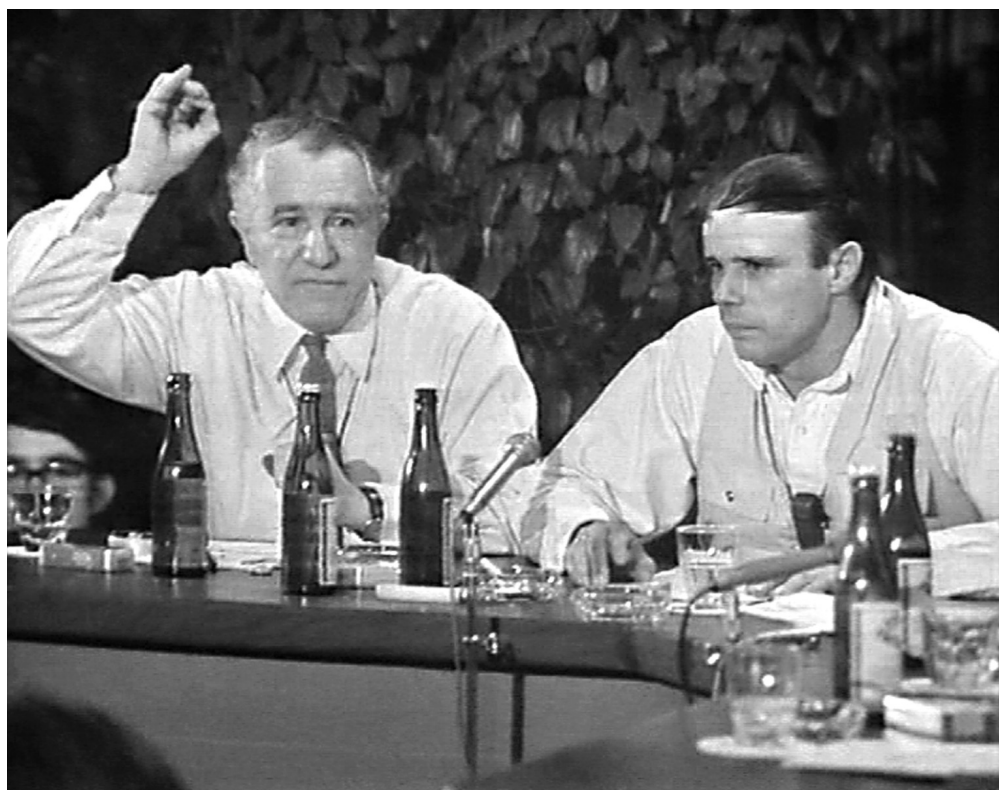


Max Bense and Joseph Beuys in discussion, Düsseldorf, 1970.



# “Hollerith ‘Feathered Crystal’”: Art, Science, and Computing in the Era of Cybernetics

CLAUS PIAS

TRANSLATED BY PETER KRAPP

*But a theory of how the intellectual is expected to exist in this world that is perfected for the worker—we do not have such a theory.*

—Max Bense<sup>1</sup>

*I believe computer screens can make people happier.*

—Ted Nelson<sup>2</sup>

I

“Hollerith ‘feathered crystal’”—this elliptical and monumental entry appears in the middle of Max Bense’s *Programming the Beautiful*. “Everything else,” he continues with lapidary brevity, “has been said.”<sup>3</sup> Full stop, paragraph. At issue: what an aesthetic text can be in the year 1960, and why it is what it is. His answer: “Methodic poetry . . . : language recurring to logic and statistics, compressed texts, left to a constraint or an accident, entrusted with the generative process, discrediting emotional and desirous projects. . . . That is the only way to approach a new being.”<sup>4</sup>

This new being, an anthropology on the horizon of cybernetics and digital calculation was figured as the big challenge to the modern arts and sciences. This essay discusses a path for European media theory that Bense eventually chose not to take. As a result of Bense’s decision, information aesthetics, a program for art with the capability to subvert the classical distinctions of the “two cultures” of hard science and the humanities, never took hold in the universities, thus falling to the same fate as the cybernetics from which it is derived. Cybernetics is less a discipline than an epistemology; it becomes activated within disciplines. Terms such as *information*, *feedback*, and *cyborg* caused very different disciplines to reformulate their knowledge and to revisit their fundamental concepts. Economics (Tustin), anthropology (Bateson/Mead), ecology (Hutchinson), and many other fields came to a productive revision of their foundations under the sign of a cybernetic epistemology. Interdisciplinarity happened only by way

of a shared set of models, thought experiments, and questions that had to prove themselves in each disciplinary context first. No academic field could be founded on this commonality, and this problem now haunts media studies just at the time of its triumphal institutional success.

If information aesthetics is understood as a prefiguration of media studies, it is clearly distinguished from two other, more easily institutionalized ways to reflect on media in academia. One is the field of communications as it developed out of economics during the First World War, first as “newspaper studies” and publishing and cemented after the Second World War as an empirical social science. The field of communications succeeded in Germany by shifting blame, during de-Nazification, onto “the media.” The argument that media manipulate the people into immaturity was a quintessential move in a strategy of dealing with the past, and its consequences are still evident today. Inversely, ascribing such a massive role to the media made “publicity consulting” a lucrative branch of industry and politics. Thus, by the early 1950s communications as a field had secured a methodological and professional terrain in academia and beyond.

The other type of reflection about media is the much younger field of cinema and television studies, established in German universities around 1968 as a direct result of a crisis in the German humanities. Combinations of aesthetics, technology, and ideological critique (*Ideologiekritik*) with media practice uncovered the political in everyday life and popular culture and elevated them to objects of serious academic study. Its methods, however, are explicitly not those of the social sciences but are instead mostly hermeneutic or philological. Thus one may say of film studies and television or broadcast studies that in time they established their own canon of objects and methods in order to become a classical discipline, even if on the margins of academia.

By comparison, the study of information aesthetics remained undefined and heterogeneous. Its knowledge was disseminated between philology and mathematics, between philosophy and electric engineering. And its methods served more the revision of foundational concepts such as mind, subject, author, work, intention, and so forth which allow the sciences not to think, as Heidegger charged. A closer look at the strategy of information aesthetics is worthwhile insofar as it reveals how much this state of denial of conventions has characterized German media studies since the 1980s.

## II

As with many phenomena, information aesthetics becomes recognizable only toward the end of its development. The prelude—and end game—for the discussion following in this essay takes place in 1970 in the auditorium

of the Werner-von-Siemens-Schule in Düsseldorf. There in 1970, the founding year of media studies in German academia, Max Bense met Joseph Beuys, two “types who won’t understand each other.”<sup>5</sup> An accounting of their relative speaking times illustrates why the televisual recording of the heated discussion is distributed under the label *Joseph Beuys Medien-Archiv*.<sup>6</sup> In this discussion we witness a paradigm shift in German postwar intellectual programs, with Bense on the losing side. After mere minutes Bense can no longer bear having to listen to Beuys:

*Bense:* My opinion is that when we talk of provocation it is a matter of the artist creating something, doing something which achieves what we commonly call the work, and which causes a shift in consciousness in society, to use the term used by Mr. Beuys. If this is in fact what is meant, that a work of art generates or causes a changed consciousness, then I would like to know what changes of consciousness the so-called works of Mr. Beuys have brought about. [Applause]

*Beuys:* I don’t care what kinds of change in consciousness my works have provoked . . .

