# CLOUD MUSIC: A CLOUD SYSTEM

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**Abstract**

This paper suggests that artworks such as Yoko Ono's Sky TV (1966), Hans Haacke's Condensation Cube (1963-65), and David Behrman, Robert Watts and Bob Diamond's Cloud Music (1974-79) are ancestors to a significant strand of contemporary art practice that binds weather, emergent technologies and the observer-participant. Such projects freed technical instrumentation (meteorological devices, cameras, video analysers and circuitry) from their conventional usage in communication or science. It will be argued that the highly variable patterns of weather provide a live, improvised score, yet are still subject to restraints, where hierarchies between artist or composer and audience, as well as human and machine, became unsettled.

**Keywords:** Ecological Aesthetics, Cybernetics, Electronic Music, Installation Art, Meteorological Art, Early Computer Art, Fluxus

The dynamic patterns of weather were adopted as a direct feed in kinetic, performance and early televisual art in the 1960s and 70s. The variability and 'liveness' of weather became a driver in 'real-time' systems in many artworks, including in the international avant-garde movement Fluxus. For instance, Yoko Ono's well-known work *Sky TV* (1966) trains a video camera on the sky in a closed circuit loop to a monitor, exemplifying an early experiment with weather and new technology. This paper focuses on the audiovisual installation *Cloud Music* (1974-79); a collaboration between the artist Robert Watts, most well known for his work in Fluxus, David Behrman, experimental composer of electronic music and Robert (Bob) Diamond, systems engineer, and video designer. A first-hand account of the development of *Cloud Music* was related to the author in an interview in May, 2013 with David Behrman and Bob Diamond; Robert Watts passed away in 1988.

The area of media art practice that I have called 'Meteorological art' [1] has links to systems theory, cybernetics and concepts of chaos and indeterminism in physics. I will refer in particular to British cyberneticist Gregory Bateson's chapter 'Cybernetic explanation' in *Steps To an Ecology of Mind* (1973) as a frame to discuss how dynamic systems operate in *Cloud Music*. The paper will examine the implications for an ecological aesthetic by taking Cloud Music as a model of relations across a series of recursive, differential systems. As a cultural 'dialectics of transformation' [2], these works suggest an analogy between changes of state in physical systems and the possibility of shifting or rethinking human-technology-nature relations.

During 1945-1960 when cybernetics was established as a discipline, Gregory Bateson, Norbert Wiener, John von Neumann, Claude Shannon among many others met at annual conferences sponsored by the Josiah Macy Foundation to formulate the core concepts of a theory of communication and control that would incorporate the bios, the human and the machinic. A key concern of this developmental phase of cybernetics was homeostasis, or the ability of living organisms to maintain steady states in diverse environments by using feedback loops. This focus was reformulated in the 1960s and 1970s as 'second-order cybernetics.' Participants from the Macy conferences, especially Margaret Mead, Gregory Bateson, and Heinz von Foerster, resolved to attend to the implications of the feedback loop that could also 'loop through the observers, drawing them in to become part of the system being observed'[3].

The concern of cybernetics is not with the substance of any one specific system, but with, "the structurality of systems in general and above all, the structurality of differential relations between and across systems", to cite theorist Louis Armand [4]. This view of systems as mutually causal and interconnected across social, biological, and technological systems, and the inclusion of the observer as participant, correlates to relational approaches to art practice in the 1960s and 1970s.

In addition, sciences that considered ways of behaving or transforming; processes rather than predetermined outcomes, sparked the attention of art practitioners of the period. The shift of focus in science from ontology (what things are) to ontogenesis (how things become) described by physicists Isabelle Stengers and Ilya Prigogine (1988) is also discernable in art experiments of the period. In addition, Stengers argues that vernacular translations of 'chaos' and 'complexity' have held a redemptive function for science, freeing science from charges of reductionism [5]. Order and disorder are no longer perceived as binaries; order is encoded within chaos, where a process such as entropy may lead to a higher order. In relation to meteorological systems in particular, new connections between computers and weather were forged during World War II that enabled meteorologists to increase the accuracy of weather prediction.

