Audiovisual Interactive Art: From the Artwork to the Device and Back

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Those who explore relationships between sounds and images investigate points of contact between temporally organized processes and spatially organized artefacts. The two are traditionally found in different artistic disciplines—the first in the performative, the second in the visual arts. Although performative arts may be recorded in the form of scripts or musical scores, they are still created with live performance in mind (by the artists themselves or by interpreters). Visual arts, by contrast, traditionally denote materially rooted works that are exhibited but not performed.

However, combinations of the two genres have long existed. Even musical performances are enhanced by the visual presence of the musicians, and in dramatic performances the acoustic aspect is inextricably linked with the visual components—the set, the costumes, and the mimicking or gestures of the actors. On the other hand, artists began to animate images in the nineteenth century, and now, since the invention of media storage technology, performances (be they acoustic or visual) and animated images can be recorded in material form for later presentation.

Thus, if hybrid forms of performative and visual arts have always existed (and increasingly so since the twentieth century), then interactive art must be based on a new type of relationship between these genres. This relationship is based on an opportunity for interaction which is created and implemented by an artist, but which can be activated at any subsequent moment as a live performance—even in the absence of the artist. A distinction must be made between programmed system performances based on feedback processes that engender live interaction between sounds and images without any input on the part of recipients, and performances based on the active participation of the recipients. In the following, the term interactive art will be used to refer to the latter kind of project.[1] Because it is oriented toward process and action, on the one hand, and because it can be retained by means of material or at least information technology, on the other, interactive art can be characterized as a hybrid between performative and visual art.

It would be a mistake, however, to equate the fusion of artifact and performance with the kind of sound/image interactions mentioned above. The hybrid nature of interactive art is also manifest in entirely silent works (such as Internet art) and in those that get along without any visual material at all (such as locative art, a subcategory of interactive art). On the other hand, many interactive artworks use preproduced or prerecorded audiovisual material (inviting the recipient to select or explore it) without depending on a causal relationship between image and sound based on programming technology. Such examples include multimedia works that, not unlike hypertext, allow selections only from within a certain range of choices.

When a sound/image interplay is created only as a result of recipient interaction, then we have a specific variant of both interactive and audiovisual art, for

1 For a more detailed discussion of the concept of interactive art, see Katja Kwastek, "Interactivity—A Word in Process," in *The Art and Science of Interface and Interaction Design*, eds. Lakhmi C. Jain, Laurent Mignonneau, and Christa Sommerer (Berlin: Springer, 2008), 15–26.

in this case feedback processes between the recipient and the system are combined with feedback processes between images and sounds. The recipient can either activate these processes, as, for example, with the interactive software in *Small Fish* (by Kiyoshi Furukawa, Wolfgang Münch, and Masaki Fujihata, 1998/1999), in which sounding graphic elements and/or effectors (taking the form of simple dots) can be moved with the mouse in order to modify musical sequences; alternatively, the recipient can "paint" sounds with the mouse or other input media, for example in Toshio Iwai's *Piano—As Image Media* (1995) and *Music Insects* (1996/1997), and in Golan Levin's *Audiovisual Environment Suite* (2000), where—unlike in Iwai's work—different parameters of the "drawing" are actually translated into sound. On the other hand again, one parameter of the image/sound interaction might remain entirely on the recipient side, whose input (in the form of gestures or noises) then produces the image or sound. The works *Manual Input Workstation* (2004) by Tmema (Golan Levin and Zachary Lieberman) and *Very Nervous System* (1986–1991) by David Rokeby are examples of projects in which visually interpretable parameters are created by means of gestures. In *Manual Input Workstation*, the superimposition of a video system on a standard overhead projection enables the direct creation and manipulation of shapes and sounds using hand gestures. The factors that contribute to the formation of a sound—volume, pitch, and timbre—are directly allocated to the characteristics that underlie shapes—volume, contour, and position.

Very Nervous System, by contrast, dispenses altogether with two-dimensional images and allows gestures and sounds to "communicate" directly. The movements of the recipient are recorded with a video camera and analyzed by a computer which responds with sound sequences that simultaneously provoke new movements.[2] Other works are based on the input of sound or text. Examples are Vincent Elka's *SHO(U)T* (2007), in which the speech or sounds emitted by visitors are translated into emotional reactions shown on an enormous projected face, and Tmema's installation *Messa di Voce* (2003), which visualizes speech input through abstract shapes.

In audiovisual interactive art, therefore, interaction between a recipient and a system developed by an artist creates or modifies an interplay between images/gestures and sounds, which results in a perceptible audiovisual outcome. The question is where exactly the artwork is located in this intricate system of reciprocation—in the system, in its operation, or in the outcome? The aim of this essay is to determine the complex ontological status of such works through a comparison of different types of devices. "Device" is used here as a generic term for diverse systems that translate, modify, or transform materials and information, and especially for the apparatus, the tool, the instrument, and the musical instrument. Each of these devices has its own characteristics, and by comparing these we can gain a better understanding of audiovisual interactive art. Another question posed in the course of this essay is whether and under which conditions such devices may be said to assume the status of an artwork.

Audiovisual Instruments?

A work of art is traditionally defined as anything that seeks to convey an idea or provoke reflection by means of an individual representation. More recent attempts to define the concept of the work of art take account of twentieth-

2 For a detailed discussion of the development of audiovisual interactive art, see Katja Kwastek, "Sound-Image Relations in Interactive Art," in *See This Sound: Audiovisuology Compedium,* eds. Dieter Daniels and Sandra Naumann (Cologne: Walther König, 2009), 163–169.

century criticism of its traditional definition as depending on originality, creation by the artist's own hand, and quality of representation. Now an artwork is defined as "anything that is carried out or sought out in relation to the discourse on art."[3] The reference to the discourse on art basically indicates the artwork's aspiration to convey something, distinguishing it from everyday communication by the fact that the artwork deliberately distances itself by mirroring, reflecting, or critically commenting on everyday life or, as is often the case in music, by seeking to create its own reality. We are used to viewing or listening to such artistic expressions in the form of depictions or performances. But many audiovisual systems based on interaction are first and foremost opportunities to manipulate and create what are mainly abstract forms and sounds. Although the artist uses them to pursue a particular aim, this intention is not presented to the recipients as a finished construct awaiting interpretation, but rather as an invitation to act—more specifically, as an invitation to produce audiovisual information themselves. As such, these systems have much in common with musical instruments, and one is tempted to designate them as audiovisual instruments, given that they also incorporate visual information.

Unlike the tool, which is used to mechanically manipulate material and to enhance the body's own strengths and abilities, we conceive of the instrument as being more sophisticated or complex, as performing scientific operations or measurements, and as availing of the physical or chemical properties of materials (e.g., glass as a prism, or mercury for gauging temperature). The musical instrument also relies on physical effects (especially vibrations and frequencies), but does not have the purpose common to other instruments of either manipulating materials or acquiring knowledge.

