Cybernetic Drawing. A Unifying Language of Pask's Cybernetics and Computer Art in Germany

Liss C. Werner

Abstract

The essay provides an overview of relationships between the cybernetics with a special emphasis on the British cybernetician Gordon Andrew Speedie Pask and the computer art developed in Germany in the 1960s-70s with an introduction to the artists Frieder Nake and Georg Nees. In the 1960s, early computer artists, such as the Max Bense, Vera Molnar, Georg Nees, Frieder Nake and others, began to explore the relationships between art, design, science and the cybernetic principle of feedback. Their computer art investigated esthetics of computer languages for automated process of generative iterations away from the fixed states of predetermined formalism. In the meantime, in the UK, Gordon Pask developed Conversation Theory, *a formal model applied in his cybernetic 'machines'. The networks and conversation diagrams that described CT represented possibilities of interaction between actors resulting in emergent forms of behavior. Both, the early computer art and Pask's logic can are based on cybernetic foundations, as a unifying language. The fields' concerns have expanded significantly and partly merged since then. The discussion still lies in the dichotomy between the urge for control and authorship over form and method of creation, and the approach of understanding form and its aesthetics as result of an activated dynamic systemic pre-programmed set of rules rather than states —all under the wings of a unifying language, namely cybernetics.*

Keywords: Cybernetics, Gordon Pask, Frieder Nake, Georg Nees, Computer Art, Germany.

Cybernetics as Unifying Language for Interrelated Systems

In 1948 the American mathematician and philosopher Norbert Wiener coined the term Cybernetics. His first published book on cybernetics *'Cybernetics: Or Control and Communication in the Animal and the Machine'* [Wiener 1948] has had a great impact and is regarded as the theoretical foundation for cybernetics as a science that would bridge between the disciplines. At that time, Wiener may not have suspected that cybernetics would grow from a tool for steering linear systems into a generator for complex drawings and self-organizing multi-dimensional semantic-networks. Cybernetics as operation is concerned with the issues of *controlling, managing, steering* and *regulating*. All of those are slightly different in definition, execution and modes of communication and the process of informa-

tion transfer; and all of them exist in systems of all kinds. On the paper I continue the argument that cybernetics can provide a unifying language to help bridging different sciences; I suggest that today we are in the process of cybernetification. [Werner 2017, Werner 2018] Communication, or the process of information transfer, is relevant to all four facets of cybernetics. Cybernetics is based on feedback. Feedback is a reaction which to an extent, not necessarily exclusively, influences the future behavior of a system; may it be for its flourishing, formal change or its termination. It is an essential driver for a cybernetic system, may it be a social system made of human interaction, a cognitive-biological system made of neurons and muscles, a technical-sensoric system —such as a thermostat— or an

algorithmic system made of binary code and memory and artificial learning algorithms. In principle a cybernetic system is made of 'programmed' signs that enable interacting constructs; interacting constructs are isomorph to the form(s) that represent them, while the form may be a numerically described algorithm or a graphic visualization. In the widest sense any 2-, 3- or more-dimensional static or dynamic data-visualization. Depending on the observer of the data-visualization the cybernetic system can a) communicate an information, possibly it carries a semantic meaning and b) extend insofar that it includes the observer into the system –as an active part of it.

The birth of cybernetics as bridging science was triggered through the problem of specialization in the various fields of sciences, such as the hard sciences mathematics, statistics, biology, (neuro)physiology, electrical mechanics, chemistry, engineering and the soft sciences, such as sociology, anthropology or psychology in the 1940s followed suit by disciplines of design such as architecture (Christopher Alexander, Cedric Price), and urban design (Yona Friedman, Constantinos A. Doxiades, project Cybersyn) in the 1960s and 70s [Werner forthcoming]. The group around the mathematician Norbert Wiener, the engineer and inventor of the *Differential Analyzer* Vannevar Bush [Bush 1931], the physiologist Arturo Rosenblueth and the computer engineer Julian H. Bigelow, based as Massachusetts Institute of Technology, Harvard University and the Bell Laboratories, pushed cybernetics as unifying science [Stewart 2000] [Van Alstyne 2006]. Goal was to solve scientific problems that were related to a number of disciplines and only solvable through each discipline depicting the issue through the specific means and expertise, the method however, was envisaged to be similar; as Wiener recalls "Dr. Rosenblueth has always insisted that a proper exploration of these blank spaces on the map of science could only be made by a team of scientists, each a specialist in his own field but each possessing a thoroughly sound and trained acquaintance with the fields of his neighbors; all in the habit of working together, of knowing one another's intellectual customs, and of recognizing the significance of a colleague's new suggestion before it has taken on a full formal expression" [Wiener 1948, p. 3].

