QUALIFICATION QUESTION #3

So Wiener, Burnham, and Tudor walk into a bar...

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QUESTION

Anthony Burr

You have been looking at the history of the use of concepts derived from cybernetics in art practice and the emergence of whats been termed systems aesthetics". Present an overview of this history paying attention to both the creation of art directly via technologies and the adaptation of conceptual structures from cybernetic thought to art practice. In addition to this overview, present a detailed analysis of one or more works by a major figure (or figures) in some detail.

1. Introduction

> "Use the word 'cybernetics', Norbert, because nobody knows what it means. This will always put you at an advantage in arguments."
>
> - attributed to Claude Shannon in a letter to Norbert Wiener[1]

Even the American Society for Cybernetics, ostensibly the institutional authority on cybernetics, offers no fewer than **forty-six** definitions of cybernetics as offered by various thinkers, artists, and scientists associated with the field. Among them, in no particular order:[2,3]

- "The science of control and communication in the animal and the machine" (Norbert Wiener)
- "[Cybernetics] tries to show that mechanisms of a feedback nature are the base

[1] "Definitions." *American Society for Cybernetics*
[2] "Definitions." *American Society for Cybernetics*
[3] Broekmannm, *Machine Art in the Twentieth Century*, pg. 101

of teleological or purposeful behavior in man-made machines as well as in living organisms, and in social systems." (Ludwig von Bertalanffy)

- "Cybernetics treats, not things, but ways of behaving. It does not ask, 'What is this thing?' but 'what does it do?' " (W. Robert Ashby)
- "Should one name one central concept, a first principle, of cybernetics, it would be circularity." (Heinz von Förster)
- "Cybernetics is the awareness of the process that keeps phenomena in balance." (Nicolas Schöffer)
- "The ability to cure all temporary truth of eternal triteness." (Herbert Brün)

The ambiguity of Herbert Brün's definition is particularly delightful, even if it seems his faith in the strength of a single branch of science is questionable. So, then, what is cybernetics? For the purposes of this text, it will be aligned most closely with Wiener and von Bertalanffy's definitions above but, as one will see, this is never quite so clear cut. Nonetheless, once cybernetics took hold in the disciplines of mathematics and physiology after the publication of Wiener's book *Cybernetics: control and communication in the animal and machine* in 1948, it found its way into biology, engineering, and eventually the arts. It is perhaps because of the wide application of the term that it gathered such diverse definitions that, although implying different perspectives, never contradict one another.

Heinz von Förster said it best: "That is the fascinating thing about cybernetics. You ask a couple of people to give you a definition and although you don't get to know much about cybernetics from them, you find out a lot about the person supplying the definition, including their area of expertise, their relation to the world, their desire to play with metaphors, their enthusiasm for management, and their interest in communications or message theory."[4]

This paper will present a brief historical overview of Norbert Wiener's cybernetics, as well as its conterpart systems aesthetics found in the writing of sculptor and art theorist Jack Burnham. As a locus, it will use David Tudor's *Bandoneon! (a combine)*, first performed at the *9 Evenings: Theatre & Engineering* in 1966 with help from Fred Waldhauer from Bell Labs. It will not serve as a technical analysis of the piece but

[4] "Definitions." *American Society for Cybernetics*

rather present it as an early instatiation of the concepts found in both cybernetics and systems aesthetics of which technical production is a crucial component.

2. Cybernetics and Systems Aesthetics: an Overview

It is not the purpose of this paper to provide a detailed summary of either cybernetics nor systems aesthetics, but rather to show their relationship to one another and their manifestations in artwork. However, having at least a cursory understanding of both is critical for the discussion that follows; thus, a brief overview.

2.1. *Cybernetics*

The word "cybernetics" often conjures up images of machines — machines plugged into machines, machines plugged into humans, a cyberpunk-like orgy of cables, sweat, electricity, and blood.[5] According to Merriam Webster, cybernetics is defined as "the science of communication and control theory that is concerned especially with the comparative study of automatic control systems (such as the nervous system and brain and mechanical-electrical communication systems)."[6] It is, essentially, the study of systems as they appear in animals and machines, and is a precursor of sorts to Ludwig von Bertalanffy's general systems theory which greatly influenced Jack Burnham's thoughts on systems aesthetics.

The term itself originated in Norbert Wiener's 1948 book *Cybernetics: or control and communication in the animal and machine*. In this seminal text, Wiener coins the term cybernetics and lays out what he sees as the tennants of the field. Of the word, Wiener constucted it from the Greek for *steersman*: "We have decided to call the entire field of control and communication theory, whether in the machine or in the animal, by the name *Cybernetics*, which we derive from the Greek $\chi\upsilon\beta\epsilon\rho\nu\eta\tau\eta\zeta$ (kybernetés) or *steersman*." While Wiener acknowledges the fact that application of the specific term cybernetics does not predate 1947, the concepts it embodies surely predate the term and were touched on by Clerk Maxwell and his article on *governors*

[5] One can dream...
[6] "Cybernetics." *Merriam-Webster*

in 1868.[7]

The aspects of cybernetics this text will primarily concern itself with are:

