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PIERRE SCHAEFFER: mediArt

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Images and Sound Created and Synchronized by Algorithm
Vladimir Bonačić's Computer-Generated Interactive Audiovisual
Object GF. E(16,4), 1969 – 1974

by Darko Fritz

Vladimir Bonačić has worked at the Ruđer Bošković Research Institute in Zagreb since 1964, where he was Head of the Cybernetics Laboratory from 1969 to 1973. He received his PhD in 1967, in the field of sample recognition and structures of concealed data. His artistic career begun in 1968 within the framework of the international New Tendencies movement in the Zagreb Gallery of Contemporary Art, which advocated his participation in the movement. Bonačić's constant inspiration was the Galois Field, a system of pseudo-random algorithms named after the mathematician Evariste Galois. The computer-generated audiovisual object GFE (16,4) has achieved the synthesis of image and sound in a unique way and enabled different levels of interaction through the control of image and sound. This object was conceived in 1969 and realized in Zagreb in 1971; it was for the first time officially presented in Paris and additionally improved in collaboration with the *bcd cybernetic art team* 1972 – 1974 in Jerusalem. The dimensions of the object GFE (16,4) are 178 x 178 x 40 cm and it weighs half a ton. The front plate has a relief structure made of 1024 fields in 16 colours. Three Galois Field generators illuminate the thus constructed three-dimensional "monitor", generating different patterns. These generators interact with other generators and control the sound that comes through four loudspeakers. The viewer / researcher / user can influence the image and sound manually or with a remote controller (in a later version of this work with a special interface featuring an external monitor and a light pen). Image and sound can be manipulated along the time constant, by "skipping" sequences, by repeating selected segments or by manipulating the performance speed. The viewer / researcher/ user cannot change the logic of the system. The entire "composition" of this audiovisual spectacle, consisting of 1,048,576 different visual patterns and 64 sound oscillators, can last from 6 seconds to even 24 days.

Vladimir Bonačić (1938–1999) worked at the Croatian national research centre Ruđer Bošković Institute in Zagreb from 1962 to 1973. There, he headed the Laboratory of Cybernetics from 1969 to 1973. He earned his PhD in 1968 in the field of pattern recognition.¹ Vladimir Bonačić's artistic path is inseparable from the international New Tendencies movement and its world view of the synergy between science and art. The Gallery of Contemporary Art organized five New Tendencies exhibitions in Zagreb from 1961 to 1973; in addition, international exhibitions were held in Paris, Venice, and Leverkusen, West Germany. A group exhibition of European artists in 1961 developed into an international movement provided a gathering place for artists, gallery owners, and theoreticians during the Cold War. This unique situation was enabled by the cultural and geopolitical position of Zagreb, in the former non-aligned Socialist Federal Republic of Yugoslavia.

In the catalogue of the first New Tendencies exhibition in 1961, artist François Morellet, a member of the Paris-based Groupe de Recherche d'Art Visuel [Visual Art Research Group], wrote: "Imagine that we are at the eve of a revolution in the arts that is as great as the revolution that exists in science. Therefore, the reason and the spirit of

¹ Vladimir Bonačić, Pseudo-slučajna transformacija podataka u asocijativnoj analizi kompjuterom, PhD thesis, Faculty of Electrical Engineering, University of Zagreb, Zagreb, 1968.

systematic research has to replace intuition and individualist expression.² Further New Tendencies ideas – that can be wholly applied to Bonačić’s work – were presented in the 1963 catalogue of the second New Tendencies exhibition in a text by the Croatian art critic, theoretician, and co-founder of the New Tendencies movement, Matko Meštrović. Tellingly, the text was later republished under the title “Ideologija novih tendencija” [The Ideology of the New Tendencies], which it surely is from its programmatic and theoretical structure. The demythicization of art and demystification of the creative process were also proclaimed through a positive approach to the industrial production of works of art (the possibility of multiplication was essential), collective work, and a rational approach. Meštrović called for the speeding up of the evolution and synthesis of science and art within the framework of rendering humanities and art more scientific, as part of the long-term utopian process of rendering all human activity scientific. In Meštrović’s view, this process could be actively begun within the framework of art immediately, as well as the development of a global model, undertaking efforts to act in the sphere of culture at a smaller scale, for example, through the appropriation of scientific methods, such as the experiment. There is the issue of distributing all material and spiritual assets in equal measure, as well as of returning the achievements of science to the public domain. Meštrović did not consider artworks as unique commodities for the art market, but as “plastic-visual research, with the aim of determining the objective psychophysical bases of the plastic phenomenon and visual perception, in this way a priori excluding any possibility of including subjectivism, individualism, and romanticism [...]”.³ Further, the thesis was advanced that ultimately art as we know it would be transcended through developing the consciousness of the world using a metamorphosis of the social into the artistic act, which actively transforms the entire world.⁴ We can trace such developments in the practices of the numerous New Tendencies artists and researchers in the early 1960s, which formed the context for the inclusion of scientist-artists later, such as Bonačić.