By the mid 1940s, the group had the opportunity to collaborate on projects, Wiener and Bigelow investigated "the theory of predictions and of the construction of apparatus to embody these theories" [Wiener 1948, p. 6]. Part of the equation was the knowledge about the human who would 'assist' a machine, e.g., a fire-control apparatus, to perform successfully. Wiener suggested, that the characteristics of this part of the system needed to be understood in order to translate into mathematics and subsequently to include it mathematically into the machines. In his book, Wiener brings up the relevance of feedback, as concluded together with Bigelow; he explains feedback as a motion, or reaction to an input. The difference of the reaction between the expected (simulated) and the actually performed one is the input that feeds back into the system. Communication and control became a focal point of the discussion. Wiener, Rosenblueth, Bush and Bigelow decided to "call the entire field of control and communication theory, whether in the machine or in the animal, by the name of *Cybernetics*, which we form from the Greek κὒβερνήτης or steersman". At this moment Wiener refers to the Clerk Maxwell's paper on *feedback* in 1868. Apart from the engineers and mathematicians mentioned above the US group of scientists in and around cybernetics as a bridging discipline on communication in the human and the machine included Aiken, von Neumann, Goldstein, McCulloch, Pitts, Weaver, Selfridges and Kurt Lewin. The anthropologists Margaret Mead and Gregory Bateson discussed and researched the side of communication within human organization and social systems –always in exchange with their colleagues from the 'hard sciences'.

On the other side if the globe, in the UK the psychiatrist Ross Ashby, the computer scientist Alan Turing and the neuro-physiologist and robotics pioneer Gray Walter [1] joined the innovative group followed by the economist Stafford Beer and the cybernetician Gordon Pask, the Austrian biologist Heinz von Foerster and others. The Macy meetings, later Macy conferences held between 1956 and 1953, funded by Josiah Macy, Jr., provided the first official frame for discussions between scientists of different fields to thrive the interdisciplinary community and to foster a unifying language for all fields [Pias 2016]. Gray Walter's tortoise is of special interest to the idea if cybernetics as unifying language, since the robots to which Walter referred to as *Machina Speculatrix* exhibited an unforeseen form of behavior based on a) a pre-programmed system and b) a combination of sensors, amplifiers, and a motion apparatus [Walter 1950].

Also, in Germany the term *Kybernetik* had been discussed and tested to a similarly large extend since the 1950s. The German physician Hermann Schmidt [2] (1894-1968) was professor for cybernetics at Technical University Ber-

lin and is considered the German father of cybernetics and specialized in "Allgemeine Regelungskunde" (science general control and regulation) focusing on technical and living systems. He also discusses cybernetics as bridging sciences [Schmidt 1941]. Herman Schmidt is regarded as the German father of cybernetics [Fasol 2002]. Schmidt, like Helmar Frank, applied mathematics to psychology and pedagogy. While Schmidt researched the effect and changing nature of the human through technology, Frank focused his on the act of learning, cybernetic pedagogy and the development of *Lernmaschinen* [3] (learning automata). While the book *Kybernetik – Brücke der Wissenschaften* (Cybernetics – Bridge between Scientific Disciplines) edited by Helmar Frank, first published in 1962 [Frank 1966], offered a foundation for the discussion about cybernetics as unifying language and science, wrote Felix von Cube *Was ist Kybernetik* (What is Cybernetics) [Cube 1967]. The latter introduces basic principles, such as the steersman, feedback and the relationship of different disciplines. One focal point in his book is the term Information (Informationsbegriff) across research fields. He states "Der Begriff der Information (im kybernetischen Sinne) läßt sich auch in den Geisteswissenschaften und […] in den Sozialwissenschaften mit Erfolg anwenden. Freilich ist stets zu bedenken, daß der kybernetische Begriff der Information nichts mit Inhalt oder Bedeutung zu tun hat. Will man im Rahmen irgendeines Wirklichkeitsbereiches inhaltliche Aussagen machen, muß man erst eine Zuordnung des betreffenden Inhalts zu den Strukturbegriffen und Strukturgesetzen herstellen" [4] [Cube 1967, p. 33]. Cube includes chapters by the German mathematician, philosopher and author, professor for philosophy and Max Bense, Professor of History and Science and Georg Nees on *Generative Aesthetics*.

The German philosopher and author Max Bense founded the Stuttgart group (Stuttgarter Schule / Stuttgarter Gruppe) at the end of the 1950s, which implemented his ideas of information-theoretical aesthetics. Computer-generated art forms such as graphics, literature, and semiotics found their place around Bense. In 1965, Bense arranged the first exhibition for computer art showing works of the artists Georg Nees and Frieder Nake in Stuttgart. Max Bense manifested cybernetics in a third field titled *Esthetics of Information* (*Informationsästhetik*), esthetics of the digital (Ästhetik des Digitalen), algorithmic esthetics (algorithmische Ästhetik) or cybernetic esthetics (Kybernetische Ästhetik) [Bense 1965]. In 1968, Bense, Nake, Nees and other computer artists of the Stuttgart group, along with Gordon

Pask and other international computer artists, showed part of their work in the exhibition *Cybernetic Serendipity* in London curated by Jasia Reichardt [Reichardt 1969]. Bense, who had exhibited at the exhibition Cybernetic Serendipity founded the Stuttgart Group end of the 1950s with which Frieder Nake and Georg Nees where affiliated. Bense's work and research focused on aesthetics and semiotics.