- feedback
- information
- interdisciplinarity

2.1.1. Feedback

Perhaps the most important concept in cybernetics is that of feedback, wherein information from the output is in some proportion added to the input before being recalculated. If there is no feedback in a system, it cannot be responsive and would thus have no information about the way in which its environment has changed, either by its own action or those actions precipitated around it by something else. Critically, the nature of the information contained in the feedback is based on its actual performance at any given moment, not its expected performance at that same moment.[8]

Wiener provides the example of picking up a pencil. This action is performeds automatically by the "will" in that one does not deliberately and consciously contract, to a specific amount, the specific muscles needed to pick it up. How, then, is this accomplished without thereby overshooting or undershooting the object? There must, according to Wiener, "be a report to the nervous system... of the amount by which we have failed to pick up the pencil at each instant."[9] Further, the "motion is regulated by some measure of the amount by which it has not yet been accomplished."[10] This report is visual (assuming the lights are on and our eyes are open) but is more generally proprioceptive; that is, kinesthetic in nature. The information which is gathered by the nervous system is *feedback* and the brain responds appropriately. Feedback, however, need not be the domain of a highly complex system such as the human body or that of a guided missle system but can be mechanically induced by the simple thermostat found in a home. This device operates by virtute of its "sense organ" that is solely thermoceptive: a two-sided band of metal expands and contracts with the temperature.

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[7] Wiener, *Cybernetics*, pg. 11
[8] Wiener, *Human Use of Human Beings*, pg. 12
[9] Wiener, *C*, pg. 7
[10] Wiener, *C*, pg. 97

It is the responsibility of the thermostat to "check" where the temperature is and to respond accordingly, either by turning on in the case of too low a temperature, or by turning off, when the temperature has reached a sufficiently high level.

From the idea that feedback is the proportion of that which has not yet been accomplished, it follows that feedback, in this instance, must be negative; that is, it opposes what the system is already doing and thus serves to stabalize the system. This stability also known as *homeostasis*. The question begs: what happens when the level of feedback is insufficient than what is necessary to stabalize the system? How does the system respond?

2.1.1.1. Oscillation or "hunting". Oscillation, or what Wiener calls *hunting*, is a natural consequence of feedback in a system. Specifically, oscillation occurs when feedback is insufficient to stablaize the system or is positive in nature, reinforcing what the system is already doing (and thus underminding stability). To return to the physiological example in the previous section, this is appears as *ataxia*. That is, the feedback from the eyes and proprioceptive sense are blunted and the brain overshoots the amount needed to give the correct result which then it attempts to correct by moving in the other direction at least as hard, which follows... the idea is clear. The same phenomenon accounts for fishtailing, in which a driver overcorrects a skid by steering in the opposite direction too far which then swings the rear end of the vehicle back even further which is overcorrected yet again. This can also appear in circuits and is primary feature of Tudor's *Bandoneon!* as will become clear later in the text.

2.1.2. Information

Through the lens of cybernetics, information is viewed as messages between systems or between components of a system that are used as input to another system. Indeed in Wiener's *The Human Use of Human Beings*, a great majority of the book is concerned with the idea of communication and its essentiality to the nature of man and society. Cybernetics itself is the study of the "effective messages of control."[11] Information is organized into *patterns*[12] which are *negentropic* in nature; that is, patterns resist

[11] Wiener, *HUHB*, pgs. 3-9
[12] Wiener, *HUHB*, pg. 4

entropy.

2.1.2.1. Entropy and Negentropy. A measure of the information present in a system at any given time is a measure of the *order* of the system and its negative is a measure of the *disorder*. In cybernetics, these are known as negentropy and entropy, respectively. Wiener further argues that entropy "almost never spontaneously decreases in an isolated system"; that is, there is a natural tendency toward disorder which, contrary to popular myth, is also a tendency toward equilibrium.[13] Incidentally, this is the second law of thermodynamics applied to communication systems. Note that being able to measure the entropy of a system demands that the information contained within the system is quantified. This in particular presents a potential problem when applying the notion of information to the arts.

2.1.3. Interdisciplinarity

While not a technical aspect of cybernetics, it is, nonetheless, an important qualitative feature. Cybernetics, as conceived by Wiener, helps to navigate the no-mans-land between disciplines and the places where the boundaries are no so distinct as they might be elsewhere.[14] The thing to note here, though, is that it is not interdisiplinary between any particular fields but it rather comes to being in those murky spaces just described.

2.2. *Systems Aesthetics*

Introduced by Jack Burnham in his article *Systems Aesthetics*, systems aesthetics is essentially an application of the concepts of general systems theory found in the writing of Ludwig von Bertalanffy to artwork and the art world in general.[15] He goes so far as to quote von Bertalanffy directly in defining a system as "a complex of components in interaction..." The principles of systems aesthetics are three-fold: environmentality, interactity, and autonomy. That is, environmental in the sense that the bounds of the artwork are no longer the physical bounds of the object; interactive in the sense that

[13] Wiener, *HUHB*, pg. 19
[14] Wiener, *C*, pg. 2
[15] Burnham, *Dissolve into Comprehension, Systems Aesthetics*

the artwork is a system of interactions; and autonomous in that the "viewer does not control the meaning, but witnesses it."[16] Though Andreas Broeckmann takes autonomy to be more figurative, systems aesthetics does not preclude the *literal* autonomy of an artwork, wherein the apparatus of the artwork can almost be ascribed its own personality.