*Bense:* So you cannot be more precise?!

*Beuys:* Please don’t interrupt me . . .

*Bense:* Well, sometimes an interruption is very good, for instance that which forces the opponent to be more precise. You have to say, what do you want to change when you provoke?

*Beuys:* Oh, so you are my opponent, that slipped out nicely.

*Bense:* For this event!—

[Beuys laughs, slaps the table]

*Bense:* Yes, did you think you had none? I have some as well!

*Heckling from the audience:* Helau!

*Bense:* Salut! Salut!

*Beuys:* Well, of course I can . . . I cannot ask continuously how my works, as Mr. Bense says, or my labor already achieved an extension of consciousness. I can only state that I tried as hard as possible to put something in my work that would cause a movement that changes consciousness. So I cannot claim that I speculate at length about how much my works are worth, but I continue to pursue mentally how I can produce what I want to work out. So it is possible . . .

*Bense:* What do you want? What do you want? What do you want? [. . .]

[*Wieland*] *Schmied* [*moderator*]: Max Bense!

*Bense:* [. . .] If you want to enlarge or change consciousness, you should know in which direction! Otherwise this is all pure nonsense!

[Laughter]

*Beuys*: Right. That's why I said, I am ready to talk about it until the dawn.

*Bense*: No, this should be decided now!

*Beuys*: Aha, in one sentence. [Laughter]

*Bense*: At once. This must come out. If you have something to say about the change in consciousness, you must be able to say in what direction that would be.

*Voice from the audience*: Right!

*Beuys*: Okay. And I can only say there is no other way except pedagogically, right, by leading people to concepts of humanity.

*Bense*: [excitedly] What is a concept of humanity?

*Beuys*: One is for instance that I consider the entire anatomy of the human being: outer anatomy and inner anatomy. If I ask: What is the pole of freedom, what is the pole of the will, what in human beings is the so-called feeling, what does it feel? What is the so-called unconscious psychologists talk about? These are the questions we are facing. And in this way, questions of my type . . .

*Bense*: But those are already behind us!

*Beuys*: I see! Yes. And what are your results?

*Bense*: Well, you can look it up in the respective works of the important people who wrote about them. [Audience murmuring]

*Beuys*: So can you suggest . . .

*Bense*: Please, there is psychoanalysis, and since the year 1900 at least! And there is . . . Do you think that is all wrong?

*Beuys*: Yes, but psychoanalysis is precisely something I want to see from a critical point of view.

*Bense*: Yes, me too.

*Beuys*: Yeah, now you too?

*Bense*: Yes, yes!

*Beuys*: You just said, . . .

*Bense*: No!

*Beuys*: You would prefer to look it up.

*Bense*: No, *you* should look it up, because you said you are not oriented.

*Beuys*: I looked up a lot. [Pause]

*Schmied*: One moment. Tonight we do not want to look things up, tonight we want to discuss things. [Applause]

The transcript gives only a weak impression of the heated discussion. Sentences from these black-and-white times, when modernity was still

modern and smokers appeared animated and vulnerable on television, come to us like ghosts. Art was something important, and engaged discussion demanded sweat and effort.

The confrontation between Bense and Beuys was predictable. Beuys's alchemistic, anthroposophical thinking in analogies was completely incompatible with Bense's neo-Cartesianism with an existentialist tinge. The science-dilettantism of the former could not stand up to the intellectual heritage in philosophy and physics of the latter. Romantic philosophy of nature does not go well with quantum physics, and fuzzy "social sculpture" is hardly compatible with the struggle for a "radical object-aesthetics" such as expressed by Frieder Nake. As Bense's assistant and wife Elisabeth Walther remembers, "everything represented, everything made has to come from a mass of existing structures. That is why Bense attacked Beuys like this; Beuys who thought that anything you throw down is already aesthetic. Well, no; he said it had to be made conscious: but first it had to be made."<sup>7</sup>

Above all, Beuys's "human science" enraged Bense, because his own science of a "future cybernetic art" was a posthuman one.<sup>8</sup> Faced with the omnipresent processes of information and feedback in living beings and machines, and under the impression of contemporary computing, Bense had come to the conclusion that the human being would be dissolved into an extended "sphere of technical being." Thus it was impossible for this early thinker of the transhuman to encompass the "human being" Beuys had in mind, as one newspaper commentary requested.<sup>9</sup>

At a time when it still went without saying that intellectuals would adhere unconditionally to modernity, free jazz and flat roofs, abstract painting and existentialism, Max Bense's technical intelligence came into its own. Works of art were to be analyzed as statistical distributions between unlikely originality and probable banality. Context, observer, author, and maybe even the historicity of art were excluded in favor of an immanence of "pure" form. The mandate of cool purity, the "cold dream of technology," as Bense put it, was the moral lesson to learn from the Nazi past. Anything that was not accessible to rationality, not stochastically objective, was ideologically suspicious.<sup>10</sup> Beuys's materials—blood and soil, wood and felt, rust and fat—appeared anachronistic from this view, a dirty Real that was almost mathematically inconceivable. The mere use of such materials was immediately seen as irrational (and hence a provocation), their "warmth" a dangerous source of vague emotions, similar to the underconceptualized "human science" and "social sculpture" that challenged the concept of "work." Bense had to argue against it: "every irrationalism finally reaches the point where a pact with the reactionary is unavoidable."<sup>11</sup>

Remarkably, at the time Bense was perceived as “shockingly reactionary,” and Beuys’s irrationality was defended because it could not articulate itself “outside the aesthetic medium” and rationally.<sup>12</sup> By 1970 the cause of information aesthetics was already lost. The student movement attacked Bense’s often fragmented technicism, opposing it with neo-Marxism, actionism, or radical criticism of science. The postmodern critique of rationality could account for the *grand récit* of rationality only in the mode of irony, revision, and working through.

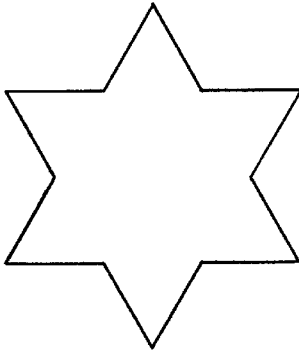
### III

Between 1928 and 1932, the first publications of the American mathematician George D. Birkhoff about the aesthetic measure of works of art appeared. Still based on the experimental psychology and emotional aesthetics of the nineteenth century, Birkhoff’s perception of form was formalized as an economy of optical stimulation and the happy feeling of associative cognition.<sup>13</sup> His references were Gustav Theodor Fechner, Theodor Lipps, and Hermann von Helmholtz. What for Birkhoff still belonged to the era of energy, and played out as a balance between the labor of perception and the payoff of emotion, was converted into the era of information in the work of Abraham Moles and Max Bense and understood as a calculable balance between redundancy and information.