The study of complexity in meteorology intensified after founder of cybernetics Norbert Wiener delivered his paper 'Non-linear Prediction and Dynamics' at Berkeley in 1956. Wiener's theory introduced a mathematical model where the coordinates would constantly fluctuate. Several meteorologists at MIT used Norbert Wiener's paper on non-linear dynamics to reinforce their current statistical forecasting methods based on formulas that cover a spectrum of changing factors, such as current temperature, combined with wind speed, or the temperatures of a neighbouring city. However one meteorologist, Edward Lorenz, felt that Wiener's paper was being misinterpreted. Lorenz tested Wiener's theories by selecting a non-linear, hypothetical set of weather data equations based on the various interactions of twelve variables. He thought he could capture the essence of how weather changes through these non-linear differentials. [6]

By 1963, the numerical experiments of Lorenz revealed the 'sensitive dependence of the initial conditions,' where the amplification of an initial discrepancy could produce a pattern that was quite different to an earlier weather forecast, in the case of a weather prediction. Yet it was not until the 1970s that 'certain fluctuations that produce a higher order through complex relationships' [7], and Lorenz's 'strange attractor diagram', become widely known as 'chaos' theory. 'Chaos' signaled a new paradigm in science that could be applied to many systems from the stock market to epidemics.

'Chaotics', a term coined by N. Katherine Hayles to describe cultural interpretations of the science of chaos, was construed on multiple levels by composers, artists and writers of the mid twentieth century [8]. Compositions by David Tudor and John Cage contain musical interpretations of disorder, order, probability, randomness, freedom and indeterminacy for instance. In many cultural forms disorder was regarded as integral to a work, rather than an aberration. Prior to *Cloud Music* David Behrman collaborated with Tudor and Cage on early 'Experiments in Art and Technology' events as a young assistant, and later as a composer with the Merce Cunningham dance company. Both chaotics and chaos theory were important to *Cloud Music*. Video designer Bob Diamond will be cited at length in the following, with

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**Page numbering begins at 1 at the start of the paper.**

regard to how the piece was connected to his work in a different environment as a systems engineer for NASA on the Apollo project.

## Cloud Music

To enable Robert Watt's poetic idea of listening to the clouds, Behrman and Diamond designed a whole system from scratch, including audio and video, that they dubbed the 'Cloud Machine'. The video analyzer, designed by Bob Diamond, linked six crosshairs on a monitor positioned towards a particular set of clouds, to six control voltages. As the light values of the moving clouds changed as they passed across the crosshairs, the voltages changed and were converted into triggered progressions of pitched sounds, made by a music synthesizer. Diamond explained, "the whole idea of it was to almost be able to feel the shape of the clouds. […] depending on the shape of the cloud different parts of the screen will be activated at different sensitive points"[9]. Behrman regarded each of the six cross hairs as possessing a 'music personality'.

The artists worked collaboratively over a two-year period from 1972-1974 to develop the work. The egalitarian nature of this collaboration was unusual for the 1970s where electronic art would often be promoted as the work of a single well-known artist, supported by unnamed assistants. Bob Diamond was shifting between a remote cabin in Montrose, Pennsylvania and working for the experimental WNET TV Lab on video synthesizers and video circuitry in New York. He custom-designed video switchers for Nam June Paik, with whom he worked closely during this period [10]. Diamond's method relies on time-base or sync signal of the video. This signal synchronizes the sweeping movement of the electron beam in a television picture tube with the Sony video camera [11].

The six circuit boards for each cross hair of the video analyzer were soldered together with Diamond's wife Pat in a smaller version of a 'Model-T Ford' production line-style process in the cabin over ten months.

Central to *Cloud Music* (1974-1979) are, of course, the clouds themselves, a highly dynamic physical system. Even in this century scientists still struggle to understand the complex set of drivers which determine the height, density, composition and color of clouds, which, combined with their ephemeral nature, means that clouds remain one of the least understood aspects of the climate system. The response of the climate system (and feedbacks) to large scale changing cloud patterns is also largely unknown [12].

