

The Blindness Paradigm: The Visibility and Invisibility of the Body

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This article focuses on the theoretic issues of the collaborative project Canções dos Olhos (Paulo C. Chagas composition, Johannes Birringer choreography and video, Veronica Endo dance) in the realm of the Interaktionslabor, a laboratory for interactive media, sound, design, digital video, telecommunications and performance on the site of the former coal mine in Göttelborn, Germany. The work, inspired by the novel Blindness by José Saramago, explores the cognitive and aesthetic dimensions of blindness in terms of embodiment experience. The project was conceived as an ‘intermedia’ song cycle resulting in a DVD and an audiovisual installation. Compositional elements include voice (soprano), processed voice, dance and digital film. Based on the experience of Canções dos Olhos, this article addresses questions of both the visibility and invisibility of the body in the autopoietic process of generating electroacoustic and digital music, and reflects on the relationship between technology and embodied human interaction in artistic collaboration.

Keywords: Body; Embodiment; Autopoiesis; Interactivity; Intermedia; Electroacoustic Music; Digital Music

To see
the visible
but not to see
the blindness
of the visible

Visible and Invisible World

The Portuguese author and Nobel Prize winner José Saramago describes in his novel *Blindness* (1995; original title: *Ensaio sobre a Cegueira*) the scenario of a fictional, contemporary city where everyone goes blind. The city is nameless and there is no apparent reason for the sudden collective blindness. The first victim is a man stricken

blind while in his car waiting for a traffic light to change. Then the blindness spreads rapidly like an epidemic. The public authorities isolate the blind in a former mental hospital. Soldiers keep watch of the internees and shoot anyone attempting to escape. The blind are provided with food, but nothing else. They have to adapt their lives to this new environment. The mental hospital very quickly becomes overpopulated, dirty and violent. Some criminals have guns and take advantage of the situation: making people pay for the food and sexually abusing the women. A revolt ensues. A woman takes revenge, killing her rapist. As the food supply dwindles, the blind learn that the entire population is also blind. They begin leaving the mental hospital and find the outside situation to be no better as they find a devastated landscape. The infrastructure and economy have collapsed, nothing functions: no electricity, water, communication, transportation. People wander blindly through the streets, struggling to find food. Life is reduced to the basic instinct of survival; despair prevails. Suddenly, when all hope has vanished, everybody can see again. Nothing explains their collective blindness.

Saramago's literary metaphor of blindness points to the vulnerability of a society on the edge of chaos with no guarantees of stability. Barbaric aspects of contemporary life easily reveal themselves, as we recently saw when Hurricane Katrina devastated New Orleans. The main threat our society faces is collective blindness—when the visible disappears in front of our eyes, when society itself becomes blind. We cannot communicate our thoughts and emotions when we are blind to each other. The only character in Saramago's novel unaffected by the blindness is the ophthalmologist's wife. Although not blind, she follows her husband into the mental hospital and, without revealing that she can see, helps the blind. This woman is Saramago's invisible narrator. She makes the blindness visible. Otherwise, who could tell the story of the blindness? 'I can see, I can see', the people in the street shout and sing, after recovering their vision, but why did they become blind in the first place? Were they ever blind? In conclusion, Saramago states the ambiguity that traverses the entire story: 'Do you want me to tell you what I think, Yes, do, I don't think we go blind, I think we are blind, Blind but seeing, Blind people who can see, but do not see' (Saramago, 1997, p. 326).

