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## Cybernetic Aesthetics and Communication

Claudia Giannetti

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Recent theory, which is influenced by cybernetics and information theory, grasps information as a key concept for the understanding of aesthetic processes. By formalizing the latter, the intention is to build up a contrary position to idealistic, neo-Kantian, and metaphysics-oriented aesthetics. For that reason, several theories based on the fundaments of cybernetics are described here, for instance the theories of information aesthetics, cybernetic aesthetics, generative and participative aesthetics, as well as of reception aesthetics, whose developments were closely associated with the computer art emergent at the same time. All these theories are concerned with the fundamentally transformed functions of the artist, with the concept of art itself, and with the role of the viewer.

### Formalization processes and aesthetic theory

Although the approaches of cybernetics and Artificial Intelligence revolutionized subject areas of science as well as its interdisciplinary modes of proceeding, scientists continued to be bound to certain philosophical traditions in the field of logic. The course of formalization research, which has its origins in the Middle Ages, shows how objective truth was increasingly placed within the context of logic and mathematics, and the search for metaphysical truth gradually moved closer to fields in the area of sensory perception, such as art. On the basis of these givens it is possible to follow a development that began in the Middle Ages with the mechanized procedures of logical operations and leads into the twentieth century with the application of heuristic techniques in systems of Artificial Intelligence.

These new functions of logic were rooted in the theory of the Catalan theologian and philosopher Raimundus Lullus (1235–1315). His work «Ars Magna et Ultima» defines logic as an instrument of universal science with which true statements about reality can be formulated. His philosophy brings together two approaches: the attempt to unite as a «cientia generalis» the sciences which are distributed over very diverse disciplines, and with this science to find the «clavis universalis» that clears the road to an infinite quantity of true statements. His notion of universal language is based on the idea of creating a scientific language of symbols that is intended to serve not as a communication medium but as a formal instrument of finding the truth. In the writings of Lullus, logic is no longer an «ars demonstrandi.» It becomes an «ars inveniendi» a heuristic instrument with which it is possible to set up universally valid propositions over logical operations. With that, the process of thinking turns into a «game of symbols» objectively structured on the basis of abstract, purely formal principles or rules. [1]

This hypothesis of calculability implies the premises of further developments, such as Thomas Hobbes' reduction of all thought to calculability, Gottfried Wilhelm Leibniz' idea of a universal language of calculus, and Charles Babbage's analytic machine. All these concepts are aimed at the formalization of human thought and the constructability of symbolic thought machines. They finally culminate in the Turing Machine and the later digital computers. From Aristotle over Lullus, Hobbes, Leibniz, Babbage up to Turing, Newell, and Simon, therefore, a line can be traced through the history of philosophy and scientific theory. [2]

Where, however, is the connection between the process of transformation of logical language toward formalization and the process of formalization in aesthetic theory ultimately to be found? The classical question of the function of language and its usage in recognizing truth concerns the sciences and philosophy alike. Up to the first half of the twentieth century, Lullus' quest for a universal language remained current in neo-positivist approaches such as those of Moritz Schlick, Rudolf Carnap, Hans Hahn and Otto Neurath. They continued the attempt to overcome problems raised by metaphysics by creating a formalized system, for instance with regard to the question of the nature of reality or the relationship between knowledge of the world and truth. Access to a determined area would insofar be linked to the formulation of a theory based on laws, models, and norms.

Formalization must be grasped as a system no less artificial than our cultural and social foundation. The first «artificial world» was created with graphically illustrative representation techniques (as in cave paintings). Other worlds of art were brought about by the standardization of language through the alphabet and writing. Throughout the history of civilization new methods and levels of artifice satisfying the need for a communication system appropriate to the prevailing social form have continuously been created. The attempt of Claude E. Shannon and Warren Weaver in 1948 to work out a logical communication system may be seen as exemplary in the framework of a general theory of communication. Shannon examined the physical and static properties of messages, whereby his approach was comparable with formalizations in the fields of logic and physics. [3]

According to Shannon's «Diagram of the Communication System» in the technical process of communication information refers not to meaning but to a quantity of signals contained in the message. The basic problem of communication technology—for instance the quantification of information, or the capacity of a channel—insofar lay for Shannon and Weaver in the fields of mathematics and physics, irrespective of signals or coding and also of whether the transmitters and receivers be machines or human beings. The same starting point was adopted by a new aesthetic direction inspired directly by cybernetics. Itsaw information as the key concept to understanding aesthetic processes, and attempted by means of formalization to create an opposing stance to Kantian and Hegelian tendencies of aesthetic theory. The objective of a formal aesthetic system aimed to deepen not interpretations or value judgements but the system of the work itself, the organization of elements and signs. Every work of art, in fact every artistic expression, was now viewed as a message transmitted by a creative individual (an artist or group of artists), known as the transmitter, to another individual (or group), known as the receiver, over a channel (systems of visual, auditory, and other modes of perception). [4]

