

and popular sculpting media alongside the "noble" stone and bronze. At the same time, new techniques of working with long-accepted materials have evolved, such as oxy-acetylene welding, which was developed in industry during the First World War, and was the main contributor to the development of iron sculpture between the two wars. Iron, steel, stainless steel and other new metals became uniquely suitable materials for linear sculpture. The new technologies and the specific qualities of the new materials excited artists' imaginations and contributed to the appearance of many new sculptural forms.

A new sculptural technique arose out of the new materials - that of "Construction". Unlike the two main traditional sculptural techniques, in which the creation of a new form must proceed by either adding soft material (molding) or by removing the unneeded material (carving), the form of the construction is created by connecting components built in space. This technique is suitable to linear sculpture because in this way a three-dimensional form may be created in space by means of a network of lines and planes, which can enfold space and shape it.

Linearity has developed into one of the foremost characteristics of modern sculpture. It evolved at the beginning of the 20th century as a result of the need to develop new artistic language that could express new concepts of reality. I believe that the use of negative space expresses the desire to abolish the solidity and substantiality of the material and to infuse it with "spirituality".[2] That desire stemmed from the intellectual climate at the beginning of the 20th century. It became a conscious mode of expression, which has progressed into an important sculptural language, sometimes replacing the traditional forms.

In the past there have been sculptures that appeared to be linear. The precedents include Cycladic sculptures, Greek sculptures (especially the geometric style – Fig. 4), Etruscan works

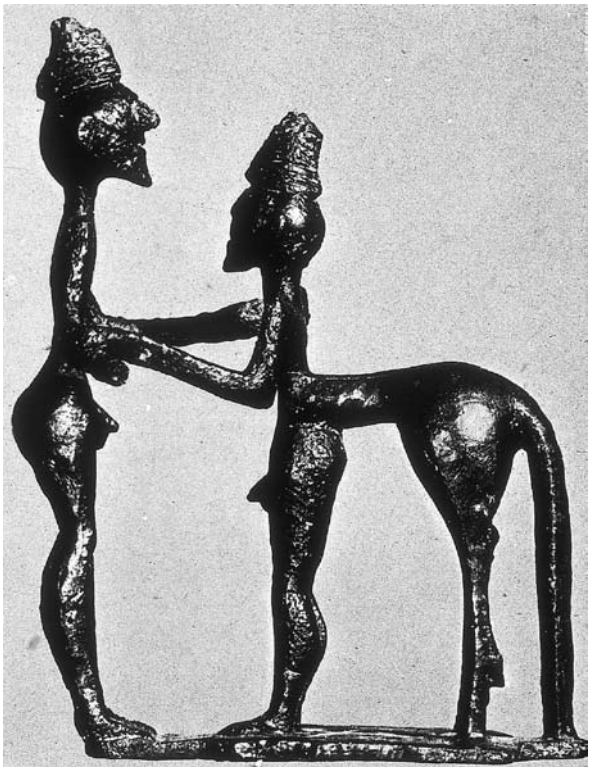

Fig. 4: *Heracles and the Centaur Nessos*, Late 8th Century B.C., Bronze, M.M.A., New York.

Fig. 5: *The Lyre Player,* 2800-2200 B.C., Marble, National Museum, Athens.

and many other examples produced by tribal cultures. These were mostly bronze pieces in which the linearity is formed, to a great extent, by the characteristics of the material. The soft material (like wax or clay, which are used for creating models for bronze casting), lends itself to creating linear forms, and even stimulates the hand to stretch them out. Automatic hand movements, which result from the malleability of the material, encourage the expression of emotional states and may lead to the creation of linear forms, even unconsciously.

However, some of the Cycladic linear sculptures, like *The Lyre Player* (Fig. 5), are uncharacteristic because they are cut out of stone, and most of the material had to be discarded in order to create an empty space. Stone makes automatic actions impossible; on the contrary, it demands the utmost attention and conscious awareness of every action in order to avoid subtracting too much material and ruining the piece. Hence, *The Lyre Player* could not have been created without a clear purpose - to create a net of line by introducing space into the sculptural whole. Making it out of stone was completely irrational and indeed most of the Cycladic sculptures are created as solid structural masses.

Nonetheless, even in *The Lyre Player* the void is real and not negative. This is the main difference between previous linear sculptures and modern ones – in all the linear sculptures created before the 20th century, no conscious use of negative space can be found. The void does not actually intrude into the sculpted form, and therefore it is a real void rather than negative; the spaces always represent emptiness.

Fig. 6: Nahum Gabo, *Constructed Head I*, 1915, 54x32x31 cm, Wood, Collection of the Artist.