Burnham cites the changing societal needs during the 1960's, shifting away from "products", that is, "filling consumer needs on a piecemeal basis" where the objects of technology strucutred the patterns of living, toward concerns such as "maintaining the biological liviability of the earth, producing more accurate social models of interaction, understanding the growing symbiosis in man-machine relationships, establishing priorities for the usage and conservation of natural resources, and defning alternate patterns of education, productivity, and leisure." This, he argues, demonstrates a "transition from an *object-oriented* to a *systems-oriented* culture. Here change emanates not from *things*, but from the *way things are done*."[17] This sentiment was echoed decades before by the philosopher Alfred North Whitehead in *Process and Reality* when he said that it was processes, as opposed to substances, that constituted the world.[18]

Fundamentally, systems aesthetics works from the notion that the function of modern art "has been to show that art does not reside in material entities, but in relations between people and betwen people and the components of their environment."[19] That is, the object itself serves as a *catalyst* for exposing these people-people and people-environment relationships as the constituents of art and *not* the superficial appearances present in the object. This, of course, applies too to sound art such as music. This idea is made concrete by Burnham's example of Robert Morris' work at the 1966 "68th American Show" at the Chicago Art Institute. Morris had created two large, L-shaped strucutres that were shown the previous year in New York City. When the work was to be installed in Chicago, it was found that it was cheaper to send plans for the work to be rebuilt in Chicago than it would be to ship the originals from New York. Burnham: "In the context of a systems aestethic, possession of a privately fabricated work is no

[16]Broeckmann, *MATC*, pg. 107
[17]Burnham, *DiC, SA*, pg. 116
[18]Whitehead, *Process and Reality*
[19]Burnham, *DiC, SA*, pg. 118

longer important. *Accurate information* takes priority over history and geographical location."[20] (Emphasis added)[21] Were there any complaints from visitors to the "68th American Show" that Morris' work was not a true "Morris" since he himself did not lay hands on the piece? If there were any, none were recorded in the historical record. In the words of Burnham, again: "In such handling of materials the idea of *process* takes precedence over end results."[22] (Emphasis original)

Burnham further suggests that a systems approach in art deals with the problem of "boundary concepts". Traditionally, it is the material limits of an artwork that define it as such; that is, they enclose the system by placing it in a frame or on a stage. From a systems perspective, however, it is the "conceptual focus rather than material limits that define the system."[23] Because of this shift from the material to the conceptual, from the object to the system in which the object resides, the information contained in and about the art object becomes a "viable aesthetic consideration." If the material object is thereby denied an ability to define the boundary conditions of itself as an artwork and that it is the relationships which it exposes and in which it sits that define it as such, then it follows that the fetish character of the "high art" object is called into question. Les Levine's *disposable* and *infinite* series make this manifest in the mass production and distribution of art objects, thus "deny[ing] scarcity as a legitimate correlative of art."[24] Moreover in the systems approach, both interaction and the autonomy of a work become important and desirable considerations since, as opposed to formalist art where the relations betwen a works *visible* elements are foregrounded, *invisible* relations are brought into aesthetic consideration.

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[20]Burnham, *DiC, SA*, pg. 120

[21]It is interesting to consider this example in particular with regard to music. In the classical music tradition, there are no qualms about a composer who originally performed their own works being absent from a performance of the same work at a different time. That is, their (un)presence does not necessarily add anything to the artwork that is transmitted to the ears of the listeners. This is not true, though, in the case of "cover bands". Perhaps this is more a function of temporal proximity or even availability of the "originals", even in old age and inferior performance, than it is about the specific notions of the art flowing through the air.

[22]Burnham, *DiC, SA*, pg. 120

[23]Burnham, *DiC, SA*, pg. 118

[24]Burnham, *DiC, SA*, pg. 122

2.3. *Cybernetics + Systems Aesthetics in the Arts*

As one might naturally suspect, the ideas codified in both cybernetics and systems aesthetics were present in the work of artists long before either Wiener or Burnham put them in writing. As early as 1925, the Hungarian artist László Moholy-Nagy imagined "simultanous, synoptic, synacoustic (optical or phonetically mechanical) representation[s] of thought (cinema, gramophone, loudspeaker) or a design of thoughts that interlock like cogs,"[25] These notions of interlocking elements assembled from various disciplines, this inter-domain feedback and communication is the backbone of cybernetics. In his *Light Prop for an Electric Stage* (1930), Moholy-Nagy created a rotating kinetic scupture using motors, metal, and electricity in order to "demonstrate the effects of light and movement."[26] The interconnected nature of the various systems used in the piece — both mechanically and conceptually — are clear forerunners of the cybernetic impulse. Despite the aesthetic intent of the piece, it is interesting to note that Moholy-Nagy speaks of his work as *demonstrating* something relatively objective: that of the formal relationships between the viewer, light, and movement. One may argue that indeed the entire project of systems aesthetics is to lay bare the relationships found within, betweeen, and amongst an interdisiplinary artwork and its context.