The approach of examining art in terms of information theory displays parallels to semiotics and its definition of message structures. For Charles Morris, one of the founders of semiotics, art was a language for the communication of values. The value function is derived from the fact that its signs represent final objects. Viewed from this perspective, the basis of language is reduced to predictable, purpose-oriented, syntactic qualities. Theory in the environs of rational aesthetics therefore evaluates the art object as a system of signs that transports formalizable aesthetic information.

### Rational aesthetics

In order to arrive at formulas as well as evaluation and procedural norms for aesthetics centered on the notion of the message, information theory was first adapted to aesthetics, and the language then formalized along with the aesthetic parameters. A first approach was taken by the American mathematician George David Birkhoff, in whose study «Aesthetic Measure» (1933) the search for reliable, objective rules for the aesthetic evaluation of works of art arrived at a formula according to which «O» measures order, and «C» the usage of material «M.» The aesthetic measure can then be represented as follows:  $M = O/C$ .

Birkhoff's manner of proceeding is basically comparable with that of Norbert Wiener, who likewise employed statistical methods used by scientists. Birkhoff introduced purely statistical methods into his aesthetic theory in order to arrive at a quantification of the analysis of a work. In this way, rational aesthetics constituted itself as an unmistakable antithesis to aesthetic models derived from the traditions of Idealism or Romanticism.

This signified a turning point in aesthetic theory, which split up into two focal research fields as of the second half of the 1930s. Although either current was pursuing the same objective—the legitimization of aesthetically reliable foundations of art—the path struck upon was diametrically opposed in either case. The one current anchored the foundations in rational methods, with the result that any reflection upon art was expected to be based on scientific procedures in order to obtain objective results. The other current, whose principles were oriented toward the truth of art, did not reduce aesthetic experience to causal and objective relations, and insofar could not be equated with exact sciences, since it was based on subjective knowledge.

Obviously, the second possibility remained closed to proponents of rational aesthetics, whose theories were formulated with a view to aesthetic objectification. In regard to concepts such as the purpose and meaning of works of art, information was applied as a «unit of measure» for evaluation. Research involved the search for probabilities, for the formation of repertoires on various levels of information, and for further concepts leading to evaluation norms. For Birkhoff, the quantity of information indicates the complexity of a message. Complexity, as a quantifiable value, constitutes in relation to the message one of the objective quantities of perception. The greater the degree of order relationships in a work of art, the smaller is its aesthetic value; the latter increases in proportion to the complexity of the representation. In this way, complexity is considered to determine the degree of innovation and aesthetic value contained in an item of artistic information.

### Information aesthetics

The philosopher Max Bense expanded Birkhoff's model to include new findings from the fields of information theory, semiotics, and philosophy. [5] A close connection to the scientifically technical terminology of cybernetics is immediately discernible in the concepts he used. He defined the measure of order as «redundancy» and material expenditure as «entropy», both scientific terms frequently used by Norbert Wiener likewise. [6] As Bense stated, art—and modern art especially—can no longer be grasped along classical lines with terms like proportion, symmetry or harmony, which stress contrasts and reject standards. Aesthetic process and physical world tend in opposite directions, and are different in principle: the world of physics is existent, that of aesthetics is constructed. Bense was convinced that a theory was lacking which could objectively evaluate this field and offer a «programming of the beautiful.» His theory took the shape of an attempt to systematize basic aesthetic principles. The information aesthetics first proposed in a lecture on «Modern Aesthetics» at the Stuttgart Technological University in 1957, and subsequently at the «Aesthetica III.» was based on the statistical analysis of art objects and consigns the subject—the recipient—to the background by substituting the usage of adequate rules in the aesthetic evaluation. Bense would later use the term «generative aesthetics» which was to be understood as «the compound of all operations, rules and theorems through whose application to a quantity of material elements able to function as signs can deliberately and methodically generate in the latter aesthetic states (distributions and/or arrangements).» [7] Bense distinguished four methods within the aesthetic synthesis: the semiotic, the metric, the statistical, and the topological. The semiotic method is based on the examination of the sign; the metric method, as a sculptural principle, uses parameters such as width, length, number, or ratio in order to define a global structure—the micro-aesthetic—that takes material form as the gestalt or form of the work; the statistical method generates local structures, or a kind of micro-aesthetic; and the topological method, based on relational principles, is directed at variations of a certain gestalt.