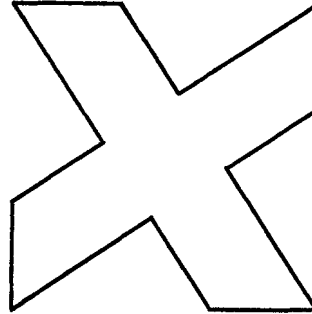
Birkhoff considered aesthetics to be a science of feeling and objects that cause feeling. Among these objects he recognized different classes of comparable objects, and his real aim was to formulate the classifications, determine their aesthetic variables, and correlate them with numerical values. These data were to form an objective basis for comparisons among objects in each class. Birkhoff developed his theory in four treatises, followed in 1933 by the publication of *Aesthetic Measure*.<sup>14</sup> He began with a report at the International Congress of Mathematics in Bologna in 1928, where he applied his theorems to polygons, flat nets, and vases. According to Birkhoff, a work of art essentially consists of three moments of perception.<sup>15</sup> First it required an effort of the sensual apparatus, disparate for different objects but always proportionate with the complexity  $C$  of an object. Second, a feeling of pleasure, Birkhoff’s aesthetic measure  $M$ , compensates for the effort. Third, the observation of objects follows an order that would later come to be called redundancy—alliterations, rhymes, chords, symmetry, and so forth. The discovery or observation of such ordering properties seemed worthwhile to Birkhoff because he postulated that the measure of order  $O$  was in direct relation to the aesthetic pleasure of  $M$ . The three variables  $C$ ,  $M$ , and  $O$  bring Birkhoff to the simple formula  $M = O / C$ , a quotient of order and complexity that could

weigh pleasure and sadness. The most beautiful of a class is that which exhibits as much order and as little complexity as possible. As problematic as *O* and *C* may be, it is remarkable that this concept of aesthetic brings up neither history nor knowledge but insists on its positivity and calculability. It is derived from the anthropological constancy of symmetrical observers who feel a narcissistic pleasure in recognizing their own structure.

Birkhoff himself began with relatively simple abstract forms. For instance, ninety polygons simplify the definition of *C* and *O* for this “aesthetic family,” whereby the following forms A and B



A



B

achieve the values  $M_A = 0.833$  and  $M_B = 0.125$ . Thus stars are objectively more beautiful, which we can easily recognize: we see symmetry on the vertical axis (*V*) as order; we see balance (*E*) and rotational symmetry (*R*); we see the fit into a horizontal-vertical net (*HV*) and the friendliness of the figure (*F*), which is to say the question whether any given vertical or horizontal cuts the polygon in (at most) two points. The result is a formula:  $M_A = O / C = (V + E + R + HV - F) / C$ . That this works best under the conditions of maximum abstraction of historical and semantic meaning was later demonstrated by Rul Gunzenhäuser, who pointed out that a simple children’s rhyme shows far more “aesthetic value” than the poetry of Poe, Coleridge, or Goethe.<sup>16</sup> Gunzenhäuser’s observation only helped the reception of this idea in the 1950s.

#### IV

After the war efforts had produced Shannon’s information theory and cybernetics had appropriated it into its epistemological foundation, the



1950s and 1960s translated Birkhoff's ideas, with new methods, into the hardware of digital computing. Around 1958, the phrase "information aesthetics" appears both in France and in Germany—in Stuttgart in Max Bense's lectures on *Modern Aesthetics* in the summer semester of 1957; and in Strasbourg in 1958 through Abraham Moles's book *Théorie de l'information et perception esthétique*.<sup>17</sup>

The reconceptualization of aesthetics in terms of information theory is so simple that Max Bense was able to do it in two pages: what Birkhoff defined as a measure of complexity, Bense argued, was the number of signs that assemble a particular object,  $M_A = f(O, C)$ . This contained the simplification that each element carried the same aspect of complexity, just as Hartley saw the informational content  $H$  as directly proportional to the number of signs,  $H = n \cdot \log_2 r$  where  $n$  is the number of signs in a transmission,  $r$  is the volume of the sign repertory, multiplied by the binary logarithm of the repertory. Bense preferred Shannon's formula; namely,

$$H = - \sum_{i=1}^r p_i \cdot \text{ld } p_i$$

where  $r$  is sign of a repertory and its probability ( $p_1, \dots, p_n$ ). Now Bense takes a simple step: where Birkhoff's aesthetic measure was a function of order and complexity, Bense replaces the complexity  $C$  with information  $H$  of the selected signs and replaces order  $O$  with redundancy  $R$  because "each order of elements is a phenomenon of redundancy, of the return of the same, the predictable, thus not innovative information."<sup>18</sup> Thus we get  $M_A = f(R, H)$ . Bense switches from the simple additions and multiplications of Birkhoff to statistics: order  $O$  becomes the statistical order of redundancy, and complexity  $C$  becomes the statistical complexity of information. Thus redundancy was

$$R = \frac{H_{\text{max}} - H_i}{H_{\text{max}}}$$

—which is to say, the relation of maximum information and actual information of the selected element. Bense changes this only a little further, calling  $H_{\text{max}}$  the "possible information" and  $H_i$  the "actual information" and defining  $H_{\text{rel}}$  as their quotient—the relative information of a work of art. Thus the aesthetic measure is

$$M_{\tilde{A}} = \frac{1 - H_{\text{rel}}}{H_i}$$

In other words,

It is easily recognized that the measure of creativity as that of innovation is given in the amount of information, while the measure of communication as amount of order is usefully determined by the amount of redundancy. Furthermore, the measure of creation amounts to what was expressed in the classical art historical term “originality,” while the measure of communicability or recognizability of a work of art is a question of its identifiable order, which is to say of a redundancy, roughly correlated to the classical art historical concept of style.<sup>19</sup>

Hence, several things are set in motion. While aesthetic measure was still tied to the senses and the feeling of pleasure for Birkhoff, and thus localized in the physiological recipient, Bense shifts it to the side of the producer and makes it a measure of creativity as counter to the mathematical denominator of style. Following this logic, the counter is called “innovation” and the denominator is “communication.” Thus we are dealing with an avant-garde theory that measures works of art by how far they risk the loss of communication. Astonishingly, the Stuttgart School here agrees with the Frankfurt School about the value of a work of art as a measure of its inaccessibility—except in Stuttgart this is called information.<sup>20</sup> Anything else is regression or culture industry, or redundancy and banality. A work achieves the maximum aesthetic score if it has no recognizable style and maximizes the improbability of its elements.