More explict in the usage of cybernetic principles are the sculptures of Nicolas Schöffer where his goal was the "total liberation of sculpture" in a practice he called Spatio-Dynamism by creating "kinetic scuptures whose movements are not predetermined and that [stand] in a dynamic relationship [to] its environment."[27] Schöffer had read the work of Norbert Wiener in the 1950's and described cybernetics as "the awareness of the process that keeps phenomena in balance," and that in an aesthetic context of this balance, "every appearance of a tendency toward periodicity or stagnation triggers the intervention of the perturbations needed to maintain the openness and the contingent character of any evolving process."[28] Schöffer's *CYSP 1* from 1956, a piece he considered to be the first work in which the principles of Spatio-Dynamism were applied in their totality, was later exhibited in 1968 at Jasia Reichardt's show

[25]Broeckmann, *MATC*, pg. 100, note 43
[26]Shanken, Edward A. *Art and Electronic Media*, pg. 18. Moholy-Nagy quoted from The New Vision, 1928
[27]Broeckmann, *MATC*, pg. 98
[28]Broeckmann, *MATC*, pg. 101

Cybernetic Serendipity, one of the first attempts at an overview of work produced by artists inspired by cybernetics and systems theory. As Andreas Broeckmann argues, *Cybernetic Serendipity* was "an art show as much as a demonstration of new technologies and cybernetic principles."[29] It is curious that in *Cybernetic Serendipity*, nearly all aspects of research in the field of computer music were included as part of the music portion, pointing to the cybernetic origins of computer music as we understand it today. This, of course, is not strictly due to the technological requisites of the practice but to the type of thinking endemic to computer music since its birth.

Systems aesthetics, as oulined by Jack Burnham, was a parallel development to cybernetic aesthetics was the aforementioned. Once again, enter László Moholy-Nagy: his 1923 piece *Telephone Pictures* prefigures the supremacy of information as the subtance in an artwork in the view of systems aesthetics. In 1970, Burnman curated the show *Software* that, among other things, showcased work that embodied the principles of systems aethetics as the "art impulse in an advanced technological society."[30] It is interesting to note that until as late as 1997, art historian Marga Bijvoet noted that despite the acceptance of systems theory and cybernetics as valid approach methods in various disciplines, the scholarly art world has generally neglected this approach. This despite the fact that artists have been explicity creating cybernetic work and enganging directly with the ideas found in Burnham's systems aesthetics since their conception including Nam June Paik, Hans Haacke, and Les Levine, apart from those already mentioned.

But what of music? Nearly all of the musical works that were included in *Cybernetic Serendipity* would be considered "traditional" computer music in the present day. Their defining feature was that of using computers and technology to enable and aid the compositional or analytical process. While relevant, these are not exactly the kind of projects this text seeks to focus on. Many years afterward there emerged on the periphery of the already obscure practice of electronic music a figure who directly engaged with these cybernetic principles both explicity and conceptually.

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[29] Broeckmann, *MATC*, pg. 103
[30] Burnham, *DiC, SA*, pg. 121

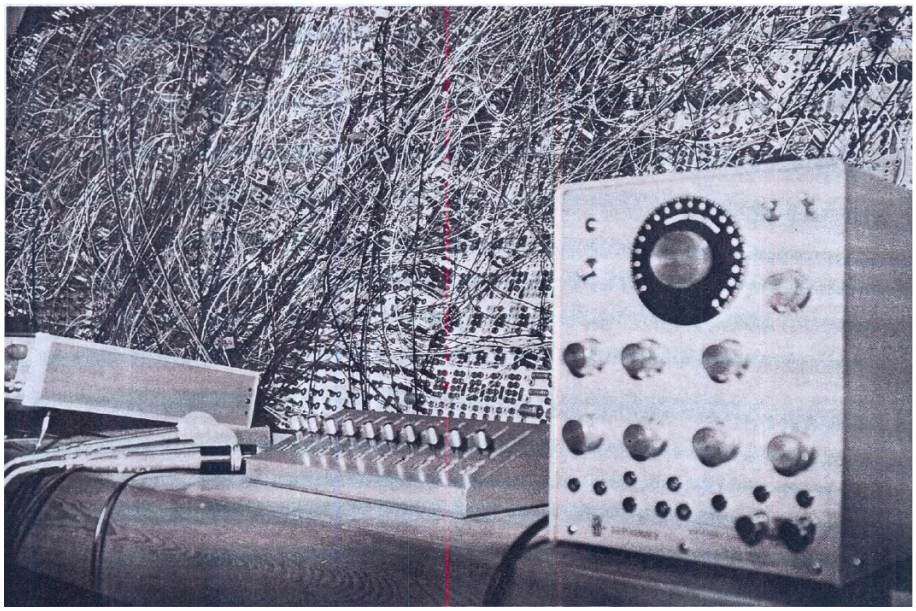

Figure 1. One of Roland Kayn's modular synthesizers.