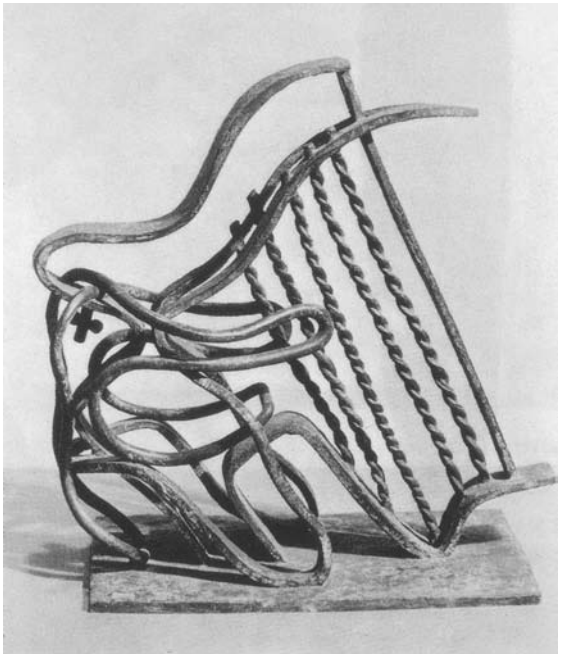

Fig. 7: Jacques Lipchitz, *The Harpist*, 1928, Bronze, H. 26.6 cm, J.B. Brooks Collection, New York. © Estate of Jacques Lipchitz courtesy, Marlborough Gallery, New York.

In summary, the nascence of linear sculpture began with the breaking off of the solid material by intruding spaces into the mass until the material served only to enclose and delineate the spaces - negative space - which had become, in itself, a new sculptural material. This process started in 1912, first in Picasso's sculpture and later was developed by the Futurists Boccioni and Balla. With time, the solid material became increasingly diminished, until it turned into a line designing a form in space - a phase to which the Russian Constructivists contributed greatly. (Fig. 6) They developed linear sculpture during the First World War while in Western Europe this movement was halted. Only after the war, during the 1920s, did linear sculpture appear again in France, with Jacques Lipchitz' transparent sculptures (Fig. 7) and then with the constructions of Picasso (Fig. 8).

Line as a Cognitive and Communicative means

At the beginning of the 20th century we witness a strong desire to purify the means of artistic expression by reducing them to the most elementary forms; it was assumed that such forms would be most effective in creating universal communication. This idea developed side by side with a new concept of reality, which cast doubt on the efficiency of the senses, and on their ability to reveal the real object, and therefore artists looked for new conceptual means of representation. Lines and patterns were seen as basic cognitive and communicative means, understandable by human beings everywhere - means which know no frontiers or language barriers.

Line is one of the most basic elements of perception. According to Rudolf Arnheim, in his book *Towards a Psychology of Art*, [3] the first impression that strikes our attention is that of the outline

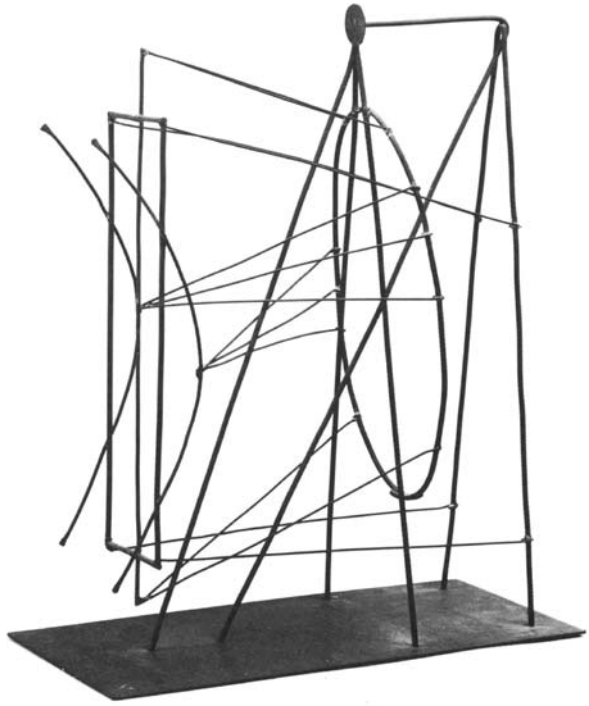

Fig. 8: Pablo Picasso, *Construction* (Figure), Original Model, 1928-1929, Wire and Sheet Iron, 59.5x18.5x40.8 cm., Musée Picasso, Paris. (M.P.264). © Succession Picasso 2003.

of the object, which forms a basic geometrical pattern that is sufficient to convey a meaningful image. In Arnheim's opinion, human grasp of reality is based on natural and automatic process of turning visual stimulus into structural patterns. Arnheim claims that the process of simplifying reality into abstract forms characterizes the basic, primitive perception and is not necessarily intellectual. The naïve eye searches for the salient and most characteristic qualities of the object and thus arrives at simplified patterns not as the result of conscious reductionism, and not as the result of a need to find characteristics common to a group of objects, but simply as a result of the mechanical process of naïve perception. This process is completely lacking in sophistication; in fact sophistication, in his opinion, occurs as a result of the process of perceiving individual details and translating them into artistic and sculptural values.