For Sybille Krämer, the difference between musical instruments and other instruments is that the former's purpose is not enhancement of efficiency but "worldmaking," or, in other words, the production of artistic worlds that allow us to experience things that are not possible in our familiar environment.[4] Thus, if we wish to gain a better understanding of the ontological status of audiovisual interactive artworks in comparison to musical instruments, we must ask, first, whether these works serve the purpose of worldmaking; that is, whether their primary objective is the production of novel compositions. Second, we must investigate whether their structural organization is comparable to that of the musical instrument. I argue in the following that worldmaking cannot be the primary purpose of interactive artworks precisely because as soon as this purpose comes to the fore, the works stop being artworks and start being devices. As I demonstrate below, the focus of the interactive system as an artwork lies instead in the process of interaction itself, not in its outcome. This fact is directly related to the structural organization of the interactive artwork, which differs from that of the musical instrument because there is no direct physical relationship between input and output and because the mechanics of the transformation are unknown to the user of the system. And these conditions, in turn, are essential for the specific type of aesthetic experience offered by interactive art, which is located in the process.

3 Wolf-Dietrich Löhr, "Werk/Werkbegriff," in *Metzler Lexikon Kunstwissenschaft*, ed. Ulrich Pfisterer (Stuttgart: Metzler, 2003), 390–395, here 390.

4 Sybille Krämer, "Spielerische Interaktion: Überlegungen zu unserem Umgang mit Instrumenten," in *Schöne neue Welten? Auf dem Weg zu einer neuen Spielkultur*, ed. Florian Rötzer (Munich: Boer, 1995), 225–235; here 225, 226. The term "worldmaking" was coined by Nelson Goodman in 1978; see Nelson Goodman, *Ways of Worldmaking* (Indianapolis: Hackett, 1978).

Structural Characteristics of Audiovisual Interactive Art: The Apparatus

In contrast to the classical musical instrument, interactive artworks rely not on physical but on digital processes. As a result, they are better characterized by the term apparatus.[5] We use the term apparatus to denote a sophisticated device that usually combines several different functions or processes (e.g., the chemical processes of exposure, optical processes of focusing, and mechanical processes of shutter control in the photographic camera) and that is based on more complex, often electronically or digitally controlled translation processes.

Devices: Apparatus, tool, and (musical) instrument and their functions

Apparatus	Tool	Instrument	Musical instrument
Programmed translation	Manipulation	Physical transformation	Physical transformation
Worldmaking	Production	Measurement	Worldmaking

The workings and the potential of apparatus were first discussed during what was known as the "apparatus debate." Apparatus theory, first developed in France in the late 1960s by Jean-Louis Baudry and others, analyzes cinema as "an apparatus for the conduit of bourgeois ideologies,"[6] and thus is not concerned with the meaning of individual films but with the worldview implicitly conveyed by the institution of cinema. The apparatus analyzed here is not primarily the technical apparatus of the film projector but in particular the institutional framework and the conditioning of the viewer. Thus, apparatus theorists are interested, on the one hand, exclusively in a particular apparatus (the cinema) and, on the other, in analyzing it in terms of discourse theory, but not in contextualizing it in terms of art theory. Nonetheless, the apparatus debate has shaped our concept of the apparatus as a complex system that is not entirely transparent to the recipient.

However, the exploration pursued here requires taking another perspective on the apparatus into account—that advocated by Vilém Flusser, who took up the discussion of the apparatus in the 1980s and focused on the role of technological or media-based factors. Nonetheless, like the early apparatus theorists, he often uses a metaphorical terminology that plays with double entendres between the technical-analytical and the sociocritical perspectives. Flusser's study is concerned with the photographic camera, which he sees as the prototype for the apparatus.[7] He defines the apparatus as a thing that is produced (in other

5 Strictly speaking, this characterization also applies to electronic musical instruments, though these are traditionally referred to as instruments.

6 Eva Tinsobin, *Das Kino als Apparat: Medientheorie und Medientechnik im Spiegel der Apparatusdebatte* (Boizenburg: Verlag Werner Hülsbusch, 2008), 13.

7 Vilém Flusser, *Towards a Philosophy of Photography*, trans. Anthony Mathews (London: Reaktion Books, 2000), 21. Flusser's concept of the apparatus is very broad. He counts as apparatus both social systems, such as the administrative apparatus, and the computer chip, which is controlled by microprocesses.

words, as a cultural product) and that "lies in wait or in readiness for something"[8] in order to *inform* it, in the sense of giving it form. For Flusser, the characteristic feature of the apparatus—as for Krämer the musical instrument—is that the apparatus does not carry out work, that its intention is not to change the world or to create works, but to change the *meaning* of the world.

Flusser's apparatus is a producer of symbols. It is based on processes that he calls programs in order to distinguish them from their material repositories. He thus concludes that "the question of ownership of the apparatus is irrelevant; the real issue here is who develops its program."[9] Flusser denotes the operator of the apparatus as a "functionary" because he or she is closely entwined with the equipment, but at the same time he describes the apparatus as a "black box": "The functionary controls the apparatus thanks to the control of its exterior (the input and output) and is controlled by it thanks to the impenetrability of its interior."[10]

While one may wonder whether black box is the best designation for the photographic camera, given its rather standardized technology, it is certainly appropriate for most interactive projects, for here the recipient does not know what to expect. Flusser's techno- and sociocritical position is especially interesting because it demonstrates substantial parallels to the kind of criticism leveled against interactive art. Many critics of interactive art bemoan in particular the recipient's lack of freedom. Wolfgang Kemp writes, "The first bond of this art that seeks to liberate the recipient is the bond to the program." According to Kemp, freedom of choice can only be simulated, not programmed: "What are programmed are pseudo-alternatives."[11]

Hans Belting also takes a clear stand when he states that electronics, as a substitute for viewer participation in action art, have created a "perfect automatization of play" that suspends "the experimental freedom of old" and subjects it to a "programmed simulation game."[12] Kristine Stiles and Edward Shanken believe that if media artworks have any meaning at all, then it "resides primarily in artists' decisions, rather than in participants' agency to shuffle or activate images, sounds, texts, and pattern sequences."[13]

Similar to Flusser's criticism of the apparatus, the critique from these authors is that the program or its author patronize the user by pretending to give them freedom to choose. This criticism should be understood as a reaction to the expectation repeatedly expressed since the early 1990s that interactive technology would deliver viewers from their passivity or even elevate them to the status of coauthors.[14]

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8 Ibid., 21.

9 Ibid., 30.

10 Ibid., 27–28.

11 Wolfgang Kemp, "Zeitgenössische Kunst und ihre Betrachter: Positionen und Positionszuschreibungen," in *Zeitgenössische Kunst und ihre Betrachter*, Jahresring 43 (Cologne: Oktagon, 1996), 13–43, here 19–20.

