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ARTIFICES OF INTERDEPENDENCY

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Abstract

The Live Electronics paradigm in the field of Contemporary Music has often been oriented toward the description or the individuation of a relationship.

When the act of composing relies on this practice, the exploration and the constitution of the role of each element which is active in such a network becomes the key of the resulting musical experience.

This paradigm is hereby examined in a specific field of application: the relationship between the *concrete* acoustical world and its digital counterpart. This exploration begins with the definition and the interpretation of these terms, the acknowledgment of what the characteristic of a concrete object are, and the consequent delineation of the boundaries that constrain the *concretization* of the musical experience.

The same importance is given to the description of the methodologies used in this process, which will allow the constitution of interconnections between the different elements.

A minor but still relevant theme is the formalization of the performative solutions which will facilitate the listener to take part in the resulting sonic experience, by means of understanding which are the links, hence the forces, which reciprocally act on each other.

Contents

1. Composition as an artificial process

1.1 The acknowledgment of the information

In 1966, Gordon Mumma moves to Manhattan to join Merce Cunningam's dance company and founds the Sonic Art Union together with Robert Ashley, David Behrman and Alvin Lucier.[1] Fresh from the experience of the ONCE Festival for new music, and involved in a multidisciplinary social and professional context, Mumma begins to develop new works primarily based on acoustical sound which is processed by hand-made analog circuits. His aim was to build performance circuits that could actively respond to signals during a live performance. These devices self-adjusted to the acoustic properties of sounds in a given performance space, generating electronic responses in the form of modulated feedback and control signals that could also trigger other sound-generating circuits. During this adjustment, some circuits would become imbalanced and "attempt to rebalance themselves,"[2] which was a desirable performance variable for Mumma's experimental works. He describes them as follows:

> *In my creative work with electronic-music resources, I have explored a direction that I call "cybersonics." Simply, cybersonics is a situation in which the electronic processing of sound activities is determined (or influenced) by the interactions of the sounds with themselves—that interaction itself being "collaborative."*[3]

Even though the term *cybersonic,* coined by Mumma himself, was not a great success in the history of music, it was in fact an appropriate one to describe the artistic practice of its inventor.

The word *cyber* derives from of the Greek word *kybernan* (to steer or guide), but the term *cybernetics*, as we know it today, refers to the general study of complex systems of various nature and their regulatory behavior. It was first adopted in 1948 by the

1 Thomas B. Holmes, "Leading Indicator for the Future: The Sonic Arts Union" in *Electronic and Experimental Music: Pioneers in Technology and Composition* (Psychology Press, 2002).

2 Holmes, 334.

3 "Composer's Notes," in Mumma, Electronic Music of Theatre and Public Activity (NWR 80632-2), pp 11–12.

mathematician Norbert Wiener in his book "Cybernetics, or Control and Communication in the Animal and Machine"[4].

Based on the notion of statistical information and control theory, the premise of cybernetics was a powerful analogy: the principles of how all living beings behave as they interact with their environment, also explains how information-feedback machines work.[5]

Cybernetics was an intellectual statement and a scientific field which broke down disciplinary barriers in the sciences. It shaped a language of feedback, control and information technology that set the intellectual foundation of today's information age.

By 1948, Wiener, as many other post war scientists, was looking at the world as an interplay between informational patterns and material objects:

> *"Information is information, not matter or energy. No materialism which does not admit this can survive at the present day."*[6]

Wiener knew that in order to succeed, this conception of information required solutions that could embody it and make it real.

Mumma's cybersonics devices were unconsciously one of these solutions.

The cybernetic signaled that three powerful actors - information, control, and communication - were now operating jointly to bring about an unprecedented synthesis of the organic and the mechanical.[7] But another important shift of paradigm occurred: while engineers understood the importance of adaptation through feedback mechanics, social scientists embraced this vision to define models of behavior of the human being.

