Interactive Art

_Ernest Edmonds_

**Introduction**

Art becomes _interactive_ when audience participation is an integral part of the artwork. Audience behaviour can cause the artwork itself to change. In making interactive art, the artist goes beyond considerations of how the work will look or sound to an observer. The way that it interacts with the audience is also a crucial part of its essence. The core of such art is in its behaviour more than in any other aspect. The creative practice of the artist is, therefore, quite different to that of a painter. A painting is static and so, in so far as a painter considers audience reaction, the perception of colour relationships, scale or figurative references is most important. In the case of interactive art, however, it is the audience’s behavioural response to the artwork’s activity that matters most. Audience engagement cannot be seen just in terms of how long they look at the work. It needs to be in terms of what they do, how they develop interactions with the piece and such questions as whether they experience pain or pleasure.

Interactive art is distinguished by its dynamic ‘behaviour’ in response to external stimuli, such as people moving and speaking. For artists, this means that observing people interact with their works provides a way of understanding exactly how the work ‘performs’, that is, how it responds to the gestures, sounds and other features of audience behaviour in the immediate environment. Observing the responses of an interactive work can reveal unexpected effects that may or may not be predictable from the artist’s point of view. Understanding how people feel about their experience with interactive artworks is an altogether different matter. It is impossible to directly observe the inner feelings of the audience but, for some artists, this is critical to the artwork. In that case, being able to explore the ‘interaction space’ involves some form of evaluation with audience cooperation. However, whatever the level of interest that the artist takes in the audience’s interaction with the work, they will typically see the physical artwork and the participating audience together as a unified system. It is impossible to understand an interactive artwork by just considering the art object unrelated to its audience and the audience actions and, hence, the artist’s focus will be on a combined artificial (art work) and human (audience) art system.
The aesthetics of interactive art include the nature of the behaviour of this total system. The aesthetic experiences of the audience include experiences of action and response as well as experiences of perception, as in a static work of art. The aesthetic decisions made by the artist include decisions about the fine details of the behaviour of the artwork as much as its appearance. The growth in interactive art as a form has, therefore, extended the range of aesthetic considerations being employed. This extension of artistic form, and extension of the scope of aesthetic decision-making, provides the underlying backdrop to this chapter.

**Interaction and the Art System**

An interactive artwork can be described in terms of its behaviour, the mechanism by which it operates and the means of its construction. As mentioned above, can be helpful to see the interactive artwork in systems terms. A system is a collection of elements, or objects, that relate one to another: a change in one implies changes in others according to the relevant relationships. A static system is one in which nothing changes. An artwork, such as a painting, is essentially a “static system”. We say “essentially” because, of course, the nature of light that falls on a painting, the colour of the wall on which it is hung, etc., certainly change how it looks. Physically, however, the painting does not change. By ‘Art System’, we mean an artwork that consists of a system that changes within itself and where that change is apparent to an observer. The physical art system itself can also be seen as an element of a larger system that includes the audience: this was referred to as 'The Matrix' in the Cornock and Edmonds 1970 paper discussed in a later chapter ‘Art, Interaction and Engagement’.

Art Systems are systems of interrelated and interacting parts that change either by virtue of their internal mechanisms or because they are responding to the environment around them. The distinction between an art system that has an internal rationale that alone determines how it responds or behaves and one that is affected or stimulated by external factors, such as the degree of light or the presence of a moving human being, is an important one, and represents the two primary kinds of art system. The first is known as a ‘closed’ system and is one that is not subject to any external influence. It is like a clockwork mechanism that moves and changes within itself according to its own logic. The second is known as an ‘open’ system in which at least some of the elements can be changed by external forces, be they the wind or human intervention. We can further distinguish between open systems that are influenced by the general environment, such as wind or temperature, and those that are (or are also) influenced by the audience. ‘Kinetic’ works that respond to wind or temperature change, are at one end of a spectrum and interactive installations at the other. Gina Czarniecki’s *Silvers Alter* interactive art system, for example, makes sense only with human participation:
“The installation takes the form of a large scale back-projection on which human forms ‘live’. These figures are changed by the audience’s presence and movement within the space. Interactivity is very physical. It encourages a social, physical and verbal interaction between people before the interaction with technology.” (Czarnecki, 2005)

By ‘interactive art system’ we mean the category where human actions, or measurements from human bodies such as heart rate, affect the behaviour of the system. In this book, the term ‘art system’ is used to refer to this interactive case.