12 Hans Belting, *The Invisible Masterpiece*, trans. Helen Atkins (Chicago: University of Chicago Press, 2001); trans. here Niamh Warde from Hans Belting, *Das unsichtbare Meisterwerk. Die modernen Mythen der Kunst* (Munich: C. H. Beck, 1998), 464.

13 Kristine Stiles and Edward A. Shanken, *Missing in Action: Agency and Meaning in Interactive Art*, unpublished manuscript (2000); available online at http://www.duke.edu/web/art/docs/Stiles_Shanken_Missing_in_Action-1.pdf.

14 See Ryszard W. Kluszczyński, "Audiovisual Culture in the Face of the Interactive Challenge," in *WRO 95 Media Art Festival*, ed. Piotr Krajewski (Wrocław: Open Studio, 1995), 24–40, here 36.

The following considerations suggest that we not be concerned with how interactive art measures up against the various utopias of freedom with which it has been linked, but rather that we determine its ontological status and its aesthetics with respect to the specific characteristics of its basis in the apparatus. If we abstract from Flusser's ideologically tinged assertion, we can agree that the apparatus not only broadens the possibilities for meaning production but at the same time also channels or limits them. Consequently, Flusser's conjecture that photographers play not only with but also against their "plaything" is also enlightening: "They creep into the camera in order to bring to light the tricks concealed within."[15]

The attraction of interacting with apparatus is not only the opportunity to avail of their invitation to produce meaning, but also the desire to plumb their limits—a desire that applies in particular to interactive art. Thus, while "apparatus" defines the modus operandi of interactive art quite accurately, it certainly would be going too far to claim the reverse: that every apparatus is an interactive artwork. What renders the interactive artwork unique is that its defining objective is not to manipulate or create materials or information, though worldmaking is not its aim either. Although both objectives certainly can be present, the real reason for the existence of the interactive artwork is the process of interaction itself. I shall explore this theory in more detail by means of comparison with the musical instrument, which exhibits the same combination of facilitation and limitation observed in the apparatus and the interactive artwork. However, fundamental differences can be seen with respect both to the form of resistance and to its significance for the interaction process.

Music: Instrumental Resistance

As outlined above, the musical instrument uses physical or mechanical effects that are in principle simple (e.g., air pressure, vibration, leverage) but that are calibrated at a highly complex level. This circumstance enables a direct mechanical or physical relation between the instrument and the instrumentalist. The manual operation of buttons or the closing of holes in musical instruments to create vibrations (in strings or airflows) and the creation of friction in string instruments or of airflows in wind instruments occur at a bodily level and are perceived as physical resistance. Thus, Aden Evens points out that the instrument does not interpose itself between the musician and the music, but likewise does not have the purpose of mediated transparency; instead, it offers the musician a productive resistance. The musician applies his technical abilities in order to use this resistance to create sound: "Musician and instrument meet, each drawing the other out of its native territory."[16] In this process, the resistance constitutes the creative potential of the instrument.

Whereas Flusser stresses that users of an apparatus control a game "over which they have no competence," the fundamental condition for the aesthetic appreciation of music is seen in the virtuosity of the musician, which manifests itself in the performance accomplished by means of the instrument. Virtuosity denotes technical bravura, first in the sense of the (learned and practiced) mastery of the instrument, and second as the ability to reproduce or interpret

15 Flusser, *Towards a Philosophy*, 27.

16 Aden Evens, *Sound Ideas: Music, Machines, and Experience* (Minneapolis: Minnesota University Press, 2005), 160.

particular scores.[17] The resistance described above can thus be inherent both in the technical structure of the instrument and in the score. The score enables or requires a temporal separation between composition and performance, allowing for a practice period in between.[18] Only in improvisation do the two occur together. Heinz von Loesch points out that successful improvisation has at times also been described as virtuoso. He writes that the benchmark is then only the technical mastery of the instrument, independent of a score that demands particular proficiency. Aden Evens even goes so far as to characterize the musical score as a limitation: "How much more difficult it is to discover the music's ownmost possibility when the correct note has been specified in advance. How can the musician become one with his instrument when a score stands between him and the music, mediating his experience of it?"[19] However, Evens adds that in improvisation there is a higher risk of failure, for example in the form of a dull result. For this reason, musicians seek out methods that bring unpredictable or random elements into play, such as the modification of an instrument or the incorporation of random operators. According to Evens, improvisation thus often actually focuses on strengthening the degree of resistance, for as soon as the musician's technique is perfect, playing becomes a habit, whereas during the learning process it is an experiment.[20]

The concepts of virtuosity and improvisation are alien to the visual arts. In the latter genre, invention and execution usually go hand in hand, so that the aesthetic categories of interpretation (in the musicological sense) and performance—to which virtuosity and improvisation are closely related—become irrelevant. In interactive art, by contrast, the recipient enters into a role that can be profitably compared with that of the musical interpreter.

Interactive Art: The Resistance of the Apparatus

The way that recipients deal with interactive art seems appropriately defined by the term "experiment" as used by Evens, but perhaps better again by the word "exploration," as there is an absence of a predefined objective. Interactive art also eschews scores or manuals. However, the recipients of interactive art are unprepared in two respects, given that they are not even familiar with the workings of the apparatus. On the contrary, one motivation for the interaction is to explore how the apparatus works and which actions it enables. The resistance of the apparatus as a kind of black box and the accompanying explorative action of the recipient are thus existential for the functionality of the interactive artwork.

Because the interactive system is unknown to the recipient, the latter cannot be expected to master it technically. The intuitivity of the system thus plays an important role, for it allows the recipient to act even without prior knowledge or terms of reference. Golan Levin and Zachary Lieberman emphasize the importance of a combination of simplicity and complexity for successful interaction between human beings and audiovisual systems: "The system's basic

17 Heinz von Loesch, "Virtuosität als Gegenstand der Musikwissenschaft," in *Musikalische Virtuosität: Perspektiven musikalischer Theorie und Praxis*, Klang und Begriff, vol. 1, ed. Heinz von Loesch, Ulrich Mahlert, and Peter Rummenhöller (Mainz: MDS, 2004), 11–16, here 12.

18 The need for practice is often used as a defining criterion for the musical instrument. As Christoph Kummer says: "Pocket noise is a real instrument. You have to practice." See the interview with Christoph Kummer by Tilman Baumgärtel in Tilman Baumgärtel, *net.art 2.0: Neue Materialien zur Netzkunst* (Nuremberg: Verlag für moderne Kunst, 2001), 246–251, here 248.