Arnheim's suggestion should raise a question: if the process of abstraction and the use of elemental forms are part of a primal manner of conception, how can we explain sophisticated modern trends of abstraction, such as Abstract Art or Minimalism? It appears that a naïve, intuitive grasp of the world can co-exist with a conceptual process of abstraction, which occurs when an artist gives up details consciously, and chooses minimal characteristics that are essential in conveying the concept of the object. The final results of both processes may look alike; modern works are often reminiscent of those called "childish" or "primitive". Differentiation between the two must refer to the process of creation and its aims rather than to the final material configuration.

Even before we take in the whole pattern of the object, claims Arnheim, we perceive its expression - that is to say, those lines within the pattern which lend the pattern its direction. Directions have emotional implications; for example, a drooping line expresses sorrow, and for this reason we call *Salix babylonica* with its drooping branches "Weeping Willow", even though the tree has no feelings - those are created in the mind of the observer. The direction of lines creates a suitable emotional reaction not only out of empathy, but because this is also a dynamic, mechanical process that occurs in our brain as part of the process of perception.

However, argues Arnheim, even before we perceive the pattern and the directional lines, we are sensitive to movement-lines. Movement-lines set off dynamic mental processes akin to those triggered by directional lines, so we react to them physically and emotionally. I would like to point out, a propos the difference between directional lines and movement-lines, that there is a problem inherent in the artistic medium; movement-lines can be realized only by using directional lines. Indeed, the need to create real movement has been one of the central problems of modern art, and one which has led to creating kinetic sculpture.

To summarize Arnheim ideas, the more the movement, the expression or the pattern are reduced to the salient lines, the greater will be the influence of the dynamic process going on in our brains, and the stronger will be our reactions. The opposite is also true: the more details we have to grasp, beyond the basic lines of movement, direction and pattern, so the possibilities of personal interpretation will multiply, and the communicational common denominator of the art-form will become more and more limited. We may conclude, therefore, that the line is the primary means by which we both perceive and represent the world; this is the most basic figure of all, common to the perception process of all human beings, regardless of knowledge or prior experience. Hence the line may form the basic artistic language, as means of expression and communication. This is so even though the line itself has no reality in nature: objects are not surrounded by lines; line is a figure, a means of conceptualization, a human creation, a mental means of reconstructing reality. The line exists only in our brains as a means by which we organize perception into conception.

The need to organize and impose order on the world is a basic need in every human being, although it can be subliminal, and is automatically carried out as part of the process of perception. This need is strengthened when conflict exists between the human being and his surroundings, which drives him to re-examine the relationships between himself and the world of phenomena. What could be more natural than to use the line, whether consciously or unconsciously, every time we feel the need to impose order on our world? This need became prominent at the beginning of the 20th century, because of the new physics.

If the line is indeed such a basic, vital element in communication, why are there so few early examples of linear sculpture? I believe that the difficulty in differentiating between the concept of the object and the tangible object itself is especially acute in the art of sculpture. In painting, on the other hand, because it is a two-dimensional medium, it is necessary to transpose three-dimensional reality into two-dimensional representations with the help of various illusionary techniques such as perspective or chiaroscuro. Even if the painter keeps to the conventions of realistic portrayal, he must translate what his eyes tell him by using all kinds of intermediate means, by themselves lacking in volume, such as lines and colors. The sculptor, on the other hand, uses tangible materials, which have the same solid, three-dimensional attributes as the

objects he wishes to represent. Hence his process of translation is directly from three-dimensional form to three-dimensional form. The possibility of recreate volume by means of media other than solid masses is not and cannot be the direct result of our sense-impressions. In order to sculpt an object by using matter with no mass - like negative void - it is necessary to give up the materiality of the object and to refer to it as a concept and not as a thing.

Giving up the traditional concept of material - its solid mass - demands a new comprehension of reality; such a comprehension was born in the 20th century. However, because of the difficulty involved in giving up the solid mass, sculpture was the last artistic medium in which the line became an independent factor. It became autonomous initially in painting, in design and in architecture, and only then, when our visual surroundings themselves began to display increasing linearity, did the line appear in sculpture.