The process of sensing the differences in clouds in *Cloud Music* relies on an analysis of pixel coordinates. Diamond professes to seeing the sky in terms of equations, saying; "I see a mesh of two-dimensional points with depth and magnitude" [13]. In Bateson's 'Cybernetic Explanation,' a chapter written contemporaneously with *Cloud Music*, he writes "Formal processes of mapping, translation or transformation are, in principle, imputed to every step of any sequence of phenomena which the cyberneticist is attempting to explain" [14]. In cybernetics, substance devolves to the information "carried" by the events and objects in the circuit in Bateson's analysis, just as the physical movements of the clouds devolve to audio information in the artwork. Although there is no causal link between Bateson's text and *Cloud Music* itself, there are parallels between cybernetic theory, Diamond's practical knowledge of feedback systems from his training in electro-engineering and Robert Watt's conceptual premise for the work.

Robert Watts would arrive in an exotic car at the cabin in Montrose to exchange ideas with Diamond on the artwork and then drive back to New York. Watts was primarily responsible for the installation design, and like Hans Haacke's *Condensation Cube* (1963-65), he made a Plexiglas box on top of a steel box to house the circuit boards. To reveal the interior of the technological black box was important to the *Cloud Music* collaborators [15]. Open or closed boxes that revealed or hid their structural workings were something of an obsession among avant-garde artists as well as a key motif in cybernetics [16]. In 1964, the Dwan Gallery staged the show *Boxes*, which included Robert Watt's work along with Edward Keinholz and Larry Bell and many others. Robert Watt's earlier artwork, *Three Clouds* (1965) included photographs of clouds and skin applied to three box-shaped plastic laminate pedestals.

The interior workings of Diamond and Behrman's intricate electronics of the 'Cloud Machine' were open to view through the clear Perspex case. Behrman's wirey custom-built audio generator included analogue as well as digital chips. From 1975 Behrman was acting director at the Center for Contemporary Music at Mills College, in Oakland, California. There was a small community of artists there who were working with emergent digital technology. Diamond described Behrman's music generator in reverential terms; "…it actually had AI (artificial intelligence) and a temporal memory. It could remember sequences that happened in the past. This was before computers had hard-drives and memories" [17].

Behrman explained further,

> The synthesizer had counters and adders that could mark and count the light-change events as they came in. It had six banks of three oscillators; each one could run backwards to replay what just happened, on a simple level. The history of light change-caused changes was recorded. Voltages from the video analyzer were changed into digits 0 to 7, and these integers determined the audio output tunings [18].

As well as having a temporal memory, environmental responsiveness was a central trope in *Cloud Music*. Behrman notes,

> If you think of a conventional composition as an object that is fixed from beginning to end, [instead] we were creating a situation to be explored by musicians. So that situation where the musician would play and trigger things is analogous to what happens in Cloud Music where the clouds could randomly trigger things. So these ideas of interactivity were in the air then, and they were related to Cage. Where you would leave in elements that you can't predict and it keeps it lively that way. You try and get rid of your own clichés. Cage used chance, [sic] he used the I-Ching to open up a situation. And, in a way, the clouds moving across the sky is like the I-Ching. […] [19]

While Behrman frames *Cloud Music* in terms of Cagean aesthetics, he also employed cybernetic notions of 'self-regulating systems that feedback on themselves' and 'drift' [20]. Behrman states that Bob Watts was certainly aware of cybernetic concepts at the time of making *Cloud Music*. The science of circular, causal mechanisms, fluctuation and 'feedback' were popular motifs for artists and composers in this period. A cultural discourse that could be responsive to chaotic factors and non-linearity

seemed to valorize the minutiae of local ecologies, even to deconstruct the liberal humanist subject and subvert the technological determinism of Twentieth century militarism.