19 Evens, *Sound Ideas*, 147.

20 Ibid., 159–161.

principles of operation are easy to deduce and self-revealing; at the same time, sophisticated expressions are possible, and true mastery requires the investment of practice."[21] Thus, the two artists develop systems that react consistently to user input but at the same time are inexhaustible because they register every slightest variation in input. The aim is to have the recipient operate the system intuitively without becoming bored. Flusser argues in the same vein, albeit from the opposite point of view: "The program of the camera has to be rich, otherwise the game would soon be over. The possibilities contained within it have to transcend the ability of the functionary to exhaust them, i.e. the competence of the camera has to be greater than that of its functionaries."[22]

Unfortunately, Flusser denies us a more detailed explanation of how the competence of the apparatus should be understood. Dieter Mersch identifies imagination and figuration as the fundamental categories of artistic productivity. He believes that the artist either creates "out of the free power of his imagination as an inexhaustible source of infinitely new images and ideas" or "he refigures [images and ideas], recombines them, and transforms them into other forms never before seen."[23] However, Mersch's reasoning neglects the process of realization and thus the resistance of the medium. Just like the instrument and the physical parameters of sound production in music, in the visual arts the material parameters and the potential of the tool used are of fundamental importance. Artistic productivity is not a purely cerebral activity, but also a labor with the medium.

In music, it is often not the composer but an interpreter who carries out this performative realization in the sense of an encounter with resistance witnessed by the public. The composer's task, by contrast, is to anticipate and configure the resistance by means of the score. The situation is similar in interactive art. Here, too, the author does not have to overcome the resistance of the medium himself, as is normally the case in the visual arts, rather he configures it for the recipient.

One could respond to Mersch that interactive art tends to leave aspects of the figuration to the recipient, for which the artist has imagined a "figuration apparatus" in advance. It remains open, however, to what extent the figuration has already been predetermined by the apparatus or its program and to what extent the user has control over the results. It may be, therefore, that elements of visual compositions or sound sequences have been created and stored in the system for subsequent activation or selection by the recipient, as in the case of *Small Fish*. Golan Levin points out that although systems that only offer limited possibilities for the manipulation or combination of precomposed sounds guarantee a satisfying aesthetic output, they greatly restrict the recipients' ability to exert their own influence on the artistic production. If recipients have little to lose, they also have little to gain, apart from their pleasure in the artist's composition: "Canned ingredients, all too inevitably, yield canned results. The problem is fundamental and has to do with the granularity of control such systems

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21 Golan Levin and Zachary Lieberman, "Sounds from Shapes: Audiovisual Performance with Hand Silhouette Contours in the Manual Input Sessions," *in Proceedings of the 2005 Conference on New Interfaces for Musical Expression*, eds. Sidney Fels and Tina Blaine (Singapore: National University of Singapore, 2005), 115–120, here 115. Full text available online at http://www.nime.org/2005/proc/nime2005_115.pdf.

22 Flusser, *Towards a Philosophy*, 27.

23 Dieter Mersch, "Medialität und Kreativität: Zur Frage künstlerischer Produktivität," in *Bild und Einbildungskraft*, eds. Bernd Hüppauf and Christoph Wulf (Munich: Fink, 2006), 79–91, here 80.

afford."[24] By contrast, Masaki Fujihata, discussing his work *Small Fish*, defends the use of precomposed elements: "Small Fish is designed so that users will come to understand the musical structure proposed by Furukawa through precisely those limitations." Fujihata explains that classic musical structures such as rising and falling sequences or different voices can be heard *within the chaos*. "But no amount of manipulation will cause them to coalesce into perfect music."[25]

Regardless of the degree of influence borne by the recipients, their activity is still always based on their interaction with a given system, whose workings are unknown to them. Unlike the musical interpreter and the artist, who know and have mastered the possibilities offered by their respective medium, the recipient of interactive art has no knowledge whatsoever of the apparatus—or rather, of the resistance of the medium—with which he is dealing. For this reason, it makes sense to supplement the parameters of figuration and imagination with a third factor—exploration. The exploration of the resistance of the system is an activity in its own right, which should be addressed as an aesthetic experience on the boundary between the aesthetics of production and the aesthetics of reception. Just as the experimental game with material is an important aspect of the aesthetics of production, the explorative game with the apparatus in interactive art is a fundamental aspect of the aesthetics of reception.

Exploration as an Aesthetic Experience

In order to illustrate in more detail the extent to which explorative action can be judged an aesthetic experience, once again the comparison with playing musical instruments proves helpful. Even if artistic accomplishment in music is primarily seen in the virtuosity of the performance of a work, the process of playing music itself (even when an amateur tries his hand) is still considered a productive and sensual experience. Psychologist Mihály Csikszentmihályi identifies the activity of composition as one example of pursuits that are based on intrinsic motivation. Proceeding from the question of why people find satisfaction in activities that have no external purpose, he coined the term "flow," which describes an absorption in the activity itself.[26]

A sensuous experience is not automatically an aesthetic experience, however. Literary scholar Hans Robert Jauß believes that aesthetic distance is the basic condition for an aesthetic experience. He maintains that the aesthetic object is constituted only by the contemplative act of the viewer.[27] So can absorption in the process of interaction ever allow the distance required for aesthetic reflection? According to Csikszentmihályi, the state of flow excludes simultaneous reflection on one's own actions. However, he also observes regular interruptions of the state of flow—moments of reflection: "Typically, a person can maintain merged awareness with his or her actions for only short periods, which are

24 Golan Levin, "Painterly Interfaces for Audiovisual Performances," master's thesis, MIT Media Laboratory, August 2000, 46. Full text available at http://www.flong.com/storage/pdf/articles/thesis600.pdf.

25 Masaki Fujihata, "Notes on Small Fish," 2000, http://hosting.zkm.de/wmuench/sf_about.

26 Mihály Csikszentmihályi, *Beyond Boredom and Anxiety: Experiencing Flow in Work and Play*, 2nd ed., (San Francisco: Jossey-Bass, 1982). Aden Evens carries this view to the extreme when he describes the image of the "immersed genius" who is totally absorbed both in his music and in his instrument to the point of self-abandon or a state of intoxication; see Evens, *Sound Ideas*, 131–132.

27 Hans Robert Jauß, *Ästhetische Erfahrung und literarische Hermeneutik* (Frankfurt: Suhrkamp, 1991), 83.

broken by interludes when he adopts an outside perspective."[28] Thus, aesthetic experience in the process of interaction requires fluctuation between self-forgetful action and reflection on one's own behavior. In interaction, then, in the ideal case, the fusion of exploration and reception leads to a convergence of the actor and the recipient in a new dual role. Even if the occurrence of and the kind of aesthetic experience ultimately depend largely on the individual approach of the recipient, it is still the invitation to interact that initiates both the action and the reflection.