2.3.1. Roland Kayn's Cybernetic Music: Programming of the Unprogrammable

The music of German composer Roland Kayn is one of the few musics that directly and explicity engage with the concepts and principles found in cybnernetics. His interest in pursuing cybernetics as a compositional approach occured following his study with the philosopher Max Bense and commenced after his relocation to the Netherlands to take a position at the Institute of Sonology. Kayn himself describes his music this way: "Cybernetic music — whether it is produced vocally, with instruments or electronically — is not initially 'composed' and practised. It arises from the interplay of merged control loops setting a process into motion."[31]

Kayn contrasted his work with more "traditional" computer music in that in traditional computer music, a composer generally translates their thoughts into a programming language while in his version of cybernetic music, the "existing sound materials are fed back upon themselves in order to create deviations from that which came before."[32] The result was that the "scores" ended up as "material-technological" configurations of analog devices, the combinatory nature of which determined the space of the work. The very nature of the analog devices Kayn used in his work precluded the determinism of symbolic notations or programmed pieces, instead relying on their

[31]Kayn, "Text"
[32]Kayn in *Infra*, as quoted in Patteson

imperfections to "guide" or "steer" in what Thomas Patteson calls the "etymological spirit of cybernetics."[33]

In the same way we shall see the technological apparatus of *Bandoneon! (a combine)* possesses its own primitive artificial intelligence due to the number and nature of interconnections, so too Kayn argued that electronic systems possessed a "sort of capacity to think for [themselves]."[34] Moreover, Kayn felt that the self-generative nature of the formal developement in his work was mirrored in the listening process. By bringing the control strucuture "within the range of audibility," the listener is able to follow the compositional process as it is carried out by the sound-producing devices and "'the acoustic construct is hence made more lucid and more of a total auditory experience..."[35] Unfortunetly, it is only possible for this text to ascertain Kayn's thought process from secondary sources, as much of his writing is unavailable or appears in the liner notes of the LP's he released throughout his life, all of which are rare and out of print.

2.3.2. 9 Evenings: Theatre & Engineering

The entire premise of the *9 Evenings: Theatre & Engineering*, staged at the 69th Regiment Armory in New York City, was to foster collaboration between artists and scientists at Bell Labs wherein both groups would have "an equal voice in the direction and all responsibility would be shared jointly."[36] By putting the artists and engineers together at the earliest stages of a works conception, organizer Billy Klüver was interested in seeing how works would develop. This act, by its very defintion, is interdisiplinary and thus sets the stage for the works to become cybernetic. Does this mean, then, that all the works at the *9 Evenings* are cybernetic by their interdisiplinary nature? While they may all be considered cybernetic by virtue of their use of various disciplines and/or feedback systems, their interdisciplinarity does not, in and of itself, make them cybernetic.

However, in order to expose how the underlying concepts might manifest themselves

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[33]Patteson, *The Time of Roland Kayn's Cybernetic Music*
[34]As quoted in *Elektroakustische Projekte* in Patteson
[35]Kayn as quoted in Patteson
[36]Klüver's intro to the catalog as quoted in Morris

in a work of art, it is worthwhile to examine one work in particular: that of David Tudor's *Bandoneon! (a combine)*. Being the most technically elaborate setup of the *9 Evenings* — using devices for sound, visual projections, lights, and kinetic scuptures — it is a prime candidate to examine these concepts both technically and conceptually.

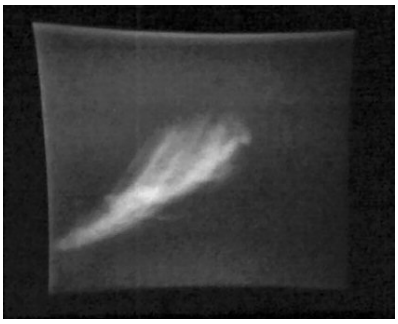
3. David Tudor's *Bandoneon! (a combine)*

David Tudor's *Bandoneon!* (pronounced "bandoneon factorial") was performed twice during the *9 Evenings*, first on October 14 and then on October 18, 1966. While the bandoneon sits centrally (literally and conceptually) in the work, it properly consists of several parts: the bandoneon with ten contact microphones; various electronic sound-producing devices including modulators, distributors, and amplifiers into which the sound of the bandoneon was routed, including the forty-channel Vochrome; twelve independent channels of sound projection (and twelve loudspeakers, one for each channel, distributed about the Armony); visual projections from Lowell Cross' TV Oscilliscope; eight light projectors; five radio-controlled mobile sculptures that moved about the space by operators being vibrated with signals from the bandoneon; and, not least, the Armory as a resonating body itself. An important addition to the bandoneon was a reset button by which the output from the Vochrome could be reset and would thus stop all sound, apart from the natural reverb in the Armony, almost instantaneously.

