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Models of Constructed Sound: Nonstandard Synthesis as an Aesthetic Perspective

This article deals with aesthetic and philosophical aspects of a body of sound-synthesis techniques that is often misrepresented and discounted. Although my aim is not the description of specific historical situations, I will proceed by historically contextualizing the idea of "nonstandard" synthesis. This discussion will primarily focus on two historical approaches: the nonstandard sound-synthesis techniques developed by composers such as Iannis Xenakis, Gottfried Michael Koenig, and Herbert Brün in the 1970s, and early 20th-century sound-synthesis experiments such as drawing sound on film (Levin 2003) and László Moholy-Nagy's ideas concerning the transformation of sound-reproduction devices into sound-production devices (Moholy-Nagy 2004 [1922]). These approaches are characterized by a close connection between sound synthesis and strongly articulated artistic positions.

This article does not present the development of sound-synthesis techniques as a chronological history of technological progress. I will rather view the history of sound synthesis as nonlinear, as a history with many bifurcations, in which ideas do not undergo continuous, progressive developments, but in which they reappear, transform, merge, and coexist. The approaches presented are, therefore, not intended to be historically comprehensive. I will, however, try to extract philosophical and aesthetic roots and implications that I deem relevant to the current situation of electronic and computer music.

These approaches to sound synthesis will be discussed as aesthetic perspectives. What unites the nonstandard techniques is not so much their rejection of harmonic or acoustic models, but rather both their intention to bring together ideas of music and ideas of sound, and their recognition of the

interdependence of the means used and the possible artistic and aesthetic ideas.

This article also attempts to defend the nonstandard approach against the stigmatizing criticisms that regard these techniques as purely speculative, far removed from empirical reality, and negligent toward the perceptual effects of their audible output. I will try to show that they instead offer profound, critical, and musically radical views on composition, technology, and sound representation.

The aesthetic perspective presented is not the position of the authors of the nonstandard synthesis systems of the 1970s, but my interpretation of, and inquiry into, those system's philosophical and aesthetic implications. In the process, I will argue for the need for an *axiomatic disorientation* as the basis of creating new possibilities.

In the following five sections, I will discuss these approaches and look at them from different perspectives. After a brief general discussion of nonstandard synthesis, I will deal with some precursors of nonstandard synthesis and the sound-synthesis systems of Koenig and Brün. Subsequently, I will deal with models of sounds. In the last section, I will discuss some implications and positions regarding technology and its development.

Nonstandard Synthesis

The composers Koenig, Brün, and Xenakis independently developed a number of sound-synthesis methods in the 1970s that have been termed *nonstandard*. This term was coined by Steven R. Holtzman to contrast with *standard* synthesis:

> Standard approaches are characterized by an implementation process where, given a description of the sound in terms of some acoustic model, machine instructions are ordered in such a way so as to simulate the sound described (Holtzman 1978, p. 1).

The term "standard approach" is used for differentiation. Its counterpart is the "non-standard approach," in which "the computer acts as a sound-generating instrument *sui generis*, not imitating mechanical instruments or theoretical acoustic models," (Koenig 1980, p. 111) and is described by Holtzman as follows:

> The non-standard approach, given a set of instructions, relates them one to another in terms of a system which makes no reference to some super-ordinated model, . . . and the relationships formed are themselves the description of the sound (Holtzman 1978, p. 1).

The differences between standard and nonstandard sound-synthesis methods are differences of sound production principles. Standard methods are based on physics, acoustics, and psychoacoustics, whereas nonstandard methods are based on compositional ideas of sound and musical organization.

The nonstandard systems are rooted in the belief that electronic and digital means allow "the composition of timbre, instead of with timbre" (Brün 2004, p. 189), and that sound production itself can be considered a compositional activity. As Karlheinz Stockhausen writes, "Every sound is the result of a compositional act" (Stockhausen 1963, p. 142 [1958]). Arguing from the etymology of the words *composition* and *synthesis*, which are synonymous in their respective languages of origin, one may see their difference as one of time levels rather than of kind. Di Scipio writes, "synthesis can often be thought of as micro-level composition" (Di Scipio 1995b). As suggested by Phil Thomson, nonstandard sound-synthesis approaches, in their "impulse towards the atomisation of musical material and control of that material on ever-lower levels," can be seen as "microsound's digital beginnings" (Thomson 2004, p. 210).

Precursors

The invention of the phonograph and the breakdown of tonality as a referential system were transformative events—they changed the situation of music and the conditions of composition in the 20th century. Sound as such became "visible," as a kind of "acoustic writing" inscribed into the phonograph record, and as a concept emerging through the decomposition of traditional models.

The move towards sound is also a move to a meta-level. It is no longer the (re)structuring of the elements, the materials, as they have existed (i.e., new ways of dealing with harmony, rhythm, counterpoint, form, orchestration), but the (re)structuring of the very structure of such elements (i.e., the limitations of previous symbolizations of the sonic reality are exceeded). Composition ceases to be "tone art" (or the German *Tonkunst*) when the notion of "tone" itself is recognized as an aggregate, as a composition of notions that then disintegrate into constituent parts. The composition of sound as such was hitherto neither possible nor even conceivable: It was indiscernible in the conceptual frameworks that conditioned musical composition.