By introducing concepts such as micro- and macro-aesthetic, Bense made clear the gap between a subjective valuation of the art object and a new aesthetic based on objective information and sign systems. Macro-aesthetic means a perceptive and representative reflection upon the work in direct reference to the art object, whereas micro-aesthetic treats the indirect relationship, which is based on signs and processes, between theory and work. The close relationship between Bense's aesthetic thinking and the theories of modern physics are evident both in the terminology (micro- and macro-physics) and in the concepts. His theoretical starting point is the replacement of aesthetic values derived from the tradition of a subjectivemetaphysical understanding of art with the objective analysis of the material circumstances of a work. For Bense, aesthetic objects are not purely of a physical nature. This concept is fundamental, since it interprets the aesthetic process as being one of information. It replaces earlier aesthetic interpretative methods with a technique of observation and communication. In other words, works of art are viewed as the mediators of information (aesthetic information): «Works of art, it might also be said, are a special (that is to say established, not given) class of «carriers» of the «aesthetic information.»» [8] The concept of information should here not be understood to mean an unquantifiable message or communication, but an informational content measurable in the transmission and storage of messages. All information on whose transmission communication is based, is built up by means of «signs.» Abraham André Moles occupies a place alongside Max Bense as a further founder of information aesthetics. While Bense's interest was focussed on the fine arts, Moles was preoccupied with linguistics and music, and above all with the computer art emergent in his time. [9]

According to Moles, machines must increasingly approximate art—and art the machines—since both are systems whose creative faculty is based on the combination of diverse elements. Their value rests in the possibility of generating high complexity from simple components. On the basis of a method he described as the «residue of a simulation» (possibly indicative of a certain degree of cybernetic inspiration), Moles introduced the key concept of «simulation.» [10] which would only later take on significance for the categorization of media art. The value of a work, as Moles saw it, does not consist in the traditional notion of «truth»—the basic concept of classical aesthetics—but in its operationalizability or, put differently, in the «degree of similarity.» Viewed aesthetically, the simulacrum implies a relation between technology and the quest for operational consistency. Moles saw a direct connection between the crisis of truth criteria and the rise of new technologies building on attributes of performativity. By transferring a factually technical concept into the artisticultural sector, Moles was far ahead of his time and underscored the original nature of his concept. Similar theses are to be found in the theory of Jean-François Lyotard, who asserts that the «criterion of performativity» [11] is one which is technological, and not suitable for judging what is truthful and right. [12] If machines can in fact simulate intellectual creation in the sense of Moles' theory, then the simulation of works of art must become the center of interest. It is a question of developing a program to that end, and of systematically addressing the question of the role of the artist within that process. In view of works created by digital means, the creative artist is assigned, according to Moles, the function of the aesthetician on the one hand, and of the programmer on the other. The artist formulates aesthetically the artistic criteria which the programmed work must, in his opinion, fulfill. In practice, however, the artist must create an algorithm containing these aesthetic qualities in the translation from creative to binary language. This concept of «translation» [13] as an artistic activity is very illuminating, and demonstrates the contribution (which is not always acknowledged) made by Moles toward an aesthetics of the digital, especially with regard to the evaluation of the role of the artist and to human-machine communication during the creation of electronic works.

In regard to the generation of works of art, Moles proposes five models: the machinic viewer, [14] the amplifier of complexity, [15] permutational art, [16] the simulation of artistic creation, [17] and the creation machine based on successive integration. [18]

Moles was aware that this «invasion of our thought by mechanical processes» [19] could spark off a regular—quantitative and qualitative—sociocultural revolution that raises a number of questions about the possible consequences of this transformation. «What are the effects on society of the usage of machinic products such as aleatoric music, artificial languages, programmed painting, automatically translated texts, a national library that is reduced to the memory of a computer [...]? How might a symbiosis with the machines be envisaged? That is the social aspect of cybernetics. [...] Will the artist be replaced by machines for the production of paintings, music, or literature, just as the bookkeeper or manual laborer has already been replaced?» [20]