In the 1950s, George Miller helped popularize a form of information measurement in experimental psychology, measuring the ability of humans to transmit information in a

4 Norbert Wiener, *Cybernetics Or Control and Communication in the Animal and the Machine*, 2nd ed. (MIT Press, 1965).

5 Ronald R. Kline, *The Cybernetics Moment: Or Why We Call Our Age the Information Age* (JHU Press, 2015), 2.

6 Norbert Wiener, 1965, p. 132

7 N. Katherine Hayles, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics* (University of Chicago Press, 2008), 8.

stimulus-response environment.[8] Ulrich Neisser formalized the field of cognitive psychology as a blend of information processing and experimental psychology. He recalled:

> *"It was not to be the mathematics of information but just the concept of information, as an entity in its own right, that would shortly transform psychology"*[9]

There was the need to express the world in terms of simplified mathematical models. The later invention of the digital computer pushed this approach eve further, allowing scientist to compute simulation of the dynamics of the natural world.

When in 1956, at MIT, Miller presented his paper "The Magical Number Seven, plus or minus two", another personality of the social sciences was involved: Herbert A. Simon.

Economist, sociologist, political scientist, and professor at Carnegie Tech (today's Carnegie Mellon University), Simon won the Nobel Prize in Economics in 1978 for his theory on "bounded rationality", for which he drew on cybernetics. He created, together with his colleague Allen Newell, the *Logic Theorist:* a computer program created to simulate human reasoning in proving mathematical theorems.

Simon developed his adaptive modeling technique in the early years of his career at Carnegie Tech, where he contributed to a variety of fields and modeled a range of human behavior, from individual rationality in organizations to simulating human decision making by computers.[10]

Simon is nowadays considered by the popular culture as the father of artificial intelligence, although in the preface of his book "The science of the Artificial" he states:

> *I shall disclaim responsibility for this particular choice of terms. The phrase "artificial intelligence" which led me to it, was coined, I think, right on the Charles River, at MIT. Our own research group at Rand and Carnegie*

8 George A. Miller, "The Magical Number Seven, plus or Minus Two: Some Limits on Our Capacity for Processing Information," *Psychological Review* 63, no. 2 (1956): 81–97, https://doi.org/10.1037/h0043158.

9 Ulric Neisser, "Cognitive Recollections" in *Making of Cognitive Science*, (Hirst), chap. 6, on 84.

10 Kline, 2015, p. 146.

Mellon University have preferred phrases like "complex information processing" and "simulation of cognitive processes."[11]

1.2 Real and artificial

Simon's researches on artificiality began as he was dealing with administrative organizations. Starting from the question, how could one construct an empirical theory that would contain more than the normative rule of good acting, he realized that "the necessity that rises above the contingencies stems from the inabilities of the behavioral system to adapt perfectly to its environment - from the limits of rationality"[12]. Thus the artifact arises from the necessity of an organizational set up.

An artificial object is by definition an object made or produced by human beings rather than occurring naturally.[13] It has an internal organization and it can be characterized in terms of functions, goals and adaptation. In order to fulfill a goal, an artificial object has to be brought into the context in which it operates: the internal organization of the artifact itself has to be related to the surroundings in which it operates.

Art - which the Greeks identified as ποίησις (poiesis) 'creation'- and technology - τέχνη (techne) translated as 'craft'- are two great sources of artifice. While the development of technology is adapted to human goals and purposes, the progress of the compositional thought is self-referential. It is purposeless in the sense that its formulation does not aim to pursue a goal, but rather towards the realization of a structure that has an internal coherence. On the one hand we can interpret the composition as an organized system of behaving objects, and as such, its purpose is to reach a final condition in which every object reaches a definite correlation in time or in space with respect to one another.[14]

As we will see in the following paragraph (see 1.3), this approach finds numerous analogies in the theory of systems.

11 Herbert Alexander Simon, *The Sciences of the Artificial*, 3. ed., [Nachdr.] (Cambridge, Mass.: MIT Press, 2008), 4.

12 Simon, 2008, p. xii.

13 "Artificial | Definition of Artificial in English by Oxford Dictionaries," Oxford Dictionaries | English, accessed June 5, 2019, https://en.oxforddictionaries.com/definition/artificial.

14 Arturo Rosenblueth, Norbert Wiener, and Julian Bigelow, "Behavior, Purpose and Teleology," *Philosophy of Science* 10, no. 1 (1943): 18–24.

However obvious it may seem, it is important to underline that what we define as "artificial" does not conflict with what we define as "real". An artificial object is real in terms of its *modes of existence*.