The development of sound visualization and recording technology played a major part in the becoming-visible of sound. With the creation of visible patterns in correlation with acoustical vibrations in Ernst Florens Friedrich Chladni's 1787 *Klangfiguren,* sound was, for the first time, associated with specific graphics. The patterns formed on vibrating plates covered with quartz dust create a relationship with the sound that is not arbitrary, but indexical. The sound has written the graphic itself. Here we find sound as a trace and traces of sound, a form of acoustical writing (Levin 2003) that also underlies some nonstandard systems in the 20th century: Xenakis's GENDYN and Brün's SAWDUST are situated at the border of compositional notation and technological sound representation. With the development of opto-acoustical film sound and the phonograph, the traces of sound became manipulable and potentially decipherable. The German media theorist and literary scholar Friedrich A. Kittler sees the reasons for this change mainly in the technological development of media. Among other inventions, it was mainly the phonograph that caused the "old European alphabetism," that is, the symbolic access to sound, to be replaced by a "mathematical-physical notation." Kittler writes that "a historical transition from intervals to frequencies" is a transition "from a logic to a

physics of sound"; thus, "the real takes the place of the symbolic" (Kittler 1999). We can then say that technological development has provided musical composition with an altered access to sonic reality. Elements that were before only manipulable within certain symbolic frameworks acquired a changed ontological status.

An early proposal that deals with traces of sound, and the phonograph as a machine for reading traces, was made by the German poet Rainer Maria Rilke. In 1919, Rilke wrote a text, titled "Ur-Geräusch" [Primal Sound], in which he imagines, triggered by the memory of a physics experiment from his school days, using a phonograph needle to render audible the coronal suture of a skull:

> What if one changed the needle and directed it on its return journey along a tracing which was not derived from a graphic translation of a sound, but existed of itself naturally—well: to put it plainly, along the coronal suture, for example. What would happen? A sound would necessarily result, a series of sounds, music . . .
>
> Feelings—which? Incredulity, timidity, fear, awe—which of all the feelings here possible prevents me from suggesting a name for the primal sound which would then make its appearance in the world. . .
>
> Leaving that aside for the moment: what variety of lines then, occurring anywhere, could one not put under the needle and try out? Is there any contour that one could not, in a sense, complete in this way and then experience it, as it makes itself felt, thus transformed, in another field of sense (Rilke 2001, p. 23 [1919])?

What Rilke suggests here is in essence a form of sonification: the rendering audible of otherwise inaudible structures, or the "putting under the needle" lines and shapes, transforming phenomena from one field of sense into another. By rendering audible that which has never been recorded, the phonograph not only acts as a generative synthesis system, but also becomes an extension of our senses in that it renders perceptible otherwise imperceptible structures.

In 1922, only three years after Rilke's text, Moholy-Nagy, the Hungarian painter, photographer, and professor in the Bauhaus school, suggested another use for the phonograph. In his famous text "Production—Reproduction," originally published in the Dutch journal *De Stijl*, he argues for "the phonograph [to] be transformed from an instrument of reproduction into one of production; this will cause the sound phenomenon itself to be created on the record, which carried no prior acoustic message, by the incision of groove-script lines as required" (Moholy-Nagy 2004, p. 332 [1922]). Moholy-Nagy is arguing that what he calls "reproduction" is a mere "reiteration of relationships that already exist," and that a turn to active "production" can create new relationships. Because art is capable of actively transforming man's cognitive and perceptual abilities, one should make use of the phonograph's transformative potential.

Whereas Rilke's idea stresses the transfer of phenomena across sensory modalities, re-reading a given environment, Moholy-Nagy emphasizes the active and intentional construction of entirely novel relationships. Both ideas, however, focus on the extension of senses and the materiality of technical mediation, and on the specificity of the medium itself.

Rilke's text, Moholy-Nagy's proposal, and the works of Oskar Fischinger and Rudolf Pfenninger (Levin 2003) can be seen as precursors of nonstandard synthesis. They strove to unite micro and macro time levels, they aimed at the composition *of* sound instead of *with* sound, they were interested in producing a music that explores the specificities of its means of production, and they believed that both technology and art actively transform human perception and cognition. By etching grooves into phonograph records and painting sound waves on film they formed a compositional synesthesia in which image, sound notation, and the physical sonic phenomenon are linked during the composition process. What emerges is the role of the medium and a preoccupation with the reality of the medium, which is not to be transcended but constitutes the real, material basis.

Music, it might be said, discovers its medium and focuses on the exploration and exhibition of what is unique to music and irreducible in music; or, on the "limitations that constitute the medium" (Greenberg 1982, p. 6). The nonstandard

synthesis approaches created in the second half of the 20th century concentrated more on limitations or formal qualities of digital sound representation and generation and less on the formal qualities of the performance, such as space and loudspeakers. Examples of these explorations of limitations or formal qualities include the digital-to-analog convertor and computer instructions (in Paul Berg's PILE and Koenig's SSP) and the composition of a waveform (in Xenakis's GENDYN and Brün's SAWDUST).