In order to answer these questions, Moles pointed to three fundamental transformations that have continued to occupy the center ground of media-art theory up to the present day: the transformation of the function of the artist, that of the notion of art, and that of reception. Obviously, the machine will not replace the artist, but it does influence his function in the creative process: «The artist changes into a programmer in the degree to which he accepts this changeover.» [21]

It remains to be examined wherein, according to Moles' theory, the «other vision» of art and artists consists, and in which form the aesthetic results of media art are evaluated by information aesthetics. To assert that aesthetic values are calculable means to carry to an extreme the formalization of the language of art. The formalization processed carried out by creation machines adhere to either the hierarchic order of an

organigram, or the order of various planes of analysis. If the artist becomes a programmer, if aesthetic values are determined by operational systems, and if the work is produced on the basis of defined creative methods, then according to Moles the aesthetician has a new function. «He compiles the elements of the program for the repertoire of the machine, he defines the hierarchy of the levels which are to be incorporated. The relevant organigrams make it clear that every machine for analyses can also be employed as a machine for syntheses, i.e. as a source of works of art. Even if not in the strict sense the author of these works, since the author vanishes behind his work, the aesthetician is at least the manager and person accountable.» [22] In the framework of information aesthetics the aesthetician can thus place himself on the same level as artists about whom previously he was merely able to write.

Moles' theory is very probably the most comprehensible, thorough and revealing of those concerned with the application of cybernetics and information theory to computer-assisted art and aesthetics. Particularly significant and farsighted are his analyses of the concepts of simulacrum and translation, his models of «creative machines», as well as his reflection upon the consequences of aesthetic change in regard to the notions of artist, work of art, and recipient. It will later be demonstrated that several theories formulated by Moles in the 1950s and 1960s would be confirmed as the twentieth century drew to a close.

### Cybernetic aesthetics

During the 1960s and 1970s, the theoretical reflection as well as the artistic practice were further developed by several followers of Max Bense and Abraham A. Moles. Herbert W. Franke and Bense's pupils Siegfried Maser and Helmar Frank carried forward the research in the field of information aesthetics, whereby Maser crossed over to a «Numeric Aesthetics» (Stuttgart, 1970), while Frank deliberated upon the psychological aspect of information aesthetics. [23] Helmar Frank and Herbert W. Franke attempted to produce a synthesis of the approaches of Bense and Moles. Both of them viewed Moles' work on the relationship between perceptual research and information theory as being particularly relevant insofar as the information psychology based upon it provided them with the fundament of their aesthetic principles. Here again, the contributions were aimed at the definitive renunciation of the Romantic idea of viewers of art being «passive consumers», when according to Moles there could be no «passive perception» since a work of art was always an «object of communication».

Herbert W. Franke emphasizes the central importance of perceptive processes in his book «Kunst kontra Technik» (Frankfurt/Main, 1978), referring to the practice of information aesthetics in order to investigate the capacity of information flow able to be assimilated by the human senses. [24] At the same time he notes the paradox of aesthetic information: that works of art are expected to possess a long-term effect and thus a high degree of complexity, yet the physical capacity to absorb of the recipient is subject to specific limits. [25] The theory of apperception indications that a «surplus offer» of information rouses the viewer's irritation, while a «deficient offer» leads to «boredom.» [26] In order to obtain a certain degree of complexity without surpassing the recipient's absorptive capacity, Franke proposes a «multi-plane model.» «It is then in the hand of the artist to occupy several «layers» of the work of art, and beyond this he can establish connections between the layers with the spectator can preoccupy himself in later phases of the reception process.» [27] As Franke sees it, the usage of new technologies in art, for instance in computer art, brings about a symbiosis of rational thought and aesthetic creation, since as an art form linked with the world of science and technology it makes use of aesthetic elements that are mathematical, logical, or technical in origin. Cybernetic aesthetics and computer art therefore prove to be far-reaching bridges that interconnect art, science, and digital-information processing.

Franke's 1967 book on information aesthetics [28] played a crucial role in establishing the discipline, and launched new concepts of cybernetic aesthetics. With the notion of «interactive systems» and active audience involvement Franke opened up a dimension unknown in Bense's information aesthetics: the nonmeasurable experience of the recipient in the process of perceiving a work of art. In the long term this concept led not only to the confirmation of certain weaknesses in information aesthetics, but also to the insight that the application of a theory that explains aesthetic and artistic values solely on the basis of quantifiable and rational criteria comes up against its own methodological borders. «In the meantime it became increasingly evident that art is an intellectual as opposed to material (and thus materially explainable) process; it is a matter of what goes on in the brains of the artist and viewer, and in this respect primarily of perceptual, thought, and behavioral processes.» [29] Although Franke's research was itself a product of information aesthetics, his skepticism prefigured the clearer knowledge we have today: the scientific goals of information aesthetics have proved to be a utopian program or model.