The Unifying Language of Gordon Pask

Gordon Andrew Speedy Pask (1928-1996) was a British Cybernetician, who in rhe beginning of the 1950s began designing a theory for conversation, which could unify disciplines of science, principiples of interaction between humans, humans and machine and machines, theories of architecture and methods of teaching and learning. From the 1950s onwards Gordon Pask developed cybernetic teaching and entertaining machines as well as interacting spaces such as *Musicolour* in 1953, or the *Colloquy of Mobiles*, exhibited at the exhibition *Cybernetic Serendipity* in 1968. One of his most known interactive architectural spaces is the *Fun* Palace, designed by the British architect Cedric Price.

Pask delved into understanding cybernetics as a general system to approach, observe, understand and analyze. His cybernetics operate on a multitude of levels, phenomenal domains and are subject to observations from all disciplines. The machines acted as physical proofs of concept for his *Conversation Theory*, which he published in of two books in 1975 and 1976. In the beginning of the 1990s the theory was complemented by his *Interactions of Actors (IA). Theory and Some Applications* [Pask, de Zeeuw, Nov 1992]. Conversation Theory entails agents and their ways of communication in a conversation, which essentially is an exchange of information in a system equipped with cognition ability. Each agent is subject to his or her previous knowledge and repertoire of signs to communicate with. CT had the "cybernetic aim of unifying theories and concepts across disciplines. Thus, for Pask, anything that can be sensibly said about 'conversation' is part of CT. As a cybernetic theory, CT is the theory of conversations." [Scott 1987, Pask 1978] Conversation theory also entails what is currently applied in experimental digital and medial architectural representation and production, specifically in the generation of computer-based or algorithm-driven design

(architecture). Based on similar principles, it emerged as a foundation before what we know in digital architecture as genetic or evolutionary algorithms. This describes an interactive algorithm that conquered digital tools, motherboards and parallel processors; with the possibility to apply parameters and disturbances in dynamic environments (ecologies, systems); these environments (ecologies, systems) experience smaller or more far-reaching radical changes that can lead to the mutation of the ecosystem or its elements.

A review by Bernard Scott engages with Pask as a theoretical cybernetician, curious and witty [Scott 1982]. He suggests that Pasks passion and life-long commitment to cybernetics as field of research began at the 1959 conference on 'The Mechanisation of Thought Processes' where the thirty-one year old inventor, biologist and physicist met the piomeers of cybernetics including Warren McCulloch, Stafford Beer, Marvin Minsky, Ross Ashby. As Pask's *An Approach to Cybernetics* shows, those early cyberneticians highly influenced the young man [Pask 1961b]. His paper *Physical Analogues to the Growth of a Concept*, mentioned by Scott, presents the advent a conversation of Pask cybernetics, design strategies and their connection to form advents. Pask discusses "the circumstances in which we can say a machine 'thinks', and a mechanical process can correspond to concept formation" [Pask 1958]. Another influential event may have been the interdisciplinary *conference on Self-organizing Systems* on May 5th and 6th at the Illinois Institute of Technology with Heinz von Foerster, Marvin Minsky, Rosenblatt, Warren McCulloch and others. Pask presented a hypothesis on *The natural History of Networks*, a paper in which Pask introduces the 'Network Space' as four-dimensional open reaction system [Pask 1959]. He applies a similar way of thinking as he does for the 'Phase Space' in *An Approach to Cybernetics* (fig. 1).

Even though we may be able to categorize Pask's cybernetics in the fields of conversation, learning, architecture and computer technology there is little chance to pinpoint and reduce Pasks cybernetics to a particular model. However, Stafford Beer's *Viable System Model (VSM)* and Ross Ashby's *Law of Requisite Variety* influenced Pask's model of *Conversation Theory*. For Pask "cybernetics is no more restricted to the control of observable assemblies and the abstract system that correspond with them, than geometry is restricted to describing figures in the Euclidean space which models our environment" [Pask 1961a]. In the 1974 BBC documentary featuring Gordon Pask, he states on the
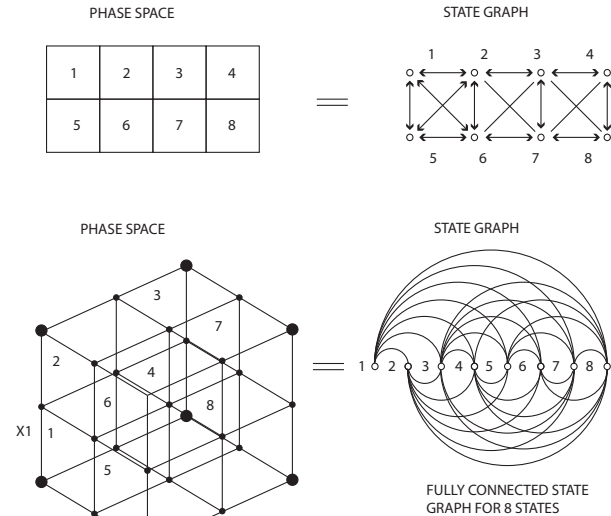

Fig. 1. Diagram of 'Phase Space' and 'State Graph' in two and three dimensions [Pask 1961a] (graphic elaboration by the author).