Computer components are frequently used in the construction of interactive art systems because of the speed and flexibility with which they can control responsive devices. Computer technology is fundamentally general purpose and at the same time readily adaptable for whatever form of interaction is required. Today, almost any interactive system from a washing machine to a car to an art system is controlled by computers and realised through software. The use of the computer as a control device that handles interactions according to complex and possibly changing rules has transformed participative art. By programming the computer with the rules that define the artwork’s behaviour, the artist is able to build significant dynamic interactive art systems that would otherwise have been impossible to construct and very difficult to conceive in the first place. However, the computer programs that act as controllers of interactive art can be quite complex. This means that considerable effort can be required to understand them and it is often difficult to be sure about the behaviours that can arise in all of the expected and unexpected circumstances. Thus the artist often experiments as a work is made, in order to be clear about what its behaviour is. The alternative perspective is to treat the work as one full of surprise, even for the artist.

**Early Interactive Art**

It is possible to debate at great length about the origins of interactive art but, for the purpose of this chapter, I will start with Marcel Duchamp. In 1913, excited perhaps by the new technology in bicycle wheel hubs, he took a wheel, fixed it on a stool and placed it, upside down in his studio. Today it is seen as a significant work of art, but Duchamp said

> “Please note that I didn’t want to make a work of art out of it. The word “readymade” did not appear until 1915, when I went to the United States. It was an interesting word, but when I put a bicycle wheel on a stool, the fork down, there was no idea of a “readymade” or anything else. It was just a distraction.” (Cabanne, 1971:47)

Part of the distraction was in spinning it, so, art or not, it was interactive in the simplest sense. When, later on, he made *Rotary Glass Plates*, this work was intended to be an artwork. It was also interactive in an extremely simple sense: the viewer had to turn it on,
and hope not to be injured it seems! According to Duchamp, the first version “nearly killed Man Ray” when he started it and the glass shattered (Naumann and Obalk, 2000: 91-95).

Much later in the century, in 1952, John Cage composed 4.33, his famous ‘silent’ piano piece. Although not exactly interactive, this work was, like the Duchamp pieces, incomplete without the actions and attention of the audience. 4.33 encouraged the audience to listen to the ambient sounds around them. Then, in 1953, Yaacov Akam started making what he called Transformable Reliefs: artworks that could be rearranged by the audience. He also made other pieces that were play objects of a sort, that had to be stroked or touched in some other way for the audience to experience them as intended. His interest, according to Günter Metken was “… to release the creativity of the art public, to encourage people to enter into the spirit of his work and change it according to their tastes” (Metken, 1977). This interest, put this way, probably captures the intention of many artists who explored interaction in the early days. Akam went on, beyond the transformable works, to try many other ways in which the audience could participate in the creative act.

The kind of work that Duchamp, Cage, Akam and others were making became known as “open works” once Umberto Eco’s 1962 essay on the subject became known (Eco, 1989). Based largely on an analysis of modern music (but not mentioning Cage) this paper articulated a growing concern for “an open situation, in movement. A work in progress.” Eco stresses that an open work is not one to which the audience can do what they like.

“The possibilities which the work’s openness makes available always work within a given field of relations. As in the Einsteinian universe, in the ‘work in movement’ we may well deny that there is a single prescribed point of view. But this does not mean complete chaos in its internal relations. What it does imply is an organizing rule which governs these relations” (Eco, 1989: 19).

Eco distinguished between a performer and a member of the audience, “an interpreter”, but argues that, in the context of an open work, they are in much the same situation. Looking at, listening to or interacting with an artwork is in essence a performance in his terms. This point is relevant to the work of Andrew Johnston that is reported in the chapter ‘Almost Tangible Musical Interfaces’ in this book. The “audience” for his virtual instruments consists of performing musicians but his consideration of their interaction with his systems is close to the other work in the book that considers members of the public as audience.
Involving the audience actively in the artwork had many advocates, such as GRAV¹ and in the development of Happenings², where participation was also prevalent. Kirby described rather basic examples of participation in Allan Kaprow's *Eat*:

“Directly in front of the entrance, apples hung on rough strings from the ceiling. If the visitor wished, he could remove one of the apples and eat it or, if he was not very hungry, merely take a bite from it and leave it dangling” (Kirby, 1965a).