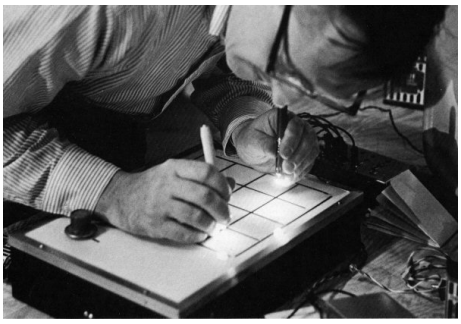
The technical needs of *Bandoneon!* provided an enormous strain on the engineers: "As Tudor played, ten conctact microphones picked up the sound, which was then distributed into four processing devices. The output of a forty-channel filter [the Vochrome] was fed into twelve speakers, and controlled spotlights on the balcony. An audio processing and modifying circuit built by Tudor fed four transducers attached to wood and metal strucutres and horn speakers on the Armory floor [the radio-controlled sculptures]. A fourth device, designed by Lowell Cross [TV Oscilliscope], controlled abstract images on three modified television projectors."[37] This description gives a very rough idea of what was occuring and Herb Schneider later wrote: "Those first two evenings of performances we were plugging in more wires at

[37] Morris, *9 Evenings Reconsidered*

(a) The Vochrome open exposing the row of harmonium reeds.



(b) The TV Oscilliscope during *Bandoneon!*



(c) Fred Waldhauer with his Proportional Control System during *Bandoneon!*

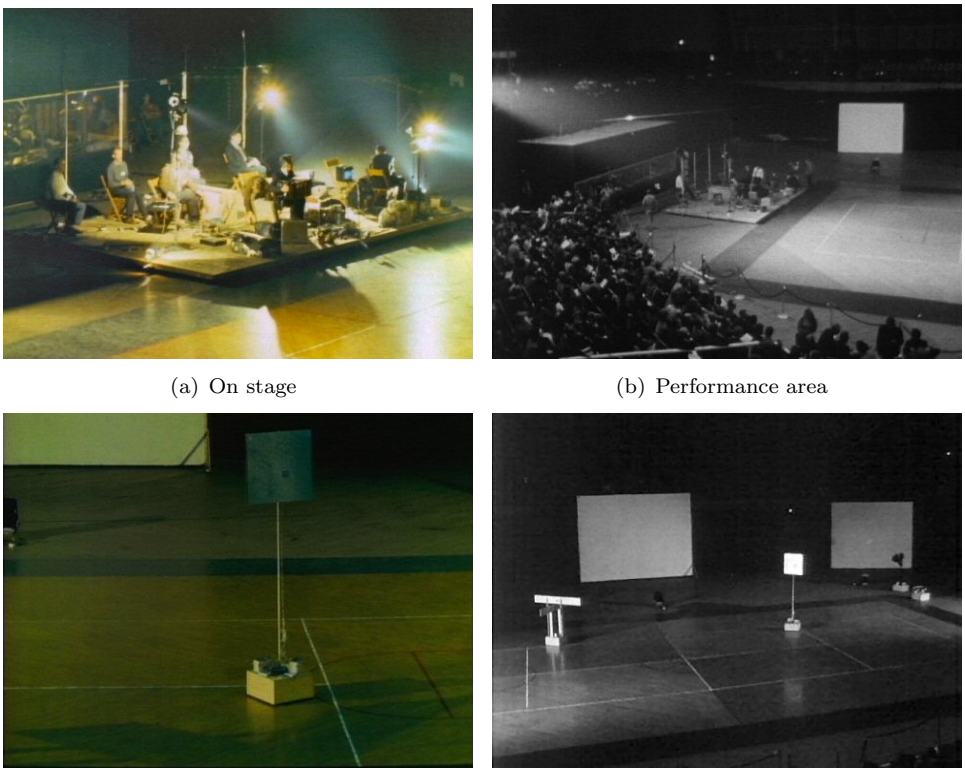
(d) David Tudor playing the bandoneon with contact mics visible

Figure 2. Various devices used in David Tudor's *Bandoneon! (a combine)*

once than I ever knew I could handle. It was a mess."[38] The specific details of how each piece of equipment functioned in the piece is not crucial for creating an analysis of the underlying cybernetic and systems principles of the work. Suffice it to say that it was multimedia in every sense possible in 1966. What *is* crucial, though, is a framing of the interconnected devices as a *meta-device*. That is, it is more helpful to think of the work not as a work for bandoneon plus various technological devices, but rather as a bandoneon-apparatus, a *technological-apparatus* of which the bandoneon was the interface.

The role of Tudor is best thought of as governor, an actor within a highly unstable machine (which includes the performance building itself) and the "performance" as this governor exploring and riding this machine. It consistently wrests control from the governor, intent on creating its own destiny; hence, the reset button. Looking at it this way, the distinction between biological and non-biological systems is diminished with the bandoneon-apparatus having a will of its own. Indeed, in his review of

[38]Whitman and Klüver, *Notes by a Partcipant*



(a) On stage (b) Performance area

(c) Mobile sculpture (d) Two mobile sculptures

Figure 3. Images of *Bandoneon! (a combine)* at the *9 Evenings*.

the *9 Evenings*, Burnham argues that the entire production required a different set of aesthetic values to appriciate the systems as art and that "[t]his suggests that systems-oriented art... will deal less with artifacts contrived from their formal value, and increasingly with *men* enmeshed with and within purposeful responsive systems."[39] (Emphasis original) The notion of the machine possessing its own will brings to mind Wiener's anecdote about the "gremlin" in aviation: "The semi-humorous superstition of the gremlin among the aviators was probably due, as much as anything else, to the habit of dealing with a machine with a large number of build-in feedbacks which might be interpreted as friendly or hostile... [The machine] may easily be felt as a personality to be antagonized when the plane is forced into unusual maneuvers."[40]