During the first half of the 1960s, the New Tendencies attained a noteworthy international reputation as a leading international platform for the avant-garde visual art that favoured rationality, social engagement, and interactivity with the user, which was achieved through the scientific methods of experimentation and algorithmic programming of visual elements in creating objects, as well as the environments made of industrial materials, movement, and light. Whereas, in Matko Meštrović’s words, “at the beginning of the movement, artists intuitively oriented towards science, often lacking a notion of what it implied,”⁵ this situation changed radically in 1968 when the programme “Kompjuteri i vizuelna istraživanja”/“Computers and Visual Research” began, and a greater number of

² François Morellet, “Untitled,” in: *nove tendencije*, exhib. cat., Galerija suvremene umjetnosti, Zagreb, 1961; translated from French.

³ Matko Meštrović, “Untitled,” in: *nove tendencije 2*, exhib. cat., Galerija suvremene umjetnosti, Zagreb, 1963, n. p.; translated from Croatian. See also: Matko Meštrović, “Scientifikacija kao uvjet humanizacije” in: Matko Meštrović, *Od pojedinačnog općem*, Mladost, Zagreb, 1967, pp. 221–230.

⁴ See: Meštrović 1963, n. p.

⁵ Statement at the symposium “Kompjuteri i vizuelna istraživanja” / “Computers and Visual Research,” 6 May, 1969, Kulturno informativni centar [Culture and Information Center] (KIC), Zagreb, transcript from an audio recording, Archive MSU Zagreb; translated from Croatian.

scientists began to participate actively in the New Tendencies. At the conferences and exhibitions, which were a part of the programme, a number of scholars, who had left the realm of pragmatic scholarly work by using computers creatively, participated alongside the artists.

In addition to his academic work at the Ruđer Bošković Institute in Zagreb, Vladimir Bonačić participated actively in all parts of the “Computers and Visual Research” within *tendencies 4*, and during this short and obviously intense period he both started to realize a wide range of artworks and developed his own theory of computers and visual research. Bonačić participated in both conferences related to computers and visual research: the colloquy in 1968 and the symposium in 1969, the papers of which were published in the journal *bit international* which was launched by the Gallery of Contemporary Art in 1968.⁶ Within the two exhibitions of 1968 and 1969, Bonačić exhibited one coproduced work, a collaboration with artist and designer Ivan Picelj, as well as twenty-one own works. He also presented a large, 36-metre computer-controlled light installation, *DIN. PR18* in a public location.

Joining the New Tendencies

How did such intensive production and presentation come about? During the preparation of *tendencies 4*, organizers from the Gallery of Contemporary Art sought collaborators at the Ruđer Bošković Institute in Zagreb. Along with other scientists who were to take part in the symposia, the New Tendencies organisers met the young scientist Bonačić at the institute, who used visual research in his scientific work. Also at this time, Ivan Picelj, New Tendencies’ chief graphic designer, was asked to design the poster for the *tendencies 4* events. He decided to use punch cards of the institute’s computer for a collage. Picelj then had the idea to take his work a step further and to produce a light object following his *Površina* [Surface] series of reliefs in wood and bronze, which he had been developing since 1961. At this point, Vladimir Bonačić came upon the scene, and they began the collaboration that resulted in the electronic object entitled *t4*, the abbreviation of *tendencies 4*. It was presented in 1969. The front panel of the object is made of a grid of round aluminum tubes, each holding a small light bulb. Each tube is cut at an angle. The upper part displays variations of the characters “t4,” moving from the left to the right, for example. The rest of the panel lights up in asymmetric light patterns, and four knobs on the back of the object allow certain manipulations. Bonačić’s experience in physics and electronics helped a great deal, as did the excellent production conditions in the workshops of the Ruđer Bošković Institute.