Participation in the artwork, by becoming part of the art system and interacting with whatever the artist provided, was becoming a familiar experience, whether it was typing at the keyboard or eating the apple.

Jack Burnham, an influential writer concerned with a systems theory perspective on art, saw the importance of understanding artworks in their environment and that all things “which processes art data,...are components of the work of art” (Burnham, 1969). By that definition, the audience is part of the artwork. Stephen Willats has also worked from a systems’ point of view. and on participation in art since the 1960s. He explains that the function of his work is,

“to transform peoples’ perceptions of a deterministic culture of objects and monuments, into the possibilities inherent in the community between people, the richness of its complexity and self-organisation ... the artwork having a dynamic, interactive social function.” (Willats, 2011)

In 1965, Willats published the first issue of Control Magazine, which has included many contributions on socially situated, participative, art and on interactive art systems. In the first issue³ he states that the artist provides a starting point for the observer⁴ and:

The observer is given restrictions inside these restrictions are variables, with which he determines his own relationship. (Willats, 1965)

This captures a significant aspect of many artists’ attitude to their work at that time. The artist set up a system, with restrictions, that the participant could operate in a way that led to their own completion or resolution. For some, like Willats, going beyond those restrictions was also welcomed, so that the possibilities become “limitless”, in Willats’ term.
A significant pioneer in interactive art was Nicolas Schöffer, who developed the concept of cybernetic sculpture through a series of innovative works (Schöffer, 1963). In 1956 he presented CYSP 1, a dynamic sculpture that interacted with a dancer and the environment, using photoelectric cells and a microphone as sensors. Another early innovator was Robert Rauschenberg who, in 1959, made the ‘combine’ painting Broadcast, which had three radios built into it that members of the audience were free to tune as they wished. It was not his only excursion into interaction. John Cage recounts:

“(I cannot remember the name of the device made of glass which has inside it a delicately balanced mechanism which revolves in response to infrared rays.) Rauchenberg made a painting combining in it two of these devices. The painting was excited when anybody came near it. Belonging to friends in the country, it was destroyed by a cat.” (Cage, 1961: 106)

Possibly the cat’s reaction was an early example of behaviour in relation to interactive art that did not conform to the artist’s expectation, although it might have pleased Cage.

As electronics developed, the opportunities for making interactive art increased. Edward Ihnatowicz, for example, showed his work, SAM, in Cybernetic Serendipity (Reichart, 1968). SAM looked rather like a flower mounted on a short backbone. It used hydraulics to move its parts in response to sound detected by four microphones in the ‘flower-like’ head. SAM was more sophisticated in the way it interacted than most of the earlier work in that it not only responded to sound, but it restricted its response to sound of an ‘acceptable’ volume - not too quiet and not too loud. Cybernetic Serendipity, at the Institute of Contemporary Arts, London, in 1968, was one of the defining exhibitions of early cybernetic and computer-based art. Another significant early interactive work in the exhibition was Gordon Pask’s The Colloquy of Mobiles (Pask, 1968). This was a work based on Pask’s cybernetic principles in which a set of five mobiles that interacted with one another, communicating through light aiming to reach a stable state of satisfaction. Although it was primarily based on interactions between the mobiles, the public was able to use lights and mirrors to influence the behaviour of the work and so it was a very early example of interactive art.

After he showed SAM, Edward Ihnatowicz went on to build The Senster (fig. 1), which was a very early, possibly the first, interactive sculpture driven by computer. It was a very large lobster-like arm construction that detected sound and movement in response to which it moved, rather in the same way that SAM did, but with a much more sophisticated appearance. In fact, as with SAM, it seems that the algorithms used to drive the behaviour were relatively simple. It was the complexity of change in the environment and certain rules
within the algorithm (such as ignoring very loud noises) that led to this sophisticated appearance. In Ihnatowicz's work, it is clear that how the sculpture looked was of relatively little importance. What mattered was how it behaved and, in particular, how it responded to the audience.

