

Committee 6
Science and Music: A Unifying Concept

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Science and Technology as an Inspiration and Support for Artists and Musicians

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Science and Technology as an Inspiration and Support for Artists and Musicians

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Abstract

The purpose of this talk is to underline the role of the sciences and derived technologies in artistic creation during the second half of the twentieth century. It is known that under the influence of contemporary sciences and technologies the arts have undergone a real metamorphosis. One may distinguish three main modes of interaction between Science and Art, including Music, where Art gets its inspiration from Science.

Numerous artists have come to incorporate in their works artifacts born from modern technology : luminescent tubes, laser beams, metal alloys with shape memory, and so on. Moreover, some recent technologies have allowed artists to create brand-new ways of expression : this is the case of infography, holography, electroacoustic music, concrete music.

In addition, some artists get their inspiration from recently discovered scientific phenomena or well established scientific theories : for instance, the second principle of thermodynamics has been put into a musical score, and a magnificent painting has been made about the three main principles of wave mechanics.

During this talk a number of examples will be given to illustrate these various ways Science and Technology are used both as an inspiration and support for Art and Music.

Introduction

Science, technology and the arts have been connected since a long time. However, these connections have increased in number and strength in the contemporary period. Many artists nowadays introduce in their works objects born from new technologies. In addition, new means of expression appear, based on these new technologies. Furthermore, some artists find their very inspiration in novel scientific concepts.

1. - Artists introducing in their works objects born from new technologies

NISUS is a good example of a work of art born from new technologies. It was realized in 1981 by Milton KOMISAR (Oakland, CA, USA). It is a luminous, sonorous and kinetic sculpture, made of a large number of luminescent tubes turning around a central axis. These tubes are organized in such a way as to create a 6-meter wide and 3-meter high central torus. This torus is penetrated by a kind of inverted obelisk. Five networks of luminescent tubes are hooked at the lower part of the torus. Each of these networks have a particular shape: one evokes an atomic model, another a balloon, another a spindle, etc.

The sculpture is put high enough to have its lower elements two meters above the heads of the spectators. A computer commands the lighting and extinction of the multicolored luminescent tubes. NISUS turns around its axis every seven minutes, and these plays of light and motion are accompanied by the playing of the sound track.

During an hour the spectator attends a kind of firework involving a labyrinth of sounds and colors.

The POLITOPOS, presented by Iannis XENAKIS during the year 1972 in the Roman Thermae of Cluny in Paris (France) is another good example. I had the privilege to attend this impressive show many times with friends.

This show was organized in a large room of the thermae. The spectators were not sitting, but lying on the ground and watching the ceiling. On this ceiling there were a large number of electronic flashes and, before them, a large number of laser beams (red, green and blue) rebounding on moving mirrors. A powerful music was accompanying the motions of the lights. An electronic computer synchronized the electronic flashes, the motions of the laser beams and the music. The spectator was completely immersed in sounds and colors.

The TOTEM DU FUTUR of Jean-Marc PHILIPPE is a third example of artists using new technologies to realize works of art. He sculpts particular materials having temperature-dependent shapes. Using such materials he has been able to sculpt the bust of a woman which becomes the bust of a man when it is put in a warm atmosphere.

The TOTEM DU FUTUR is made with a material of that kind. It looks like a very simplified tree having a temperature-dependent shape. The shape is simple during Winter, a little more sophisticated during Spring, and strange but beautiful in Summer. Jacqueline BRENOT has written the following poem on the TOTEM :

"Une forme épurée étincelante
s'élance
dans une ferveur complice de l'Espace
et de l'Instant.
Elle EST – se FAIT – se DEFAIT,
inclinaison parfaite, dans tous ses états, dans tous ses moments.
Et par le jeu des formes interactives

elle incarne – le temps
engendre – la mémoire.
Unité jointe de l'artiste et du savant
dans une ultime palpitation métallique
elle sculpte une Conscience normale
dans le jardin des dieux."