From a philosophical point of view, Étienne Souriau expresses the problem of existence in three principal questions:

> *The first is that of the intensive modes of existence. Before asking "does this exist and in what manner?," it is necessary to know if this question can be responded to with a yes or a no, or if it is possible to exist—a little, a lot, passionately, or not at all....*
>
> *The second, that of the specific modes, properly speaking, is governed by the opposition between two methods. We can consider invested experience and take responsibility for the total ontic content of human representation so as to classify its modes and evaluate its positive existential content; or rather (considering that existence can be found not only in beings, but between them), begin with as restricted an ontic given as possible and seek the shifts, the connections (representing new modes of existence), by which we can pass from the same to the other.*
>
> *[...] The final question is that of the search for possible unifications, implicating the notion of surexistence.*[15]

"What is *Real*" can therefore be explained as objects related to the human perception of concreteness, which is the physical essence of being, the actual acknowledgment of the existence of a relationship and the empirical understanding.[16]

Another approach to the notion of reality, specifically oriented to the field of technology, is given by the French philosopher Gilbert Simondon.[17] By the time of his

15 Étienne Souriau et al., *The Different Modes of Existence* (University of Minnesota Press, 2015), 106, https://www.jstor.org/stable/10.5749/j.ctt1b9x2qq.

16 As pointed out by Latour and Stengers in their article "The sphinx of the Work" in The Different Modes of Existence, 2016, 11–90., Souriau never actually gives a proper definition of the term *surexistence*, but rather the book itself exposes the reader to this concept. It is a journey of progressive determination guided by our judgment.

17 Gilbert Simondon, *On the Mode of Existence of Technical Objects* (Univocal Publishing, 2017).

publication, Simondon was struggling with the then-current cultural undervaluation of machines, and the purpose of his book was to stimulate awareness of the significance of technical objects.

His frustration against the society is expressed in the introduction of his book:

> *Culture is unbalanced because, while it grants recognition to certain objects, for example to aesthetic things, and gives them their due place in the world of meanings, it banishes other objects, particularly technical things, into the unstructured world of things that have no meaning but do have a use, a utilitarian function.*[18]

The *technical reality* is not discernible from the human reality since "the world of technical objects" is "the mediator between man and nature"[19]. The technical object is the end product of an evolutionary process, which he calls *concretization*, at the end of which the *concrete* object "approximates the mode of existence of a natural one"[20].

The process of *concretization* starts with the conception of an *abstract* entity, a primitive form in which "each theoretical unity is treated as an absolute that has intrinsic perfection of its own that needs to be constituted as a closed system in order to function"[21]. By the time of its development, the abstract object may then advance in terms of function or limitation by means of putting it in relationship with other functional sub-systems, so that the technical object improves through interior redistribution of functions into compatible units. The result of this process is a concrete technical object whose *real system* "is not the individual function but the synergic group of functions"[22].

In conclusion, the terms *real* and *artificial* do not represent a dichotomy, but rather one (the artificial) is a subsystem of the real, and the real is nothing but a mode of existence of an object.

18 Simondon, 2.
19 Simondon, 1.
20 Simondon, 46.
21 Simondon, 14.
22 Simondon, 30.

1.3 Complex systems

All of the above mentioned theories, from cybernetic to Souriau's formulation of existence, agree at least on one common aspect: every object is in some form related to the environment in which it exists or behaves.

This consideration is the foundation of what is today known as the System Theory, which will I now introduce, and that will lead to the concept of *interdependency.*

A complex system is hence composed of many interacting parts, whereby the system is more than just the sum of these parts, because the trajectory of each component - the set of points in state space, which are the future states resulting from a given initial condition - changes according to the state of the system itself. The way those parts behave when they interact might be qualitatively different than the way they behave if isolated.

Although each of these elements, or agents, are not necessarily homogeneous, they are interconnected in a framed network, or spatial structure, through which the agents might as well influence the behavior of one another, thereby creating a condition of *interdependency*. This circumstance is not limited to the agents themselves but it can be extended to the surrounding environment in which they are in.

To respond and adapt to such a context, the system might present a sophisticated internal causal architecture that stores and processes information, a mechanism that allows each component to behave adaptively, to predict and possibly control. In some cases, the agents are capable of responding to signals which they get from a local structure (another agent) or globally (from the system itself).