Self-Referentiality and Multimodal Reflexivity

At the beginning of this essay, I identified the decisive factor in defining an artefact as an artwork as its intention to convey something or to invite the viewer to reflect. This necessary metalevel—in the traditional sense of iconography or imagery—may exist in reference to something found outside the composition itself. However, many artworks do not refer to a meaning that is external to themselves, but rather lay bare their own functionality or mediating nature. This kind of self-referentiality has not been a widespread artistic strategy only since modernism, though it is associated in particular with the artistic avant-garde. It can occur within a particular genre (such as when Yves Klein emphasizes that his painting is founded on the materiality of the color) or across genres in the sense of the *paragone* (such as when Lucio Fontana tears the canvas in order to bring painting face to face with plasticity). The complexity and the novelty of the mediating aspect of interactive art renders such self-referentiality particularly interesting.[29] Here, the work of art does not exhibit its color or plasticity; rather, the system scrutinizes its own interactivity, or the interface design contemplates the programming language on which it is based. In the audiovisual interactive artworks described in this essay, the self-referentiality is primarily rooted directly in the image/sound relationship. The multimodality of the works allows mutual exposition and reflection of both visual and acoustic information—as well as gestural information in some cases—in the interaction process.

As pointed out already, the image/sound relationships are not physically conditioned transferences, but rather settings that have been chosen by the artist. Sound and image are allocated to each other either associatively or symbolically, such as in *Small Fish* or in Toshio Iwai's work; they are mutually translated by means of calculated transformation, as in many works by Levin and Lieberman; or they react to each other, as in Vincent Elka's *SHO(U)T* and David Rokeby's *Very Nervous System*. The aim of these relationships is not putatively neutral visualizations or sonifications in the sense of objectifiable expositions of the other modality on the one hand, actions made by the recipients, on the other. The image/sound relationships in interactive art are conscious settings, not causal reactions, and this situation is what renders their creative exploration an aesthetic experience during interaction with the artistically conceived system. In Rokeby's *Very Nervous System* and Levin and Lieberman's *Manual Input Workstation*, additional sensory faculties are addressed by means of the corporeality of the interaction. Levin and Lieberman emphasize the novelty of the system in *Manual Input Workstation*, "in which the hands are used to simultaneously perform both visual shadow-play and instrumental music sound."[30]

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28 Csikszentmihályi, *Beyond Boredom and Anxiety*, 38.

29 See, for example, Erkki Huhtamo, "Seeking Deeper Contact: Interactive Art as Metacommentary," *Convergence: The International Journal of Research into New Media Technologies* 1, no. 2 (1995), 81–104.

30 Levin and Lieberman, "Sounds from Shapes," 115.

At the same time, the interface technology fades into the background, although in a completely different way than has been described by various authors with respect to musical instruments. When Philip Alperson writes that it is often difficult to ascertain where the body ends and the instrument begins,[31] he is referring to the physical chain of cause and effect that leads from body movements or air supply via the instrument's keys, strings, and sound box to the resulting sound. By contrast, the visual tracking technologies used by Rokeby and Tmema allow the body to almost magically influence sounds and images in the absence of any physical resistance whatsoever. The resistance is programmed by the artist: the characteristics of the system are written into the apparatus and its program.

Resistance and Originality: From the Artwork to the Device and Back

Whereas the resistance of the musical instrument is a physical and technical resistance which is overcome by virtuosity, in the interactive artwork the resistance remains central as an experimental challenge. It is based on the programs developed by the artist—each with an individual logic that does not shy away from paradoxes and delusions, given that it often seeks to irritate or surprise the viewer in order to facilitate an intense aesthetic experience. The programmed resistance of these artistic systems can also be overcome, but then the artwork gradually fades into the background, becoming a pure device, while the result obtained from it gradually becomes the focus of interest. Aesthetic experience by means of creative exploration requires the originality of the system or at least its novelty for the user. The instrumental aspect of the musical instrument is known and standardized just like the functionality of the cinema projector or the photographic camera. Standardization is a condition for the commercial use of apparatus, on the one hand, and for the composition of complex scores, on the other, which proceed on the basis of stable basic constitutions (such as the timbre of instruments). However, the better both the user and the recipient know how the device works, the less attention they give it. Their attention is focused on the created product.

The apparatus aspect of the interactive artwork, by contrast, is unique, unknown, and novel. Thus, the exploration of the apparatus is given greater attention. However, there are cases of interactive audiovisual systems created as artworks that proved so popular that they are now being standardized. One example is *reacTable* (2003–2005) by Sergi Jordà, Martin Kaltenbrunner, Günter Geiger, and Marcos Alonso. *ReacTable* is a "music table" on which musical building blocks tagged with markers are positioned; all the blocks can be activated simultaneously.[32] Another example is Toshio Iwai's *TENORI-ON* (2004), a portable panel with 256 LED switches that allow programming, playing, and visualization of melodies all at the same time.

In principle, of course, (almost) all interactive audiovisual artworks allow recipients to explore the system so well that operating it with virtuosity becomes possible. However, the more the recipient becomes a virtuoso, the more the invitation to interact shifts in emphasis from artwork to device, insofar as its workings

31 "In some cases it is hard to tell where the body ends and where the instrument begins." Philip Alperson, "The Instrumentality of Music," *Journal of Aesthetics and Art Criticism* 66, no. 1 (2008), 37–51, here 39.

32 Sergi Jordà, Günter Geiger, Marcos Alonso, and Martin Kaltenbrunner, "The reacTable: Exploring the Synergy between Live Music Performance and Tabletop Tangible Interfaces," in *Tangible and Embedded Interaction: Proceedings of the 1st International Conference on Tangible and Embedded Interaction* (New York, 2007), 139–146.

become increasingly transparent and the potential for reflection diminishes. At the same time, the outcome of the interaction gains in importance because it is increasingly intentional and controllable and, as an autonomous result, can assume the status of an artwork itself. Contemporaneously, as the virtuosity of the recipient increases, the aesthetic experience shifts from probing exploration to target-oriented expression.