Line and Space as Expressive Means of the New Reality in Modern Science

The first two decades of the 20th century, at least till the outbreak of the First World War, saw many social and intellectual revolutions, in which science, technology and philosophy all took part. The following few examples suffice to show their accumulative effect: in 1900 Max Planck published his theory of quantum mechanics, which caused a scientific revolution. In the same year Sigmund Freud published *The Interpretation of Dreams*, which opened the way to understanding the conscious and unconscious processes of the human mind. The book was in fact published in 1899, but the date 1900 was imprinted on the cover, according to the request of Freud himself, who apparently saw symbolic value in the fact that his book would open the new century. It still took some time, however, before it was to be translated and warmly acclaimed throughout Europe and America, where its influence begun to be felt most after the First World War.

In 1900 and 1901 Edmund Husserl published his two-volume *Logical Investigations*, in which he established the fundamentals of Phenomenology, and suggested a new approach to reality which was, according to his former student Jaako Hintikka, very like that of the Cubists, although at that time Husserl was not yet known in France.[4] I believe that it is no coincidence that these two like-minded approaches developed side by side and independently in disparate fields as epistemology and art.

In 1903 Orwell and Wilbur Wright took off on their first flight and opened up the skies to man. In doing so, they gave mankind a new perspective on the world and, at the same time, a new dynamic pace of life, full of changes. In 1905 the first movie theatre was opened, thus adding the "Seventh Art" to the more traditional art forms, and giving artists a new dynamic medium of expression. In 1908 Henry Ford's first "Model T" rolled off the production lines, giving the man in the street a personal, fast and convenient method of locomotion. That same year Arnold Schoenberg introduced his atonal twelve-tone music and upset the world of traditional composition.

In 1905 Albert Einstein published a paper in which he set forth what came to be known as the special theory of relativity, which changed forever the ideas of traditional physics about Time, Space and Matter. In 1910 Ernest Rutherford laid the ground for nuclear physics and in 1911 formulated his theory of atomic model (the nuclear atom). In 1913 Niels Bohr developed his atomic model using quantum theory and then established the basis of quantum mechanics.[5]

The division of the atom undermined the traditional concept of matter and this affected many artists, among them Vassily Kandinsky, who wrote in 1910 that the disintegration of the atom was for him like the disintegration of the whole world; he felt insecure, as the firm laws of physics began to waver.[6] That year he created his first abstract painting and wrote his book *Concerning the Spiritual in Art*[7], in which he suggested that the creation of art no longer needed figurative forms; they could be replaced by an autonomous language of symbols composed of colors, shapes and lines.

The early signs of this revolution appeared already at the end of the 19th century. First came the discovery of X-rays in 1895, then the discovery of radioactivity in 1896 and the discovery of the electron in 1897. During the 19th century scientists were already studying electro-magnetic phenomena; in their efforts to measure the speed of the "ether" (the medium in which electro-magnetic waves were supposed to move), they came to the conclusion that the speed of light was a constant, thus opening the way for the new theories about space and time. Feuer claims that the term "Relativity" had become accepted everywhere by the end of the 19th century; a whole generation of revolutionaries was influenced by various relativity theories, and these found expression in the social, political and scientific ideas that created the cultural background to Einstein's theories.[8]

What had begun in the 19th century as a trickle turned to a flood in the 20th. The pace of invention and theory was so rapid and so widespread over many fields of enquiry that quantity led to quality - a succession of changes that became a revolution, which caused a paradigm-shift in the way people conceived reality. However, the traditional solid body of theory on "reality" was not simply replaced by another type of certainty. Rather, the random occurrences of quantum mechanics replaced clockwork-like Newtonian mechanics. Non-Euclidean space became the background for Science. This new approach to reality was non-intuitive and did not fit in with the way people had perceived and conceived the world of phenomena. Furthermore, if the Laws of Nature could be reconstructed again and again according to new theories - that were only true until disproved - then it would be possible to consider a much more flexible understanding of reality and of the definition of the object.

Nevertheless, at the beginning of the century, as the new theories were developing, many scientists expressed hope and optimism. They saw the destruction of the old reality as a way to achieve a new reality. Einstein expressed these hopes to find some absolute truth by looking for one grand unification theory. In fact, argues Bergman, the term "Relativity Theory" does not suit Einstein's theory and may even contradict it. His proof that Space and Time are not absolute arose out of a desire to find an absolute theory that would do away with immeasurable factors: Einstein's purpose was to make it possible to describe natural phenomena in a way that would not be influenced by the one-sided observer but should fit any point of view, any state of movement, any observer.[9]

Nonetheless, the theory of relativity showed that in addition to the phenomena we experience, it is our interpretations of these phenomena too that are important. Changing the personal into universal and the subjective into objective is also the role of both modern art and modern science. "The duty of Science is to build, out of the many human emotions, a free construction of the objective world," wrote Bergman.[10]