Visible and Invisible Body

Saramago's *Blindness* plunges us into the aftermath of our own blindness. We cannot avoid associating the breakdown of the social system he describes with some of our personal experiences. While reading *Blindness*, I reconstructed my own experience as a 17-year-old imprisoned during the Brazilian military dictatorship in 1971. I was arrested for collaboration with opposition groups. Arriving in the military prison, I was put in the 'fridge', a small room, acoustically isolated, and completely dark and cold. Various noises and sounds (hauling oscillators, rumbling generators, distorted radio signals, motorcycles, etc.) shot from loudspeakers, hidden behind the walls. Incessantly, the electronic sounds filled the dark space and overwhelmed my body for three long days. After a time, I lost consciousness. This auditory and acoustic torture

was then a recent development, partially replacing traditional methods of physical coercion that killed thousands in Latin American prisons between the 1960s and 1990s. Such sounds injure the body without leaving any visible trace of damage. The immersive space of the torture cell, soundproofed and deprived of light, resonates in my memory as the perfect environment for experiencing the power of sound embodiment.

In such an extreme situation it becomes evident that the body cannot escape the auditory and acoustic sensory experience. The sound traverses the molecules and deterritorializes the cognitive and physical domains. The torture cabin would not have been so effective if the body had been exposed to visual stimuli only. Compared to visual perception, sound has a higher coefficient of deterritorialization, which, as Deleuze and Guattari argue, comes from a 'phylogenetic' line. The machinic phylum that operates on sound can impose its cognitive patterns on the body's responses. Sound accounts for the great ambiguity of the musical experience: '[S]ound invades us, impels us, drags us, transpierces us. It takes leave of the earth, as much in order to drop us into a black hole as to open us up to a cosmos. It makes us want to die' (Deleuze & Guattari, 1987, p. 348).

The philosophic vision of music articulated by Deleuze and Guattari is related to Schopenhauer's conception of the 'world as will'. According to Schopenhauer (1958), music embodies the will and is opposed to the universe of images, which belongs to the domain of representation. Similarly, Deleuze and Guattari state that the essence must be found 'in the molecular domain of transverse becomings' (Bogue, 2003, p. 16). Music arises in the 'territories' formed by 'milieus' and 'refrains' as the 'creative, active operations that consist of deterritorializing the refrain' (Deleuze & Guattari, 1987, p. 300). The notion of 'refrain' refers to any kind of rhythmic pattern that marks a territory, whereas the notion of 'rhythm' should be understood as a qualitative *difference*, a relationship between 'milieus'. Just as music has a strong force of deterritorialization, it also has the powerful ability of reterritorialization. Bodies can be reconstructed through acoustic vibrations; trumpet signals can move armies into battle (Deleuze & Guattari, 1987, p. 348). Hip hop music on ipods prompts the bones and muscles of athletes and soldiers, preparing them for competition and battle; music tunes the body for great accomplishment; music collects and destroys forces. This overwhelming power of embodiment accounts for the 'potential fascism of music' (Deleuze & Guattari, 1987, p. 348).

In addition to functioning as a motor for war machines, music and sound embodiment can drive sacrifices, trance and possession. In *La musique et la transe*, Gilbert Rouget (1990, p. 230) argues that musical vibrations are palpable movements conveying an immediately material and concrete experience. He perceives vibrations as transformations of objects affected by sound, including those that produce the sound and those that vibrate sympathetically with it. The human body is such an object. Rouget (1990, p. 231) describes different kinds of perceptions in different parts of the body, such as the large African drums perceived through vibrations in the belly and the small drums through vibrations in the head.

Truax (2001, p. 55) proposes a model of acoustic communication based on the opposition between sound and meaning mediated by the sonic structure. He distinguishes between the sound energy produced by sound waves and that produced by electric signals. Such a model of musical communication justifies the opposition between ‘performing’ and ‘listening’ bodies (i.e., bodies that are, respectively, actively and passively involved in the musical experience). However, I believe that this opposition does not account for the complex processes of decoding and recoding, deterritorialization and reterritorialization, that undergo the reorganization of functions and the regrouping of forces by the musical cognition. Rather than a response to external impulses, sound sensations should be considered a process of embodiment, which is not necessarily related to the physical presence and function of bodies. Distinctions between performance and listening are only operational descriptions of relations. Performing requires listening and listening requires performing. As Rouget (1990, p. 231) argues, music activates ‘external’ and ‘internal’ sound sensations. By singing, for example, we feel the vibrations spreading from the throat to the neck, face, thoracic cavity, and the abdominal and pelvic regions. Music is at the same time an ‘animation of things and a palpitation of the being’. Rouget articulates the two different kinds of impact music exerts on the body as a distinction between ‘acting’ and ‘undergoing’. Again, this opposition should not be understood as a distinction between performing and listening, but as different operations of bodies involved in the process of *observing* music.