On the one hand, the preoccupation with the medium's formal qualities requires the composer to invent content where there is almost nothing, and on the other hand it implies dismantling the relationship between the real and the semblance, a reflexive approach that avoids imitation and stresses the fact that art is something made, something composed. This distancing exposes the mutual determination of real and illusion. The French philosopher Alain Badiou writes in his book *The Century*:

> Distancing—conceived as the way that sem-
> blance works out its proper distance from the
> real—can be taken as an axiom of the [twen-
> tieth] century's art, and of "avant-garde" art
> especially. What is at stake is the fictionaliza-
> tion of the very power of fiction, in other words,
> the fact of regarding the efficacy of semblance
> as real. This is one of the reasons why the art of
> the twentieth century is a reflexive art, an art
> that wants to exhibit its own process, an art that
> wants to visibly idealize its own materiality
> (Badiou 2007b, p. 49).

Koenig's SSP and Brün's SAWDUST

In the 1970s, a number of nonstandard synthesis systems were designed and implemented, among them Xenakis's Dynamic Stochastic Synthesis, Paul Berg's PILE, Koenig's SSP, and Brün's SAWDUST. To illustrate and concretize the origins of the theoretical considerations presented in this article, I will take a brief and critical look at the latter two systems.

Koenig designed the sound-synthesis program SSP in 1972, although earlier design plans date from the 1960s (Berg 2009). The system is based on the fundamental proposition that "musical sounds may be described as a function of amplitude over time" (Koenig 1971, p. 93). The program makes use of Koenig's selection principles, which he had developed and used for the composition of instru-mental music. The selection principles are serial and aleatoric procedures that abstract fundamental musical behaviors such as repetition, expansion, di-rection, and reduction. In his composition program *Project 2* these principles were used to order lists of parameter values. Instead of ordering higher-level properties, such as dynamics, rhythm, duration, pitch, etc., in SSP they are used to sort instanta-neous sound pressure levels and time values, and thereby to compose the sound wave itself. The selected time and amplitude values are collected in segments and the selection principles are used to create sequences of segments.

The relatively unaltered transference of principles from the macro level to the micro level, as well as the self-containment of the system, can suggest a notion of "purity". The search for a definition of purity, as it has been attributed to modernist movements, has been described by the American art critic Clement Greenberg:

> What had to be exhibited was not only that
> which was unique and irreducible in art in
> general, but also that which was unique and
> irreducible in each particular art. . . . It quickly
> emerged that the unique and proper area of
> competence of each art coincided with all that
> was unique in the nature of its medium. . . .
> Thus would each art be rendered "pure," and in
> its "purity" find the guarantee of its standards of
> quality as well as of its independence. "Purity"
> meant self-definition (Greenberg 1982, p. 5).

It can be said that SSP is a search for what is "irre-ducible" in music, and that it is concerned with "all that is unique in the nature of its medium." Yet, in-stead of understanding it as an attempt to construct a "pure" approach to sound, or to maintain the self-contained "purity" of a compositional method, it should be understood as a "radical subtraction," to

use Badiou's term. Badiou contrasts subtraction with the idea of a necessary destruction that can "clear the way for an entirely new avant-garde practice" (Hallward 2003, p. 162). The subtractive strategy seeks "to purify reality, not by annihilating it, but by withdrawing it from its apparent unity so as to detect in it the minuscule difference, the vanishing term that is constitutive of it" (Badiou 2007b, p. 65). Badiou uses the term radical subtraction to describe Kazimir Malevich's painting as well as Stéphane Mallarmé's poetry and Anton Webern's music. In these cases, the radical subtraction seeks to explore the conditions of its means of production.

Nonstandard-synthesis approaches have been reproached for being formalistic and for disregarding the perceptual dimension of musical experience. Pierre Schaeffer, for example, wrote that, "Xenakis has not taken the trouble to verify the relationships which exist between mathematical production of sonic objects and their authentic musical perception" (Schaeffer 1971, p. 75). However, such a critique neglects, on the one hand, the "dialectic between the conceptual and the perceptual in the musical experience" (Di Scipio 1995a, p. 370–371), and, on the other hand, Xenakis's search for a new percept by means of a distancing and a conceptualization. It also neglects that synthesis methods that are lacking in predictability require a working method that involves continual aural evaluation.

The radical subtraction that takes place in Xenakis's and Koenig's synthesis methods, which unite structural and timbral design and axiomatically eradicate the differences of micro and macro time levels, can be understood as a kind of disorientation. Traditional ways of describing musical sound are not applicable in SSP: The composer is forced to invent new ways of describing sound and has to invent content where there is almost nothing. The stringency of the system is not a search for purity, but an axiomatic disorientation, a subtraction that seeks to explore compositional sound descriptions.

Here we can see what Badiou calls the "passion for the real." His example is the minimal difference of Malevich's *White on White*. It is not a passion to "unmask copies, to discredit fakes," but a "passion devoted to the construction of a minimal difference, to the delineation of its axiomatic" (Badiou 2007b,

p. 56). The axiomatic reduction of composition to the coordination of time and amplitude points in the construction of the waveform, in systems like SSP and SAWDUST, can be seen as a "radical subtraction" whose driving force is a "passion for the real."