## V

This configuration has a historical and systematic background. Bense stated that aesthetics was dominated by an “emotional chaos of unmethodical art criticism that apparently can be practiced by anyone, and without thinking pitches documentation of ‘direction’ against the statement of aesthetic reality.”<sup>21</sup> Everywhere, he noticed a

slackening of the tension of the mind in all products labelled as creations, . . . [and] a flood of handcrafted, pseudo-theoretical, and confessional self-reflections . . . spread these days in the treatises and manifestos of the painters and their gallerists, without covering over the imperfection of the fabrications, but in fact demonstrating to the knowledgeable observer the very frugality of the intellect.<sup>22</sup>

In short, art and criticism collaborate in the expulsion of civilized intelligence. On the side of the critics he found the domination of an “anti-intellectual style” that “seeks to value the collapse of rationality as a stimulus for life and an argument against the progress of the technical world.”<sup>23</sup>

On the side of art, however, he saw a betrayal of modernity, claiming “liberties in artistic materials and forms” but without their theoretical foundations, which are replaced irrationally with “mythologemes, emotionality, vitalism, confessions and the like.”<sup>24</sup> When someone argues like this, he also knows the answer: Bense calls for

the constant reflection of criticism to a theory that is afraid neither of a system of defined concepts nor of a system of numerical methods. The scientific state of art criticism becomes inevitable if art is at all to be understood as an intervention of intelligent beings in the process of our civilization, and if we want to dispute the famous remission of intelligence in art.<sup>25</sup>

But if the “essential existence in the technical world is the expert,”<sup>26</sup> then the critic would have to be the technically trained specialist for aesthetics—and only for aesthetics. “Criticism can only consist of aesthetic statements if it wants to be about art, not of historical, sociological or psychological sentences.”<sup>27</sup> Aesthetics must cease the “dubious existence of a philosophically speculative science” and develop “under the new aspects into a technical science.”<sup>28</sup> In sum: “aesthetics as information theory, as a special theory of messages that are only realized and communicated as works of art, will today transform the metaphysical discipline into a technological one.”<sup>29</sup> Thus from the late 1950s to the early 1970s, we deal with a theory that self-consciously considers the aesthetic calculable. This theory is as abstract as the art of its time (e.g., Art Informel, Tachism, or geometrism) because it comprehends the aesthetic as its own properly valid category, an *aisthesis materialis* beyond sense and meaning; it is not interested in comprehension but in counting, because even sensual effects are describable mathematically.<sup>30</sup> This is a double program of salvation—one for the humanities and one for art itself—and this may be its genuine relevance in terms of the multiple current discussions of the interplay between art and science.

Against the background of the two cultures discussion, Bense recapitulates the victorious history of the natural sciences in coupling cognition and construction. Technology verifies the “reality-force” of the hard sciences.<sup>31</sup> Connected to nature via the “communicative channel” of mathematics, technology realizes her laws. It aims for a “fundamental fungibility of the world” and is oriented toward the future, because it operates in terms of precision, security, and deduction.<sup>32</sup> Technology does not surprise but generates regularities. This allows Bense to connect natural sciences and technology with art and aesthetics. The work of art is shifted into the systematic position of technology, and aesthetics into the systematic position of a natural science. Physics and aesthetics meet where the “two only possible

Diagram according to Max Bense,  
*Programmierung des Schönen*  
(Baden-Baden: Agis-Verlag,  
1960).

artificial realities, namely art and technology overlap.”<sup>33</sup> This overlap occurs in the rationality of doing and thinking that acknowledges no fundamental difference between scientific and artistic production. But while technical objects do not surprise but are trivially generated for reliability, aesthetic objects are surprising and unimaginable in their factual generation.<sup>34</sup> In a kind of division of labor in the process of civilization, technology takes on the task of automation (that is, repetition), while art takes on the task of generating improbability (that is, innovation). The innovations of art are expected to provide the “surplus in civilization” that is consumed by automation.<sup>35</sup>

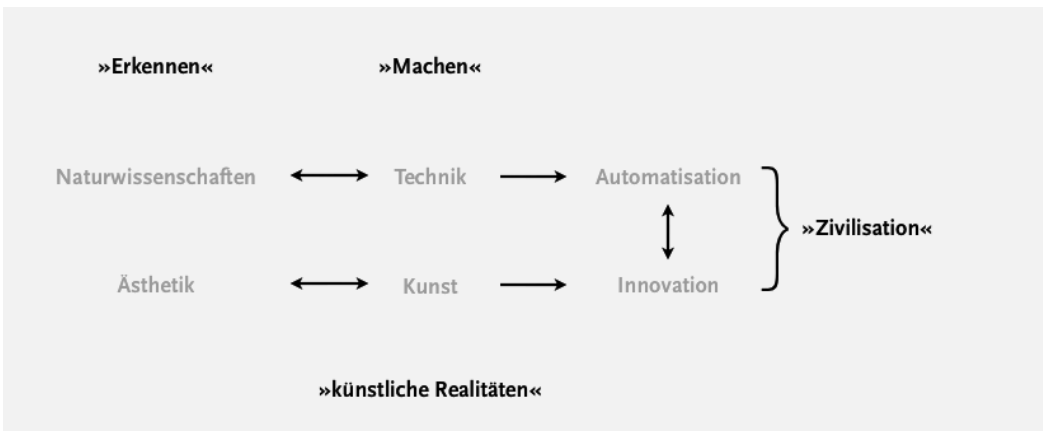
This integration of scientific cultures depends on the possibility of a common language—which is imaginable only as a cybernetic inspiration. Aesthetics would have to swear off the “chatter” of sociology and psychology if it wanted to see eye to eye with the hard sciences. Turning aesthetics into “a mathematical and technological language” was portrayed as

the only legitimate and successful process to escape from the certain impression of the meaninglessness of art. . . . Art has the chance to gain innovation in proportion to the progressive automation only in subtle use of the generative technologies, not in exploitation of emotions, trailers, or faces—or else art remains outside civilization.<sup>36</sup>

A kind of coevolution was going to catch art and aesthetics up with the state of production of technology and the natural sciences.

## VI

As much as information theory contributes in Bense’s work to the foundations of a reconciliation of art and technology, other elements of a cybernetic discourse remain weak. The relation between human beings and machines in particular, which had been described philosophically as a kind of “symmetrical anthropology,” seems hardly addressed on the aesthetic level, which is to say in the relations between artist and computer. Bense, philosopher of technology, remained far removed from the reality in the computer lab. But his readers and students nonetheless took the unity of cognition and creation, aesthetic theory and practice quite seriously. The recently rediscovered stochastic poems and algorithmic graphics were direct results of the application of a “technological language” written on punch cards.<sup>37</sup> Aesthetic research was converted by Bense’s students into applications, generating “innovation” with Monte Carlo methods and “communication” with Markov chains.<sup>38</sup>



Still, that feedback was never a topic is astonishing because in Europe at least cooperation between human and machine was hardly observed. Computer art, just like computer use in general, started in interpassive batch processing with its strict division of input, processing, and output.<sup>39</sup> Human-Machine-Interaction was taboo during these mechanical processes, except for the elimination of bugs.<sup>40</sup> The computer remained an “Ersatz phantasm” of the automation of mental activities, as Jörg Pflüger put it, and thus one of the few examples of a cybernetic-technical object is the car that Max Bense considered in 1970.<sup>41</sup> From Bense’s preferred passenger seat, the distributed intelligence of human beings and machines was easier to observe.

## VII

The theory of information aesthetics contemporaneously developed in Strasbourg is similarly avant-garde. Abraham Moles insisted on the combination of experimental, analytic, and synthetic aspects. Computers were the bridge between aesthetic objects and their theory. Foundational was Moles’s epistemological diagnosis of cybernetics as an epoch of modeling and simulation: “The science of the 20th century will be above all one of models. . . . Cybernetics can answer the question of what something is on the day it can build a model.”<sup>42</sup> Cybernetics is an epistemological achievement because it simply undermines the difference between categories of being and of cognition, offering instead the provisional but practical relations of possibility.<sup>43</sup> This was already true of Norbert Wiener’s behavioral systems of human beings, animals, and machines, which end “largely uniform,”<sup>44</sup> as well as of Warren S. McCulloch’s idea of a calculus that models nerve switches as electrical engineering, imagining every possible thought as a switch.<sup>45</sup> The same also ought to be possible, Moles postulated, in the realm of art: a calculus to liberate it from its remaining metaphysics. His central argument was that aesthetic perception and artistic production should be modeled with the aid of computers, and as a consequence, become accessible to simulation processes.