The concept of ‘observation’, as I use it here, must be understood as the operation that draws distinctions and creates form (Spencer-Brown, 1969).¹ The different ways of perceiving sound and music (physiologically, psychologically, affectively, aesthetically, etc.) can be reduced to the operation of *observation*, through which systems interact with their environment. Autopoietic living machines, such as human beings, are closed systems and cannot establish any contact with their environment. They can only operate in the recursive realm of their own boundaries.² The cognitive operations of perception are determined by the operational mode of the sensory-motors apparatus (consciousness), which creates a distinction between self-reference (inside) and hetero-reference (outside) (Luhmann, 2000, p. 9). According to Luhmann, the distinction between ‘inside’ and ‘outside’ is processed simultaneously and remains internal to the system. When we observe sounds—it does not matter if we are producing sounds or listening to sounds, or even writing about sounds—we distinguish between bodies and vibrating systems, but what we call ‘vibration’ is only the boundary that marks the difference between our bodies and the world. Music emerges in the system of art as a structural coupling between perception and communication, through which acoustic sensations are correlated to meaningful structures of communication observed in the social system. Works of music and commentaries on them are both observations. The perception of and the communication of a work of music are elements of an autonomous and closed system that can only reproduce its own operations. There is no ‘transmission’ of information between living systems and social systems.³

Visible and Invisible Machine

Digital technology is responsible for a significant transformation of the perception of the body. Electronic processes connecting bodies to computers and other such digital devices produce sound, images, dance, language and other artistic forms that account for the variety of aesthetic and performance contexts in the social system. Concepts such as ‘virtuality’ and ‘interactivity’ emerge in posthumanistic discourse and practice as two opposite poles of the relationship between body and technology.⁴ On the one hand, ‘virtuality’ refers to the idea that the body becomes invisible and, on the other, ‘interactivity’ conveys the idea that the body becomes visible. The discourse of virtuality emphasizes the disembodiment of information, the fragmentation of the physical world through the manipulation of digital data, the simulation as an ersatz of the experience (Virilio, 1988; Baudrillard, 1995). The discourse of interactivity stresses the embodiment of information, the material interface between bodies and digital machines and the emergence of the transmediale cognitive and affective experience (Hayles, 1999; Hansen, 2004; Birringer, 2005c).⁵

An important shift has occurred in recent years from the structuralistic approach that establishes a separation between information and meaning and conveys the conception of information as a disembodied entity (Shannon, 1948; Wiener, 1961), to a phenomenological approach of cognition as a process involving ‘multiple levels of interconnected, sensorimotor activity that shapes a world’ (Varela et al., 1991, p. 206). This approach, defined as ‘*enaction*’, is opposed to the idea of *representation*, which has been the paradigm of informatics and cybernetics of the first order (Foerster, 1981, 1993, 2002; Hayles, 1999) and is still referenced in research on artificial intelligence (AI).⁶ The enactive approach views cognition as embodied action, as a *structural coupling* between systems that reflect each other’s histories and make possible the emergence of a world. Embodiment is the domain of interactions between autonomous systems that are in principle closed and communicate only through self-reference, but can undergo transformations when structurally coupled. This domain of interactions is the being-in-the-world of cognition. It cannot be reduced to the notion of body as a physical entity, such as the structure of bones and muscles or electronic circuits.