Modern science has legitimized senses that were previously not considered to be scientific, like intuition, inspiration and creativity, which have played a central part in the creation of this new scientific reality, as they do in art. Intuition, inspiration and creativity have also an important role in the scientific discovery, claims Kantorovitch theory in his book *Scientific Discovery, Logic and Tinkering*. He believes that scientific discovery is a creative process that resembles the process of creation in art. This process is linked to two unconscious and involuntary factors. One is the process of "incubation" – a random mental process of instinctive selection, which goes on in the inventor's mind. The other creative factor is the socio-historical setting, which creates the conditions under which the discovery is made. Neither process is voluntary or intended and neither is controllable, though they can be cultivated. A third, essential (non-creative) factor is Reason, which must assess both the theories and the results.[11]

Einstein's theory of relativity turned the term 'simultaneity' into a keyword both in the sciences and in art at the beginning of the 20th century. If each observer sees an event in his own space-time framework, this event is occurring in "relative simultaneity."[12] In other words, the same event is observed differently - yet simultaneously - from different observation points. Therefore the viewpoint of one observer is no longer enough to describe an event or a phenomenon, and one viewpoint is no more "correct" than any other. Hence artists tried to introduce various viewpoints into their works so as to represent as many aspects of an object as possible. Depicting an object from many angles constitutes the "comprehensive (surrounding) simultaneity" developed by Analytical Cubism, following Cézanne.[13] Another aspect of simultaneity is the simultaneous perception of the external form and texture of an object combined with its internal structure or essence. The discovery of X-rays contributed to that interior-exterior simultaneity: The Futurists, for example, believed that the modern artist should have "X-ray eyes", with which he should penetrate the object's inner essence - its "inner core", and thus experiencing its "state of mind".

A further inference from the theory of relativity is that Time, Space and Energy are basic elements in the nature of matter and these dimensions must be integrate simultaneously in the depiction of any object represented by an artist. The Cubists, for example, used the term "Fourth Dimension" and understood this simplistically as Time, even though the term is completely abstract and exists only in mathematical formulae derived from relativity theory.[14]

As far as the study of modern sculpture is concerned, the importance of the theory of relativity lays mostly in the new definitions given to the nature of matter. Mass, in Einstein's formula $E=MC^2$ (energy equals mass multiplied by the speed of light squared), is not solid matter. In fact, energy and mass are two aspects of the same thing. This may explain why matter, which until then had been understood as a substantial mass that can be perceived by the senses, turned into something fluid and formless, lacking in solidity and unperceived – like space. In fact, if mass and space have identical qualities, matter may even become interchangeable with space. Cézanne had already depicted both matter and space as they were either solid or transparent, and he was later followed in this by the Cubists. In fact, the artistic language of the Cubists was the first to accept the challenge of these new concepts of reality: the representation of the principle of simultaneity, the intrusion of time into the painting and the exchange between solid and void. These ideas led to the use of two new sculptural "materials" - space and line.

In summary, the scientific revolution of the early 20th century affected modern art because it led to a change in the way the object was perceived and conceived. Time, space and movement had all become an integral part of the object itself and thus had to be part of its representation. At the same time, mass became energy and matter was no longer understood as a solid mass, but as non-material, changeable and unstable.

Line and Space as expressive means of a New Reality in Modern Philosophy

While the scientific revolution was going on some significant changes took place in epistemology too, which also had a great influence on the way reality was perceived and conceived. The three European philosophical systems in the beginning of 20th century that were most influential in creating the intellectual climate were those of Kant and the post-Kantian's idealism, Bergson's metaphysics, and Husserl's phenomenology. I cannot elaborate upon these theories in depth here, but I shall mention a few of their principles of epistemology that are common to the way the object is perceived in modern art.

The greatest problem in knowing an object is the fact that we never really see it; we only see the rays of light that return from the object and are perceived by our eyes. These sense-impressions activate areas in our brain, which creates an image of the object. But is the object-in-itself identical with our sensory impression of it? In fact, a direct comprehension of an object is not possible; our understanding of the world of phenomena is always mediated by changeable internal and external factors. How then, are we to move from such subjective sense-impressions to objective knowledge of an object?

Kant claims that our knowledge of the world cannot be based only on pure logic since there is no knowledge without experience; we cannot know the world without sensory perception. On the other hand, true knowledge cannot be achieved through experience alone - the raw experiences have to be categorized into rational experience with the help of criterions. Perception, in Kant's opinion is structured by a priori categories that cannot be understood empirically, such as awareness of time and space; these are categories with which we translate raw sensory data into meaningful concepts. Knowledge of the world is the result of synthesis of the data received by our sensory perception and our a priori categories. The ides that synthesis is a method of knowing the world was later developed by Kant's followers. Hegel, for example, believed that synthesis is essential to understanding the world. His dialectic method (thesis, antithesis and synthesis) was the way to comprehend the internal rational structure of the world.