Georges DYENS lives in Canada. During the year 1987, with the help of scientists and technicians, he realized a *holosculpture*, that is, a combination of sculptures and holograms. The sculpture was made with a block of earth having layers and fossils. In the atmosphere of the block was suddenly appearing a sphere of light and after that a rainbow produced by holography.

As in NISUS this play of lights was accompanied by the play of a sound track. An electronic computer was supervising the show.

2. - New means of expression based on new technologies

The use of holography initiated by Georges DYENS is nowadays becoming a new mean of expression for some artists. During a long time it had been only a procedure to make three-dimensional photographs.

For example, the German artist Dieter JUNG uses holography to realize real works of art. With the help of an electronic computer he is able to produce holograms which are abstract three-dimensional paintings: large compositions are floating in space, where elegant color sheets enlace and interlace. From these strange nebulosities, these unusual transparencies, there springs a delicate charm, a new kind of abstraction.

We have already mentioned that many artists nowadays use electronic computers for making works of art. The name *infography* has been given to this technique. The great expert in the field is Benoit MANDELBROT, who lives in

the United States. He is able to give orders to a computer in such a way that it gets able to produce a nice painting.

Each point of a canvas can be represented by a complex number:

$$Z = X + iY.$$

MANDELBROT introduces the formula:

$$Z' = \lambda Z(Z - 1).$$

To each point Z , this formula associates a point Z' , which is a function of Z :

$$Z' = f(Z).$$

MANDELBROT asks the computer to repeat a great number of times this operation:

$$Z'' = f(Z'); Z''' = f(Z''); Z'''' = f(Z'''); \dots$$

If little by little the point goes to infinitum the initial point Z is painted in black. If the point does not go to infinitum the initial point Z is painted in a color introduced by MANDELBROT in the computer.

The result of this operation depends on the value given to λ . For certain values of λ the result is a beautiful dragon. For others it would be a wonderful landscape.

Obviously we could introduce in the computer other kinds of formulae and obtain other kind of pictures.

A completely different mean of expression is due to Arthur UNGER, who lives in Luxembourg. As an administrator in KATANGA, he has shared the life of tribes, felt the power of fire, and been impressed by copper ores.

There he got the idea to use sheets of copper to engrave his colored impressions. Arthur UNGER traces arabesques with Indian ink on large sheets of electrolytic copper and warms the result with the flame of a cutting torch. The copper produces oxides of various colors. The result looks like a strange abstract painting. The artist calls this a "pyrochimigram".

It is well known that new technologies have had a strong influence on the evolution of music. New instruments have permitted to conquer a new sonorous universe.

The simple tape-recorders have been able to register tiny components of numerous phenomena. Thanks to tape-recorders, the sounds could be submitted to various kinds of mixings, deformations, undoublings, transpositions.

Electronic sound generators were associated with tape-recorders. And the electronic computer became very useful to analyze and synthesize sounds and also to help musicians to compose.

Towards 1948, under the impulse of Pierre SCHAEFFER was born concrete music. Musical sounds and noises, registered on recording tapes, became sonorous objects, able to produce a completely new kind of music.

Pierre HENRY was one of the composers who used these new technologies very successfully. "Le voile d'Orphée", "Variations pour une porte et un soupir", "Messe pour le temps présent" are good examples of such compositions.

About the same time was developing electronic music, under the impulse of Karlheinz STOCKHAUSEN. This technique is not far from that of concrete music. The main difference is in the fact that in the field of electronic music one uses only sounds produced by an electronic generator. Later on, by using simultaneously electronic and instrumental music, STOCKHAUSEN produced real masterpieces.

On the 14th of November 1994 the STOCKHAUSEN STIFTUNG FÜR MUSIK was ratified as a non-profit foundation, having as a purpose "the advancement of musicology, including the stimulation of music culture, based on the creative work of Professor Karlheinz STOCKHAUSEN".

A rather strange, but very interesting work of STOCKHAUSEN is "The helicopter string quartet" (1992-1993) for string quartet, four helicopters with pilots and four sound technicians.

Towards 1970 Roger LAFOSSE invented a very strange music instrument: the CORTICALART. Electrodes were fixed on the head of the composer, detecting three kinds of electric signals emanating from his brain.