At the same time that Ihnatowicz was developing *The Senster*, Stroud Cornock and I were using a computer to develop another interactive artwork, called *Datapack*. Interestingly, but perhaps not surprisingly, we used a very similar machine to Ihnatowicz. We used a Honeywell DDP-516IX and he used a Philips machine that was very similar and, possibly, a re-badged version of the same computer. This early interactive artwork is described more fully in the chapter, 'Art, Interaction and Engagement' in this book.

![Figure 1. The Senster, Edward Ihnatowicz](image)

By 1966, Roy Ascott had developed a view in which participation and interaction between the audience and the artwork was central (Ascott, 1966):

“In California in the 1970s, introduced to the computer conferencing system of Jacques Vallée, *Informedia*, I saw at once its potential as a medium for art and in 1979 abandoned painting entirely in order to devote myself wholly and exclusively to exploring telematics as a medium for art” (Ascott, 1998).
Ascott has become one of the most active figures in the community, as a teacher, speaker, writer and conference organizer, as well as a practicing artist. Notwithstanding the fact that he “abandoned painting entirely” in the 1970s, he has continued to produce objects from time to time, as can be seen in his 2011 London exhibition\textsuperscript{3}, but all of them have addressed the issues of participation and the implications for art of the ideas of computing and communications.

The development of interactive art was a geographically wide phenomenon with significant activity, for example, in Australia. The Sydney collective ‘Optronic Kinetics’ were committed to ‘responsive artworks’ and they made such a work (unnamed) around 1969.

“It consisted of a dark room in which was placed a cathode ray screen controlled by a radio frequency device sensitive to movement. As one moved about the room a wave pattern changed form on the screen and a sound of varying pitch was emitted from a device called a Theremin.” (Davis Smith, of Optronic Kinetics, quoted by Stephen Jones in his book on early art and technology in Australia (Jones, 2011: 164))

**The Growth of Interactive Art**

From the early days of experimental interactive art, it became apparent that the computer could have an important role in facilitating, or managing, interaction. This role is quite different to the computer as a means of producing graphic art images. By ‘managing’, was meant that the computer controls the way an artwork performs in relation to its environment including its human audience. Because the role of the computer was envisaged as critical to the experience, some speculated that such work could transform the artist from a maker of artworks to a catalyst for creativity. The role of the audience was seen as the important new element in the artwork.

Once the personal computer and the individual workstation appeared, the pace of change in interactive art accelerated significantly. Earlier mini-computers had been interactive and people had developed ideas about human-computer interaction before personal computers appeared, but the new availability of computer power brought access to interactivity out of specialist laboratories. Although artists did not necessarily restrict themselves to using personal computers, the availability of such machines certainly caused a significant growth in interest and activity. The history of these developments in interactive art still has to be told in full, but a number of authors have included partial histories as part of books that address the broader subject of digital, or information, art. Stephen Wilson devoted significant parts of his major book “Information Arts” to reviews of developments in art using artificial life, robotics, gesture and touch etc. (Wilson, 2002) and covered an interesting selection of such art in a later publication (Wilson, 2010). Another example is Wolf Lieser’s book on “Digital Art”,...
which includes a section devoted to selective artworks involving ‘Interactive Objects and Art in Public Spaces’ (Lieser, 2009). There is no space to repeat or extend such histories in this book, but a few examples will help to present a background picture of the field and illustrate the context in which authors have conducted their work.

Karl Sims is an artist, with expert technical skills, who developed a strong line of work around the notion of evolution in artificial life-like systems, implemented in his case, as for many others, by the use of Cellular Automata (CA). A cellular automata system is a matrix of simple on/off elements (cells) that have an effect on their near neighbours at each step in a step by step process (each step being called a ‘generation’). All kinds of rules may be invented to determine the effect, for example a cell might be set ‘on’ at the next step if it has two neighbours that are on. Artists, such as Sims and Dave Burraston who contributes a chapter to this book, produce graphical representations of such evolving processes as time based artworks, sometimes using random variation in the rules and a selection algorithm that decides which alternative next generation to go with.