interest of cyberneticians that "We are not much interested in what the conversation is about, we are interested in how it takes place. And the hypothesis we test are about how people understand or learn or what can we understand about processes of conversations" [Davies 1974]. Rather than engaging in content as research subject, Pask emphasized on the system of information transfer. Principles of encoding, decoding, understanding and information carrier were the basis of Pask's work. We can see parallels to Felix von Cube's observation mentioned earlier. In 1976 Gordon Pask defines and describes in which man-made organizations or disciplines a cybernetic method can be applied in future. In the so-called 'Belgian Paper' *Future Prospects of Cybernetics* Pask states: "Cybernetics is the science of control, communication and organization. As such, it is primarily concerned with synthesizing goal directed (purposive) systems or analyzing the behavior of internal functioning of those that already exist. These systems may be of various sorts. For example, there are mechanical or electronic regulators for plant control, factory control (automation), vehicle control and the like; […] The mind and the brain of man is a goal directed system in the province

of psychological cybernetics (sometimes known as cognitive studies) and it is possible to imitate certain mental faculties by machine or computer programs ('heuristic programming' and 'artificial intelligence'" [Pask ca. 1976]. Main characteristic, for Pask, is that the system is required to be goal-directed. Pask differentiates between cybernetics and operational research. He emphasizes on a man-system interaction that implies from man-machine interaction, learning and decision-making processes through computer assistance (man-machine-interaction). In the paper Pask defines cybernetics as a science, a method, and approach, a characteristic for a system (cybernetic system) and a theory. He stresses the necessity to research cybernetics in light of human's involvement in a system. He describes cybernetics as a method and a theory in his thoughts as plea to the future: "Although the mathematical theory of engineering Cybernetics is more sophisticated that that of the other branches it is interesting to observe that the theory is underutikised by industry and commerce. […] The fact is that in view of the nature of man, society and the economic system automation (computerisation, mechanisation etc.,) is frequently undesirable. In one sense this is disappointing to the professional, in another, it suggests that as a general rule insufficient attention has been given in the past to man machine relationships, cognition and the character of the social organisations in which all Cybernetic systems are ultimately employed. Hence I am inclined to the view that the most exciting and fruitful directions of Research are those that involve human beings as part of the system" [Pask ca. 1976]. Gordon Pask finally suggests that the cybernetic approach is "conversational rather than authoritarian" or mathematics based "automation like systems" [Pask ca. 1976].

Algorithmic Art, Computer Art, Information Esthetics

Algorithmic esthetics, generative esthetics, digital esthetics or information esthetics refer to the esthetics, the perceived formal outcome, of computer programs. Rule-based art as such irritated and simultaneously stipulated the discipline of art in the 1960s and 70s. German philosopher-physicist Max Bense, the French-Hungarian media artist Vera Molnar, the German mathematicians Georg Nees, Michael Noll, Frieder Nake and others, began to explore the relationships between art, design, science and the cybernetic principle of feedback. Their work was a part of a digital
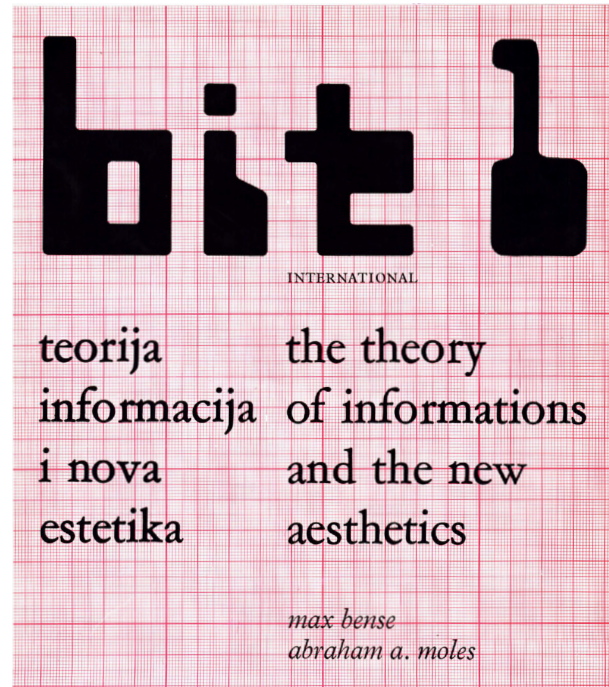
Fig. 2 Cover of the first issue of Bit International Magazine. <https://monoskop. org/File:Bit_International_1_The_Theory_of_Informations_and_the_New_ Aesthetics_1968.jpg> (accessed 2018, October 24).

media revolution celebrated with an exhibition titled *Algorithmische Revolution – zur Geschichte der interaktiven Kunst* (Algorithmic Revolution – on the history of interactive art) curated by Peter Weibel und Dominika Szope Katrin Kaschadt and Margit Rosen between 2004 and 2008 at the ZKM, *Zentrum für Kunst und Medien* in Karlsruhe, Germany. The work triggered the idea to rationalize, represent and describe design formally abstract – rather than figurative. It was an experiment, a movement and a trigger to create art (drawings) through rules. A scientific approach, where by the artist would design the system, the computer program, and not a final product. One of the birthplaces for computer art in Germany was the literature department of Max Bense - who had studied physics, chemistry, mathematics, geology and philosophy. The so-called *Stuttgarter Schule / Stuttgarter Gruppe* [Döhl 2012] researched on