### Reception aesthetics

Helmar Frank, like Herbert W. Franke, was seeking a negotiable path toward a theory of cybernetic aesthetics. Frank discerned the need for a renewal through elements of information psychology that would be relevant not just to the pedagogic aspect of theory, but to its content, as well. This approach took him into the proximity of anthropo-cybernetics.

Frank propagated an aesthetics closely linked with the process of perceiving art. Aesthetic processes, according to Frank, are bound to everyday procedures in a number of ways, and difficult to separate from these procedures. [30] Just as Franke developed a multi-plane model, Frank too drew up a model of the successive evaluation of a work that allows a progressive discovery of its complex structure. Going beyond the aforementioned perceptual theory, this model processes insights from cognitive theory as well as from behavioral research, which is used to evaluate the role played by emotions in the aesthetic process.

The analysis of information paths constituted a foundation of an aesthetics based on perceptual theory. As described by Frank/Franke, [31] this physiological and cognitive process begins with information processing in the sensory organs. However, a considerable difference exists between the initial absorption of information and its subsequent processing in the consciousness, which only selected and variously codified data reach. Of the information received by the short-term memory with a dwelling time of maximum two hours, only a small part (some 0.05 bit/sec.) reaches the long-term memory, to which a capacity between 105 and 108 bits is attributed. Over associations, the consciousness can retrieve data from the short- and long-term memory. Seen in these terms, every type of information, including the aesthetic and emotional, is subject to certain physiological processes that determine how they are received. A surplus of information can rouse irritation, a deficit can lead to a monotonous impression. The information conveyed by a work of art must insofar hold a quantitative balance of information, and the same time not offer wholly redundant information types (principle of exception and information). If this standard is attained, the recipient has the pleasant feeling of having perceived something new and creative.

Taking information theory as his starting point, Frank proposed an expansion of the communication process, saying that aesthetic information is not solely dependent on one-way communication (transmitter—receiver—message) but must allow the subject to go beyond his receiver existence, and into the context of the work of art behave also as a transmitter. In this respect, it is not at all a matter of «automatic» communication in the sense of an unconscious reflex. For Frank, creativity consists in the deliberate conception of communicative signs and precisely not in the usage of real signs. Aesthetic creation and reception can insofar be measured by their degree of automation: the higher the degree of automation, the lower their aesthetic value. In this sense, Frank's notions on redundancy and complexity scarcely differ from those of cybernetics. Yet, at the same time they make it obvious that his position was opposed to the cybernetic view of artistic processes that focuses on indeterminacy, aleatorics, or randomization—basically automated processes. The notions of art as a process, as well as the recipient's dual function as transmitter and receiver, were to be elaborated by other theorists and cybernetic artists.

### Participative and generative aesthetics

In the early phase of computer art the work produced referred to methods of order and to syntactic analyses of parameters like repetition, combination and variation. Neo-Constructivism in the fine arts can be viewed as one of the forerunners of the procedural modes that re-emerged in computer-assisted works such as those of Manfred Mohr, A. Michael Noll, Frieder Nake and Georg Nees. While the Constructivists had concentrated on mathematical and geometrical models, the Neo-Constructivists and likewise the exponents of generative art and process aesthetics worked with the visualization of algorithms and statistical methods allowing them to expand their formal aesthetics. In contrast to most Neo-Constructivist works, which for practical and technical reasons were limited to relatively simple structures, computer-generated works attained far more complex forms.

Frieder Nake adopted a programmatic standpoint based on art generated by process-based aesthetic programs. «Polygonzüge» is a good example. In this work and others, the concept of the algorithm [32] takes on special significance for Nake. Works of art made on the basis of generative aesthetics enable the creation of aesthetic situations that are specified in various, albeit limited, steps.

For Georg Nees the computer represents a «generator» of the process of artistic creation; its result is the model of a work of art. According to Nees the core of computer-based work consists in the selection and distribution of signs on a predefined surface or composition. This composition can consist in the statistical distribution of selected elements of a repertoire over the overall surface of the work of art. His computer-graphic image «23-Eck» of 1964 is a representative example of a generative aesthetics that builds on the principle of stochastic computer graphics and on aesthetic redundancy.