Bonačić stated “computer must not remain merely a tool for the simulation of what exists in a new form. It should not be used for painting in the way that Piet Mondrian did, or for composing like Ludwig van Beethoven. The computer gives us a new substance; it

⁶ See: Vladimir Bonačić, “Mogućnosti kompjutera u vizualnim istraživanjima” / “Possibilities for Computer Applications in Visual Research,” in: *bit international 3*, Boris Kelemen and Radoslav Putar (eds.), Galerije grada Zagreba, Zagreb, 1968, pp. 45–58. Vladimir Bonačić, “Umjetnost kao funkcija subjekta, spoznaje i vremena” / “Arts as Function of Subject, Cognition, and Time,” in: *bit international 7*, Boris Kelemen and Radoslav Putar (eds.), Galerije grada Zagreba, Zagreb, 1971, pp. 129–142.

reveals a new world before our eyes. In that new world, after many years, scientists and artists will meet again, driven by a common desire for cognizance.”⁷ Bonačić’s reference to Mondrian was a critique of A. Michael Noll’s experiment with a computer-generated Mondrian-like drawing.

The “Galois Field“

The “Galois field,” named after the French mathematician Évariste Galois (1811–1832), whose work marked one of the beginnings of group theory, was a source of general inspiration to Bonačić. In abstract algebra, the finite fields are known as Galois fields, and Bonačić studied them in connection with his work on the roots of polynomial equations. First in his scholarly work, and later in his artworks, Bonačić developed his own, original method of studying the Galois field through the way that he visualized it. In his article “Kinetic Art: Application of Abstract Algebra to Objects with Computer-controlled Flashing Lights and Sound Combinations“ (1974) he noted: “One of the most interesting aspects of this work [on Galois fields] is the demonstration of the different visual appearance of the patterns resulting from the polynomials that had not been noted before by mathematicians who have studied Galois fields.”⁸ In the visualization of algebra of the Galois field, the calculated algebraic result can be shown in both symmetrical and asymmetrical visual compositions.

Dynamic Objects

Bonačić further elaborated the dimension of time, which in the works described above was achieved through the combination of technologies of computer-generated images and the medium of photography, in a series of computer-generated light objects and installations, which he called “dynamic objects.” All of Bonačić’s dynamic objects have the possibility of interacting with time dynamics, as viewers (users) are enabled to control the rhythm of images or stop them. From 1969 to 1971, Bonačić created a series of dynamic objects consisting of the different computer-programmed light patterns displayed on an originally designed panel made of metal tubes of different shapes and sizes. For all his dynamic objects Bonačić made use of the “pseudorandom“ algebra of Galois fields (see “GF“ in the title of the work). The patterns were programmed on a SDS-930 computer in Real-Time FORTRAN, allowing a direct usage of Assembler, too, thus providing an excellent tool for various bit manipulation techniques.⁹ The software co-programmer was Miro A. Cimerman.¹⁰ Bonačić used custom-made hardware for all his dynamic objects that were produced or assembled from the electronic components by himself and experts at the Ruđer Bošković Institute. The dynamic objects were embodied statements of what he later elaborated on in his critique of the influence of the commercially available display equipment on the computer-based arts.¹¹ In his 1974 article “Kinetic Art,” Bonačić emphasized that this was “akin to an artist being limited to the use of only two or three colours in a painting. It is true that much can be done

⁷ Bonačić 1968, p. 58.

⁸ Vladimir Bonačić, “Kinetic Art: Application of Abstract Algebra to Objects with Computer-controlled Flashing Lights and Sound Combinations,” in: *Leonardo*, vol. 7, no. 3, 1974, pp. 193–200.

⁹ Personal communication of the author with Miro A. Cimerman.

¹⁰ Cimerman collaborated with Bonačić at the Ruder Bošković Institute from 1968.