The α waves correspond to a state of repose, the β waves to a state of reaction, of awakening, of attention, and some artifacts are associated with the motions of the eyes. These waves were used to modulate electronic sounds produced by seven electronic generators.

I had the privilege to follow the first public composition made by Pierre HENRY with the CORTICALART. It was during the year 1971 in the "Palais d'Arts Modernes" in Paris. The spectators were sitting around him on cushions and during one hour Pierre HENRY created a sonorous atmosphere which literally hoodooed the listeners. The effect of this music was a little similar, but more effective, than the music of an Indian ragha.

3. - Artists finding their very inspiration in novel scientific concepts

The American artist Bettina BRENDEL, after a discussion with the German physicist Werner HEISENBERG in 1972, painted five very interesting pictures called: "Particle or Wave ?"

They are inspired by a central topic of contemporary physics, the fact that a particle such as an electron or a photon reacts in some instances as if it were a very small grain and in other instances as it were an immaterial wave.

It was in order to describe the ambiguous behavior of such particles that the French physicist Louis de BROGLIE invented wave mechanics in 1923. On the paintings of Bettina BRENDEL one can see a circular ring, some corridors that evoke the optical microscopes, where the photons are treated as waves, and the electronic microscopes, where the electrons are treated as particles. Furthermore, many short lines evoke the "energetic radius" of the moving particle or the "life time" of the photon.

During the Summer of 1984, after a conversation with me, the French artist Nicole LEMAIRE D'AGAGGIO made a magnificent painting of length 7 m and height 2.2 m. This painting is inspired by the three main principles of wave mechanics, which help us introduce a mathematical government of electronic molecular populations. The back of the painting shows some scarcely outlined pillars which evoke a temple elevated to the glory of wave mechanics. In the center of the painting appears the wave equation:

$$H\Psi = -\frac{h}{2\pi i} \frac{\partial \Psi}{\partial t}.$$

As Nicole LEMAIRE D'AGAGGIO has worked with calligraphy artists when she was Tokyo, the equation is written in a calligraphic manner.

On the left of the painting is evoked the first principle of wave mechanics: "To each physical quantity is associated an operator (linear and hermitic), and the spectrum of the quantity is identical with the spectrum of the associated operator". This principle is recalled in the writing of the space and momentum coordinates, the shadow of these letters representing the associated operators.

The third principle (spectral decomposition) is represented by a vector associated with the wave function Ψ , projected on the eigenfunctions of the operator associated with the considered physical quantity.

Furthermore, the whole painting is crossed by a beam of light falling on the screen, with two holes through which the beam is diffracted into two other beams which interfere. This is to represent the very well known experiment of YOUNG, and to recall that wave mechanics was born from a long speculation on the history of the theory of light.

Finally, to produce a more attractive painting the artist has pasted pieces of copper, bronze and gold looking like burning breezes and whose aspect depends on the position of the spectator. All this, to evoke the rational beauty of wave mechanics.

Some time ago an Argentinian artist, Norberto IERA, was visiting the laboratory of a German scientist, Professor PEYERIMHOFF. He saw a number of isoelectronic density curves calculated for various molecules using wave mechanics. He found some analogies between these curves and particular lines of the human body. There he got the idea of creating paintings on which one could see a head, hands, legs which seemed to emerge from a bundle of isoelectronic density curves. He told that, for him, this was a way to give a kind of sentimental life to the world of molecules.

During the year 1973 I conceived a choreographic entertainment about the history of the electron concept. It was performed by Michèle RABIER, the star dancer from the Opera of Stuttgart, at the European Palace of Menton, France, for the opening of the first meeting organized by the International Academy of Quantum Molecular Sciences.

The music I used for the basic elements of the choreography was a great organ composition by the fine French composer Jean GUILLOU.

The classical electron, as it was represented before the advent of quantum mechanics, is evoked in the first part of the choreography. The tutu-clad dancer moves to the steps of romantic choreography, rotating rapidly on her own axis to suggest the electron spin.