However, Kant believed in the existence of "the-thing-in-itself", which cannot be the object of sensory perception, so it cannot be known. What is "the-thing-in-itself"? Those who followed Kant gave up this idea, and see no dichotomy between phenomenon and "Object"; all material forms are imprinted in the spirit; all spiritual forms are imprinted in matter, since matter is created by spirit. Hence the difference between mater and spirit is quantitative rather than qualitative.

The idea that matter is created by spirit reaches a peak in the work of Nietzsche, who rebelled against Reason and Science as one, and extolled emotion and imagination. The idealistic understanding of the world, especially as expressed by Romanticism, elevated art to be a cognitive and communicative instrument. Imagery became a means by which it was possible to find a deeper insight than that of science. It gave artists the hope that they might

approach the transcendental Object behind the phenomena. The desire to aspire to knowing the Object beyond the world of appearances was shared by some modern artists; it is one of the reasons why they sought to escape from solid mass and seek a new, insubstantial matter like negative void. This aspiration is also linked to the new concept of matter mass and energy of the new physics. It became impossible to represent the non-material attributes of the object by using solid matter.

Husserl's phenomenology was another philosophical theory that contributed to a change in the way we understand the object. It should be noted, again, that prior to the First World War, his theory was unknown in France, and although Hintikka believes that Cubism is the expression of phenomenology in art, he points out that the simultaneous rise of Cubism in France and of phenomenology in Germany were not connected in any way.[15] Husserl differentiates between the "intention" - the meaning we attribute to the object - and the object itself. These "meanings of being" he calls *noema*; phenomenology is actually an inquiry into *noemata*. Husserl suggests ignoring the object altogether (putting it in brackets) and dealing only with its phenomena - its *noema*, by means of "phenomenological reduction".[16] Since we already have a preconceived idea of the object, based on previous experience, we do not need to process all the sensory data and can depict its image by reducing all the unnecessary details, to a minimal form.

Husserl also sees synthesis as a key to the understanding of the object, since the *noema* is in fact a synthesis of all aspects and characteristics into the one object - a synthesis of the accumulation of all our preconceived ideas, memories and expectations that we associate with the object - the summation of all our knowledge about it. However, even though we are limited to knowledge of the phenomena and the subjective meaning we attach to them, the *noema* does not consist of subjective impressions; the relativity of the subjective phenomena is translated into objective reality, or, as he calls it - "Transcendental Subjectivism". Thus Husserl is suggesting a way to progress from the world of subjects to a system of objective laws that allows us to comprehend the object. This objective reality, however, is only transient: when we experience a new aspect of the phenomenon, new knowledge is acquired and creates a new process of synthesis. Therefore our perception of the object is always a creative and dynamic process, and objective reality is in a state of constant change.

The most influential philosopher to affect the French art world at the beginning of the 20th century, was Henri Bergson. During the years 1900-1914 his lectures at the Collège de France were a central point in the intellectual life of Paris. They were open to the general public who streamed to the Collège to hear him - students of philosophy, historians, journalists and members of society. Bergson also had a strong influence on scientists such as Louis de Broglie and on his theory of "wave mechanics". De Broglie even suggested that if Bergson had been able to study quantum theory in detail, he would have found how close it was to his own ideas.[17]

Bergson, in spite of his attacks on Positivism and Evolutionism, never gave up sensory reality and reason, although he stated that they were not sufficient for understanding the world. He claimed that Intellect alone cannot reach the essence of life and of objects, and our mistake is that we apply our usual way of thinking to conceive what our mind is not structured to conceive.[18] He differentiated between "quantitative multiplicity" and "qualitative multiplicity". Our external self acts within the sphere of consciousness and is only capable of comprehending quantitative multiplicity; it knows time as homogenous reality, as a dimension that is interconnected with

space, which could be measured and divided. This is the Bergsonian "Fourth Dimension" that is, in effect, a translation of Time into sequences situated in Space. On the other hand, our inner self that comprehends the qualitative multiplicity acts within the time he called "duration" (*durée*) – that exists in heterogenous reality and cannot be measured or divided.