Musical embodiment can be analyzed through the lens of performance and listening, aspects of music that are most affected by the deterritorialization/reterritorialization vectors of electronic and digital machinery.⁷ Musical embodiment is a temporal experience that requires the *synchronization* of temporal *objects* and *events*.⁸ In traditional musical practices, such as the Yoruba drum ensembles or Western symphony orchestras, the presence of performers and listeners who physically share the same time and space provides the framework for the synchronization. This mode of embodiment creates the unique ‘aura’ of the work of music, which, according to Benjamin (1977), has been eliminated by mechanical reproduction. By re-interpreting Benjamin (maybe the most cited author in new media studies) through the concepts of Deleuze and Guattari, the loss of the aura

becomes a process of deterritorialization/reterritorialization through which the matrix of performance/listening becomes *invisible* and the medium of technology *visible*.

Different notions of form arise from the relationship between body and media—for example, Hayles' (1999) operative distinction between *body* and *embodiment* as different domains of interaction. The body, according to Hayles, is an abstract idealized form, a discursive universal construct. The embodiment, on the other hand, is always 'contextual, enmeshed with the specifics of place, time, physiology, and culture, which together compose enactment' (Hayles, 1999, p. 196). Hayles' reflection accounts for the ambiguity of the posthuman condition. The discourse holds both an apocalyptic and optimistic vision of the world, a world inhabited by humans, machines and other life-forms. She relates the distinction between body and embodiment to other operational distinctions such as inscription/incorporation and pattern/randomness (Hayles, 1999, pp. 198–199). A similar approach has been developed in music theory with other distinctions such as periodicity/aperiodicity (Pousseur, 1970, pp. 241–290) and sound/noise (Atali, 1985). Binary categories belong to the domain of the observer and indicate the possibility of recursively re-entering the distinction system/environment into the form of the distinction itself.⁹ The form, as defined by Luhmann, is not an ontological definition of objects, states or *Gestalten*, but the operation that establishes a *difference* in the world and draws a boundary between a marked and an unmarked space. The environment is the medium; the system is the form. The environment is the domain of invisibility, a loose coupling of the elements; the form is the domain of visibility, a tight coupling of the elements.¹⁰ As I argued before, system and environment are closed domains that interact only through structural coupling; the world itself 'remains invisible even when, as precisely when, it is laced with forms' (Luhmann, 2000, p. 33).

The visibility of music, rather than incorporated in the materiality of sound, emerges from the gesture of performance. The concept of gesture is not necessarily related to the 'purposive movement of the human body' (Wittgenstein, 1980, p. 42e), but to the *understanding* of form. 'Architecture is a gesture', claims Wittgenstein (1980, p. 42e), and sometimes a gesture can be the simplest way to 'understanding and explaining a musical phrase' (Wittgenstein, 1980, p. 69e). Following Wittgenstein, we can define gesture as the form that makes visible the invisibility of musical understanding. Flusser (1994) sees, in the gesture of listening to music, the logical matrix of the fertilization of matter through the spirit (*Geist*). Since it expresses the transformation of both 'body in music and music in body' (Flusser, 1994, p. 155), the gesture of listening shows the embodiment of mind and thinking. Vocal and instrumental gestures are analogous models activated by the synchronization of performers and listeners (Chagas, 2002, p. 191). A vocal gesture consists of a physical and metaphysical effort, a projection of an identity (*Dasein*) in some other context (Tarasti, 2002, p. 157). Instrumental gesture requires a synchronized action between body and object. Both vocal and instrumental gestures are ritualizations of *myths*, which are coupled with a medium such as orality and acoustics. By contrast,

gestures in electroacoustic and digital music are ritualizations of *programs* (Flusser, 1985, 1994), which emerge as transmediale (or intertextual) couplings of different media: sound, noise, language, space body, machine and so on. Vocal and instrumental gestures account for the visibility of the gesture of performance; electroacoustic and digital gestures make the gestures of performance invisible.¹¹