¹¹ See: Bonačić 1974, p. 193.

with such equipment, but one can hope that ways will be found to take better advantage of computers.¹² In 1977, almost ten years after his first artistic experiments, Bonačić stated that a dynamic object was a “concept in which impregnable unity is established between the computer system and a work of art.”¹³ In 1987 he added: “To integrate computer systems and art, without allowing one to dominate the other, is seen as a step towards the common language. This means that the artists and their work of art are able to communicate; artists and their art use a common language.”¹⁴

From a contemporary perspective, Bonačić’s Dynamic Objects are a pioneering example of the use of interactivity in the computer-based art. Like many other artworks created within the New Tendencies context,¹⁵ Dynamic Objects by Bonačić are designed both as artworks that can be experienced aesthetically, and as instruments or tools for visual research. Especially the latter aspect could lead us to the cognitive process (visual learning of mathematics and its hidden laws), a possibility mentioned by Bonačić when describing his art production.¹⁶ All Dynamic Objects were made to be manipulated either by the author (or someone from his team) or by the observer. Such experimentation and visual research (in the literal sense of the term) can be done within the controlled environment of an artist’s or scientist’s studio or laboratory with the assistance of the artist or his collaborators, or by gallery visitors.

GF. E(16,4) - NS C M

Bonačić introduced a higher level of interactivity in the Dynamic Object *GF. E(16,4) - Ns C M*, which was conceived, developed, and built in Zagreb from 1969 to 1971.¹⁷ It is 187 × 187 × 30 cm large and weighs half a ton. The front panel shows a relief structure made of 1,024 light fields in 16 colours. Several Galois field generators operate in order to light the grid in different patterns and to produce the sound played through four loudspeakers, which create a quadraphonic sound system within the installation space. The field of interaction is not confined to the object. The researcher/user/observer can influence both sound and image by using various knobs and switches on the (custom-made) special-purpose computer which is positioned next to the object. Sound can be manipulated by excluding some tones. The speed of the visual display can be adjusted by looping the selected sequences. A remote (radio) control can be used by the viewer to manipulate some basic features. However, the observer cannot change the logic. The entire “composition“ of this audiovisual spectacle, which consists of 1,048,576 different

¹² Ibid.

¹³ Vladimir Bonačić, “On the Boundary between Science and Art,” in: *Impact of science on society*, vol. 27, no. 1, January/March 1977, p. 25.

¹⁴ Vladimir Bonačić, “A Transcendental Concept for Cybernetic Art in the 21st Century,” in: *Visions for Cybernetic Art*, exhib. cat., Paris Art Center, Paris, 1987, n. p.

¹⁵ For example, *Reljefometar [Relief-Metre]* (1964–1967) by Vjenceslav Richter, manipulable lumino-kinetic works by Gruppo MID, or *Un instrument visuel [A Visual Instrument]* (1965) by Michel Fadat, all exhibited at the New Tendencies exhibitions.

¹⁶ See: Bonačić 1971, pp. 129–142.

¹⁷ This computer sculpture was first exhibited in 1971 at the 7th Biennale in Paris in the section “Interventions“ at Parc Floral, Bois de Vincennes, from 24 September to 1 November, 1971, followed by the exhibition at the UNESCO building in Paris, from November 1971 until November 1972, on the occasion of the 25th anniversary of the UNESCO.

visual patterns and 64 independent sound oscillators, can be played within 6 seconds or with a duration of 24 days.¹⁸

The bcd cybernetic art team, which was founded in 1971, consisted of Bonačić, his colleague from the Ruđer Bošković Institute, Miro A. Cimerman, a software designer, and Bonačić's wife, architect Dunja Donassy. They worked together until Bonačić's death in 1999. The bcd cybernetic art team continued to develop the Dynamic Object *GF. E(16,4) - Ns C M* over a number of years and experimented with different forms of external hardware. The *GF. E(16,4) - Ns C M* was an instrument that changed interface design, not only by taking advantage of the newest technical possibilities that were rapidly changing between 1969 and 1974, but also by developing the original new solutions. Between 1972 and 1974, several upgrades were carried out that extended the interactivity level of the *GF. E(16,4) - Ns C M* by using an external computer and a light pen: the computer offered a new interface – an interactive monitor – and the light pen enabled more intuitive interaction with its graphic interface. The object was also connected to the standard computer industry hardware, such as the GT40 graphic terminal with printer, but the use of human brain-wave activity was also considered as a possible interface of interaction. The object's tranquil audiovisual output and the transcendental quality of the cognitive and physical experience of higher mathematics led to the object being set up in St. Kilian's Church in Wiesbaden, Germany, from 1983 to 1985, "where it helps the Franciscans to prepare for meditation."¹⁹ In 1975, two music concerts have been performed by Bonačić using the *GF. E(16,4) - Ns C M* hardware, at the Dormition Abbey at Mount Zion and as well in the Italian Consulate, both in Jerusalem.