A problem that results from the treatment of amplitude and time values as compositional raw material is the lack of differentiation in the output of the application of macro-level methods to the micro level. The selection principles *alea* and *series* (random selection with and without repetition) do not produce noticeably different-sounding output when applied at the sample level. The problem stems from the context-dependency regarding the sonic significance of time values and sound pressure levels in a waveform. An instantaneous sound pressure level has in itself no recognizable identity. A result of this problem was that users of SSP concentrated on the ordering of segments, short collections of amplitude and time values. This step, the permutation (the selection and concatenation of waveform segments), "was as an effective generative mechanism" (Berg 2009, p. 84), and allowed the creation of distinct states and transitions. Berg, who composed one piece with SSP, writes:

> The ordering of segments using tendency masks was particularly successful. A wide selection of segments would result in a noisy sound structure. Narrow masks led to unstable sounds within a confined frequency region. Masks moving from narrow to wide could produce dramatic transitions between these two extremes (Berg 2009, p. 84).

Brün's program SAWDUST is also concerned with the compositional structuring of waveforms. In the program, the composer specifies small fragments of waveforms, which are then linked, merged, concatenated, repeated, and eventually interpolated using a limited number of operations. In contrast to Koenig's SSP, the emphasis is not on a rule-based approach to composition, but rather on the extension and relocation of musical material. The focus is on the composer's work, the manual, subjective, compositional labor that takes place on the level of the waveform. The composer is

"forming sounds just as precisely as the macro events of his composition" (Brün 1969, p. 117). The material and its organization are inseparably interlinked. As Di Scipio writes, "this represents a thoroughly constructivist approach: nothing in the music has the status of something that exists prior to the composers work, not even the so-called sound material" (Di Scipio 2002, p. 24). Brün often stresses the importance and the necessity of compositionally exploring the specificities of technology, as well as his dislike of simulative synthesis methods:

> There is one dignified way, by which the computer might be made a musical instrument, without making it a redundant simulator of orchestral treasures. A computer, that can be programmed to generate acoustical phenomena, that the existent instrumental body could not generate, would be an asset (Brün 1964, p. 4).

In contrast to Brün's emphasis of the unique possibilities of the computer, his compositional praxis and his use of his own program SAWDUST are especially concerned with serial organizations of pitches. Indeed, his sketches reveal that he was constantly linking waveform lengths to tempered pitch scales and even producing twelve-tone rows and chords for the organization of waveforms.

Although nonstandard sound-synthesis systems, such as SAWDUST and SSP, are characterized by a rejection of harmonic and acoustic models, they operate within a physically conditioned medium. A sampled digital time-domain signal is also a representation of a sound, which is based on an acoustic model, however rudimentary it may be. The nonstandard sound-synthesis systems are thus based on an acoustic model. The disregard of the inherent conditions and structures of the medium within which a model operates entails a limitation of the functionality of the model. With their concentration on a purely symbolic, compositional level, synthesis models such as Koenig's SSP tend to overlook physical and phenomenal consequences and constraints. A consequence of this reduction is that the conceptual differentiations of the system's operations are not always properly reflected in its output. On the other hand, we can see such models as experimental starting points that seek to explore borders of music and musical material, operating from within music. In contrast to approaches in which the sound material is given and then is processed, shaped, and compositionally structured, the synthesis methods of Brün, Xenakis, and Koenig form frameworks in which the sound material itself emerges in the composition process.

Models of Sounds

A sound-synthesis method is a formalism, and this formalism can be conceived of as a model. A common and predominant understanding of models presupposes a separation between an empirical reality and a formal modeling of that reality. The assumption is that we are on the one hand neutrally observing the facts, and on the other hand, actively producing a model. It is a confrontation between a real thing and an artificial reproduction, it is an opposition between reality and thought, and it essentially boils down to nothing more than the opposition of "nature" and "culture."

In his first book, *The Concept of Model*, written in 1968, Badiou quotes several passages from John Von Neumann and Oskar Morgenstern's *Theory of Games and Economic Behaviour* (Morgenstern and von Neumann 1944), exemplifying the aforementioned understanding of models. The authors state that models "must be similar to reality in those respects which are essential in the investigation at hand," and that "similarity to reality is needed to make the operation significant" (Badiou 2007a, p. 16). In Badiou's opinion, the authors deny that science is a "process of practical transformation of the real," and that, in their conception, science is nothing but the "fabrication of plausible images" (Badiou 2007a, p. 94). Claude Lévi-Strauss writes, "The best model, will always be that which is true, that is, the simplest possible model which, while being derived exclusively from the facts under consideration, also makes it possible to account for all of them" (quoted in Badiou 2007a, p. 16). Is not science, in this understanding, nothing more than a functional simulation, an imitative artifice? Badiou writes that Von Neumann and Morgenstern's view "effaces the reality of science being a process of

production of knowledge" (Badiou 2007a, p. 17), and denies science's historicity and its internal discourse. We find a similar positivist philosophy underlying the way in which Julius O. Smith, one of the leading proponents of physical modeling, speculates about the future of synthesis models:

> The most straightforward way to obtain interesting sounds is to draw on past instrument technology or natural sounds. . . . The best way we know to understand a sonic transformation is to study its effect on the short-time spectrum, where the spectrum-analysis parameters are tuned to match the characteristics of hearing as closely as possible. Thus, it appears inevitable that sampling synthesis will migrate toward spectral modeling. If abstract methods disappear and sampling synthesis is absorbed into spectral modeling, this leaves only two categories: physical-modeling and spectral-modeling. This boils all synthesis techniques down to those which model either the source or the receiver of the sound (Smith 1991, p. 9).