The invisibility of performance remains one of the main controversial aspects of electroacoustic and digital music. This problem has been haunting composers since the beginning of ‘tape’ music in the 1950s. John Cage made very accurate observations in the beginning of the 1960s, pointing to the problem as well as foreseeing the solution:

[T]he most important thing to do with electronic music now is to somehow make it theatrical...by introducing live performance elements. That is to say, people actually doing things...[and] the actual, visual manipulation of the machines, to begin with; the distinct giving to the audience of the impression that something is happening then which is unique to that particular experience. (Ascott, 2003, p. 124)¹²

Cage suggests that the theatrical dimension implies that electroacoustic and digital music must deterritorialize/reterritorialize the experience of *temporality*, which traditionally became apparent through the synchronization of performance and listening, by structural coupling of the medium ‘sound’ with other ‘media’. The sensorimotor embodiment, according to enaction, requires ‘a frame or window of simultaneity that corresponds to the duration of lived present’ (Varela, 1999, p. 272). Varela’s phenomenological approach accounts for the emotional motivation that engages any cognitive action, including listening. Affect is the dispositional orientation that coordinates different scales of temporality and makes possible the experience of simultaneity (Varela, 1999, p. 300), which is crucial for music. Vocal and instrumental sounds are *transparent*; they make visible the flow of gestures—including gestures of affects—that configure the embodiment of the musical experience. On the other hand, electroacoustic and digital signals are *opaque*. They break the transparency of the musical flow, block the experience of simultaneity and, thus, the disposition of affective experience. In other words, electroacoustic and digital music has to compensate blindness by inventing new forms that emphasize sonic sensory qualities (e.g., visual, tactile, textural, spatial, etc.) and stimulates, as Cage said, the ‘involvement in the behavior of performers and the musical “machines”’ (Ascott, 2003, p. 124).

Visible and Invisible Interactivity

The visibility and invisibility of the body are the central issues of *Canções dos Olhos* (*Augenlieder*), a composition for soprano, processed voice, dance and digital image created in collaboration with the choreographer and media artist Johannes Birringer and the dancer Veronica Endo. The work was developed in a period of two weeks

(18–31 July 2005) in the ‘Interaktionslabor’, an international workshop founded and directed by Birringer in 2003 on the site of the former coal mine of Götteleborn, Saarland, Germany. After the cessation of mining activity in the 1990s, which plunged the region into a crisis of chronic unemployment, the local government set up an initiative to attract high-tech companies to the abandoned mine. This recycling of the industrial landscape gave birth to the project of the ‘future *cité*’, a post-industrial living environment shaped as a network of individuals and machines sharing the dream of a telematic society (Flusser, 1985). The Interaktionslabor emerged inside this dream as a self-organizing ‘laboratory for interactive media, sound, design, digital video, telecommunications and performance’ (Birringer, 2005a, 2005b). Since 2003, it has promoted an annual summer workshop by inviting groups of artists, scientists, engineers and so on from Europe, North and South America and Asia. Participants live for two weeks in the region (since 2005, at the site of the mine) and work on individual and collaborative projects in which digital media and interactive performance are coupled with specific qualities of the physical environment. The artistic activities of the Interaktionslabor are experiences of deterritorialization and reterritorialization. They generate meaningful structures for the possibility of converting a post-industrial society into a utopia of the information society, the living network towards which many of our personal dreams converge. In this sense, the Interaktionslabor is the structure that makes visible the possibility of dreaming; it is the visibility of the ‘future *cité*’ itself.

I previously explored the novel *Blindness* in a project for Interaktionslabor 2004: *Ensaio sobre a Cegueira* (Blind City) was a model for an interactive opera installation that ‘focused on the haptic and the auditory, seeking to displace proprioception from vision, [to] make us “see” without seeing’ (Birringer, 2005b). In the conception of *Canções dos Olhos* (*Augenlieder*) for Interaktionslabor 2005, I revised Saramago’s narrative, focusing on the operational distinction between visibility and invisibility. Inspired by Schubert’s *Winterreise*, I imagined a cycle of ‘intermedia songs’ exploring the relations between sound, image and dance in the unique environment of the mine. The song cycle focuses on the character of the doctor’s wife—performed by the dancer—the only person that apparently can see in the virtual city where everyone else has gone blind. Her story is not told as a linear narration, but rather as an invisible layer of fiction that ‘actively probes the spaces between the different media’ (Higgins, 2002, p. 91).