*Sl. 12. Na svakom nivou komunikacije
između odašiljača i primaoca, koja se odvija
po bilo kakvom kanalu, moguće je uvijek
razlikovati dva aspekta poruke. Poruka ima
s jedne strane semantički aspekt koji odgovara
stanovitom repertoaru standardiziranih i
univerzalnih znakova, a s druge strane
postoji estetski aspekt (MOLES) ili
ektosemantički (MEYER, EPPLER) koji je
izraz varijacija što ih signal može podnijeti
a da ne izgubi svoju specifičnost u granicama
jedne norme. Te varijacije predstavljaju
polje slobode koje svaki odašiljalac
iskorišćuje manje-više originalno. Poruka
koja stiže do primaoca može se dakle
smatrati sumom informacija semantičkih H_s
i estetskih H_e.*

*Fig. 12. A chaque niveau de communication
entre l'emetteur et le récepteur par un canal
quelconque, il est toujours possible de
distinguer deux aspects dans le message.
D'un côté l'aspect sémantique, correspondant
universels, de l'autre, l'aspect esthétique
(MOLES) ou ectosémantique (MEYER
EPPLER) qui est l'expression des variations
que le signal peut subir sans perdre sa
spécifité autour d'une norme; ces variations
constituent un champ de liberté que chaque
émetteur exploite de façon plus ou moins
originale. Le message qui parvient au
récepteur peut donc être considéré comme la
somme des informations proprement
sémantique H_s et estétique H_e.*

Semantički i estetski modus shvaćanja poruke.
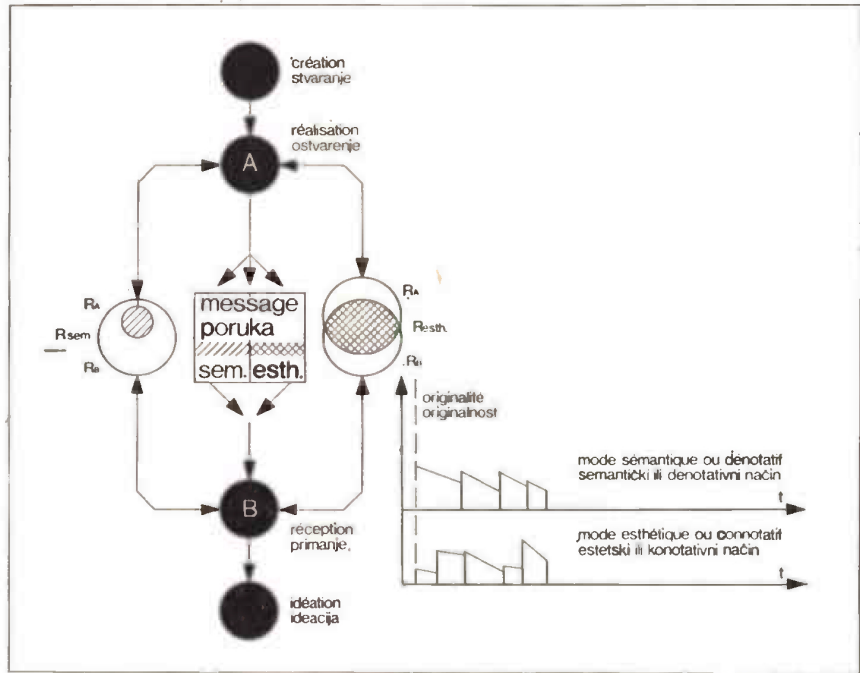Modes sémantique et ésthétique d'apréhension de message.

Fig. 3 Diagram 'semantic and esthetic modes of message apprehension', by Abraham A. Moles. Source: Bit International, Issue 1, Zagrab, 1968, p. 39.

computer poetry, whereby the semantics and semiotics of words would have been transformed into visuals. Bense initiated the first exhibition of *artistic computer graphics* in Germany in 1965 (the exhibition *Cybernetic Serendipity* curated by Jasia Reichardt took place in 1968), where he showed works by Georg Nees, and later works by Frieder Nake. Georg Nees, who had worked for the Siemens AG, was mathematician who later received his doctoral degree in philosophy from Max Bense.