It is interesting to note that the source comes before the model in Smith's description. The sound-synthesis model thus aims to imitate an existing behavior. It is not understood as generating a unique sonority nor as actively transforming listening habits.

Brün's concept of "anticommunication" is virtually the exact opposite of Smith's idea of "modeling the receiver." We can see Walter Benjamin's understanding of the nature of perception as transient and historically conditioned as a presupposition for Brün's idea of anticommunication. Benjamin writes that "just as the entire mode of existence of human collectives changes over long historical periods, so too does their mode of perception" (Benjamin 2008, p. 23). Anticommunication is an attempt to say something through a channel which is not yet available, not yet established. In this way, one can "retard the natural decay of information," the process of meaning assignment. Anticommunication provides the possibilities for non-trivial connections to occur. Brün writes, "communication uses the order and the law that is meant to be recognized by the receiver as the receiver's own; anticommunication creates the order and the law that is meant to be discovered by the receiver for the first time" (Brün 2004, p. 229).

Knowledge is thus not seen as a compilation of empirical data, but as actively constructed by cognitive processes. As Heinz von Foerster, long-term colleague and friend of Brün, famously formulated, "the environment as we perceive it, is our invention" (von Foerster 2003, p. 212). The emphasis is thus not placed on the consensus a model engenders, but on the possibilities of action it creates. The listener is not seen as a passive system, which is fed with a certain input, but the relation to the music is rather like a perturbation of the receiving system causing structural change in it. By contrast, Smith's modeling of the receiver, once the model becomes an "aid" for composition, can be viewed as constraining and conditioning music (as does much research in psychoacoustics and music psychology).

The goal of ensuring comprehensibility, to tune the music to the receiver, is a strategy of preventing change. As Brün says, "insistence on communication ultimately leads to social and physical violence . . . anticommunication ultimately leads to the insistence on composition and peace" (Brün 2004, p. 289).

Smith couples his description with the classical concept of simplicity and exhaustiveness, when he writes that the "fundamental difficulty of digital synthesis is finding the smallest collection of synthesis techniques that span the gamut of musically desirable sounds with minimum redundancy. It is helpful when a technique is intuitively predictable" (Smith 1991, p. 1). If we assume that art is essentially not occupied with the generation of function, but with the generation of sensations, then music can indeed reflect on, and deal with, function, but neither "minimum redundancy" and predictability, nor the modeling of preexisting sources and the listener, are in essence relevant to music composition or sound art. Smith's statements can be interpreted as reducing music to being the empirical proof, the verification, of the model.

So, how can sound-synthesis models be of interest for music composition? Models allow a very particular access in that they define operations. These operations, however limited they might be,

are fundamental to the composition process. In nonstandard sound synthesis the model is also a model of composition, or at least forms the basis of models of composition. On the one hand, it abstracts and generalizes the multifaceted layers of a reality, it is a formalism and forms something *intelligible*. On the other hand, the model is descriptive and productive of something *sensible*. What is particularly interesting about sound-synthesis models is that we can understand them as working at the intersection between the sensible and the intelligible, while not belonging exclusively to either of them. The approaches presented here understand sound-synthesis models both as models of sound and as models of composition, thereby seeing models as *productive* rather than imitative and emphasizing the intersection of the intelligible and the sensible.

Technology

"The idea of the unstoppable, quasi-natural technological progress" (Zielinski 2006, p. 3) is a common understanding of technology, which we find often in today's science, art, and everyday life. It implies a subordination of art, politics, etc., to technological development. Society and thereby art is seen as acted upon, not as acting. Technology has effects, but its development is in itself immutable and autonomous. It thus becomes the governing force, and art works become footnotes of the history of its progress. It creates a history of improvement, from old megaphones to the telephone, from shadow images to 3-D cinema, from ceiling painting to virtual reality. This history stresses the "constant perfection of media's illusionist potential" (Zielinski 2006, p. 3). The new is thus nothing but confirmation of what has already been. Moreover, tools are measured by how effectively they can realize a given end. Andrew Feenberg strongly criticized this view, which he termed "technological determinism":

> Determinism rests on the assumption that technologies have an autonomous functional logic that can be explained without reference to society. . . . It would seem that society's fate

is at least partially dependent on a non-social factor which influences it without suffering a reciprocal influence. That is what is meant by "technological determinism" (Feenberg 1995, p. 5).

In this section, I will briefly try to show how nonstandard sound synthesis challenges two notions of technology: (1) technological determinism and (2) the notion of technology as "neutral," as merely a means with no greater influence on the distribution of power.