Various kinds of information processing and storage can be associated with how a system is organized. The way this information is obtained is an active part of the study and the design complex systems. In conclusion, they might be capable of producing complexity in terms of emergent behavior - any behavior of a system that is not a property of any of the components of that system - due to the presence of non-linear components.

Complex systems are studied through computational methodologies which analyze the trajectories of each subsystem and theirs reciprocal interaction, describing them as mathematical models.

1.4 The composer engineer

The paradigm of complex systems merges the process of evolution in time and the chain of relationships, which are proper of the musical experience.

Designing, hence composing, is the action of establishing relationships by means of analyzing elements.

> *“The inventor works to establish communication, to recover a complete universe that is not lost in a mythic past, but is projected into a still unrealized future […] each step ... presents itself as the solution to the previous states”*[23]

> *“The inventor overcomes the contradictions of the imaginary by making real the image he/she has in his/her head.”*[24]

The *concretization* of a musical experience is based on both technical skills an accumulation of experience. Problems are solved by intuition and, in the specific case of electronic music, by simulation, as a technique for achieving understanding and predicting the behavior of systems, but once in operation, the “technical object” frees itself from its inventor[25] as we will see in the following parts of this text (see 3.2).

23 Gilbert Simondon, *L’individu et sa genèse physico-biologique* (J. Millon, 1995), 203.

24 Pascal Chabot, *The Philosophy of Simondon: Between Technology and Individuation* (A&C Black, 2013), 105.

25 Chabot, 15.

2. The role of the sound sources

2.1 The elaboration of the relationships

The Live Electronics paradigm is a compositional practice that relies on the constitution, or the individuation, of the roles of different musical processes in two different domains: the electronic and the acoustical one.

This dichotomy in turn leads to the exploration of different types of relationship between the two domains. Emmerson, reflecting upon this theme,[26] describes these relationships in four main categories:

1. real time treatment of acoustic instruments using analogue or digital resources, a paradigm which maintains the human performer firmly in the center of focus;
2. 'mixed' music, which combines instruments (or voice) with recorded electroacoustic sounds;
3. the use of human–computer interfaces or sensors which track and measure physical action;
4. the adoption of devices which analyze the sounds produced in performance to convert them into a suitable format for the control of sound production or processing.

My artistic research is predominantly oriented towards the last category. It was when I first read Agostino Di Scipio's article "Sound is the Interface"[27] when I decided to embrace a more "systemic-oriented" approach. In his article, Di Scipio talks about a paradigm shift from *interactive composing*[28] to *composing interactions* by means of constructing interdependencies among real-time control variables.

The models of feedback network, initiated by the cybernetic theory and further developed in the set of theories of the complex systems, underlie my compositional

26 Simon Emmerson, "'Losing Touch?': The Human Performer and Electronics," in *Music, Electronic Media and Culture* (Ashgate Publishing, 2000), 194–216.

27 Agostino Di Scipio, "'Sound Is the Interface': From Interactive to Ecosystemic Signal Processing," *Organised Sound* 8, no. 03 (December 2003), https://doi.org/10.1017/S1355771803000244.

28 Joel Chadabe, "Interactive Composing: An Overview," *Computer Music Journal* 8, no. 1 (1984): 22–27, https://doi.org/10.2307/3679894.

practice, where musicians and both the digital and the physical environment are connected by a composed (hence artificial) system of interdependency.

2.2 The concrete technical object

According to Simon the core of building a complex system is to define a hierarchical system, wherein the terms of hierarchy do not describe a formal organization of roles within the system, but describe rather an intensity of interaction.[29]

At the top – or to be more consistent "at the core" - of my compositional model resides the element/agent which represents the driving force of the whole system. It is an object which suggests different uses, possibilities and boundaries and internal coherence. As such it can be embraced and adopted as an agent without further alterations. Following the interpretation of Simondon,[30] I consider this object to be a concrete object, as it has already overcome a process of refinement and internal development (see 1.2).