In 1968, Max Bense and Abraham Moles contributed largely to the journal *bit international – the theory of informations and new aesthetics*, published in Zagreb –former Yugoslavia– with texts published in English, Croation, French and German (fig. 2). It discussed the subject of information and esthetics through philosophical ideas, generative drawings and newly developed theories compiling and juxtaposing semantics and aesthetics through e.g. phenomenology, experience or reception. The core of all texts is a cybernetic principle of information transfer. Abraham A. Moles' diagram (fig. 3) is titled 'semantic and esthetic modes of message apprehension'. It shows the process from creation to realization and its translation to reception and ideation through the attribute 'message'. He describes (originally in French) "At every level of communication between the departure and the recipient, which takes place through any kind of channel, it is always possible to distinguish two aspects of the message. On one side the semantic aspect of a certain repertoire of standardized universal characters, and on the other hand there is an aesthetic aspect (MOLES) or ectosemantics (MEYER, EPPLER) which it is
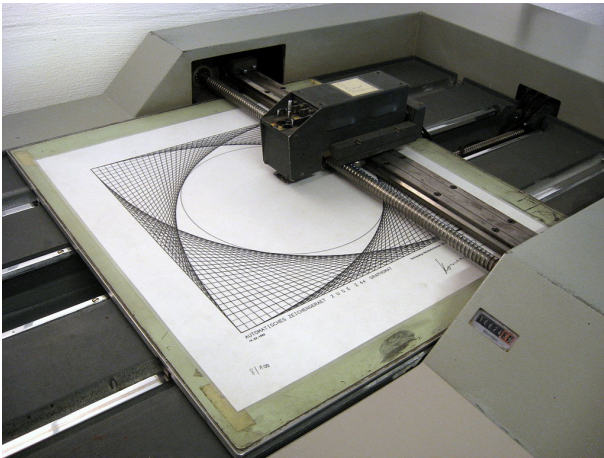
Fig. 4. Automatisches Zeichengerät ZUSE Z64, flatbed drawing machine Graphomat Z64, photograph by Tomasz Sienicky:<https://commons.wikimedia.org/wiki/File:Automatisches_Zeichengeraet_ZUSE_Z64_ubt.JPG> (accessed 2018, September 24).

Fig. 5. 23-ecke, by Georg Nees, ink on paper (29,7 x 21 cm). Originally published in the journal rot issue 19, Stuttgart 1965 [Nake 2009].

the term variation of the lto signal. It is used by the signal without losing its specificity within the boundaries of a norm. These variations represent a field of freedom that every dispatcher uses. Message received by the recipient are therefore to be considered a sum of information of the semantics Hs and aesthetic He'' [Moles 1968, p. 39]. Max Bense's text 'ästhetik und programmeriung' theorized modern esthetics. He states that modern esthetics defined the artistic object as carrier of an 'esthetic state'; and that this esthetic state is –in comparison to the actual material object– rather weak. Bense differentiates between *numeric esthetic*, s*emiotic esthetic*, s*ematic esthetic* and *generative esthetic*, whereby the first describes the material esthetic of the artistic object the second and third describe the ontological aspect and the fourth relates to the computation of the artistic object. This includes a de-construction (Zerlegung) of the processes used to produce the art. In the case of generative art generative esthetics derives from the algorithm used [Bense 1968, pp. 83-86].
Georg Nees, Frieder Nake and Michael Noll, became the 3Ns, ''pioneers of computer art [Klütsch 2007]. Nees experimented with the computer language ALGOL (Algorithmic language) on a *Zuse Graphomat Z64*. The Z64 was a combination of a computer and a drafting machine (fig.

4). The programs (sets of consecutive commands) were given to the drafting apparatus in form of punch cards. The programs would repeat constantly executing the same set of rules. Stochastic control created a random scattering of the output data, so-called *esthetic innovations*. In context with his description of his artworks –his impossible esthetic states– *8-ecke* and *23-ecke* [5] (fig. 5) Nees describes: ''jede grafik besitzt zufällige parameter. das program zur einzelnen grafik wiederholt operierende grundoperation so, daß die bloßen wiederholungen die ästhetische redundanz, die zufälligen parameterwerte bei jeder wiederholung die ästhetische unwahrscheinlichkeit der grafik erzeugen''

[6]. According to Georg Nees, the random factor would repeat after 2^{30} repetitions. Cube describes the realized computer program for the information aesthetic *'Gardinen'* as a set of instructions: in the frame of a rectangle draw 60 lines parallel to the shorter edges of the rectangle in a way that the distances between the parallels decreases randomly towards the outer edges (fig. 6). Drawings by A. Michael Noll (Gaussian-Quadratic, 1965), Georg Nees and Frieder Nake (Nr. 5 'Verteilung elementarer Zeichen', 13. Sep. 1965) [7] were exhibited at the *Cybernetic Serendipity* exhibition in 1968. In the very same exhibition Gordon Pask's showed his interactive kinetic spatial sculpture *Colloquy of Mobiles*.

He states "Man bemerkt, daß die maschinelle Erzeugung *der Unwahrscheinlichkeit ästhetischer Zustände* durch eine methodische Kombination von Plan und Zufall ermöglicht wird" (One notices that the machinic creation if the impossibility of esthetic states is enabled through a methodical (systemic) combination of plan and coincidence) [Cube 1967, pp. 27]. In 2012, Nake describes the momentum critically "Information Aesthetics was a short-lived but influential attempt to establish an aesthetic theory of mathematical rigor without subjective elements. It was based on information theory, semiotics, and communication theory. It was mainly developed in Germany and France during the 1960s. It not only" gained some influence among designers and artists, but also among teachers of art. Its concepts turned out to be reductionist and schematic, which we argue led to its eventual disappearance, if not failure" [Nake 2012]. In the 1960s, however, the momentum was similarly to the momentum of cybernetics at the first peak of its existence.