Sims has made works where he has turned such systems into interactive artworks by replacing the selection algorithm by human choice, a process that he called ‘perceptual selection’ (Sims, 1992). Sim’s work Galápagos, from 1997, exemplifies this approach. The work consists of twelve screens on stands driven by a network of twelve Silicon Graphics workstations. Pads on the floor are used for participant actions. They are used in two ways. When there is a set of displays on the screens a participant can stand in front of the one they ‘like best’ and so make the ‘perceptual selection’. Other pads are provided that will activate the development of the next generation of the system. As Sims put it:

“Twelve computers simulate the growth and behaviors of a population of abstract animated forms and display them on twelve screens arranged in an arc. The viewers participate in this exhibit by selecting which organisms they find most aesthetically interesting and standing on step sensors in front of those displays. The selected organisms survive, mate, mutate and reproduce... Although the aesthetics of the participants determine the results, the participants do not design in the traditional sense. They are rather using selective breeding to explore the hyperspace” of possible organisms...” (Sims, 1998: 68)

The interaction is simple, but the computational complexity that it drives is quite high. It is an example of interaction where relatively simple acts, when taken together and over time can lead to a wide range of outcomes and to complexities that may seem quite surprising in relation to those simple acts taken individually.
Christa Sommerer and Laurent Mignonneau have a substantial history of collaborating on interactive art works based on artificial life (Sommerer and Mignonneau, 2009). Indeed, as early as 1992 they made a work, *Interactive Plant Growing*, that used *real* plants as the interface that participants touched or approached.

![Image](image.jpg)

**Figure 2. Life Spacies, Screenshot © 1997, Christa Sommerer & Laurent Mignonneau, collection of NTT-ICC, Tokyo, Japan**

A classic example of their work is *Life Spacies*, which was created in 1997. Physically, the work consists of a laptop computer on a stand in front a large projection screen. Virtual creatures, appear, grow and move on the screen using artificial life concepts. Participants are invited to type text into the laptop and, as they do, the text is used by the computer to generate new virtual creatures that enter the space. Participants can also type in text that becomes food for the creatures to feed on.

“The creature’s lifetime is not predetermined, rather it is influenced by how much it eats...a creature will starve when it does not eat enough text characters and ultimately die and sink to the ground...

Written text ... is used as genetic code, and our text-to-form editor translates the written texts into three-dimensional autonomous creatures whose bodies, behaviors, interactions and survival are solely based on their genetic code and the users’ interactions.” (Sommerer and Mignonneau, 2009: 107-8)
Many artists have explored artificial life in various ways. Mitchell Whitelaw has talked with many of them and published a theoretical study of the field (Whitelaw, 2004). In his article "Twenty years of artificial life", Simon Penny provides a brief survey of those developments (Penny, 2011). He cautions us to remember the vast changes in technology when we look at early examples of this (and implicitly other) kind of art. As he says, however, "... there is still much grist for the mill in the application of these ideas in emerging cultural forms." In other words, despite the rapid growth in research and art in this area and the changes in technology that have gone with it, artificial life still has significant potential to inspire new work.

An interactive artwork that uses a direct relationship between the input and aspects of the output is *Iamascope*. As the designers of this system describe it:

"The Iamascope is an interactive kaleidoscope, which uses computer video and graphics technology. In the Iamascope, the performer becomes the object inside the kaleidoscope and sees the kaleidoscopic image on a large screen (170") in real time. The Iamascope is an example of using computer technology to develop art forms. As such, the Iamascope does not enhance functionality of some device or in other words, "do any thing", rather, its intent is to provide a rich, aesthetic visual experience for the performer using it and for people watching the performance." (Fels and Mase, 1999: 277)

The idea is that one member of the audience acts as ‘performer’. An image processing system detects certain body movements that they make (typically, waving their arms) and uses that to generate both kaleidoscopic type image transformations of them and music. It is also intended to be interesting to other members of the audience who just watch the action - and it is!
Some artists have placed more emphasis on the object and the physical, one might say sculptural, qualities of their interactive art works than the interaction process. Jeffrey Shaw, for example, has made many such artworks where the interaction process is quite simple but the sculptural qualities are quite powerful. A well known early work of his is *The Legible City*, 1988-91. In this work a:

“...bicycle with a small monitor on the handlebars is mounted in front of a big projection screen. When the observer pedals, a projection is activated and he can move through three different simulated representations of cities (Manhattan, Amsterdam and Karlsruhe). The architectural landscape of streets is formed by letters and texts... Jeffrey Shaw presents a poetic image of the architecture of different cities, and leaves the discovery of the virtual information structure to the observer on the bicycle... The illusion is successful because riding, looking and reading compel the observer to dive into the picture. The rider loses himself in total immersion.”