The concepts of redundancy and complexity are closely linked in cybernetics, and must be evaluated in relation to a reference subject (the observer). This connection is intensified in Nees' aesthetic, too. The more familiar the models or forms in a repertoire, the more redundant and less complex they are, thus diminishing a work of art's degree of innovation. Aesthetic information insofar rests not only on the communication of content, but above all on the receiver of the message—on the audience. Like in his work «White Noise», the artist Manfred Mohr deliberately deploys elements that disrupt the symmetry and balance in order to generate visual tension and rouse aesthetic interest. [33]

While the generative contributions concentrated primarily on process-based methods, other cybernetic approaches were distinctive for their examination of the role of the recipient. In the 1960s the artist Kurd Alsleben investigated in his works and writings the possibility of the «dialogic» work of art, whose point of reference lay in aesthetic communication. In his book «Ästhetische Redundanz» of 1962, he draws on the development of intentional works and the theories of Helmar Frank, and in particular the latter's studies of perception in connection with information aesthetics. His later work with telecommunications and Net art [34] carried forward these ideas. Art that operates within a communications network builds on open, interpersonal communication, and is in this respect art without a determinable audience. The basic element is communication: art as «intercourse.» The notion of participation is connected with the communication process, whereby uncompleted and open works offer the audience spaces for action.

The recourse to formalization and systematic, measurability-based methodology taken by various rationalistic aesthetic currents was indicative of the attempt to set up universally valid statements for all areas of art. Herbert Franke, for instance, articulates the opinion that if a whole series of very different activities, from painting to video, is subsumed under the single concept of «art», then a valid statement must be found for all these areas, «and thus also a comprehensive theory of art. That specifically is the object of the model we are seeking, i.e. to obtain findings valid across all the areas.» [35] . The cybernetic aestheticians are aware that this objective can be realized only if one works with extreme degrees of abstraction.

In resuming it can be said that «information» is becoming the key parameter to understanding aesthetic processes and to structuring aesthetic theory. The various aesthetic currents influenced by, or based on, cybernetics differ from each other in the way they evaluate the «information» parameter. To grasp the work of art as information therefore means to prepare the ground for a commensurate conception of aesthetics. This process must take into account that the overcoming of subjectivist discourse and the turn toward a communicative evaluation of art is subject to the influences of theories such as those of phenomenology, hermeneutics, and semiotics. Information aesthetics and cybernetic aesthetics highlight all the more clearly the gulf between ontological-metaphysical aesthetic schools on the one hand, and rationalist aesthetics on the other.

### Critique of information aesthetics and cybernetic aesthetics

The rationalist aestheticians deserve great credit for having worked out an aesthetic model based on the new research parameter of information. However, it must also be said that several orthodox positions of rational, informational and cybernetic aesthetics come up against their own dogmatic borders. The logic of information aesthetics does, in fact, point to a paradox: The idea of communication is closely connected to the «information» parameter. Aesthetic information is treated differently from semantic information, since its main concern is not the conveyance of meaning but of that which Max Bense described as «realization.» He proposes a system based on the unidirectional transmission of information. This transmission model reduces communication to the one-sided problem of «output» in the discourse of the aesthetic object. Precisely this fact allows information theory to transform aesthetic evaluations, such as that of beauty, into quantifiable concepts.

If one reduces aesthetic questions to a purely rational and numeric evaluation of the work (information as a quantifiable value), then one concedes a cognitive-theoretical value neither to the work itself nor to the aesthetic experience—and herein lies the paradox—and thus renders more difficult the process of truly open communication or, as may be the case, of an exchange of information.

The kind of communication structure proposed by information aesthetics is sequential and reductionist in character. It understands communication to mean de facto the process of information transmission as one-sided «information transmission» from transmitter to receiver in the sense of the «classical model» of Shannon and Weaver. No attention is paid to the subjects involved in this communication process, to the context in which it takes place, or to the semantic content. By ascribing importance merely to those properties which are accessible and quantifiable, information aesthetics limits itself to syntactic structures, with the result that the information is confined to a very reduced range. The attempt to find an aesthetic «measure» for evaluations immanent to the work of art and independent of reception and context, and therefore resting solely on the information content of aesthetic communication, can be viewed as a failure. For that reason, a different understanding of communication is required that can be applied to the area of aesthetics. If the aesthetic is brought into connection with the area of communication, then this means in other words that aesthetics is understood to be a processual category of the social system. Accordingly, such an «aesthetics as communicative process» would be at home not in the theory of Shannon or of cybernetics, but rather in system theory and Constructivism. However, in order to get close to the subject of aesthetics relationship between «communication» and «art» must first be conceptually harmonized. And this is all the more necessary in view of the evidently large number of various meanings of either concept.