The intermedial approach of *Canções dos Olhos* reflects on the autopoiesis of the artistic creation itself, the invisible forces that drive experiences of exchange, collaboration, communication and interaction between human beings and machines. In opposition to the discourse of interactivity as a connection between bodies and digital interfaces, I define interactivity as the *embodiment of the collaborative experience that materializes the creation process in the form of the work itself*. The paradigm of ‘interactivity’, as Flusser (1985, pp. 173–181) argues in his prophetic book *Ins Universum der Technischen Bilder*, is chamber music. Following the theory of autopoietic systems, there is no (nor can any exist) ‘interactivity’ between human

beings and machines because they operate in different living domains that are operationally closed to each other. Interactivity is a being-in-the-world, not an ensemble of devices or patches that we put together. Interactivity is a form of synchronization of systems, which cannot distinguish between perception and communication, and therefore cannot communicate. There is no possible communication between a human being and a computer; only communication can communicate.

The main issue of artistic creation today is how to shape a *dialogue* process between different kinds of systems, a process in which the different systems operate as partners and not in a hierarchical structure. The problem becomes evident when we observe the existing uses of technology by society, particularly by digital artists. We observe people making sounds, dancing for cameras, tracking data with sensors and playing with interfaces, but no interactivity develops if no dialogue occurs between the systems operating in that particular time and space. What we usually see is either the machine dominating the human being or the human being using the machine as a slave for her or his purpose. In fact, we reproduce in our relationship with technology the same patterns of oppression and exploitation that inherently drive capitalist and imperialist systems. There is definitely a need for ethical and moral reflection on the 'new' theories of 'digital phenomenology'. 'Interactivity' is mostly interpreted as a synonym for computer calculation and justified as *projections* for the future. However, as Flusser (1985, pp. 173–174) says: '[T]he futuristic computer devoured the future. To predict the future is to destroy the future with the purpose of preventing catastrophes'.

Since the 9/11 attacks against the 'Empire', technology development has been focused on 'security' against the global threat of terrorism. Ironically, these new developments fail to protect us, instead accelerating our capability for self-destruction. We all witnessed the powerful disintegration of the American Gulf Coast social system after Hurricane Katrina. This was only a small model of disintegration, but it clarified how quickly a system can collapse. This development is also apparent in the use of robots and uninhabited vehicles for replacing soldiers during military conflicts. There is a strong tendency to make the body invisible through the development of technologies meant to protect us from physical destruction. The suicide bombers from Baghdad and the Gaza Strip also create a dimension of 'invisibility' when their bodies are used as weapons for the destruction of life and property. This kind of invisibility is driven by their belief in the superiority of a particular (religious) conception of God. The former kind of invisibility is driven by the belief in the superiority of technology, that it can enable the body to disappear behind computer systems, making it impervious to our enemies. Both forms of invisibility are motivated by the same kind of thinking. And this is our major problem.

Notes

- [1] Spencer-Brown's concept of form is an imperative demand: 'draw a distinction' (Spencer-Brown, 1969, p. 3).