Already in 1958, Moles demanded aesthetic research in the laboratory, under the heading “Materiality of Communication.” During the period of the 1960s this was not only the laboratory of experimental psychology but the computer lab. Aesthetics was no longer the realm of the “ethereal philosopher talking about beauty, but of the practical expert.”<sup>46</sup> No longer

a socially disadvantaged being that had long suffered from inferiority complexes because he talked about what others do, the aesthetics expert advances to the equivalent rank as the artists he used to only talk about. . . . He offers the elements of programs for the repertory of

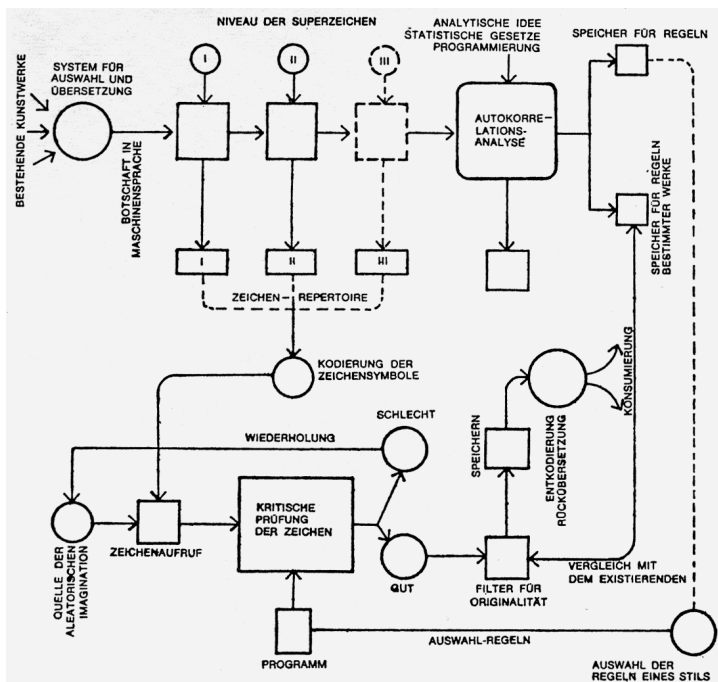
machines, he determines the hierarchy of levels . . . so that each analytic machine may serve as a synthetic machine, which is to say as the origin of works of art for which he is the responsible manager.<sup>47</sup>

The computer is indispensable here—for example, as an analog-digital converter with filters for redundancy, symmetry, and so forth, exercising the elementarization that is needed for information-theoretical measurement; or as the instrument of observations of relations of order where human beings are not able to “master the flood of originality”;<sup>48</sup> or in the sense of an augmentation of human intelligence in the creative process (as Doug Engelbart conceived of it around the same time). As Moles argued, “our mind is too weak for the ideas it imagines, it needs the technical assistance which computers may offer.”<sup>49</sup>

This human weakness in the end required a generally conceived strategy of digitizing works of art so they could be analyzed by computer programs that would characterize them statistically. Moles suggested the automation of discourse analysis at the moment of its appearance. Once the computer has stored the elements and transitional probabilities of entire epochs, one can data mine the archives of knowledge. The rules of formulating statements would no longer be a matter of a historian’s capacity for abstraction but would be objectified in algorithms. Moles suspected that the historical field of possibility of a Johannes Brahms would eventually be formalized in the computer, which would then yield insight into his actual originality. This would also allow the creation of software that could compose everything that Brahms would have been able to compose.<sup>50</sup> It was no longer appropriate to create works, but to focus on the feasibility of works, on the creation of models, and on potentiality as an autonomous value.<sup>51</sup> In this manner, originality is stripped of its myth of genius and is conceivable only as a function of difference from a historical archive. “The artist is not a species that transcends universality, he is a programmer, as will we all be.”

And these days, one “can rely on the technicians, whether in space travel or in art.”<sup>52</sup>

The social meaning of this conception solves the relation of art and the masses. “The problem is the foundation of an art that does justice not to the individual but to the entire society.”<sup>53</sup> The Brahms simulation indicates how factual lack



“Simulation of a Composition Process.” Diagram from Abraham A. Moles, *Kunst und Computer* (Cologne: DuMont, 1973).

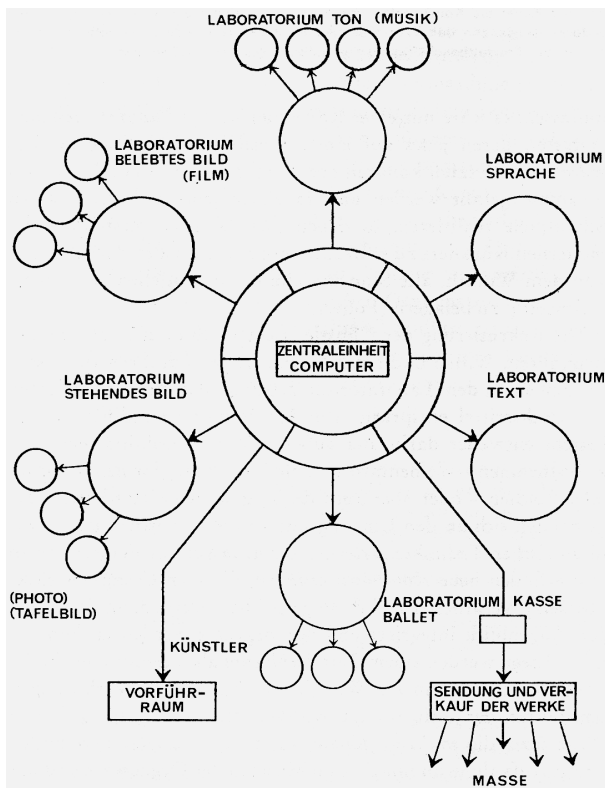
is expected to become virtual excess: by way of a kind of *mass customization* of art which is much more refined than any of Victor Vasarely's universal claims for aesthetics or the fabrication of serial art as multiples. For those aesthetic objects that are only possible under the condition of the computer, by means of algorithms, operationalized accident and superhuman speed are not similar to each other like one industrial product to another—they exhibit ever-new differences and thus “innovation” and “originality.” Even the avant-garde is automated, as long as the machines are “intelligent” enough: “Every shopper can get their table top, customized with a uniquely personalized inlay pattern by a special artist-machine.” Rather than industrial standardization, digital individualization is the motto: “the algorithm-creators feed the people's hunger for culture.”<sup>54</sup>