Even if the interactive system mutates in this way from an artwork into a device, this device—if we wish to present a coherent ontological argument—cannot be called an audiovisual instrument in analogy to the musical instrument because its resistance is not physical but programmed. The correct term is apparatus, given that its complex and programmed resistance is its constitutive element, which (depending on the status of the recipient) itself becomes the actuator of aesthetic experience or, instead, serves the purpose of producing an audiovisual result. In audiovisual interactive art we are therefore dealing with artwork apparatus that also can be used as device apparatus. And the reverse process is also possible. For example, *Manual Input Workstation* was created from a device that the artists had developed for their own performances and only subsequently—on the basis of its huge success—turned into an interactive installation. In the same way, standardized musical instruments can be used or manipulated in infinitely new ways in order to shift the focus back to the moment of exploration. This point was made by John Cage when he wrote: "Fortunately the piano is there and one can always prepare it in a different way. Otherwise it would become an instrument."[33]

Devices vs. artworks: Apparatus, tool, and (musical) instrument and their functions and uses

Standardization / Mastery > Result

Apparatus	Tool	Instrument	Musical instrument
Programmed translation	Manipulation	Physical transformation	Physical transformation
Worldmaking	Production	Measurement	Worldmaking

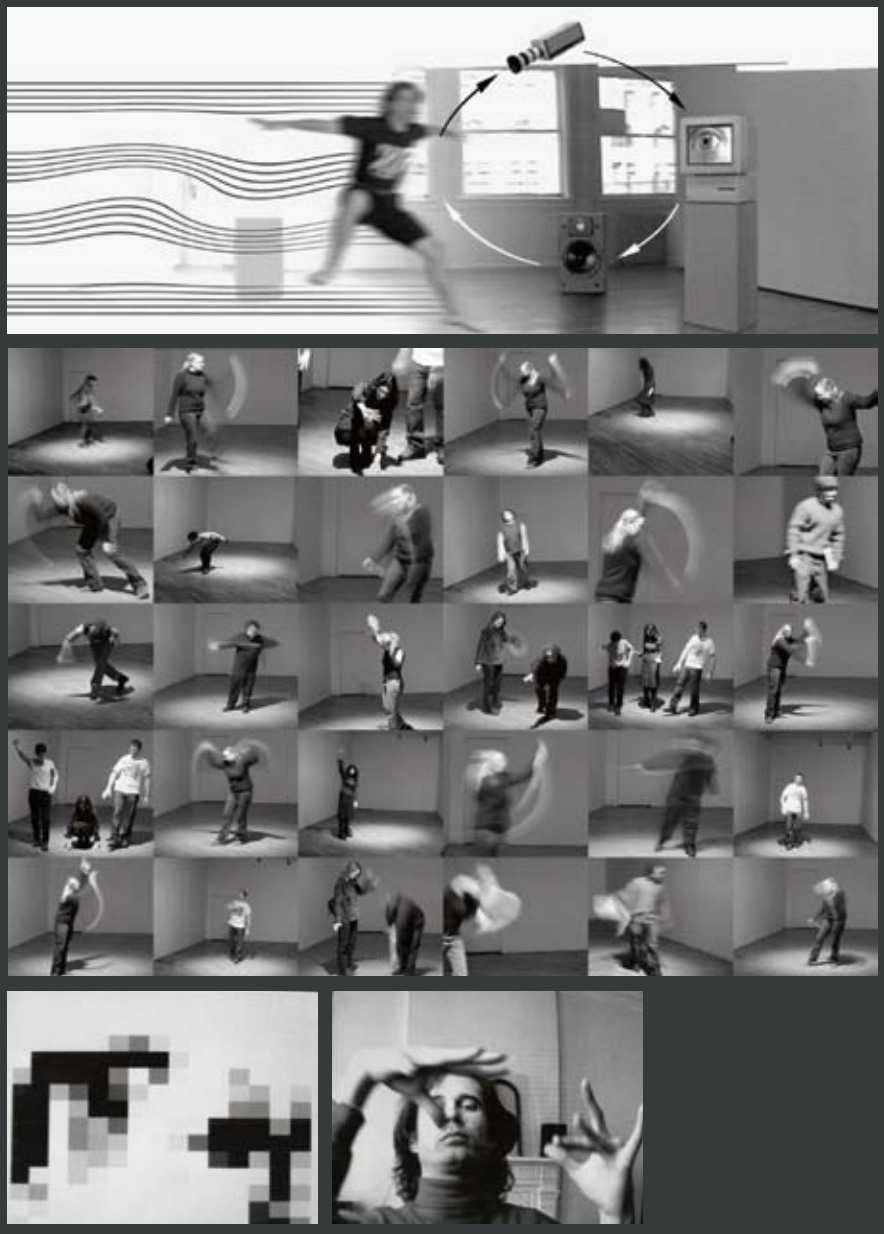
Originality / Exploration > Process

Artwork

33 John Cage, "45' for a Speaker" (1954), in *Silence*, 9th ed. (Middletown: Wesleyan University Press, 1954), 146–193.

David Rokeby
Very Nervous System (1986–1991)

– Participants interacting with the *Very Nervous System* (1986–1991) by David Rokeby and images of the early motion extraction process. © David Rokeby, courtesy the artist.



– Participants interacting with the *Very Nervous System* (1986–1991) by David Rokeby and images of the early motion extraction process. © David Rokeby, courtesy the artist.

In the 1980s, Canadian media artist David Rokeby created a complex system for physical, spatial interaction between human motion and sounds, the interactive environment *Very Nervous System*. The movements of a person are recorded by a video camera, analyzed by motion tracking computer software, and then responded to by sequences of sounds that simultaneously induce new movements. During the process, the software registers individual body parts in movement, but also the direction, speed, and rhythm of the motion. The resulting sounds imitate the voices of different instruments, but also reproduce everyday noises such as human breathing and rippling water.[1] Rokeby describes each instrument that can be motion-activated as a behavior—an electronic personality that observes the user and accordingly chooses its own actions. Thus, for example, an instrument might tend toward offbeats or change the rhythm when the user increases movement speed.[2] The artist points out that his interest in interactivity is not focused on straightforward and logically graspable control of processes. He is more interested in challenging the image of the computer as a logical machine detached from the body by creating a system based on intuitive actions that are bodily controlled. His concern is not navigation but resonance, not reciprocal control but mutual oscillation.[3] This differentiates Rokeby's installation from musical instruments in the tradition of the theremin, whose objective is the controlled generation and manipulation of sounds through movements.

1 Rokeby created various compositions or algorithms of sound. Often his installation is configured in such a way that the compositions change depending on the particular interactive behavior.

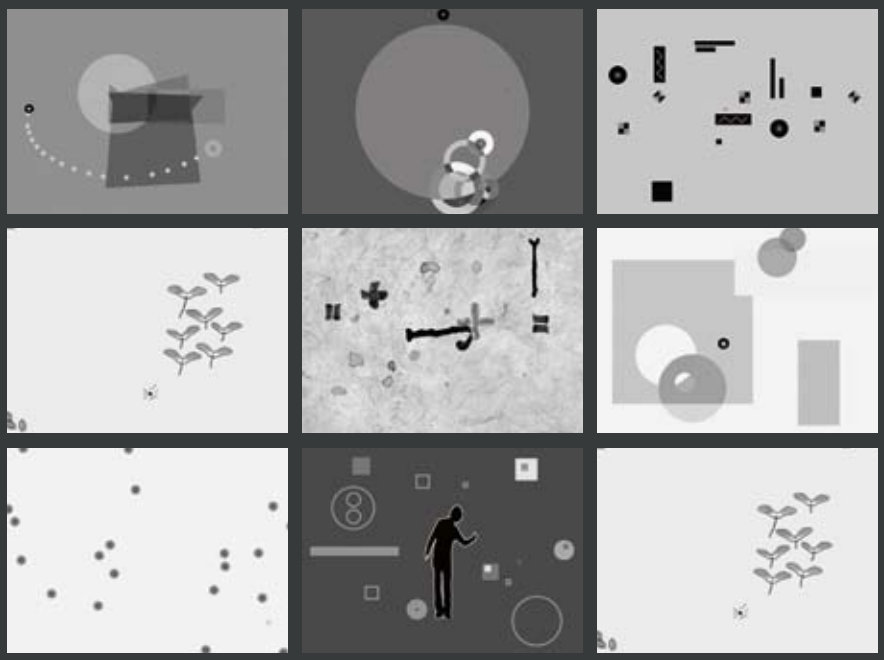
2 Interview with David Rokeby in *Wired*, http://www.wired.com/wired/archive/3.03/rokeby.html.