The second part of the dance deals with the concept of the electron in the framework of wave mechanics, where its trajectory can no longer be followed. The dancer has discarded her tutu and leaps suddenly to and fro under various flashes of light. It is impossible for the spectators to follow the trajectory of the dancer. Her movements were inspired by a choreography from the French artist Maurice BEJART. Spot lights cast a shadow of the dances on the backdrop to symbolize the associated operator. The operator was also evoked musically by the pedal rank of the organ.

The final interlude is an apotheosis representing the eigenvalue of the spin operator, in which the dancer uses her body to shape the letter Greek Ψ (above equation), the wave equation itself appearing as a shadow on the screen.

The mathematical concept of an envelope has inspired Iannis XENAKIS the creation of a very impressive musical composition: METASTASIS.

An envelope is a curve tangent to a set of straight lines. Sixty-one musical instruments are necessary to play METASTASIS, including 12 first violins, 12 second violins, 8 altos, 8 cellos, 8 double-basses. Each of them plays a different glissandi. On the score each glissandi is represented by a straight line. A set of straight lines are tangent to the envelope in such way that in the partition there appears various envelopes. In fact, it was this mathematical concept of partition that suggested Ianis XENAKIS to create METASTASIS. But he was also impressed by the nice shapes of this family of envelopes, and when he came to create the Philips Pavilion for the International Exhibition in Brussels in 1958, he

constructed part of this Pavilion by searching inspiration from the shapes of the envelopes in the score of METASTASIS.

In the music of Iannis XENAKIS, mathematics and architecture are indissolubly bonded. This music may seem a little crazy, but it is of that creative craziness that was inhabiting the Olympus, remaining supremely human.

Tristan MURAIL has managed to create an attractive musical composition around the second principle of thermodynamics. According to this second principle the entropy (and therefore the disorder) of an isolated system can only increase.

To evoke this principle, Tristan MURAIL uses two tape-recorders. The first one reads the sounds indicated by the composer while the second one asks the first recorder to register the same sounds a little bit later. Little by little a superposition of sonorous themes is produced and the limpid themes heard at the beginning become a complex aggregate. The disorder increases in this sonorous universe.

Another well known music composer, Henri DUTILLEUX, has written a musical composition called METABOLE. He said that Metabole, this word of rhetoric he adopted for his musical composition, is a good translation for the thoughts of the author in these five pieces, which present one or many ideas in a certain order, under various aspects, until they undergo little by little a change of nature.

There is a metabole within each piece, but the phenomenon also appears in the whole composition. The composition is at the same time united and open, obeying the laws of metabolism, the set of chemical and biological transformations that occur in living beings.

Marja RANTANEN-MARUANI has conceived a very attractive musical composition called IMPRESSIONS OF TWO SPACE TRAVELLERS, inspired

by the concepts of modern cosmology. In this composition, of which you will hear a piece in a moment, she describes musically the simultaneous inner and outer trips of a human couple travelling through the solar system, towards other stars of the Milky Way, until they are trapped and swallowed by a black hole.

Concluding remarks

During the important meeting that begins, we shall have the opportunity to discuss many other interesting aspects of the relations between Science and Music.

The European Academy of Sciences, Arts and Humanities, which I am presiding now, has a special interest in the relations between Science and Art in general and Music in particular.

During the year 1996 Professor Federico MAYOR, General Director of UNESCO, asked the General Secretary of the European Academy, Nicole LE-MAIRE D'AGAGGIO, to conceive an exhibition on this topic. This exhibition, called "La Science et l'Art", took place at the UNESCO Palace in Paris during May 1997, and was registered on Internet. The works of many artists, included those presented in this talk, were displayed during this exhibition. We are now preparing a workshop on the same topic, which will take place at the Palace of the Academies in Brussels in the Fall of 2000, under the auspices of the Royal Academies of Belgium.

A special interest will be given to the role of Internet in the evolution of the arts, especially interactive arts, and to the role of the artists in our society in the future. But all kinds of relations between science, technology and art will be taken under consideration. If you are interested to participate in this meeting, please write to me at the European Academy headquarters in Paris or give your name and address to Dr Jean MARUANI, who is the member of our Academy.

Thank you for your attention.

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