Art Installations in Public Spaces

Bonačić also developed the computer-based light installations for public spaces which enabled another kind of interaction: interaction at the social level. As part of the *tendencies 4* exhibition in 1969, he set up the large-scale Dynamic Object *DIN. PR18* on the facade of the Nama department store at Eugen Kvaternik Square in Zagreb. The 36-metre-long installation consisted of 18 elements; each element had a 3×5 grid light matrix. The installation performed a light show that flickered 262,143 patterns of the irreducible 18th-degree polynomial $(x^{18} + x^5 + x^2 + x + 1)$.²⁰ The clock was set at 200 milliseconds, but there was a possibility to set it to different rates at "the border of the perception of the observer and frequency clock."²¹

At that time, the square was rather dark, with little public lighting, so the installation also acted as additional illumination. In July 1969, art critic and curator Želimir Košćević published in the cultural review *Telegram* an affirmative evaluation of the "message"

¹⁸ In his *Leonardo* article, Bonačić elaborates these different kinds of interaction from a practical and theoretical point of view, and also considers the use of brainwaves in artistic practice; see: Bonačić 1974, pp. 195.

¹⁹ Raymond Daudel, "The Cybernetic Art of the bcd Team," in: *Visions for Cybernetic Art*, exhib. cat., Paris Art Centre, Paris, 1987, n. p.

²⁰ See: Vladimir Bonačić, "Eksponati u okviru *tendencija 4* Zagreb maj 1969" / "Exhibits within *tendencies 4*, Zagreb May 1969," the text of the explanatory plaques for the *tendencies 4* exhibition, Archive MSU Zagreb, n. p.

²¹ *Ibid.*

of this public light system, used for an aesthetic rather than a commercial purpose, as opposed to the illuminated signs of companies that had started to appear in Zagreb's city centre.²² Koščević also found that this public installation demonstrated a refinement of the idea of democratization of art within the context of the New Tendencies movement. He observed that Bonačić, "with his ideas, is a part of the front that, within the 'Tendencies' movement, attempts to open a path for art that would simply be work, the results of which will be intended for everyone, without the obligation to take our hats off and buy an entrance ticket for the unavoidable museum or gallery before we can confront it. Tomorrow is, as it seems, meant for just that kind of art."²³

In 1971, the installation *DIN. PR18* was replaced by a more complex installation, *DIN. PR16*, in the same place, at the top of the facade, but in the form of a triple frieze of light elements. A spatial extension was added by new light elements set in the continuation of the frieze on the other side of the building, as well as into the indentation of the front. A year before, in 1970, another Dynamic Object was set up on the facade of the Museum of Contemporary Art, Belgrade for the 4th Triennial of Yugoslavian Art.²⁴ When Bonačić replaced the installation at Nama in 1971, he also set up another installation on the facade of the Nama department store on Ilica Street, the Dynamic Object *DIN. PR10*.

Finally, another Dynamic Object was exhibited only several hundred metres away on the facade of the Kreditna banka Zagreb building on Ban Jelačić Square in Zagreb. None of the "outdoor" works mentioned here that were set up in public spaces are still in place, nor can their original elements be traced at present. However, at least, all of Bonačić's "indoor" Dynamic Objects still exist and are in good condition;²⁵ they belong to the small group of the computer-generated interactive objects from the 1960s that are still functioning today.