3 David Rokeby, "The Harmonics of Interaction," in *Musicworks 46: Sound and Movement*, 1990, http://homepage.mac.com/davidrokeby/harm.html.

– View of *Piano—As Image Media* (1995) by Toshio Iwai.

Toshio Iwai
Piano—As Image Media (1995)

Toshio Iwai created *Piano—As Image Media* in 1995. This installation uses a piano as a type of music box that transforms musical scores composed by visitors into both sounds and visual images. Visitors operate a trackball to draw lines or simple pixel drawings that are projected onto a semitransparent stretched fabric, one end of which terminates at the keyboard. The pixels are then set into motion, as though the visitor were drawing on a rotating cylinder. The impression created by the projection is that the fabric is transporting the pixels toward the keyboard. The movement gives them a temporal order and transforms them into a score that moves steadily—like the pin roller of a music box—toward the point where it is translated into sound. When they reach a certain threshold, the pixels speed up en route to the keyboard, which then strikes the required note itself. The pixels now seem to traverse the keyboard until they stream out of the piano—now seen in a vertical projection—in the form of colored, geometric objects. In visual terms, simple dots are thus transformed into multifarious colored shapes. In 1996, Toshio Iwai and Ryuichi Sakamoto developed a multimedia performance based on this system and entitled *Music Plays Images x Images Play Music*.



– Screenshots from *Small Fish* (1999) by Masaki Fujihata, Kiyoshi Furukawa, and Wolfgang Münch.

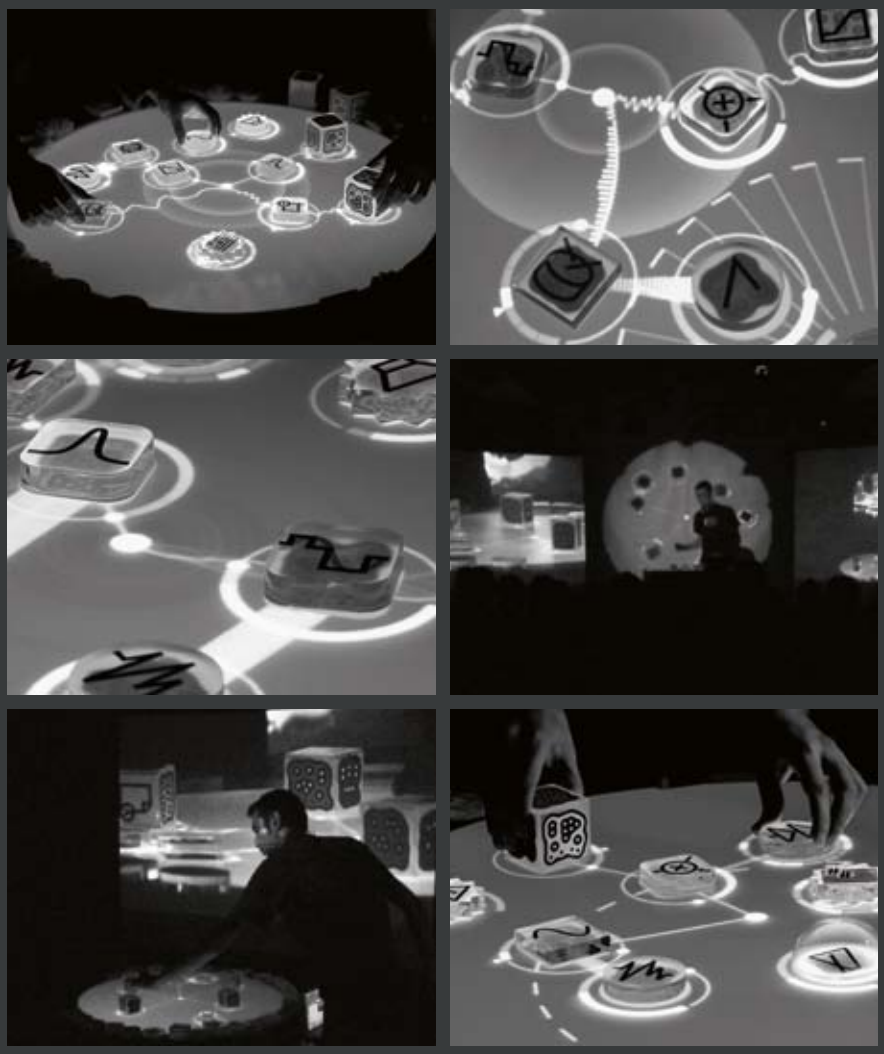
Masaki Fujihata, Kiyoshi Furukawa, and Wolfgang Münch *Small Fish (Chamber Music with Images for Computers und Players)* (1998/1999)

Small Fish is presented as an interactive CD-ROM with fifteen different programs for activating and manipulating audiovisual compositions. Almost all of the programs work on the principle that one or several effectors, mostly in the form of simple dots, move across the screen creating notes and changing direction each time they collide with each other, with sounding elements, or with the boundaries of the field.[1] The sounding graphical elements and/or the effectors can be moved with the mouse in order to manipulate musical sequences. The collision or bouncing of the effectors in different corners creates a lively dynamic reminiscent of commercial pinball machines. Stylistically, many of the programs refer back to the abstract painting of the classical avant-garde, for example Wassily Kandinsky, Henri Matisse, or Joan Miró, with the spectrum ranging from playful abstracting to abstract geometrics. The sounds are synthetically created imitations of classic instruments, mainly based on piano sounds, but also on percussion and wind instruments. The relationship between the visual design of the elements and their corresponding sounds should be seen at a more symbolic, associative level however. Wolfgang Münch emphasizes the object-oriented programming of the software. It consists of numerous small code objects that "communicate among themselves, exchange information, and constantly create new connections."[2] He explains that manipulation by the user is only one of the possible means of interaction in this application: "If necessary, the system interacts with itself."[3]

1 Only three of the works are based on different principles: in *Planets*, shapes moving in circles can be manipulated; in *Parrot*, the movement of the cursor creates sounding dots that are imitated by another sound object after a time delay; in the title interface, *small fish*, the sounding elements pursue the cursor.