Indeed, Broeckmann speaks of how it appears that Tudor "were working on an overly powerful interface whose complexity he could not yet master, and whose beyond-control aspects became a crucial factor of the aesthetic experience of the perfor-

[39]Burnham quotes in his review of *9 Evenings*. Bijovet, *Art as Inquiry*, pg. 33
[40]Broeckmann, *MATC*, pg. 96, note 28

mance."[41] This "beyond-control-ness" likley necessitated the particular compositional approach Tudor is said to have used in the work: "In essence, Tudors basic compositional approach in *Bandoneon! (a combine)*, one he shared with contemporaries such as Pauline Oliveros, Gordon Mumma, and especially John Cage, was to set up a series of material conditions — staging, electronic wiring, instrumental combinations, and so on — and then to conceive of a composition as a nearly automatic playing out of these conditions."[42] The question is, then, what technical and conceptual strucutres found in both cybernetics and Jack Burnham's systems aesthetics are articulated, with varying degrees of clarity, in Tudor's work?

3.1. *Technical Underpinnings*

Investigating the technical apparatus of *Bandoneon!* is perhaps the most clear and obvious resource in which to find these concepts and structures. It is itself a system — perhaps the most complex system presented at the the Armony show — which in a sense has its own life, its own desires, its own modes of being. Viewed this way, the *Bandoneon!* apparatus would be called an "open system" in the lexicon of von Bertalanffy; that is, a system which is open to responses from its environment. In this case, it is Tudor providing an input (the sound of the bandoneon) and taking the apparatus' output as feedback, makes decisions as to what to do next by stimulating the single sense organ of the apparatus: the bandoneon. The apparatus also feeds on itself: in the modulation device built by Tudor, one side of the bandoneon was modulated against the other side. Tudor: "*Bandoneon! (a combine)* uses no composing means since when activated it composes itself out of its own composite instrumental nature."[43] Surely, the instrument he refers to is the very complicated case of the bandoneon-apparatus with its various ins, outs, and what-have-yous; these are all strands Tudor must keep in his head.

In fact, the entire work and the bandoneon-apparatus itself were built on the premise of feedback: "I had discovered this principle of whats called a saturated amplifier, where you arrange feedback around an amplifier to the point where the circuit oscillates of

[41] Broeckmann, *MATC*, pg. 102
[42] Goldman, "The buttons on Pandora's Box: David Tudor and the bandoneon", pg. 54
[43] Tudor in the program notes. Morris, *9 Evenings Revisited*, pg. 17

itself. All you have to do is activate it by putting a signal in, and it can keep oscillating forever and ever. Which is one of the features of the piece."[44] This feature, incidentally, was what required the installation of the reset button on the bandoneon in order to stop the sound. Tudor again: "...by touching that button I could stop the sound. The silence was deafening, because the sound in the Armony was extraordinary. Once you started something oscillating, it would go on forver."[45] These are clear manifestations of the oscillation Wiener speaks about in *Cybernetics*. Instead of treating them as disorders, as Wiener does in his examples, Tudor treats these as properties to be harnessed and utilized for a creative end.

3.2. *Conceptual Underpinnings*

More interesting than the technical aspects of the work is the way in which *Bandoneon!* embodies (some of) the explicit conceptual aspects of both cybernetics and systems aestethics, as well as appropriating the technical features as aesthetic frameworks. For a field such as cybernetics, this is a fairly natural leap, since it does not exist within or among any particular disciplines, its concepts are readily adapted to new contexts.

3.2.1. Information

If we are to take Burnham at his word that accurate information (indeed, all the information surrounding a work) is a core feature of system aesthetics, then it must be the case that all the interactions between Tudor (the artists) and the engineers are also part of the artwork(s) and that the performance(s) during the *9 Evenings* is the "display", the physical manifestations, of these interactions, the aesthetic decisions bearing fruit. Moreover, the push-and-pull nature of the artist-engineer interactions are akin to the oscillations of feedback systems described by Wiener manifested in human-human relationships.

To paraphrase Wiener in speaking of the similarities of both man and machine: "Both of them [Tudor; the bandoneon-apparatus] have sensory receptors at one stage in their cycle of operation: that is, in both of them there exists a special apparatus

[44]Taped interview on the DVD *Bandoneon! (a combine)*
[45]Interview with Joel Chadabe in the notes for the *Bandoneon!* DVD

for collection information [Tudor: ears, eyes; bandoneon-apparatus: the bandoneon, the Proportional Control System] from the outer world at low energy levels, and for making it available in the operation of the individual or of the machine. In both cases these external messages are not taken *neat*, but through the internal transofmring powers of the apparatus, whether it be dead or alive. The information is then turned into a new form available for the further stages of performance. In both the animal and the machine this performance is made to be effective on the outer world. In both of them, their *performed* action on the outer world, and not merely their *intended* action, is reported back [fed back] to the central regulatory apparatus [Tudor, in the case of the machine; the brain, in the case of Tudor]."[46] (Emphasis original)