Critique of True Randomness in Computer Art

"I am especially sceptical of the attempts to produce computer art through a play with randomness and the deliberate introduction of errors in the programmes prepared for non-artistic purposes,"²⁶ wrote Bonačić in 1974. He supported art practices where, like in his Dynamic Objects that make use of pseudorandomness, the "feedback loop might be closed with an aesthetic output to an art object, which would then provide semantically relevant information to a viewer. I believe that such interactions will add to cognition, which will be reflected in the language and perhaps provide the improved means of communication."²⁷

²² See: Želimir Koščević, "Svjetlost nove urbane kulture," in: Telegram, 479, July 4, 1969, p. 17; translated from Croatian.

²³ Ibid; translated from Croatian.

²⁴ 4. trijenale jugoslovenske likovne umetnosti, Muzej savremene umetnosti, Beograd, 3 July – 15 September, 1970; curator: Jerko Denegri.

²⁵ In total, eight electronic Dynamic Objects were presented at the *bit international* exhibition, curated by Darko Fritz: seven objects at the Neue Galerie [New Gallery] in Graz, 2007, and three at the ZKM | Centre for Art and Media Karlsruhe, 2008/2009. Miro A. Cimerman, Dunja Donassy-Bonačić, and ZKM experts restored *GF. E(16,4) -Ns C M* for its first public exhibition since 1985.

²⁶ Bonačić 1974, p. 193.

²⁷ Ibid., p. 194.

In his paper of 1969, Bonačić discussed the notions of information and entropy, and redundancy and originality in the writings of George David Birkhoff, Max Bense, and Abraham A. Moles: "Observing the qualitative relation for the aesthetic measure, we come to the conclusion that the maximal originality (namely, disorder created by the random selection of symbols) brings immense aesthetic values. Let us suppose we have created the programme in some other way; but it is still the programme that will result in an aesthetic object. Using the random generator, we shall carry on with random distribution of the existing information. Although a consistent use is made of the random generator, we speak of 'maximal originality,' no matter what the results of the programme might be. The random generator creates the accidental and unique presentation, which has neither value nor importance for human beings. Such information can evoke various associations in the observer. However, a computer used in such a way lags far behind the human being. Even if the expressive potentialities of the computer were equal to those of a human being, the essence of Pollock's world and creation would not be surpassed, regardless of the complexity of future computers or peripheral units. That, of course, does not mean that a man (or a monkey or other animal) aided by a computer could not create an aesthetically relevant object if they act consciously or unconsciously obeying the law of accident."²⁸

This critique inspired the creation of the object *Random 63*, which used 63 independent true random generators, each of which activated an electric lamp. The geometric pattern of the placement of the light bulbs on the object's front was calculated with a PDP-8 computer using the pseudorandomness of the Galois fields. This is the only object by Vladimir Bonačić that makes use of true randomness for the dynamic control of the lights. Bonačić expressed doubts about information aesthetics, a theory which was important to several participants of *tendencije 4 / tendencies 4*. In his book *Science and Technology in Art Today* (1968), Jonathan Benthall, who participated in two Tendencies conferences, observed: "Max Bense writes that mathematical aesthetics is a process which is 'devoid of subjective interpretation' and deals objectively with specific elements of the 'aesthetic state' of as one might say the specific elements of the 'aesthetic reality.' These elements include meanings as well as sensuous or formal qualities. Bense proposes a 'generic aesthetics' which would explain how aesthetic states are generated in the same way as generative grammar in linguistics attempts to explain the logical processes by which sentences are performed and interpreted; but a prior stage of analytical aesthetics is held to be necessary. The main mathematical techniques proposed by Bense are semiotic (the study of signs, originated by Charles Sanders Peirce and others), metrical (concerned with forms, figures, and structures), statistical (concerned with the probability of appearance of elements), and topological (concerned with the relations between sets of elements)."²⁹ Benthall pointed out: "Vladimir Bonačić is sceptical about the applicability of information theory to aesthetics, since it takes so little account of semantics. But he approaches visual phenomena in a mathematical and systematic way."³⁰

²⁸ Bonačić 1971, p. 138.

²⁹ Jonathan Benthall, *Science and Technology in Art Today*, Thames and Hudson, London, 1972, p. 59.

³⁰ *Ibid.*, p. 62.