Conclusion

Both, Gordon Pask's cybernetics and the early German computer art, describe a cybernetic approach to interrelated systems, their algorithmic causation and aesthetic appearance. The biggest difference can be regarded the approach to what happens with the information after it arrived at its destination. Nake refers to the Shannon/Weaver model, *The Mathematical Model of Communication*, conceived in 1948, which allows for input, process and output. The debate around the questions of aesthetics and art rose, that question discussed an ultimate truth or existence of an objective aesthetics vs a subjective aesthetics [Nake 2012]; or in cybernetic understanding by the observer.

Claude E. Shannon's model does not include feedback for a next iteration. The model is restricted to itself as a closed system. It can be observed, analyzed and evaluated from an external observer, but does not encounter for including the observer into the process of operation, into the equation. The cybernetic model used by Gordon Pask made use of the observer. It included the observer as active part of the system, who could learn and teach the system. Pask referred to conversations; the output of a conversation would act as input for a next iteration of the conversa-

Fig. 6. *Gardinen, by Georg Nees, 1968, created on a Graphomat Z64 [Cube 1967, p. 276].*
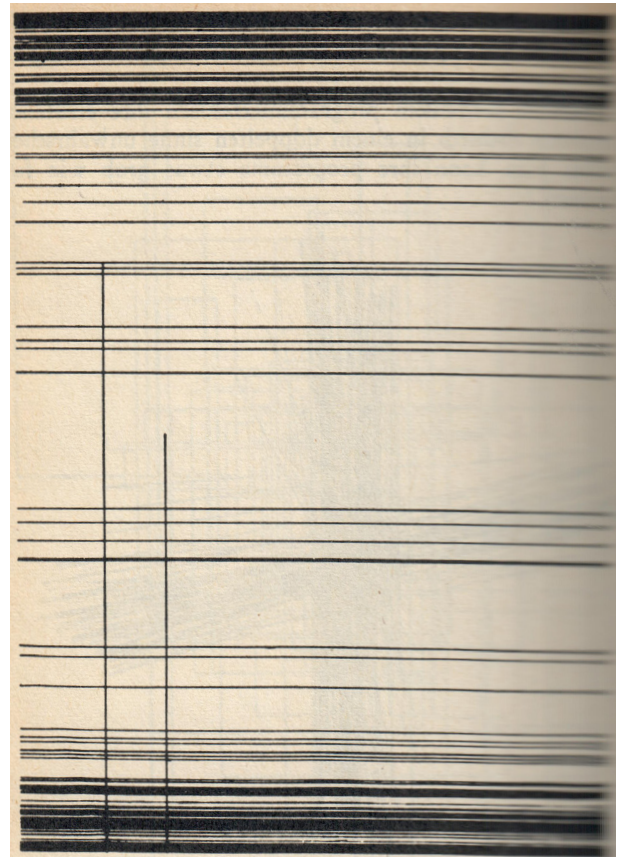
tion. Thus, the process of conversation would be driven by itself, and continuously create new forms. Strictly speaking, the model referred to for computer art in the 1960s is a model of 1st order cybernetics, the model referred to for the work of Gordon Pask is a model of 2nd order cybernetics; Pask included the human. If we extend the system to create computer art, generative aesthetic, information aesthetics to the designer of the computer program, such as Georg Nees, who experimented with circles, amount of lines and the parameters to arrive at an emergent artistic expression, if we include the designer, the programmer artist into the equation, then, I suggest, computer art in the 1960s followed by a model of 2nd order cybernetics.

We observe a two-level construct, with the first level being reduced to simply executing an algorithm through e.g., a flatbed drawing machine, and the second level with the observer who, as part of the construct, processes the produced drawing as input for further decision-making and action, as input for tweaking the algorithm. I would like to conclude with the suggestion that systemic principles applied to the act of creating information aesthetics in the 1960s and the systemic principles of creating interacting robots, teaching and learning machines are based on cybernetics as unifying language –not only because of their common affordance to interdisciplinary creation, but to their common principles of information process, their focus on information handling, rather than evaluation of content or meaning. I would further like to refer to Cube's thought that the combination, the almost coincidental collision of planned and spontaneous non-planned events is a pre-requisite of *the impossibility of esthetic states* or, if we look through the lens of cybernetics of the pre-requisite of a constant emerging and growing of new states, new situations, new constructed realities based on epistemological ground. Cube emphases on the operation of the *systemic combination* which affords a steersman.

Notes

[1] Gray Walter (1919-1977) invented the 'Anticipating Tortoise', one of the first automated small moving robots, that could recognize objects and avoid them while transiting.

[2] Hermann Schmidt's scientific works are currently kept safe in the university archive of Technical University Berlin. We are in the process of viewing the works for further research on cybernetics.

[3] Helmar Gunter Frank (1933-2013) was influential in the development of learning automata based on a cybernetic theory of psychology and pedagogy. He pursued his PhD at University of Stuttgart in Informational Esthetics. He was appointed professor for informational sciences (later cybernetics) at the Pedagogical University Berlin.

[4] "The notion of information (in the cybernetic sense) can also be used successfully in the humanities and social sciences. Of course, it must always be remembered that the cybernetic concept of information has nothing to do with content or meaning. If one wants to make substantive statements in the context of any realm of reality, one must first establish an association of the relevant content with the structural concepts and structural laws."