Technological Determinism

We find—as I believe—a proponent of technological determinism in the German media scientist Friedrich A. Kittler. The radical position he presents has grown out of the application of a Foucaultian discourse analysis to "writing systems", a term Kittler uses for technical systems of data processing, transmission, and storage of literature. Through detailed historical analyses, Kittler tries to demonstrate the media-theoretical horizon which is determining our very access to reality in a way that cannot be circumvented. Means of storage, transmission, and processing are conditioning our culture fundamentally. He shows, at great length, how inventions in media technology have caused changes in the arts and social structures. Whereas his earlier writings place media and technology within a more complex network of mutually determining factors, his later writings elevate technology to be the all-determining force.

> The media revolution of 1880, however, laid the groundwork for theories and practices that no longer mistake information for spirit. Thought is replaced by Boolean algebra, and consciousness by the unconscious, which . . . makes Poe's "Purloined Letter" a Markoff chain (Kittler 1999, p. 16).

Kittler's vision, however, leaves little or no space for art to maneuver. In fact, it leaves little space for humanity to maneuver. In his view, art is essentially a supplementary byproduct of

technological developments, which in themselves know only one motivation: war. His complete rejection of all modern art on the grounds of its futile rebellion against technical reproducibility (Kittler 2005) fails to see that technology is only as socially and culturally determining as it is socially and culturally determined.

Whereas other thinkers who relocated attributes of a previously autonomous subject to external determinants, such as Karl Marx and Sigmund Freud, in the same move opened up an emancipatory possibility, Kittler's move is exclusive and ultimate. It leads to the "computational end of art" (Kittler 2005). If art wants to escape such a one-sided determination by technology, the design of technology has to be at least partly non-technological, part of the artistic activity itself. The molecular biologist and science historian Hans-Jörg Rheinberger stresses the necessity of non-technical and "tinkered" approaches to technology in the process of experimentation. He argues that new questions in science emerge through "non-technical ensembles of technological objects" (Rheinberger 1997). The stabilized knowledge embodied by the tools can thereby again be destabilized. Rheinberger writes:

> In its nontechnicality, the experimental ensemble of technical objects transcends the identity conditions of its parts. According to the same pattern, established tools can acquire new functions in the process of their reproduction (Rheinberger 1997, p. 32).

The nonstandard sound-synthesis system's radically compositional approach to technology can be seen as a such an experimental "non-technical ensemble of technological objects." Instead of succumbing to the "computational end of art," artistic approaches to the design of technology can act as types of grassroots resistance, which reverse and thereby undermine the determining logic of technology.

Technology and Sound Synthesis

In the text "Technology and the Composer" (Brün 1971), Brün makes the distinction between learning from language, that is, adapting one's means of expression to a commonly understood vocabulary, and teaching language to say what one wants to say, thereby "retarding the decay of information" and extending vocabulary. It is during this moment of structural change, this "interregnum"—a moment in which there exists a discrepancy between the encoding of the message and how the receiver decodes it—that the new emerges.

Brün stresses the ubiquity of technological considerations in musical composition. He also criticizes the view of technology as a mere means to preconceived ends. The composer needs to engage in actively designing artificial systems. Free from any anti-technological fear, Brün highlights the "common ground" of art, science, and technology, which he locates in the idea of the system. The differences between these disciplines are thus differences of attitude towards systems. Science, he says, stipulates systems which are "analogous to an existent truth or reality," technology creates systems that "are to function in an existent truth or reality," and the arts create systems which are "analogous to an existence desired to become true or real." This underlying desire reveals the intrinsic utopian motivation in his point of view. It is the desire to create an "intelligent society." Artificial systems need to be developed, for they can have "properties which man either cannot have, or does not yet have."

At the same conference where Brün presented the aforementioned text, Pierre Schaeffer presented a paper dealing with his view of the relationship of music and technology. In his lengthy contribution, Schaeffer discusses a wide variety of issues. Most revealing for our discussion is his view on the relationship between "the artist and the engineer." Schaeffer proposes "the interesting and fruitful notion of two types of creators: those whose job it is to generate 'musical ideas,' in complete independence, and those who are faced with the task of interpreting these ideas" (Schaeffer 1971, p. 88).

Schaeffer's proposal describes a de facto practice in some electronic music institutions today. A harmful repercussion of this division of labour is the dissociation of ideas of sound and ideas of music. The "complete independence" of the

development of the musical ideas from the medium in which they are to be realized prevents the material from unfolding its structural, musical consequences, and from being further developed and supplemented by musical demands. If we bring to mind Theodor Adorno's description of material as "all that the artist is confronted by, all that he must make a decision about" (Adorno 1997), we see that Schaeffer's proposal splits art—the deduction of sensations from a material—apart at its very core.

Partly due to technological development, and partly due to the breakdown of music's own referential systems (e.g., tonality), musical material changed dramatically in the 20th century. Yet, by the end of the century, we see a restorative movement: Music that does not essentially question its own conventions is, as Douglas Kahn puts it, "rejuvenating" (Kahn 1990) its material. This happens without delivering a critique of its means of production and distribution, or questioning the world of expressive conventions from which it originates. Often sound is equated with timbre, which is equated with the Fourier spectrum, which is then equated with harmony. Such an understanding is often found in French spectral music, but the equation of sound with timbre is a wider phenomenon; as Antoine Bonnet says, "timbre is the modern name for sound" (Nancy 2007).