2 Wolfgang Münch, "Small Fish, Hinter dem Interface," in *ZKM digital arts edition #3: Kiyoshi Furukawa, Masaki Fujihata, Wolfgang Münch: Small Fish*, ed. ZKM-Institut für Musik und Akustik und ZKM-Institut für Bildmedien, 1999, DVD booklet, 6.

3 Ibid.



– Views of *reacTable* (2005) by Sergi Jordà, Martin Kaltenbrunner, Günter Geiger, and Marcos Alonso.
Photos: Xavier Sivecas, courtesy the artists.

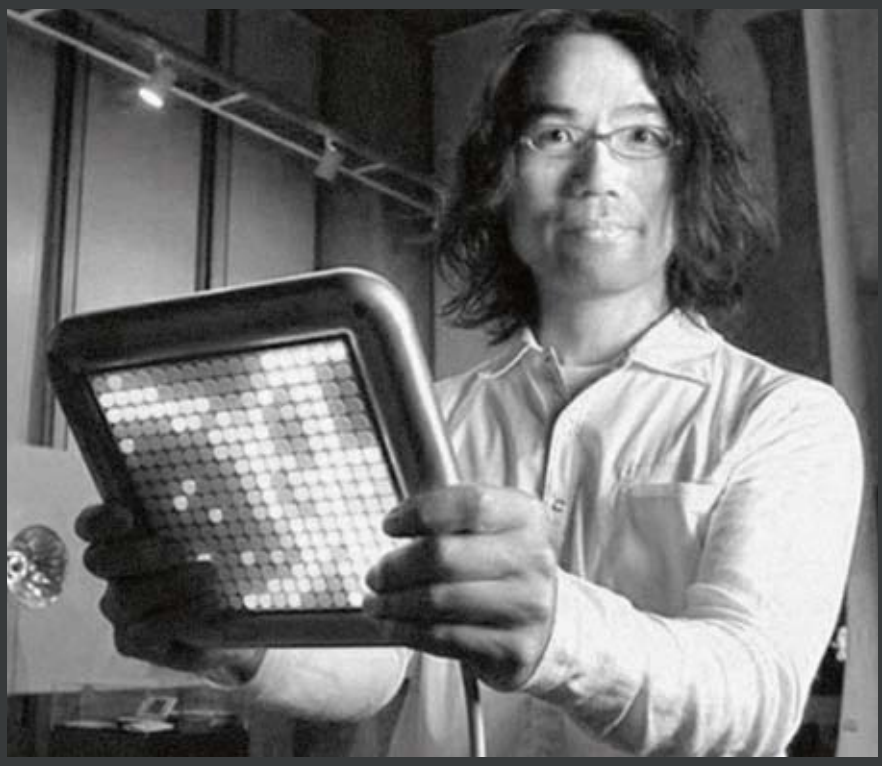
Sergi Jordà, Martin Kaltenbrunner, Günter Geiger, and Marcos Alonso
reacTable (2005)

The *reacTable*, built by media artists and developers Sergi Jordà, Martin Kaltenbrunner, Günter Geiger, and Marcos Alonso, was first presented to the public at a performance held in 2005. This system is a highly sophisticated and complex version of the many music tables that already exist.[1] The *reacTable* is a round table on which various cube- and disk-shaped musical building blocks tagged with markers can be positioned. While some of the building blocks are used to create sound directly, others can be employed to manipulate the emerging sound composition, for example by changing the rhythm.[2] The building blocks function as sound generators, sound filters and sound effects, controllers for modifying the function of other blocks, and global objects that affect the entire composition. The positioning of the building blocks determines their effect on one another, whereas rotating each block modifies its own characteristics. The table acts as a display that visualizes both the current activity of the blocks by means of circular graphics around them, and the interplay between the blocks by means of connecting lines indicating frequencies and rhythms. However, the visitor does not need to know or be able to identify all the functions in order to create sound compositions. What is interesting about the *reacTable*—in addition to its truly vast range of possibilities for intuitive, real-time music production and visualization—is its potential for collaborative improvisation on the part of several performers. The *reacTable* has proven to be very popular in the music world—Icelandic singer Björk has used it in her live concerts, for example—and now will be marketed as a commercial product.[3]

1 See the description available online at http://reactable.iua.upf.edu/?related.

2 See Sergi Jordà, Günter Geiger, Marcos Alonso, and Martin Kaltenbrunner, *The reacTable: Exploring the Synergy between Live Music Performance and Tabletop Tangible Interfaces*, available online at http://mtg.upf.edu/reactable/pdfs/reactable_tei2007.pdf.

3 See http://www.reactable.com/reactable/.



Toshio Iwai with *TENORI-ON* (2005) by Toshio Iwai and Yu Nishibori.

Toshio Iwai, together with Yu Nishibori
TENORI-ON (2005)

TENORI-ON was developed in 2005 by Japanese media artist Toshio Iwai, together with Yu Nishibori of the Yamaha Center for Advanced Sound Technology, and is described by its creators as a "digital musical instrument for the 21st century."[1] *TENORI-ON* is a portable square panel in a metal frame with built-in loudspeakers. The panel consists of a sixteen-by-sixteen grid of LED switches that serve for both input and output by lighting up to indicate the note that has been programmed or played. Notwithstanding the apparently simple interface, *TENORI-ON* is a complex instrument that allows preprogramming of different parts, levels, and blocks: the sixteen different levels (rows of LED switches) act as "recording tracks" to which different notes and sounds can be allocated. In addition, *TENORI-ON* can be played in six different and combinable modes, which are based on different methods of note input and operation. The different modes include a horizontal scan bar as a time axis (score mode), replaying notes in the order in which the keys have been pressed (random loop mode), and wandering lights that generate sound when they hit the bottom of the panel (bounce mode). Iwai's main aim with *TENORI-ON* is to render musical structures visible: "I want to handle both light and sound simultaneously and pleasantly, as we play music or draw pictures."[2] *TENORI-ON* has been produced commercially by Yamaha since 2007 and is also used in live concerts by numerous professional musicians.[3]

1 Toshio Iwai and Yu Nishibori, "TENORI-ON," in *Proceedings of the 2006 International Conference on New Interfaces for Musical Expression (NIME06), Paris, France, June 4–8, 2006*, ed. Norbert Schell et al. (Paris: IRCAM, 2006), 172–175, here 172; available online at http://recherche.ircam.fr/equipes/temps-reel/nime06/proc/nime2006_172.pdf.

2 Ibid, 175.

3 See http://tenori-on.yamaha-europe.com/germany/.