We can consider any sonic source as a concrete object. Dealing with a musical instrument, either digital or acoustical, means in the first place acknowledging its own rules and its own coherence. A space such as a room, in which a performance takes place, with its physical and acoustical properties, for example, often has a strong impact on the realization of a musical experience. Furthermore, it may even present specific architectural characteristics which suggest a particular use. A sonic phenomenon such as positive audio feedback, although it lacks of tangibility, materializes through the combination of various elements.

The *affordances*[31] of the designated concrete object, hence the physical qualities that suggest its appropriate use, lead me to the individuation of other agents or processes which could also be adopted in order to construct a more complex network of relationships.

29 Simon, *The Sciences of the Artificial*, 187.

30 G. Simondon, C. Malaspina, and J. Rogove, On the Mode of Existence of Technical Objects (Univocal Publishing, 2017).

31 The term *affordance* has been introduce by James J.. Gibson as the substantive of the verb "to afford". Bruce A. Whitehead, "James J. Gibson: The Ecological Approach to Visual Perception. Boston: Houghton Mifflin, 1979, 332 Pp," *Behavioral Science* 26, no. 3 (July 1, 1981): 127.

2.3 Composition as an abstract object

Since my compositional process starts from the individuation and the consequent analysis of a concrete object, there are no "a priori" rules or boundaries which limit the structure of the final composed musical experience. At this stage, the system of interdependency is an abstract entity, a potential condition of becoming, which has to overcome the process of concretization.[32]

This path is divided into two phases: an analytic and an intuitive one. The analytical approach is based on the fact that a sound (as a concretized object) carries a conspicuous amount of information. Which and how much information is extracted will lead to the development of artificial listening tools and to the consequent delineation of a potential relationship. The intuitive one is based on the observation of the evolution in time of the behavior of two interconnected objects. It is a practice which is connected to the computational methodologies used in science to study the behavior of complex systems. Given an initial condition, the composer observes the evolution of the reciprocal interaction between different objects by means of simulation, and tunes the system accordingly.

These two methods are continuously alternated throughout the whole process of concretization, since the established relation can be in turn analyzed and observed.

2.4 The mediator(s)

The choice of tools dedicated to the constitution of control signals, useful in formulating the interconnections between the agents, is an important aspect of the compositional process, as their use might influence the formalization and the realization of the performance (see 3.1).

These tools include a wide range of technical devices such as microphones, loudspeakers, mixers, midi controllers, sensors etc., and numerous digital signal processing algorithms.

The first category mediates between the physical and the digital environment by means of energy transduction. These devices are usually not operated in real time by the performer, but are crucial for the calibration of the system when presenting the

32 Simondon, Malaspina, and Rogove, *On the Mode of Existence of Technical Objects*.

performance in a different physical space, as certain factors, such as the positioning of the microphones, for example, might have a strong impact on the behavior of the system.

The digital mediators, mainly music information retrieval algorithms, filters and dynamic processor, are instead an intrinsic part of the overall compositional project, without which the process of concretization would not be possible. Their role is to shape and construct the information flow that will eventually establish the system of interdependency between the agent, the ground around which the piece will become materialize.

3. The Performance

3.1 The paradigm of listening

When entering the field of live electronic music performance Bob Ostertag[33] affirms:

> *"Music that uses electronically generated sound from synthesizers or computers suffers from the problem that one cannot actually get one's fingers into the generation of the sound"*

Assuming that this statement is a fact, the success of a musical experience is given, in my opinion, by the acknowledgment of the actual processes that materialize a sonic event. The adoption of technical devices, such as MIDI controllers, affects the generation of sound in terms of actions which initiate a process with no efforts. In another terms, it implies gestures which affords no tension and, in the worst case scenario, no direct connection with the resulting sound production.

This is a very important aspect for the formulation of my performances. The act of listening, or more generally speaking, the act of *experiencing* a sonic environment, differs from person to person not only because of the sonic matter to which the individual is exposed, but also the space, the social context, and the presence or the absence of a performer are all elements which influence the perception of musical experience. Revealing the source of a sound object, or the mechanism that produces it, becomes a key factor in the development of the musical experience.

In my works, I have been inclined to adopt a gestural compound, specific for each composition, that leads the audience to a better understanding of what the mechanisms that *concretize* a sound are.