If technological development serves the "rejuvenation" of music's material, it is seen as an "enrichment of musical material" (Murail 2005) that takes place in an essentially conservative form. The new is thus only an improvement, an improved control over the material, and the means are thus measured by how effectively they can realize a given end. The French composer François Bayle says, "a great artist can create a work of art that transcends the medium, that makes one forget the medium" (Desantos 1997, p. 18). Here the medium serves the "great artist" to express his or her ideas of beauty. This is the path that leads to equating music with the results of its productive activity, where it is disembodied from its process of production, and where it tends to be reduced purely to the auditory experience. Here, technology is used for its ability to create illusion.

An approach to sound synthesis which is characterized by an avoidance of imitation can be traced back to the electronic music of the Cologne school, where it was assumed that in order to compose new music with a new kind of material, one has to find new ways of treating this material. If one assumes that art evolves from the examination of the means of its production, it is necessary to explore the possibilities of musical organization that our means of production can provide us, instead of searching for ways of emulating already known situations with new tools. Koenig writes that when composing electronic compositions he has "always searched for causes in the technical conditions of the studio . . . the machines should not only be used economically, but also musically, they should take over form building tasks" (Koenig 1987, p. 168). We can contrast this view with Jean-Claude Risset's statement:

> Insofar as the composer is familiar with the sounds of an instrumental type, he will inevitably find it simpler, in front of the computer, to make use of his previous musical concepts and his science of orchestration (Risset 1971, p. 127).

Making "use of previous musical conceptions and science of orchestration" as a goal for dealing with new tools can be seen as preventing change. This article presents a perspective in which technology and its function are not accepted as pre-given or as immutable; not as merely a means for realizing a preconceived objective, but as something to be explored, to be determined, to be defined. The question is not so much which desires one can satisfy with a given technology, but rather which (old and new) desires emerge from it. It is the search for possible roles of technology in music. It is part of the composer's work to establish such roles. Di Scipio writes:

> Adorno observed, too, that an artist's labor always implies a personal or shared "critique of technology," but it can actually only do so only by confronting and exploiting the technology without getting rid of it . . . , we can argue that, today, art can confront technology in an approach of "subversive rationalization" (Di Scipio 2002, p. 24).

Adorno argued in favor of an aesthetic rationality, because the art work can thus internalize the rationality of the external world and at the same time oppose it. "Subversive rationalization" is therefore a strategy of using "the rationality of the world of empirical reality as a means of freeing itself from the repression of means-ends rationality" (Paddison 1993, p. 141). Adorno writes:

> Art works oppose domination by mimetically adapting to it. If they are to produce something that is different in kind from the world of repression, they must assimilate themselves to repressive behaviour. . . . In sum, aesthetic rationality wants to make amends for the damage done by instrumental rationality outside art (Adorno 1997, pp. 403–404).

Conclusion

I have tried to trace out an aesthetic perspective based on nonstandard sound-synthesis systems. Although nonstandard sound-synthesis methods of the 1970s have served as starting points, my objective has not been to provide merely an interpretation of a historic approach to sound, but to construct an aesthetic perspective with relevance for the current situation of computer music.

Two intentions have formed the basic motivation of this article: firstly, bringing together musical composition and ideas about sound as a phenomenon, thereby interpreting sound-synthesis methods as embodiments of these ideas, and secondly, asserting the need for an axiomatic disorientation as the basis of creating new musical and sonic possibilities.

In realizing these intentions, this article has sketched out a connection between early 20th-century precursors and the nonstandard sound-synthesis methods of the 1970s. I have taken a critical look at Koenig's and Brün's systems. I have pointed out that the modeling of the listener and source is an intrinsically positivist conception and, further, shown how synthesis models can overcome the dichotomy of empirical reality and representation. Finally, I have taken a brief look at the role of technology in music composition and criticized both "technological determinism" and the notion of technology as "neutral" in favor of a more open-ended and less linear view, in which the design of technology is seen as part of the artistic work.

Acknowledgments

References

Adorno, T. W. 1997. *Aesthetic Theory*. Minneapolis: University of Minnesota Press.

Badiou, A. 2007a. *The Concept of Model: An Introduction to the Materialist Epistemology of Mathematics*. Prahran, Australia: re.press. Originally published as Badiou, A. 1969. *Le concept de modèle*. Paris: Maspéro.

Badiou, A. 2007b. *The Century*. Cambridge: Polity Press.

Benjamin, W. 2008. *The Work of Art in the Age of Its Technological Reproducibility and Other Writings on Media*. Cambridge, Massachusetts: Harvard University Press.

Berg, P. 2009. "Composing Sound Structures with Rules." *Contemporary Music Review* 28(1):75–87.

Brün, H. 1964. "Musical Ideas for Synthetic Sound." Available on-line at ada.evergreen.edu/~arunc/texts/brun/synthetic.pdf. Accessed April 2011.

Brün, H. 1969. "Infraudibles." In H. von Foerster and J. W. Beauchamp, eds. *Music by Computers.* New York: John Wiley and Sons, pp. 117–121.