Translation by Tom Morrison

[1] In this respect Lullus' «disc device» represents an approach of logic towards technology that would later be methodically developed further by Descartes and Leibniz.

[2] The AI researchers Herbert A. Simon and Allen Newell built the first «intelligent» machines, the «Logic Theorist» (1957) and the «General Problem Solver» (GPS, 1959) attempting to simulate the cognitive and problem-solving behavior of humans. Both researchers worked on the assumption that universal rules exist for the deductive solution of problems. In this way it was possible to formulate in programming language theories of information processing by the human mind, and test them by computer simulations of the anticipated behavior.

[3] Claude E. Shannon/Warren Weaver, «The Mathematical Theory of Communication.» Urbana, Illinois, 1949.

[4] See Abraham A. Moles, «A abordagem informacional.» in A Estética e as Ciências da Arte, Mikel Dufrenne (ed.), Lisbon, 1982, p. 300.

[5] See Max Bense, Metaphysische Beobachtungen am Schönen (Aesthetica I), Krefeld/Baden-Baden, 1954; Ästhetische Information (Aesthetica II), 1956; Ästhetik und Zivilisation (Aesthetica III), 1958; Programmierung des Schönen (Aesthetica IV), 1960; id., Einführung in die informationstheoretische Ästhetik, Reinbek/Hamburg, 1969.

[6] From the cybernetic perspective, order is expressed by redundancy, and transformation by innovation.

[7] Bense used the term «generative aesthetics» in his essay «Projekte generativer Ästhetik» in the journal rot 19 and in Part V of the Aesthetica. Cited after Erwin Steller, Computer und Kunst, Mannheim, 1992, p. 198.

[8] Max Bense, «Ästhetische Kommunikation,» in Wolfhart Henckmann (ed.), Ästhetik, Darmstadt, 1979, p. 333; and in Semiotik. Allgemeine Theorie der Zeichen, Internationale Reihe Kybernetik und Information, Vol. 4., Baden-Baden, 1967, pp. 18–25.

[9] See Abraham A. Moles, Théorie de l'information et perception esthétique, Paris, 1958 (deutsch: Informationstheorie und ästhetische Wahrnehmung, Cologne, 1971); «Cybernétique et oeuvre d'art» in Revue d'Esthétique 18, 1965, pp. 163–182; Art et ordinateur, 1971.