In Bergson's opinion, although we cannot perceive "duration" consciously, since it lies at an unconscious level, we can raise the level of our consciousness by means of intuition, by integrating intellectual understanding with instinct and thus advancing from the subjective to the objective level. Bergson points out that intuition is not a metaphysical force but a different method of thinking; it is based on scientific research and facts, but indicates new connections between them. It is a new method that is not deductive and rational, but nonetheless it is a spiritual activity that leads to new and deep insights.[19]

Understanding reality by intuitive means includes a wide range of quantitative and qualitative experiences. But such multiple viewpoints necessarily creates fragmented reality; seeing the object from a thousand different viewpoints will not recreate its tangibility, unless it is synthesized. The multiplicity is perceived not as a mass of fragments but as a growing continuum - the whole being greater than the sum of its parts. Hence, perceiving the world is a dynamic process of creation that is constantly changed by a constant stream of impressions and experiences. Reality, as Bergson understands it, is in a process of constant creation in the "duration".

For Bergson, dynamism is the essence of the object existing in Bergsonian time and space, both homogenous and heterogenous. World, life and our knowledge of the world are dynamic. Everything moves, but some objects look relatively static. Matter is not static and therefore cannot be limited by counter-lines; it is fixed only in our imagination, which gives it form and outlines, but any object continues to act and induce its energy beyond its outline. Therefore there is no void, no empty space. The idea that space is not empty, but occupied with the force-lines that continue the object beyond its outline, was accepted by the Futurist and influenced their works. They were also influenced by Bergson's notion of "quantitative multiplicity" and "qualitative multiplicity" and of duration.

Conclusion

The main streams of thought in the philosophy and science at the beginning of the 20th century have several common principles:

1. No direct perception of the object is possible, but one should attempt to approach the object-in-itself by means of both matter and spirit. Whereas the matter is perceived by the senses, the spirit is an a priori category, a reduction of the inner self, by which we conceive the object.

2. Perceiving the world is a dynamic and creative process, therefore reality is changing all the time. Our perception is a synthesis that is carried out by means of intuition, which make matter and spirit one. "Synthesis" and "intuition" became keywords in 20th century thought in philosophy, science and art and afforded new freedom, both to the scientist and to the artist.

3. Time, Space and Movement are connected with the essence of life and matter and should be part of the characterizations of the object.

4. Mass and solid matter are not the same - matter can be formless energy and energy may metamorphose into matter. Hence matter has no final, solid, fixed shape, therefore the

representation of the object cannot deal only with its outward form, which is actually the result of the senses, but must includes its essence.

Such world-views created a cultural climate that had a deep influence on the artist, who found freedom to create a reality that may not be solid and static but is nevertheless true. Art, as one of the fields of epistemology, can create new objects that are not imitative of existing objects, but represent their concept. The Cubists and Futurists before the First World War were particularly interested in epistemology - the knowlegde of the world and the relationship between man and the world of phenomena. In their search for the essence of absolute reality, they dealt primarily with the world of objects.

Finally, I would like to address a question that may arise out of the connection I have made between art, philosophy and science: Can art be seen as a concretization of the theories mentioned above? Does the artist create out of a conscious desire to express these theories? Picasso was very clear on this point, saying that mathematics, trigonometry, chemistry, psychology and what not were used to explain Cubism, was a lot of nonsense that blinded people with theories.[20] Jacques Lipchitz too referred with a wink to the "philosophizing" of his friends, admitting that he did not always understand them.[21] On the other hand, he mentions in deep appreciation his many conversations with Juan Gris about artistic and philosophic theories, and he states that Cubism added a new dimension to art, changing the way artist perceived both nature and art.[22]

Unlike those who denied the contributions of science and philosophy to art, or who belittled them, Archipenko, in his *Fifty Creative Years*", often quoted Bergson, and admitted that he was directly influenced by his ideas.[23] Boccioni, in all his writings, was also influenced by Bergson and suggested that modern science and technology were the basis of Futurism.[24] Naum Gabo, perhaps more than any of the rest, was deeply influenced by scientific and philosophical ideas and often mentions this subject in his many writings. He claimed that the new concepts of space in sculpture were derived, in part, from the intellectual climate of his time and argued that intellectual and philosophical events at the beginning of the 20th century left their imprint on the mentality of his generation. He went so far as to suggest that even if not everybody understood what was happening in science, this was not important, because "it was in the air" and sensitive artists, like sponge, absorbed every idea that came their way.[25]

I would like to suggest that whether artists were consciously influenced by the intellectual climate, or whether they argued that they were not influenced whatsoever, in both cases their work drew directly from the intellectual climate of their time; they matured artistically within it and they themselves took part in it, and so their personality and their very consciousness took shape as an integral part of the world-view accepted at the time. This is why, as McMullen pointed out, new and radical beginnings happened almost simultaneously in art, science, technology, philosophy, mathematics, politics, etc.[26] However, as McMullen also adds, artist are not only the seismograph of their time but are also active agents in the changes that they help to create.[27]