This means, of course, that Moles would close the art schools, replacing them with computer laboratories that research and generate, test and market art. In these laboratories of realization built around central computer organisms, research and development go hand in hand—with artists who are no longer afraid to work scientifically and to accept programming languages as artistic competence.<sup>55</sup> “The recruitment of the artists,” Moles thought,

depends on their competence, their will and their endurance. Depending on their interests, they could work in the laboratory that corresponds with their specific means of expression. The work there is indifferent and consists either in taking sensory elements from the outer world—elementary visual or acoustic forms, objects or signs—or in the creation of entirely new ones. They become used to combinatory and organizational techniques, learn new machine languages, and invent new compositional ideas that are translated back by computers,

processed and then stored in order to be called up and integrated, at the right time. These ideas will be presented to a test audience as experiment or rehearsal; after their value is measured in relation to the user sensibility of their time, they are distributed in multiple copies world-wide, and find acceptance into the imaginary museum of the present and the future.<sup>56</sup>

As much as this suggestion adheres to the contemporary topology of a central computer and its terminals, it is still



“Organigram of an Art Center.”  
Diagram from Abraham A. Moles,  
*Kunst und Computer* (Cologne:  
DuMont, 1973).



far beyond other concepts of its time, such as Andy Warhol's Factory. While the Factory was a critique of the lone-wolf genius of abstract expressionism in the name of the industrial age, the European vision of Moles is already firmly rooted in the postindustrial age. Here there are neither laborers nor "executive artists" who generate serial production according to the guidance of the factory management. The art center as conceived by Moles has automated all handicraft, dismissed the laborers, and hired intelligent machines. Even the development of models is not the job of inventive human beings but the synergy effect of collaboration between human beings and machines. And the coherence of the independent laboratories is only infrastructural, a computer architecture that administers data not space.

Even if this vision reveals a rather crude idea of the production of the values of high culture for a society that "needs beauty"—these products would surely tend toward kitsch—Moles nonetheless makes some remarkable assumptions. His vision adumbrates the exit of art from the logic of its supposedly necessary anachronism on the level of its means of production and the structures of its knowledge. The art center as imagined by Moles resembles that postmodern type of laboratory: the particle-physics laboratory where interaction, communication, and synchronization of subsystems are the central questions of research organization.<sup>57</sup> Just as Bense wanted to overcome the difference between the hard sciences and the humanities by relegating both to a common scientific language, Moles aimed for an infrastructural and technical solution that was specific to Europe.

## VIII

While information aesthetics flourished in Europe, computer makers boomed in the United States. In the 1960s, this led to ideas of a man-machine symbiosis. In computer interaction, as Joseph Licklider and Douglas Engelbart held, human beings would become more productive and creative.<sup>58</sup> The performance of "computerized society" would be a matter of performance between humans and machines, and this would require concrete interfaces. This is the "civilization" phase of computing—an era that explored its limits and possibilities in text processing, air travel reservations, CAD programs, and electronic music, applications that were exhibited in the legendary show *Cybernetic Serendipity* right next to computer art.<sup>59</sup>

This era also saw the rise of the hacker.<sup>60</sup> Testing the limits of what is allowed and forbidden, useful and meaningless, visible and invisible, the hacker shifts these limits ceaselessly. The hacker is neither a user (another



category that had just been invented) nor an artist or trained technician (programmer)—a hacker lacks respect for the arbitrary restrictions of programs, systems administrators, or contexts for permissible use. Only technology itself limits and legitimates the hacker's adventures, because the hacker is after possibilities that are latent in technology. Thus the hacker aims to invert dominant ideologies, turning the established cathexis upside down: friendly versus cold, community versus arcane expertise, decentralization versus mainframe, excess versus efficiency, human versus inhuman, and so on. But the decisive turn away from pure technocentrism is the concept of the "medium" at the end of the 1960s. Hackers, influenced by Marshall McLuhan, whose theories engage with the prehistory of cybernetics, no longer thought of the computer as an "electronic brain" or "calculator" but as a medium.<sup>61</sup> McLuhan's media-theoretical diagnosis of the computer age was read by people who actually dealt with computers, and they realized that computers are media. Information aesthetics had its lonely hackers, namely those experimenters who produced European computer graphics and computer poems. But the transmission of the art discussions into media discussions did not take place in Europe. While Bense and Beuys argued in West Germany about the value of artworks, aesthetic changes of consciousness and provocative potential, the U.S. scene congealed into the pedagogical, political, and aesthetic programs that became the basis for the personal computing revolution. A few years ago, Gundolf Freyermuth offered his diagnosis: "a techno-bohemia between technological bricolage and messianic agitation expected nothing less from the new technology than that it change the world."<sup>62</sup> Just as video art derived the concept of "feedback" from cybernetics in order to charge it with McLuhan's media theory and politicize it,<sup>63</sup> the personal-computer movement turned the thinking machines into media that were to be understood as cybernetic rather than dismissed or degraded as trivial machines.

Ted Nelson's appeal, "You can and must understand computers NOW," on the cover of *Dream Machines/Computer Lib* expresses this succinctly. The future of the computer and thus the future of society is decided in education: "The human mind is born free, yet everywhere it is in chains."<sup>64</sup> This is precisely the utopian point of entry for computers, for "today, at this moment, we can and must design the media, design the molecules of our new water. . . . Computers offer us the first real chance to let the human mind grow to its full potential."<sup>65</sup> Seymour Papert's suggestions for a transition from "precomputer cultures" to "computer cultures" similarly express this chance for a new epoch. The computer as medium that bridges the chasm between concrete and formal thought becomes an "object to think with" that gives rise, in a nice cybernetic loop, to "thinking about

thinking.”<sup>66</sup> Thanks to the computer, children become epistemologists, which means that the political question of postmodern curricula must be answered with aesthetics and media technology.

## IX

The examples of the “American way” of reformulating the computer as a medium are easily multiplied; for example, with Nicholas Negroponte, Lee Felsenstein, or Alan Kay. But the differences between the European and the American development are clear: the postwar program of a renovation of scientific theories of art can be seen in information aesthetics, in the service of proving an unideological European aesthetics. The result in Europe was, on the one hand, the attempted salvation or reconciliation of art and technology, of aesthetics and natural sciences on the horizon of the two-cultures debate; by the same token this salvation program implied the questions, on the other hand, of what an art of the technological age would look like (permutational art), what the appropriate aesthetic knowledge would have to be (knowledge of programming languages), and what organizational and institutional forms they would require (laboratories). The same program conjoins cognition and production, analytic and operational aspects. Aesthetic knowledge has a technical, applied side. Participation was understood as the mass distribution of individualized art objects, in the European avant-garde, that stem from advanced aesthetic research in laboratories. With the exception of electronic music, performativity played no role here, because interactivity (simply in the computer setup) was not an issue; instead, graphic objects, texts, or musical compositions develop from batch processing (input-processing-output).