(Schwarz, 1997: 149)

Immersion is one of the qualities of the interactive experience that many artists, including some of those in this book, such as Sarah Moss, have pursued and *audience experience* is a concern in most of the other contributions.
**New Developments in Interactive Art**

The work described in later chapters of this book naturally builds on the art mentioned above but it is also influenced by the many more recent developments. A few examples of the technologies that have been employed include robotics, global positioning systems, the web, virtual reality and many interaction techniques, such as gesture recognition, image processing and active objects. The range of artwork produced is too extensive to cover here, as has already been indicated, but the Wilson and Leiser books are good examples of descriptions of these recent developments (Wilson, 2002; Leiser, 2009). The basic principles of interaction and participation, however, stand above the exploitation of interactive technologies and the current focus is on understanding and exploring the area in terms of participant experience.

The contributors to this book are all involved in advancing the practice of interactive art through research of some form or another. A common theme is coming to an understanding of experience; in the context of facilitating audience experience, provoking it or gaining knowledge about it. Experience can take many forms, from pleasure to fear, from captivation to creation, of danger, of difficulty, of joy. Any of them can be part of an art system. When creating interactive art, the artist will often be considering issues of audience experience in terms of one or more of these forms. As we discussed in ‘The Aesthetics of Interaction”, in this book’s introduction, whether or not an artist talks about aesthetics explicitly, they make aesthetic decisions and, in the case of interactive art, some of those decisions relate to the quality of the interactive experience. There are aesthetic qualities in interaction just as there are such qualities in colour, shape, movement or sound. One way of reading many of the contributions to the book is as an investigation into aesthetic decision making in relation to interaction and interactive experience. Examples of the properties that Boden identifies as pertaining to aesthetics of interaction are predictability and control (discussed by Bilda in this book), attributability (to what extent is the audience able to detect that they are causing change, for example) and the speed of feedback (‘response time’ in computer terms) (Boden, 2010).

The quality of the interactive experience is an issue for the aesthetics of interaction and the decisions made by the artists represented here are often framed by the kind of experience that the work is concerned with. For example, Brigid Costello, in her chapter ‘Many Voices, One Project’, identifies thirteen alternative characteristics of pleasurable experience in a play framework. These range from subversion to camaraderie, from sympathy to danger, from exploration to discovery. Choosing between them is part of the aesthetic decision making process that the artist engages in. Costello is interested in the nature of play in interactive art.
and she has argued that the nature of play can best be understood and applied in art making through a taxonomy. She terms this a “pleasure framework” (Costello and Edmonds, 2007). The subject of such art is play and pleasure and the works engage the audience in playful behaviours. That is the context that frames the aesthetic decisions made during the construction of such a work. The aesthetic results, of course, may be important in other respects. Art is many-layered and we certainly must not assume that the significance of playful art is limited to play itself.

The advances described in later chapters include the development of new interactive art forms. These new forms come from exploiting the new technologies that have grown, primarily, in the areas of computing and communications. Developments in human-computer interaction techniques are both exploited by and invented by artists such as those represented here. At the same time, the use of software as a medium is also significant in facilitating the invention of the new forms of interaction and new interactive conversations and relationships that we see in this kind of artwork.

None of the contributors limits themselves to providing new content into an existing art form. Putting new content into old forms is a common and very respectable way of making art. Many a portrait painter, landscape artist or adventure film director does it with every intention of respecting the ‘old form’. Not infrequently, however, even in these cases, new twists or angles are included that bend the form in unfamiliar directions. More extreme innovation in form can be seen when, for example, the still life is extended by the inclusion of collage or the portrait is redefined using cubist multiple views. Many of the developments that are explored in this book are of this more extreme variety. It is often the case that the invention of a new form is central to the artwork.

Andrew Johnston, for example, describes how he has developed new interactive ‘instruments’ and in so doing evolved a new kind of performance art in which the musician or musicians, using conventional instruments, play with a responsive computer-based art system to provide an integrated audio-visual improvised performance. Beyond the normal, integral, aesthetics of images, sound and movement, this work pays significant attention to the relationships between musicians and the ‘instrument’, so that the way that that relationship is formed is also an important aesthetic consideration. Jen Seevinck, as another example, has shown how the very tactile process of moving ones fingers through sand can provide the basis of an interaction with an art system that is both very physical, with the sand, and quite virtual in the images that it generates. The experience of manipulating the sand can be playful, exploratory or purposeful, for example. In any case, the artist has made concrete aesthetic
decisions about the relationships between such experiences and the resulting images. Both of these kinds of work, by Johnston and Seevinck, facilitate new experiences through their new forms of interaction.