For instance, art critic Jack Burnham cites Hans Haacke on his *Condensation Cube* as follows, "I was very excited about the subtle communication with a seemingly sealed off environment and the complexity of interrelated conditions determining a meteorological process" [21]. According to Haacke, this process produces in the viewer's mind a conceptual oscillation, in dialectical conflict with both traditional art and the hierarchical organisation of physical relationships. Whether or not a 'conceptual oscillation' is actually produced is a matter of speculation but his statement suggests that the audience might take an equal role in the constitution of an artwork. In second order cybernetics the observer in a living system is part of the cycle of information exchange, rather than a one-way model of transmission and reception. The observer does not just monitor pre-existing systems, but actually creates them through the act of observation. Haacke's later work *Recording of climate in an art exhibition* (1970), references the effects of the respiration of the audience in a particular environment, in his 'systems-based art' [22].

Although Behrman was frequently experimenting with harmonic tonal compositions where the frequencies would develop randomly and the sequences would eventually drift, in Cloud Music the system was intended for a long-term, unmanned installation so it was not allowed to drift indefinitely, or, as the musician comments, the oscillators would go out of tune. Behrman explains,

> There was a finite set of pitch possibilities derived from one Master oscillator, using digital dividers and multipliers. This gave the sound of *Cloud Music* a slightly colder feeling than earlier pieces that were allowed to drift. [Yet] Even on a day with a plain blue or grey sky, some little change will happen in the sky once in a while, causing a voltage to cross over a threshold in the synth, resulting in a harmonic change. [23]

Although *Cloud Music* was clearly a reactive artwork, the tendency towards random harmonics in the Cloud Machine mechanism was restrained by a return to the original family of harmonic tones. Behrman contends you could always recognize the sounds in the installation as *Cloud Music*. To think about the piece in relation to cybernetics once again, Bateson describes such systems where 'the circuit is energized from some external source', or 'events within the circuit may be influenced from the outside or may influence outside events' as always open. Bateson writes, "A very large and important part of cybernetic theory is concerned with the formal characteristics of such formal circuits, and the conditions of their stability. Here I shall consider such systems only as sources of restraint" [24]. The harmonic changes in *Cloud Music* might be understood by an analysis of the restraints, or stabilizing effects, whereby the ceaseless variation of the clouds was countered by mechanisms in the circuit. Undoubtedly these restraints were also intended for aesthetic effect.

Bateson asks the reader to entertain the following idea,

> Consider a variable in the circuit at any position and suppose this variable subject to random change in value (the change perhaps being imposed by impact of some event external to the circuit). We now ask how this change will affect the value of this variable at that later time when the sequence of effects has come around the circuit. Clearly the answer to this last question will depend on the characteristics of the circuit and will therefore, be not random. [25]

Bateson's notion of randomness as part of a greater pattern can also be read as a reference to a larger relational nexus, or ecology; as that which exists beyond the confines of the box in which a system is located. As Hayles argues, if pattern was initially a privileged term among the electrical engineers developing information theory, randomness became increasingly understood as the creative ground from which new kinds of pattern can emerge. [26] If pattern is the realization of a certain set of possibilities, for Bateson randomness is "the much, much larger set of everything else, from phenomena that cannot be rendered coherent by a given system's organization to those the system cannot perceive at all." [27] In the case of *Cloud Music* there are given restraints in the circuit that reveal that even the chance occurrence of cloud movement, or the timing of encounter of the viewer of the sound may be part of a higher order.

Diamond's experience in the space research environment translated to his willingness to experiment with the chaotic problem of sensing the clouds. He reflects;

> For two years I was working for NASA, working on Project Apollo. And one of the problems was that the engines kept exploding. And I was working on a way of determining by analyzing the engines to figure out why they were failing. Part of that problem was chaos; where the engine was acting like a whistle and it was blowing itself up because of the vibrations. […] This experience influenced me a lot in thinking about interactivity and designing an artwork that was interactive. Because depending on what that engine was sensing it would react in an interactive way; you could have blown on the exhaust and cause an oscillation that could explode it. […] The work with systems in *Cloud Music* was actually some kind of closure of this period of NASA research, where a concept that was causing so much pain could actually be resolved into a pleasurable experience. [28]

Diamond also noted that the video analyzer for *Cloud Music* was made from military grade parts that could withstand up to 100 degrees Celsius and work in a radiation environment or on a spacecraft. The cross hairs on the monitor themselves that sense differences in light are similar to the task of marking targets from ground-based artillery. Technologies initially developed for destruction were redeployed in an art context, as a means of subversion. However, the power dynamics that theorist of science Peter Galison (1994) points to in his discussion of the military origins of cybernetic ontology, including Wiener's development of war machines such as the 'Antiaircraft AA predictor', may also be considered in relation to *Cloud Music* [29].