Brün, H. 1971. "Technology and the Composer." In *Music and Technology (Proceedings of the Stockholm Meeting organized by UNESCO)*. Paris: La Revue Musicale, pp. 181–192.

Brün, H. 2004. *When Music Resists Meaning.* Middletown, Connecticut: Wesleyan University Press.

Desantos, S. 1997. "Acoustic Morphology: An Interview with François Bayle." *Computer Music Journal* 21(3):11–19.

Di Scipio, A. 1995a. "Centrality of Techné for an Aesthetic Approach on Electroacoustic Music." *Journal of New Music Research* 24(4):369–383.

Di Scipio, A. 1995b. "Inseparable Models of Materials and of Musical Design in Electroacoustic and Computer Music." *Journal of New Music Research* 24(1):34–50.

Di Scipio, A. 2002. "Systems of Embers, Dust, and Clouds: Observations after Xenakis and Brün." *Computer Music Journal* 26(1):22–32.

Feenberg, A. 1995. "Subversive Rationalization." In A. Feenberg and A. Hannay, eds. *Technology and the Politics of Knowledge*. Bloomington: Indiana University Press, pp. 3–22.

Greenberg, C. 1982. "Modernist Painting." In F. Frascina and C. Harrison, eds. *Modern Art and Modernism: A Critical Anthology*. London: Harper and Row, pp. 5–10.

Hallward, P. 2003. *Badiou: A Subject to Truth*. Minneapolis: University of Minnesota Press.

Holtzman, S. R. 1978. "A Description of an Automatic Digital Sound Synthesis Instrument." DAI research report No. 59. Edinburgh: Department of Artificial Intelligence.

Kahn, D. 1990. "Track Organology." *October* 55:67–78.

Kittler, F. 1999. *Gramophone, Film, Typewriter*. Palo Alto, California: Stanford University Press.

Kittler, F. 2005. *The Relation of Art and Techne*. Available on-line at http://www.egs.edu/faculty/friedrich-kittler/videos/the-relation-of-art-and-techne/. Accessed 30 April 2010.

Koenig, G. M. 1971. "The Use of Computer Programs in Creating Music." In *Music and Technology (Proceedings of the Stockholm Meeting organized by UNESCO)*. Paris: La Revue Musicale, pp. 93–115.

Koenig, G. M. 1980. "Composition Processes." In M. Battier and B. Truax, eds. *UNESCO Computer Music: Report on an International Project Including the International Workshop Held at Aarhus, Denmark in 1978*. Ottawa: Canadian Commission for UNESCO, pp. 105–126.

Koenig, G. M. 1987. "Genesis of Form in Technically Conditioned Environments." *Interface* 16(3):165–175.

Levin, T. Y. 2003. "'Tones from out of Nowhere': Rudolf Pfenninger and the Archeology of Synthetic Sound." *Grey Room* (12):32–79.

Morgenstern, O., and J. von Neumann. 1944. *Theory of Games and Economic Behavior*. Princeton: Princeton University Press.

Moholy-Nagy, L. 2004. "Production–Reproduction: Potentialities of the Phonograph." In C. Cox and D. Warner, eds. *Audio Culture: Readings in Modern Music*. London: Continuum. (Chapter originally published 1922.)

Murail, T. 2005. The Revolution of Complex Sounds. *Contemporary Music Review* 24(2):121–135.

Nancy, J.-L. 2007. *Listening*. New York: Fordham University Press.

Paddison, M. 1993. *Adorno's Aesthetics of Music*. Cambridge: Cambridge University Press.

Rheinberger, H.-J. 1997. *Toward a History of Epistemic Things*. Palo Alto, California: Stanford University Press.

Rilke, R. M. 2001. "Primal Sound." In D. Rothenberg and M. Ulvaeus, eds. *The Book of Music and Nature*. Middletown, Connecticut: Wesleyan University Press, pp. 21–24. (Chapter originally published 1919.)

Risset, J.-C. 1971. "Synthesis of Sound by Computer and Problems Concerning Timbre." In *Music and Technology (Proceedings of the Stockholm Meeting organized by UNESCO)*. Paris: La Revue Musicale, pp. 117–128.

Schaeffer, P. 1971. "Music and Computers." In *Music and Technology (Proceedings of the Stockholm Meeting organized by UNESCO)*. Paris: La Revue Musicale, pp. 57–92.

Smith, J. O. 1991. Viewpoints on the History of Digital Synthesis. In *Proceedings of the International Computer Music Conference*, pp. 1–10.

Stockhausen, K.-H. 1963. "Elektronische und instrumentale Musik." In *Texte zur elektronischen und instrumentalen musik*. Cologne: Verlag M. DuMont, pp. 140–151. (Chapter originally published 1958.)

Thomson, P. 2004. "Atoms and Errors: Towards a History and Aesthetics of Microsound." *Organised Sound* 9(2):207–218.

von Foerster, H. 2003. "On Constructing a Reality." In *Understanding Understanding: Essays on Cybernetic and Cognition*. New York: Springer Verlag, pp. 211–228.

Zielinski, S. 2006. *Deep Time of the Media, Towards an Archeology of Hearing and Seeing by Technical Means*. Cambridge, Massachusettes: MIT Press.