- [2] The theory of autopoiesis was formulated by the neurobiologists Humberto Maturana and Francisco Varela (see Maturana and Varela, 1980, 1987; Varela, 1979).
- [3] Luhmann developed the analysis of the functional subsystem of art in several articles and in the book *Die Kunst der Gesellschaft* (1995), which has been translated into English (Luhmann, 2000). For an introduction to Luhmann's theory of autopoietic social systems, see Luhmann (1990).
- [4] Most of the new theories or philosophies of 'new media' are focused on visual arts and offer very little, if no insight, to the acoustic domains of artistic creation (e.g., Manovich, 2001; Hansen, 2004).
- [5] For an analysis of the evolution of music and sound art from the age of reproducibility to the age of connectivity, see Chagas (2003a).
- [6] Rodney Brooks takes a different approach to artificial intelligence in his research in the AI laboratory at MIT; Varela describes it as enactive AI (see Brooks, 2002; Varela et al., 1991, pp. 208–212).
- [7] Guattari (1992, pp. 11–52) introduces the concept of 'machinic subjectivity' for describing the impact of machines of information and communication technology on human subjectivity.
- [8] For an analysis of the role of temporality in cognition, see Varela (1999).
- [9] For the distinction between system and environment, see Luhmann (1984, pp. 35ff, 242ff; 1997, pp. 60ff). For the concept of re-entry, see Spencer-Brown (1969, pp. 69–76).
- [10] The distinction between medium and form is discussed in Luhmann (2000, pp. 102–132); for an application in the musical domain, see Chagas (2003c).
- [11] For a phenomenology of vocal, instrumental and electroacoustic gestures inspired by Wittgenstein and Flusser, see Chagas (2003c).
- [12] Interview with John Cage, quoted in Reynold (1962).

References

- Ascott, R. (2003). *Telematic embrace: Visionary theories of art, technology and consciousness*. Berkeley, CA: University of California Press.
- Atali, J. (1985). *Noise: The political economy of music* (B. Massumi, Trans.). Minneapolis, MN: University of Minnesota Press.
- Baudrillard, J. (1995). *Simulacra and simulation* (S. M. Glaser, Trans.). Ann Arbor, MI: University of Michigan Press.
- Benjamin, W. (1977). Das Kunstwerk im Zeitalter seiner technischen Reproduzierbarkeit. In S. Unsel (Ed.), *Walter Benjamin: Illuminationen* (pp. 136–169). Frankfurt am Main: Suhrkamp.
- Birringer, J. (2005a). *Interaktionslabor*. Available online at: www.interaktionslabor.de (accessed 30 October 2005).
- Birringer, J. (2005b). *FutureHouse, blind mine*. Available online at: http://art.ntu.ac.uk/performance_research/birringer/bibl.htm (accessed 30 October 2005).
- Birringer, J. (2005c). *Performing art performing science*. Available online at: http://art.ntu.ac.uk/performance_research/birringer/bibl.htm (accessed 30 October 2005).
- Bogue, R. (2003). *Deleuze on music, painting and the arts*. New York: Routledge.
- Brooks, R. (2002). *Flesh and machines: How robots will change us*. New York: Pantheon Books.
- Chagas, P. C. (2002). Spiel und Dialog: das Komponieren mit Apparaten. In E. Ungeheuer (Ed.), *Elektroakustische Musik. Handbuch der Musik im 20. Jahrhundert Band 5* (pp. 182–196). Laaber: Laaber-Verlag.