Rather than tracing the cybernetic lineage in militarism, theorist of technology Andrew Pickering (2010) focuses on the emergence of cybernetics in the science of the adaptive brain and the environment. For instance in 1952, the British cyberneticist and psychologist Gordon Pask developed the *Musicolour machine*, an electro-mechanical device that collaborated with the musician to create a synthetic light show. Pickering suggests that Pask's musicolour machine undercuts any familiar dualist distinction between the human system and the machine. Similarly, in *Cloud Music* we find an assemblage of cloud-machine-observer or listener. To extend agency to the clouds and the machine extends informational importance and creativity to

the non-human physical world. Instead of the urge to dominate machinery and nature, in Pickering's words, we experience the possibility "of riding the inscrutable dynamics of the machines circuitry" [30] along with the chaotics of the clouds. *Cloud Music* is important in an ecological sense as it asks the audience to listen intently to the messages of the clouds, as mediated by technology.

Systems theory, cybernetics and ecological relations co-evolved as Bateson makes explicit when he posits that cybernetics is a means to think through the problem of "relations between an organism and its environment", when faced with the destruction of the world's environment [31]. He warns that if you "arrogate all mind to yourself, you will see the world around you as mindless and therefore not entitled to moral or ethical consideration. The environment will seem to be yours to exploit" [32]. Bateson finds 'mind' immanent in pathways and messages outside the body, in the structural organization of a system. If the mind expands outwards beyond the ego he writes, "a certain humility becomes appropriate, tempered by the dignity or joy of being part of something much bigger" [33]. His attribution of mind to non-human systems resonates with Bruno Latour's more recent exhortation to recognize the agency of non-human entities or 'things' conjoined into an expanded version of democracy [34]. To watch the sky and listen to non-human messages or patterns creates immediate affects that are beyond the self. Weather shifts in *Cloud Music, Sky TV* and *Condensation Cube* operating through the senses of the audience suggest a relational, rather than autonomous art object and a relational sense of self, or Bateson's "organism plus environment".

In conclusion, *Cloud Music* is a timely work to revisit as it reflects the multi-directional flows between art and science, technology and nature. We can recognize this project's importance as a release mechanism from the regulated informatics of meteorological science or the instrumentalism of the space race era. Such art practice is frequently framed in terms of resistance to scientific power-mechanisms, yet implicitly techno-industrial forces also move through creative works, as we can detect in the materials and operation of the Cloud Machine itself. In contemporary art, a growing number of artists are mediating between the atmospheric sciences, digital processes, online networks and 'live' weather itself. A high degree of specialization is often needed to understand scientific messages about our weather but the affective processes of media art, in the 70s as today, can mobilize our passions more immediately. *Cloud Music* models the complementarities and contestations between art, science and technology, and an emergent ecological consciousness.

**References and Notes**


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**2.** J. Burnham and H. S. Becker and J. Walton, *Framing and being framed: 7 works 1970-75/ Hans Haacke; with essays by Jack Burnham, Steps in the formulation of real-time political art* (Halifax: The Press of the Nova Scotia College of Art and Design, 1975) p. 131.

**3.** N. K. Hayles, *How We Became Posthuman: virtual bodies in cybernetics, literature, and informatics* (Chicago: University of Chicago Press, 2010) pp. 7-9.

**4.** L. Armand, "Language and the Cybernetic Mind" *Theory, Culture & Society* **25**, No. 2, (2008), p. 127.

**5.** I. Stengers, *Power and invention: situating science (*Minneapolis: University of Minnesota Press, 1997) p. 3.

**6.** E. N. Lorenz, *The Essence of Chaos* (Seattle: University of Washington Press, 1993) p. 8.

**7.** Lorenz, [6].

**8.** N. K. Hayles, *Chaos Bound: orderly disorder in contemporary literature and science* (Ithaca, N.Y., Cornell University Press, 1990).