An example of this practice is my piece "reverie". Composed in 2018, this work is a study on the resonances and the reflections of a space excited by a single clap of hand at the beginning of the performance[34]. The real time analysis of this impulse calibrates a resonant environment which occurs because of a number of microphones positioned

33 Bob Ostertag, "Human Bodies, Computer Music," *Leonardo Music Journal* 12 (December 1, 2002): 11–14.

34 A video documentation of this piece can be found at: https://vimeo.com/335944624.

inside a ring of loudspeakers – condition thanks to which the Larsen effect[35] emerges. The development of the piece is controlled by the performer who actually displaces the microphones in the room . These actions, visible and physical, are entirely linked to the alteration of the sonic result, and shall demonstrate that such a sonic situation is the result of physical relationships that exist in the environment in which the performance takes place.

Another strategy that I have been adopting to facilitate the perception of interconnections between two behaviors is the use of lights. In the performance "communication#0.1", which I wrote in 2017, the interpreter holds two microphones in front of a pair of loudspeakers. Moving his or her arms, the performer is changing the distance between the microphones and the speakers thus affecting the long term behavior of a digital instrument which changes its state accordingly. The loudness of the input of each microphone controls the intensity of a colored light projected by a pair of LED lamps which are positioned underneath the loudspeakers. The more sudden the movement, the brighter the lights.

Although I originally conceived this element simply as a tool to emphasize the movements of the performer in order to further stimulate the audience's attention, the use of lights became a structural element of the composition. Their behavior is connected to the performer's action in real time, hence any physical action will immediately affect their of intensity. This aspect allows the performer and the audience to focus on both the long term evolution of the sonic environment and on the state of the latter at any given moment.

3.2 How a process is connected to the experience

In such a musical context, the role of the performer is crucial for the concretization of the sonic experience. The performer is in charge of the manipulation of the concrete object around which the whole performance is structured. Given a limited range of musical gestures, the musician has to engage in a process of assimilation and comprehension of what the system of interdependency, of which the musician is an integral part, affords. Every action might have both a short and a long term influence on

35 Also know as positive audio feedback.

the digital processes, hence the performer can only try to pursue a particular sonic situation without the certainty that the latter will also occur. The learning process differs from a more traditional approach based on the interpretation of a score in that it develops a specific level of awareness which will allow the performer to orient his or her self in the sonic dimension, which is at the same time the cause and the effect of his or her actions.

With these tools the musician is therefore able to organize his or her performance, a performance which will result in the exploration of all of the potential behaviors that such a system might afford. My role as a composer is at this stage limited to the mere supervision of this final process of concretization.

The last example which summarizes the above mentioned considerations, is the piece “incontro” for solo cello.[36] The piece is an exploration of the body of the instrument as an object made of lines, surfaces and edges. The musician is instructed with a few indications related to the sound material that may be produced throughout the duration of the overall performance. The musician bows the profile of the instrument from the scroll to the pin, and by applying more or less pressure to the wood, can produce pitched or noisy sounds. By hitting the instrument with the stick, or scratching it with the bow´s hair, the musician can also produce percussive sounds. Within this framework, the musician may decide which material is presented at any given moment, being aware that these actions will have different repercussions in the evolution of the electronic musical texture. These choices are influenced by the sonic result that the musician wants to achieve, and at the same by the instantaneous reactions that emerge from the digital processes.

36 A video documentation of this work performed by Myriam García Fidalgo, can be found at: https://www.youtube.com/watch?v=B8t-_QWWYns

Conclusions

The compositional methodology and the terminology illustrated in this text are the result of a retrospective observation of the workflow that I have been developing during the course of my studies. This practice has been driven by the necessity of exploring the use of digital technologies as a source to identify, and consequently materialize, physical entities - such as acoustic features of a space – or emergent phenomena derived from specific sonic circumstances. This condition led me to embrace a post digital vision of the performance in which the composition of a musical experience assumes the digital element rather than highlights it.

Reflecting upon the path that my work will take in the upcoming future, I would like to explore the possibilities that technologies such as the Internet might generate in my work, researching new paradigms in the constitution of networks of interdependency.

While working on this text brought me to reflect upon the meaning of *artificiality*, my growing interest in the development of computer networks encourages me more and more to approach another important philosophical concept: that of *virtuality* as an aspect of reality.

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