- Chagas, P. C. (2003a). Virtuality and metadesign: The sound art in the age of connectivity. In *Proceedings of the Ninth Biennial Symposium on Arts and Technology* (pp. 24–35). New London, CT: Connecticut College.
- Chagas, P. C. (2003b). La distinction entre médium et forme: une nouvelle approche de la sémiotique musicale. In *Proceedings of the Tenth Journées d'Informatique Musicale*. Montbéliard: École Nationale de Musique.
- Chagas, P. C. (2003c). Gesture in Electroacoustic Music: Vocal, Instrumental and Technological. Paper presented at the International Conference on Music and Gesture, University of East Anglia, Norwich.
- Deleuze, G. & Guattari, F. (1987). *A thousand plateaus: Capitalism and schizophrenia* (B. Massumi, Trans.). Minneapolis, MN: University of Minnesota Press.
- Flusser, V. (1985). *Ins Universum der technischen Bilder*. Göttingen: European Photography.
- Flusser, V. (1994). *Geste: Versuch einer Phänomenologie*. Frankfurt am Main: Fischer.
- Foerster, H. von. (1981). *Observing systems*. Seaside: Intersystems.
- Foerster, H. von. (1993). *KybernEthik*. Berlin: Merve.
- Foerster, H. von. (2002). *Der Anfang von Himmel und Erde hat keinen Namen: eine Selbsterschaffung in 7 Tagen* (K. H. Müller & A. Müller, Eds). Berlin: Kadmos.
- Guattari, F. (1992). *Chaosmose*. Paris: Galilée.
- Hansen, M. B. N. (2004). *New philosophy for new media*. Cambridge, MA: MIT Press.
- Hayles, N. K. (1999). *How we became posthuman: Virtual bodies in cybernetics, literature and informatics*. Chicago, IL: University of Chicago Press.
- Higgins, H. (2002). *Fluxus experience*. Berkeley, CA: University of California Press.
- Luhmann, N. (1984). *Soziale Systeme. Grundriß einer allgemeinen Theorie*. Frankfurt am Main: Suhrkamp.
- Luhmann, N. (1990). The autopoiesis of social systems. In *Essays on self-reference* (pp. 1–20). New York: Columbia University Press.
- Luhmann, N. (1997). *Die Gesellschaft der Gesellschaft*. Frankfurt am Main: Suhrkamp.
- Luhmann, N. (2000). *Art as social system* (E. M. Knodt, Trans.). Stanford, CA: University of Stanford Press.
- Manovich, L. (2001). *The language of new media*. Cambridge: MIT Press.
- Maturana, H. & Varela, F. (1980). *Autopoiesis: The realization of living* (Boston Studies in the Philosophy of Science 42). Boston, MA: D. Reidel.
- Maturana, H. & Varela, F. (1987). *The tree of knowledge: The biological roots of human understanding*. Boston, MA: Shambhala.
- Pousseur, H. (1970). *Fragments théoriques sur la musique expérimentale*. Bruxelles: Université Libre de Bruxelles.
- Reynold, R. (1962). Interview. *Generation* (January) [sic].
- Rouget, G. (1990). *La Musique et la Transe* (2nd edn). Paris: Éditions Gallimard.
- Saramago, J. (1997). *Blindness* (G. Pontiero, Trans.). San Diego, CA: Harcourt.
- Schopenhauer, A. (1958). *The world as will and representation* (E. F. J. Payne, Trans.). Indiana Hills, CO: Falcon's Wing Press.
- Shannon, C. E. (1948). A mathematical theory of communication. *Bell System Technical Journal*, 27, 379–423, 623–656. Available online at: <http://cm.bell-labs.com/cm/ms/what/shannonday/shannon1948.pdf> (accessed 20 October 2005).
- Spencer-Brown, G. (1969). *Laws of form*. London: George Allen & Unwin.
- Tarasti, E. (2002). *Signs of music: A guide to musical semiotics*. Berlin: Mouton de Gruyter.
- Truax, B. (2001). *Acoustic communication* (2nd edn). Westport, CT: Ablex.
- Varela, F. J. (1979). *Principles of biological autonomy*. New York: North Holland.
- Varela, F. J. (1999). The specious present: A neurophenomenology of time consciousness. In J. Petitot et al. (Eds), *Naturalizing phenomenology: Issues in contemporary phenomenology and cognitive science* (pp. 265–314). Stanford, CA: Stanford University Press.

- Varela, F. J., Thompson, E. & Rosch, E. (1991). *The embodied mind*. Cambridge, MA: MIT Press.
- Virilio, P. (1988). *La machine de vision*. Paris: Galilée.
- Wiener, N. (1961). *Cybernetics: Or control and communication in the animal and the machine*. Cambridge, MA: MIT Press.
- Wittgenstein, L. (1980). *Culture and value* (P. Winch, Trans.). Chicago, IL: University of Chicago Press.