Notes

1. Based on the introduction to R. Markus, *Sculpting with Line and Space,* Tel Aviv 2003 (Hebrew).
2. This desire expresses itself in other techniques used by modern sculptors, like blurring of the substance of the material by polishing it or by applying a layer of reflective material. Archipenko, for example, polishes some of his sculptures to a high sheen, which breaks up the material so that the viewer is confused as to whether certain surfaces are concave or convex. Another way to blur the nature of the material is by the use of color.
3. In the following I summarize several conclusions from Arnheim's theory in A. Arnheim, *Towards a Psychology of Art*, Berkeley and Los Angeles 1966. I have especially based myself on the following chapters: "Perceptual Abstraction and Art", 27-50 and "The Gestalt Theory of Expression", 51-73.
4. J. Hintikka, "Concept as Vision: On the Problem of Representation in Modern Art and in Modern Philosophy," *Iyunn*, 25/3 (July 1974), 144. (This article is based on the Hebrew translation of a lecture given by Hintikka during his visit to Israel in 1974; an English summary of the article is provided on 238-240.)
5. More on the accumulation of revolutions in the turn of the century (19-20c.), see: R. McMullen, *Art Affluence and Alienation - The Fine Arts Today*, London 1973.
6. W. Kandinsky, "Reminiscences", in R. L. Herbert (ed.), *Modern Artists on Art*, Englewood Cliffs 1964, 27.
7. W. Kandinsky, *Concerning the Spiritual in Art and Painting in Particular*, New York 1947.
8. L. S. Feuer, *Einstein and the Generations of Science*, New York 1974, 67.
9. S. H. Bergman, *Contemporary Thinking*, Jerusalem 1974 (Hebrew), 15. See also Feuer, *Ibid*.
10. Bergman *Ibid*., 16. The metaphor "Free Construction" is also suitable to describe linear sculpture.
11. A. Kantorovich, *Scientific Discovery, Logic and Tinkering*, New York 1993, 3. Kantorovitch claims that most of the discoveries were made by chance, and even if they were the result of an organized scientific experiment, the discovery was not the original aim of the research. He calls this process "tinkering" and suggests that tinkering characterizes human creation in general. Indeed, tinkering seems to be the technique Picasso used to work on his metal sculptures. In this context one may recall his famous saying that he does not seek but always find.
12. P. G. Bergmann, "Relativity", *Encyclopaedia Britannica*, 15 (Macropaedia), 582.
13. See elaboration on all aspects of Cubistic Simultaneity: surrounding simultaneity, inside-outside simultaneity and interchanging attributes of matter and space: R. Markus, "Picasso's *Guitar*, 1912: The Transition from Analytical to Synthetic Cubism", *Assaph* 2 (1996), 233-246.
14. For a discussion of the Cubists and the fourth dimension see: L. Darlymple Henderson, "A New Facet of Cubism: 'The Fourth Dimension' and 'Non-Euclidean Geometry' Reinterpreted", *Art Quarterly*, 34/4 (October 1971), 410-433. With regard to misunderstanding this term, see also: E. F. Fry, *Cubism*, London 1966, 111.
15. Hintikka 1974, 142.
16. *Ibid*., 142-143. The following is based on both Hintikka's paper and Husserl's *Cartesian Meditation,* The Hague 1960.
17. De Broglie, "The Concepts of Contemporary Physics and Bergson's Ideas on Time and Motion", in P.A.Y. Gunter (ed.), *Bergson and the Evolution of Physics*, Knoxville 1969, 192.
18. This and the following are a summation of some of Bergson's idea in H. Bergson, *Creative Evolution*, New York 1911 and *Time and Free Will, An Essay on the Immediate Data of the Consciousness*, New York 1960.
19. H. Bergson, *Écrits et paroles* III, Paris 1959, 456.
20. A. Barr, *Picasso: 50 Years of His Work*, New York 1974, 270-271.
21. Lipchitz suggested that some of them had taken the mathematical analogy of Time - as the fourth dimension – too seriously, and had turned it into part of the Cubist ideology. J. Lipchitz and H. Arnason, *My Life in Sculpture*, London 1972, 40.
22. *Ibid*., 9.

23. A. Archipenko, *Fifty Creative Years, 1908-1958*, New York 1960.
24. See for example U. Boccioni, "The Plastic Foundation of Futuristic Sculpture and Painting (1913)", in U. Apollonio (ed.), *Futurist Manifestos*, London 1973, 88-90.
25. N. Gabo, *Gabo* with introduction by H. Read, London 1957, 156.
26. McMullen, 1973, 11.
27. *Ibid*., 4.

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