**9.** D. Behrman and R. Diamond interviewed by Janine Randerson, Cloud Music (Auckland, New York, San Jose via Skype connection, May 12th, 2013).

**10.** Bob Diamond also developed video synthesizers at WNET TV-Lab for Sesame Street and The Electric Company (1971-79).

**11.** D. Behrman, R. Diamond and R. Watts, "Cloud Music: a hybrid audio-video Installation" (1976) in ed. W. and S. Vasulka, *Pioneers of Electronic Art* (Linz: Ars Electronica, 1992) pp. 152-153.

**12.** G. L. Stephens, "Cloud Feedbacks in the Climate System: A Critical Review" *American Meteorological Society* **18** (2005) p. 237.

**13.** Behrman and Diamond interview [9]

**14.** G. Bateson, "Cybernetic explanation" *Steps to an Ecology of Mind: collected essays in anthropology, psychiatry, evolution and epistemology*. (St. Albans: Paladin, 1973).

**15.** Behrman and R. Diamond interview [9]

**16.** Norbert Wiener used the box motif in the well-known description; "I shall understand by a black box a piece of apparatus, such as four-terminal networks with two input and two output terminals, which performs a definite operation on the present and past of the input potential, but for which we do not necessarily have any information of the structure by which this operation is performed. On the other hand, a white box will be similar network in which we have built in the relation between input and output potentials in accordance with a definite structural plan for securing a previously determined input-output relation." See N. Wiener, *Cybernetics: or Control and Communication in the Animal and the Machine* (Massachusetts: MIT Press, 1948), preface. page xi. (footnote 10).

**17.** Behrman and Diamond interview [9]

**18.** Behrman and Diamond interview [9]

**19.** Behrman and Diamond interview [9]

**20.**'Drift' is a term used by linguists and in Wiener's pure mathematics. George Kubler (1964) describes drift as produced by "cumulative changes in the articulation of sounds can be related in turn to the interferences that distort any audible communication." (Kubler, cited in P. Lee, *Chronophobia: on time in the art of the 1960s* (Cambridge; Mass.: MIT Press, 2004) p. 233.

**21.** Burnham [2] p. 132.

**22.** For a detailed explanation of Hans Haacke's practice in relation to both cybernetics and systems theory see L. Skrebowski, "All Systems Go: Recovering Hans Haacke's Systems Art," *Grey Room* **30** (2008) pp. 55- 83.

**23.** Behrman and Diamond interview [9]

**24.** Bateson, [14] p. 410.

**25.** Bateson, [14] p. 410.

**26.** Hayles, [3] pp. 285-286.

**27.** Hayles, [3] pp. 285-286 cites Bateson's comments on randomness from the prologue of G. Bateson, *Our Own Metaphor* pp.13-16. Hayles also compares Bateson's idea of randomness with Francisco Varela's biological model of randomness as the 'froth of noise from which coherent microstates evolve' from F. Varela, *Making It Concrete: Before, During, and After Breakdowns*. We could equally refer to Gilbert Simondon's schema of concretization, (which he also refers to as condensation --an analogy appropriate to *Cloud Music*). Concretization is the operative solidarity of formerly disparate energetic fields in a new technological invention. G. Simondon, "Technical Mentality," *Parrhesia* **7** (2009) p. 41.

**28.** Behrman and Diamond interview [9]

**29.** P. Galison, "The Ontology of the Enemy: Norbert Wiener and the Cybernetic Vision," Critical Inquiry **21**, No. 1 (1994) pp. 228-266.

**30.** A. Pickering, *The Cybernetic Brain: Sketches of Another Future* (Chicago: University of Chicago Press, 2010) p. 320.

**31.** Bateson, [14] p. 454.

**32.** Bateson, [14] p. 468.

**33.** Bateson, [14] pp. 467-468.

**34.** B. Latour and P. Weibel, *Making Things Public: atmospheres of democracy* (Cambridge, Mass, MIT Press; Karlsruhe, Germany, ZKM/Center for Art and Media in Karlsruhe, 2005).