[5] The titles *8-ecke* and *23-ecke* refers to the initial graphics with either 8 edges or 23 edges executed by the Z64.

[6] Translation by the author: Every graphic has random parameters. the program to the individual graphic repeats basic operation so that the mere repetitions produce the esthetic redundancy, the random parameter values with each repetition the aesthetic improbability of the graphic.

[7] See *Bit* issue 1, page 95. <https://monoskop.org/images/b/bf/Bit_International_1_The_Theory_of_Informations_and_the_New_Aesthetics_1968.pdf> (accessed 2018, September 24).

Author

Liss C. Werner, Institute of Architecture, Technical University Berlin, liss.c.werner@tu-berlin.de

Reference List

Bense, M. (1965). *Aesthetica Einführung in die neue Aesthetik*. Baden-Baden: Agis Verlag.

Bush, V. (1931). The Differential Analyzer, A New Machine For Solving Differential Equations. In *Journal Franklin Institute*, 212, 4, pp. 447-488.

Cube, F. v. (1967). *Was ist Kybernetik? Grundbegriffe, Methoden, Anwendungen*. Bremen: Verlag Schünemann.

Davies, B. (1974). *The Experimentors - Gordon Pask 1974*. London: BBC.

Döhl, R. (2012). *Der Kreis um Max Bense. Als Stuttgart Schule machte.*

Fasol, K. H. (2002). Hermann Schmidt: pioneer in control and cybernetics. In *IEEE Control Systems*, 22 2, pp. 24-28.

Frank, H. (1966). *Kybernetik Brücke zwischen den Wissenschaften; 29 Beiträge namhafter Wissenschaftler und Ingenieure*. Frankfurt/Main: Umschau Verl.

Klütsch, C. (2007). *Computergrafik: ästhetische Experimente zwischen zwei Kulturen; die Anfänge der Computerkunst in den 1960er Jahren.* Cham: Springer.

Nake, F. (2009). The semiotic engine: notes on the history of algorithmic images in Europe. In *Art Journal*, 68, 1.

Nake, F. (2012). Information aesthetics: An heroic experiment. In *Journal of Mathematics and the Arts*, 6, 2-3, pp. 65-75.

Pask, G. (1958). *Physical Analogues to the Growth of a Concept.* Paper presented at the Mechanization of Though Process Conference, Symposium held at the National Physical Laboratory.

Pask, G. (1959). *The Natural History of Networks.* Paper presented at the Self-Organizing Systems: Interdisciplinary Conference.

Pask, G. (1961a). *An Approach to Cybernetics* (3 ed.). London: Hutchinson & Co Ltd.

Pask, G. (1961b). *An approach to cybernetics.* London: Hutchinson.

Pask, G. (1978). A conversation theoretic approach to social systems. In *Sociocybernetics*, pp. 15-26. Cham: Springer.

Pask, G. (ca. 1976). *Future Prospects of Cybernetics.* Paper with handwritten notes, Gordon Pask Archive, Vienna.

Pask, G., de Zeeuw, G., Nov, L.E. (1992). Interactions of actors, theory and some applications. In *OOC/CICT/Universiteit Amsterdam*, 1.

Pias, C. (2016). *Cybernetics: the Macy-Conferences 1946-1953.* Zürich u.a.: Diaphanes.

Reichardt, J. (1969). *Cybernetic serendipity: the computer and the arts.* New York-Washinghton: Frederick A. Praeger.

Schmidt, H. (1941). Regelungstechnik. Die technische Aufgabe und ihre wirtschaftliche, sozialpolitische und kulturpolitische Auswirkung. In *Zeitschrift des VDI*, 85, 4, S. 81-S. 88.

Scott, B. (1982). The Cybernetics of Gordon Pask, part 1. In *International Cybernetics Newsletter*, 17, 21.

Scott, B. (1987). Human systems, communication and educational psychology. In *Educational Psychology in Practice*, 3, 2, pp. 4-15.

Stewart, D. (2000). An essay on the origins of cybernetics. In *Retrieved February*, 22, 2008.

Van Alstyne, G. (2006). *Biomedia: Past, Present and Future.* <https://www.academia.edu/4470739/Biomedia_Past_Present_and_Future> (accessed 2018, October 25).

Walter, W.G. (1950). An imitation of life. In *Scientific American*, 182, 5, pp. 42-45.

Werner, L.C. (2017). Cybernetification I: Cybernetics Feedback Netgraft in Architecture. *10.14279/depositonce-6121*, 1, 16. doi:10.14279/depositonce-6435.

Werner, L.C. (2018). Cybernetification II: toward a sixth ecology. In A. Graafland, D. Perera (eds.). *Architecture and the Machinic: Experimental Encounters of Man with Architecture, Computation and Robotics*, pp. 58-71. Dessau: Anhalt University Dessau.

Werner, L.C. (forthcoming). The Origins of Design Cybernetics. In C.M.H.T. Fischer (ed.), *Design Cybernetics: Navigating the New.* Cham: Springer.

Wiener, N. (1948). *Cybernetics: or the Control and Communication in the Animal and the Machine.* Paris: Herman & Cie.