The situation was different in the United States. There, too, the question of education in the technological era came up, but it was answered differently and by people from different backgrounds. The European information aesthetics after 1968 was wiped away by sociology or transformed into semiotics, and just as media studies began (as film studies) in Germany an American counterculture adapted parts of cybernetics as “media” and started its unparalleled career.<sup>67</sup> The later definition of a hacker-ethos not coincidentally contains the statement “You can create art and beauty on a computer.” This was evident in Europe, but did not flourish in the hands of young *bricoleurs* of revolutionary temperament. The inexpensive supply to universities of U.S. military computing equipment also made a hands-on difference. Furthermore, the very idea of art was different in the North American context, and the question of education in the era of technology was not discussed against the backdrop of a common language of science such as information theory but in the context of situating the computer as a

medium, as Nelson did, earlier than the Europeans, drawing attention to the media-technological bias of culture. In contrast to the European information aesthetics, in the United States working with computers was understood as a performance, as interactive thinking with the other. This thinking between formal and concrete, as Papert had it, does not deal with the production of aesthetic objects but is fundamentally dependent on aesthetic formulas that render the formal concrete and formalize the concrete. The U.S. imperative was to “be creative”—and not “to each their own individualized table-top”: the point was not to satisfy the art-hungry masses but to furnish them with personal computers for the problems of tomorrow, as Nelson had it. Against the dominant ideology of optimizing labor processes and centralizing computing, decentralized structures and the creative and aesthetic potential of thinking machines—composing, writing, drawing, playing, programming—were technologically implemented and heated up with utopian promises. This critique of ideology quickly became the biggest ideology and in this regard fared no better than the optimistic technofuturism of the 1950s and 1960s that met with critiques, in 1968, that it hoped already to have dodged.

## X

At least two repercussions can be indicated. In media studies, Max Bense’s plan of radicalizing the humanities, his demand for informatics and mathematics, his diagnosis of the end of man and the advances of technology as its own discursive program between or beneath the two cultures finds a sustained echo in Friedrich Kittler’s discourse analysis since 1980. In the latter, it is transformed via French deconstruction, poststructuralism, and Lacanian psychoanalysis, and it is based upon the media-technological bias of the personal computer rather than on batch processing. Nonetheless, because these four modifications are themselves already owed to cybernetics, their return a quarter of a century later—whether as materiality of communication, as *aisthesis materialis* or as the exorcism of “Geist” (mind or spirit) in the “Geisteswissenschaften” or humanities—is hardly astonishing. The revision of cybernetics and of its different consequences raises questions about the methodical claims and systematic reach, the disciplinary mooring and historical foundations of media studies.

The second repercussion is felt in the art world. After Jack Burnham dismissed the techno-fantasies of the 1960s as a disaster of false expectations and grandiose ideologies, media art nonetheless celebrated a kind of revival in the late 1980s and early 1990s, complete with fantasies of reconciling art and science and talk of new worlds, celebrating interactivity, calculation, and machine aesthetics.<sup>68</sup> After the end of the European “information

aesthetics” version of cybernetics, creative computing reached Europe. The heavily subsidized and institutionalized media arts scene is characterized above all by a revival of mysticism in the innermost circles of technofetishism. When we sift through the historical evidence today, we should not forget the information aesthetics that had its own peculiar dream of a different tomorrow.

## Notes

1. Max Bense, "Der geistige Mensch und die Technik," in *Philosophie*, vol. 1 of *Ausgewählte Schriften*, (Stuttgart: Metzler, 1997), 194.
2. Ted Nelson, *Dream Machines* (1974; reprint Redmond, WA: Microsoft Press, 1988), 48.
3. Max Bense, *Programmierung des Schönen* (Baden-Baden: Agis-Verlag, 1960), 72.
4. Bense, *Programmierung des Schönen*, 72.
5. Karl-Heinz Bohrer, "Herr Bense stellt Herrn Beuys, aber Herr Beuys läßt sich nicht . . .," *Frankfurter Allgemeine Zeitung*, 29 January 1970, 24.
6. *Meinung gegen Meinung*, "Provokation: Lebensstoff der Gesellschaft: Kunst und Antikunst" (broadcast of the WDR, Düsseldorf, 27 January 1970). I am grateful to Stefan Rieger for this reference.
7. "Philosoph in technischer Zeit—Stuttgarter Engagement," *Kaleidoskopien* 5 (2004): 72.
8. Max Bense, "Kunst und Intelligenz," in *Philosophie*, 360.
9. Georg Jappe, "'Provokation als Lebenselement': Joseph Beuys im Verhör," *National-Zeitung Basel*, 4 February 1970, 56.
10. A comparable claim to de-ideologization (or de-Stalinization) is described in Slava Gerovitch, *From Newspeak to Cyberspeak* (Cambridge, MA: MIT Press, 2002), esp. ch. 4–5.
11. Max Bense, "Ästhetischer Irrationalismus," in *Philosophie*, 376.
12. Jappe, 56; and Bohrer, 24.
13. "An instructive analogy is the following. Among business enterprises those are regarded as most successful in which the annual profit  $p$  is largest in comparison to the investment  $i$ , thus the ratio  $p/i$  is regarded as the economic measure of success. Now in aesthetic experience, the effort of attention measured by  $C$  corresponds to the investment, and the order  $O$  corresponds to the profit. By analogy it is the ratio  $O/C$  which represents the aesthetic measure  $M$ ." George D. Birkhoff, *A Mathematical Theory of Aesthetics and Its Application to Poetry and Musics*, The Rice Institute Pamphlet, vol. XIX, no. 3 (Houston: Rice Institute: 1932), 191. Birkhoff's concepts are proximate to those of crystallography.
14. George D. Birkhoff, *Aesthetic Measure* (Cambridge: Harvard University Press, 1933). Compare Rul Gunzenhäuser, *Die ästhetische Theorie G.D. Birkhoffs: Versuch einer kritischen Darstellung und Erweiterung im Rahmen eines informationstheoretischen Modells für ästhetische Prozesse* (Ph.D. diss., Stuttgart University, 1962); and Siegfried Maser, *Numerische Ästhetik* (Stuttgart: K. Krämer, 1971). Gunzenhäuser's dissertation was supervised by Bense. Maser introduced a unit called "birk" and also the "mbirk" (Millibirk).
15. Birkhoff, *A Mathematical Theory of Aesthetics*, 189.
16. Gunzenhäuser, 67.
17. Abraham A. Moles, *Théorie de l'information et perception esthétique* (Paris: Flammarion, 1958). Helmar Frank and Herbert W. Franke, *Ästhetische Information/Eстетика информация* (Munich: Institut für Kybernetik-Verlag, 1997). Also available online at <http://wwwcs.uni-paderborn.de/extern/fb/2/Kyb.Paed/IAE/ttste.html>. The terms *cybernetic aesthetics* and *Aesthetikybernetik* never took hold, for good reasons.
18. Max Bense, "Einführung in die informationstheoretische Ästhetik," in *Ästhetik und Texttheorie*, vol. 3 of *Ausgewählte Schriften*, (Stuttgart: Metzler, 1998), 316.
19. Bense, "Einführung in die informationstheoretische Ästhetik," 317.
20. See *Kaleidoskopien*, 5 (2004): 64.
21. Max Bense, "Ungehorsam der Ideen: Abschließender Traktat über Intelligenz und tech-

nische Welt," in *Philosophie*, 375.

22. Bense, "Ungehorsam der Ideen," 375.

23. Bense, "Ungehorsam der Ideen," 376.

24. Bense, "Ungehorsam der Ideen," 376.

25. Bense, "Ungehorsam der Ideen," 360.

26. Max Bense, "Technische Existenz: Essays," in *Ästhetik und Texttheorie*, 128.

27. Bense, "Ungehorsam der Ideen," 358.

28. Bense, *Programmierung des Schönen*, 14.

29. Bense, "Ungehorsam der Ideen," 352.

30. For the classical argument, see Claude E. Shannon, "The Redundancy of the English Language," in *Cybernetics/Kybernetik: The Macy Conferences 1946–1953*, vol. 1, ed. Claus Pias (Zürich: Diaphanes Verlag, 2003), 248–273.