The interactive works described by Andrew Johnston and Jen Seevinck, are concerned with the interactive experience of different audiences. In Johnston's case the "audience" consists of expert musicians in performance and the nature of the interactive experience influences how the musicians relate to the art system, for example in using it to augment their music or having a creative "conversation" with it. In Seevinck's case, she emphasises the ways in which the art system can stimulate and facilitate experiences of emergence by the audience. In cases like these, the aesthetics of the audience experience itself is a crucial part of the art.

Most of the work discussed exhibits interactive behaviour that involves direct and more-or-less immediate feedback to the audience. Some of the works described in the book, such as those by Mike Leggett, Brigid Costello and Jen Seevinck, involve the audience in actually touching and manipulating a physical object in innovative ways. Others, such as those by Andrew Johnston and Chris Bowman are ambient in the sense that the audience influences the art system through sensor systems that they do not directly touch. For example, the art system might analyse sounds or images captured through microphones or cameras.

Chris Bowman, Mike Leggett, Sarah Moss and Damian Hills are particularly concerned to engage the audience in a narrative building experience. So the key concern is with the narrative: however, unlike earlier art forms, such as cinema or the novel, the narrative structures on offer are not linear. In fact, they are not finished or determined until the audience engages with the art system and the particulars of that engagement are crucial to the aesthetic quality of each work. Ian Gwilt's work also has a narrative element but here the emphasis is on the bringing together of the physical world in which the audience is placed with a virtual one that augments the experience and may reveal narrative elements or stimulate the emergence of understandings and experiences. His exploration of augmented reality also uses this rapidly emerging technology to create a new interactive art form; one that gives the audience a careful blend of the physical and the virtual to provide an aesthetic experience that is, in itself, a core part of the art.

Looking at the work of the artists mentioned above, we see that there are many different ways of advancing interactive art: investigating the aesthetic implications of an interconnected human and art systems, developing new forms of audience engagement with the art, exploiting new technologies to aesthetic ends and creating new narrative forms. The common
theme, and perhaps the current ‘hot topic’ is the understanding of audience experience: facilitating it, provoking it and gaining knowledge about it.

**Research: Advancing Interactive Art**

The nature of the research-based interactive art practice described in the chapters of this book is very much a process of exploring new forms of interaction from an aesthetic perspective, of exploiting emerging technologies for aesthetic purposes and, perhaps most of all, trying to come to a fuller understanding of the implications of the many new developments in interactive systems in the sense in which they represent new media with which and within which to make art. Consequently, this research is at the heart of the art practice described. In the making of interactive art, the concerns for understanding audience responses, on the one hand, and technological opportunities, on the other, lead inevitably to the need to integrate forms of research into art practice. Thus the importance of what is termed ‘practice-based research’, which is a significant element in all of the chapters in this book. In the next chapter, a discussion of this mode of research is given in the context of the interactive art practice that the contributors are engaged in, from one perspective or another. Through practice-based research new forms of interactive art emerge.

**Notes**

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I GRAV: Groupe de Recherche d’Art Visuel. In their 1966 manifesto they promote, for example, the “active participation of the spectator” (GRAV, 1966).

II Happening: a form of theatre, performed ‘in the street’, sometimes confused with Fluxus. See Kirby (1965b)

III Roy Ascott was one of the contributors to Control Magazine 1

IV Today we would be more likely to use the term ‘participant’ rather than ‘observer’

V CYSP 1 (Cybernetic Spatiodynamic 1), an environmentally perceptive robotic sculpture http://www.museomagazine.com/938538/THE-CERTAINTY-OF-UNCERTAINTY

VI “This was the first interactive art work that I encountered. I saw it in the 1964 Rauschenburg exhibition at the Whitechapel Gallery, London.

VII Nicolas Schöffer was another exhibitor.

VIII An algorithm: A set of instructions performed in a defined sequence to achieve a goal.


XI See, for example, the chapter in the book by Dave Burraston