The statement of Brazilian artist Waldemar Cordeiro at the *tendencije 5 / tendencies 5* conference that “Constructive art belongs to the past, its contents correspond to the Paleocybernetic Period of computer art”³¹ – that computer art had replaced Constructivist art – found its proof in Bonačić’s artwork. Moreover, with his dynamic objects, especially those set up in public spaces, Bonačić probably managed to make real the utopia outlined by Matko Meštrović and other New Tendencies theoreticians at the beginning of the 1960s. Bonačić’s work is exact research that leads to cognitive insights. Science has been humanized, and art has been scientized. Works have been realized through the use of machines, and their basic materials were time and light. They involve the viewer as an active participant, sometimes in physical interaction with dynamic objects, and they are both socially engaged and democratic. It is possible to multiply the works by programming purpose-built software and constructing hardware.

It seems that Bonačić’s work fulfilled and dynamized Meštrović’s visions of 1963, introduced at the beginning of this text, which are summarized in the idea that “[a]rt must perform a breakthrough into the extra-poetical and extra-human sphere, because today, without that action the human sphere cannot be enriched.”³² Bonačić’s work has, at least temporarily, realized the programme of the New Tendencies that at a certain point in time looked merely utopian. However, today it is being reactualized in a new geopolitical, technological, and cultural climate.

Parts of this text were previously published in two essays on Bonačić’s work by Darko Fritz: “Vladimir Bonačić: Computer-Generated Works Made Within Zagreb’s New Tendencies Network (1961–1973)”, in: Leonardo - Volume 41, Number 2, MIT Press, Cambridge, Mass., 2008, pp. 175-183 and “The Work of Vladimir Bonačić: A Temporary Realization of the New Tendencies Program”, in: A Little-Known Story about a Movement, a Magazine, and the Computer’s Arrival in Art: New Tendencies and Bit International, 1961-1973, Rosen, Margit, Darko Fritz, Marija Gattin and Peter Weibel (eds.), ZKM, Karlsruhe / MIT Press, Cambridge, Mass., 2011, pp. 49-56.

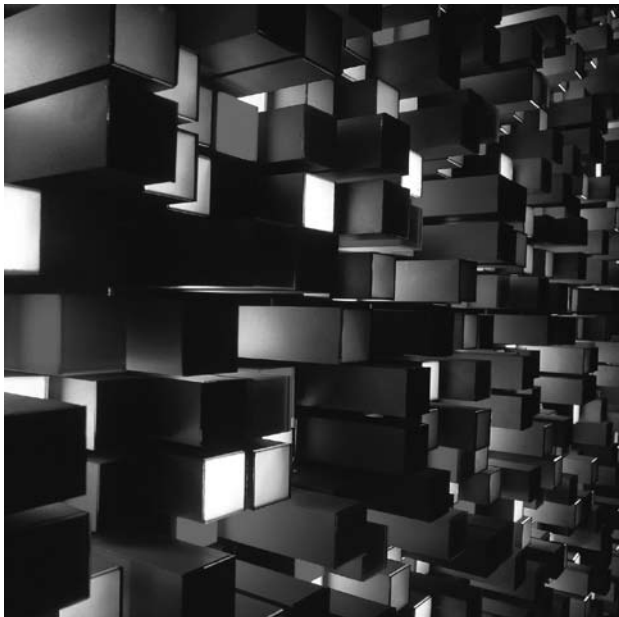
Courtesy by the author

³¹ Waldemar Cordeiro, “Analogical and/or Digital Art,” *tendencije 5 / tendencies 5*, “The Rational and Irrational in Visual Research Today. Match of Ideas,” Galerija suvremene umjetnosti, Zagreb, 2 June, 1973, conference proceedings, n. p.

³² Meštrović 1963, n. p



Vladimir Bonačić in interaction with GF. E (16.4), computer-controlled dynamic object / audiovisual installation, 187 x 187 x 30 cm, 1969-1971. (<c> Dunja Donassy Bonačić--bcd cybernetic art team. Photo: Petar Dabac.)



Vladimir Bonačić, GF. E (16.4), detail, computer-controlled dynamic object / audiovisual installation, 187 x 187 x 30 cm, 1969-1971. (<c> Dunja Donassy-Bonačić--bcd cybernetic art team. Photo: Petar Dabac.)