31. Bense, *Programmierung des Schönen*, 13.

32. Bense, *Programmierung des Schönen*, 10.

33. Bense, *Programmierung des Schönen*, 17.

34. To what extent Bense's interest in quantum physics, that is with the realization of reality via measurement, plays a role here must remain speculation.

35. Bense, *Programmierung des Schönen*, 25.

36. Bense, *Programmierung des Schönen*, 23, 25.

37. There is a growing interest for early computer art in Germany. See Barbara Buescher, Hans-Christian von Hermann, and Christoph Hofmann, eds., *Ästhetik als Programm: Max Bense/Daten und Streuungen* (Berlin: Kaleidoskopien, 2004); Wulf Herzogenrath and Barbara Nierhoff, eds., *Ex Macina: Frühe Computergrafik bis 1979* (Munich: Deutscher Kunstverlag, 2007); Heike M. Piehler, *Die Anfänge der Computerkunst* (Frankfurt: dot, 2002); Christoph Klütsch, *Computergrafik* (Vienna, New York: Springer, 2007). In addition, Kunsthalle Bremen organized retrospectives for the following artists: Frieder Nake (2004), Georg Nees (2005), Otto Beckmann (2006), Kurd Alsleben (2006), Vera Molnar (2006), Manfred Mohr (2007), and Herbert W. Franke (2007).

38. See Lejaren A. Hiller, *Informationstheorie und Computermusik* (Mainz: Schott, 1964).

39. Martin Warnke, *Der Zeitpfeil im Digitalen* (Stuttgart: Alcatel SEL Stiftung, 2004).

40. Jörg Pflüger, "Konversation, Manipulation, Delegation: Zur Ideengeschichte der Interaktivität," in *Geschichten der Informatik*, ed. Hans-Dieter Hellige (Berlin: Springer, 2004), 367–408; and Frieder Nake, "Und wann nun endlich 'Kunst'—Oder doch lieber nicht?" in *Zukünfte des Computers*, ed. Claus Pias (Zürich: Diaphanes Verlag, 2004), 47–66.

41. Jörg Pflüger, "Konversation, Manipulation, Delegation. Zur Ideengeschichte der Interaktivität," in *Geschichten der Informatik*, ed. Hans-Dieter Hellige (Berlin/Heidelberg: Springer, 2004), 367–408. Max Bense, "Auto und Information: Das Ich, das Auto und die Technik," in *Poetische Texte*, vol. 4 of *Ausgewählte Schriften* (Stuttgart: Metzler 1998), 291.

42. Abraham A. Moles, "Die Kybernetik, eine Revolution in der Stille," in *Epoche Atom und Automation, Enzyklopädie des technischen Zeitalters*, vol. 7 (Geneva: Kister, 1959), 8. On cybernetic modeling, see Herbert Stachowiak, *Allgemeine Modeltheorie* (Vienna: Springer-Verlag, 1973); and Herbert Stachowiak, *Denken und Erkennen im kybernetischen Model* (Vienna: Springer-Verlag, 1965).

43. The most famous piece of evidence for the proposition that cybernetics is an episte-

mological achievement surely is the hydrogen bomb, whose construction was accessible neither experimentally nor analytically but only through computer simulation.

44. Arturo Rosenblueth, Norbert Wiener, and Julian Bigelow, "Behavior, Purpose and Teleology," *Philosophy of Science* 10 (1943): 18–24.

45. Warren McCulloch and Walter Pitts, "A Logical Calculus Immanent in Nervous Activity," *Bulletin of Mathematical Biophysics* 5 (1943): 115–133.

46. Abraham A. Moles, *Kunst und Computer* (Cologne: DuMont, 1973), 78.

47. Moles, *Kunst und Computer*, 98.

48. Moles, *Kunst und Computer*, 80.

49. Moles, *Kunst und Computer*, 88. This goes for art but also for politics. As Jay Forrester stated about his simulations for the *Club of Rome*, the world is too complex to leave it to politicians. The motto of cybernetics and its science fiction is that faced with this complex situation, we can be saved only by computers.

50. Moles, *Kunst und Computer*, 87.

51. Moles, *Kunst und Computer*, 99, 104.

52. Moles, *Kunst und Computer*, 136, 274.

53. Moles, *Kunst und Computer*, 12.

54. Moles, *Kunst und Computer*, 94, 273.

55. Moles, *Kunst und Computer*, 262.

56. Moles, *Kunst und Computer*, 264.

57. Peter Galison and Caroline A. Jones, "Factory, Laboratory, Studio: Dispersing Sites of Production," in *The Architecture of Science*, ed. Peter Galison and Emily Thompson (Cambridge: MIT Press, 1999), 497–540.

58. See, for instance, Joseph C.R. Licklider, "Man-Computer Symbiosis," *IRE Transactions on Human Factors in Electronics, HFE-1* (1960; digital reprint, Palo Alto: Systems Research Center, 1990).

59. *Cybernetic Serendipity: The Computer and the Arts*, exh. cat., ed. J. Reichardt (London: ICA, 1968). See also Christoph Klütsch, "The Summer 1968 in London and Zagreb: Starting or End point for Computer Art?" in *Creativity and Cognition: Proceedings of the 5th Conference* (New York: ACM Press, 2005), 109–117; and Christoph Klütsch, *Computergrafik: Ästhetische Experimente zwischen zwei Kulturen* (Vienna: Springer, 2007).

60. Claus Pias, "Der Hacker," in *Grenzverletzer*, ed. Eva Horn, Stefan Kaufmann, and Ulrich Bröckling (Berlin: Kadmos, 2002), 248–270.

61. Marshall McLuhan, "Cybernation and Culture," in *The Social Impact of Cybernetics*, ed. Charles R. Dechert (New York: Simon and Schuster, 1967), 95–108.

62. Gundolf P. Freyermuth, "Die Geburt des PC aus dem Geiste des Protests: Eine kleine Kulturgeschichte," *c't* 24 (2003): 270–276.

63. Cornelius Borck, "Feedback as a Form of Art" (presentation at "When Cybernetics Meets Aesthetics," Lentos Kunstmuseum Linz, Austria, 31 August 2006), available online at <http://www.aec.at/de/festival2006/podcasts/index.asp>.

64. Nelson, 18.

65. Nelson, 2.

66. Seymour Papert, *Mindstorms: Children, Computers, and Powerful Ideas* (New York: Basic Books, 1980).

67. This was in 1971, the year Friedrich Knilli filled the first professorship in media studies in Germany, at Technische Universität Berlin. The reasons why the conceptualiza-

tion of the computer as a medium happened so late, despite the fact that McLuhan was consumed “like Marx and Mao,” are diffuse. Friedrich Knilli to the author, e-mail, 11 February 2007.

68. Jack Burnham, “Art and Technology: The Panacea That Failed” (1980), in *Video Culture: A Critical Investigation*, ed. John G. Hanhardt (New York: Visual Studies Workshop Press, 1987), 232–248. Compare Jack Burnham, *Beyond Modern Sculpture* (London: Penguin, 1968), 312–376.