What of the nature of the information that is transmitted to the spectators? Is there a framework which allows the cybernetic analysis of information contained within an artwork? There are two, in fact: Max Bense's "analytical aesthetics" and a branch of artificial intelligence called *computational aesthetics*. Both purport to be able to answer these questions and provide a quantitative basis upon which artwork can be evaluated but a study on the veracity of these claims is beyond the scope of this text.[47,48] What can be said regardless of the nature of this aesthetic information, though, is that artworks — *Bandoneon!* included — are a negentropic force with regard to the system-of-things in which they exist. To be sure, an artwork is a pattern-making entity which organizes information and presents it to an audience. This is true of any and all artwork and is not limited to *Bandoneon!*.

What is further interesting about the "information" in the piece (the non-aesthetic information) is the way it is *transformed*; that is, the bandoneon emits aural information which is turned into electrical signals by the pickups. This is then routed to a numbner of devices and used as control signals. The information is thus again transformed, sometimes presenting itself in several ways simultanously. What does this say about the information's "accuracy"? Is it accurate? In what way is it accurate? What good is information if something meaningful cannot be decoded from it?

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[46] Wiener, *HUHB*, 15
[47] Neumann, *Defining Computational Aesthetics*
[48] Bo et al., *Computational aesthetics and applications*

3.2.1.1. Entropy. While the work of art always appears as a negentropic force in terms of its organization, one might also point to the complexity with which *Bandoneon!* was produced and call it entropic. While true in a very superficial sense, it is also true in sense that a great deal of *Bandoneon!* is *indeterminte*; that is, indeterminacy can be equated with entropy. Not knowing how a system will respond to a message is functionally equivalent to entropy of information.

3.2.2. Cultural Contexts

To take the view of systems aesthetics, analyzing artwork only makes sense when taking into account their "assigned context."[49] This context, according to Burnham, includes not only the immediate and literal space, but also the social, political, and technological spaces within which the work exists. Taken this way, the mere fact of the collaboration as equal entities upon which the *9 Evenings* was predicated challenged the traditional role of the "artist" as we recieive it from the broader culture: that the artist is *not*, in fact, a lone mind working on an isolated island of abstraction and thoughts. This is even more the case with *Bandoneon!* and Tudor's place in it: while he certainly was the navigator or governor, the indeterminacy of the technical apparatus is striking and cannot be ignored. What is the role of a performer who is enmeshed in an instrument which they cannot fully contain nor fully control? Whom is controlling whom?

This notion also subliminally addresses an often expressed sentiment since the dawn of the Industrial Age: namely, that of man's anxiety surrounding the role of machines. As early as 1863 the novelist Samuel Butler, writing under the pseudonym Cellarius, expressed dismay at with the encroachment of machines: "Day by day, however, the machines are gaining ground upon us; day by day we are becoming more subservient to them; more men are daily bound down as slaves to tend them, more men are daily devoting the energies of their whole lives to the development of mechanical life."[50] In the paragraph following, Butler declares war against them, opines that no exceptions ought to be made, and that mankind should "go back to the primeval condition of the

[49]Burnham, *DiC, SA*
[50]Butler, *Darwin Among the Machines*, pg. 185

race." *Bandoneon!* confronts this notion head-on by assigning a machine, a man-made creation, an essentially equal role in the manifestation of an aesthetic experience.[51] Did the elevation of the machine to be equal with man in any way detract from the aesthetic experience offered by Tudor? The answer will perhaps be forever unknown as most reviewers panned the lengthy delays, "amateurism" of the event, and did not remain in attendance at the festival long enough — apart from Robert Rauchenberg's work — to see it.

Regardless, one imagines that this notion of the *uncanny*, in the sense that Stanley Cavell uses it, was awoken at some level. Cavell rejects Freud's contention that the animate/inanimate conflation does not lie behind the uncanny, but that it pricely describes it. That is, the uncanny is the "philosophical anxiety exacerbated by the ambiguity created when it is unclear whether a mind or merely an inanimate object is at hand."[52] It is interesting, though, that Cavell makes the distinction between a mind and an inanimate object for it begs the question: what is a "mind" in the first place? Since the bandoneon-apparatus pushes and pulls the work in ways Tudor cannot necessarily control nor anticipate, it does not seem out of line to say that the bandoneon-apparatus does indeed possess a kind of mind, albeit a relatively primitive one. This is consistent with the gremlins in Wieners aviators and the way Kayn speaaks of his systems as having "a sort of capacity to think for itself, a capacity which in a sense can be described as artificial intelligence..."[53] Maybe the distinction for the uncanny then ought to be not mind or inanimate object, but rather one of "our" minds (a human) and the mind of a human creation, one that seems to threaten the very essence of humanity.

[51]This is relatively commonplace in the present day with the ubiquity of interactivity in artwork, yet the fact that the fear remains is rather telling of the insecurity of man.

[52]Broekmann, *MATC*, pg. 97

[53]As quoted in *Elektroakustische Projekte* in Patteson

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