- [10] Cf. the text section «VR, AI and AL: Aesthetics of simulation as endo-systems» in Claudia Giannetti, «Endo-aesthetics.»
- [11] «The true goal of the system, the reason it programs itself like a computer, is the optimization of the global relationship between input and output, in other words, performativity.» (Jean-François Lyotard, *The Postmodern Condition: A Report on Knowledge* (1979), Manchester, 1984.
- [12] Jean-François Lyotard, *The Postmodern Condition: A Report on Knowledge* (1979), Manchester 1984.
- [13] Cf. the text section «Translation» in Claudia Giannetti, «Aesthetics and Communicative Context.»
- [14] The machinic viewer is based on the idea of creating a machinic evaluation system for works of art. In view of the steadily growing quantity of iconic and textual information, this machine would assume the function of serving the aesthetician or the artist as a «mechanical critic.»
- [15] According to Moles the machines, as «capacity amplifiers» are supposed to assist the artist in processing information so that more complex projects can be carried out. Moles sees in this kind of machines a system whose usefulness is intellectual as well as merely practical, since an amplifier of this kind could even be able to open up new fields of artistic creation.
- [16] «Aesthetic machines» form the basis of that which Moles describes as permutational art. This model serves the identification and definition of an area of possibilities. In this case the artist creates through symbolic codes not just the algorithm that establishes a repertoire, but is also accountable for the end result. The machine is capable of producing a large number of potential works that are analyzed and selected by the artist.
- [17] The task of this model is the simulation of the process of artistic creation, which is divided into an analytic and a synthetic phase. The role of the artist is here confined to defining the stylistic or aesthetic parameters to be executed by the program, which produces further works. The machine, and no longer the artist, is now responsible for the result.
- [18] The model of the creative machine is based on the idea of integration on successive levels. The machine functions as a kind of prosthesis for the limited human perceptual capacity. It could serve as a database of every kind of shape, which would facilitate the creation of new shapes. In this respect, such programs function as a source of inspiration or an observation medium.
- [19] Abraham A. Moles, «Kybernetik und Kunstwerk.» in *Ästhetik*, Wolfhart Henckmann (ed.), Darmstadt, 1979, p. 329.
- [20] Abraham A. Moles, «Kybernetik und Kunstwerk.» in *Ästhetik*, Wolfhart Henckmann (ed.), Darmstadt, 1979, pp. 329–330.
- [21] Abraham A. Moles, «Kybernetik und Kunstwerk.» in *Ästhetik*, Wolfhart Henckmann (ed.), Darmstadt, 1979, p. 330.
- [22] Abraham A. Moles, «Kybernetik und Kunstwerk.» in *Ästhetik*, Wolfhart Henckmann (ed.), Darmstadt, 1979, p. 330.
- [23] See Abraham A. Moles/Helmar Frank, *Grundlagenprobleme der Informationsästhetik und erste Anwendung auf die mime pure*, dissertation, Technische Hochschule Stuttgart, 1959; Helmar Frank, *Kybernetische Analysen subjektiver Sachverhalte*, Quickborn/Hamburg, 1964; Herbert W. Franke, *Phänomen Kunst*, Munich, 1967 (*Phänomen Kunst. Die kybernetischen Grundlagen der Ästhetik*, 2nd enlarged edition, Cologne, 1974; *Kybernetische Ästhetik - Phänomen Kunst*, 3rd enlarged edition, Munich, 1979).
- [24] See Herbert W. Franke, *Wege zur Computerkunst*, Vienna, 1995, pp. 50–61.
- [25] The human ability to absorb information, or the time and velocity of apperception is put at  $C = 16$  bits/sec. In his text of 1978 Franke calculated with a rate of 20 bits/sec., which was amended to 16 bits/sec. in his most recent publication (with Helmar Frank) of 1996.
- [26] Herbert W. Franke, «Aufmerksamkeit — zwischen Irritation und Langeweile» in the online magazine *Telepolis*, 1998.
- [27] Herbert W. Franke, *Wege zur Computerkunst*, Vienna, 1995, p. 54.
- [28] Herbert W. Franke, *Phänomen Kunst*, Munich, 1967 (*Phänomen Kunst. Die kybernetischen Grundlagen der Ästhetik*, 2nd enlarged edition, Cologne, 1974; *Kybernetische Ästhetik - Phänomen Kunst*, 3rd enlarged edition, Munich, 1979).
- [29] Herbert W. Franke interviewed by Florian Rötzer, «Der Monitor als Fenster in einem unbegrenzten Raum.» in *Digitaler Schein. Ästhetik der elektronischen Medien*, Florian Rötzer (ed.), Frankfurt-on-Main, 1991, p. 285.
- [30] See Helmar Frank, «Informationsästhetik — Kybernetische Ästhetik.» in Helmar Frank/Herbert Franke, *Ästhetische Information. Eine Einführung in die kybernetische Ästhetik*, Berlin/Paderborn, 1997, p. 37.
- [31] Helmar Frank, «Informationsästhetik — Kybernetische Ästhetik.» in Helmar Frank/Herbert Franke, *Ästhetische Information. Eine Einführung in die kybernetische Ästhetik*, Berlin/Paderborn, 1997, pp. 116–117.
- [32] The algorithm as a «rule of play» consists of a «finite list of instructions that are well defined. After a finite number of steps the algorithm delivers a solution to every problem in a class of problems by executing the instructions one after the other.» (Frieder Nake, *Ästhetik als Informationsverarbeitung. Grundlagen und Anwendungen der Informatik im Bereich ästhetischer Produktion und Kritik*, Vienna/New York, 1974, p. 188.) This system is especially useful for artists who work with image sequences, and is diversely applied in computer programs. Images are integrated into repertoires, they are subject to aesthetic redundancy, and insofar can be viewed as «variations on a theme.» Cf. on Nake and other computer artists also Matthias Weiß, »What is Computer Art?« in the module «Generative Tools.»
- [33] See Manfred Mohr, *Meta Language II*, 1974.
- [34] Cf. Inke Arns, «Interaction, Participation, Networking: Art and Telecommunication» in the module «Overview of Media Art.»
- [35] Herbert Franke, «Gibt es eine ästhetische Information?» in *Ästhetische Information. Eine Einführung in die kybernetische Ästhetik*, Helmar Frank/Herbert Franke (eds), Berlin/Paderborn, 1997, p. 106.

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