Interaction Models for Audience-Artwork Interaction: Current State and Future Directions

Hanna Schraffenberger[1,2] and Edwin van der Heide[1]

[1] Media Technology Research Group, LIACS, Leiden University
Niels Bohrweg 1, 2333 CA Leiden, The Netherlands
{hkschraf,evdheide}@liacs.nl
[2] AR Lab, Royal Academy of Art, The Hague
Prinsessegracht 4, 2514 AN Den Haag, The Netherlands

Abstract. Interactive art is of great relevance to the arts, sciences and technology alike. A common field of interest among researchers of different disciplines, practising artists and art institutes is the interaction between audience and artwork. This paper reviews existing research concerning interaction in interactive art and discusses its applicability for describing and classifying audience-artwork interaction. In pointing out possible future directions, we identify a need for models describing the relation between the audience's and artwork's actions and reactions as well as the necessity for future research looking at interaction as a continuous bi-directional process between work and audience.

Keywords: Interaction, Interactive Art, Audience-Artwork Interaction, Classification, Taxonomy, Categorization, Model, HCI, Archiving.

1 Introduction

It can be argued that art has always included interaction between artists, audience and performers and that the experience of art is always interactive, considering the interplay of environment, perception and the audience's generation of meaning [13]. However, it is since the 1960s that active audience participation with artworks has created particular interest among artists as well as theorists. A theoretical standpoint in which participation and interaction between audience and artwork are central has for instance been developed by the British artist and theorist Roy Ascott as early as 1966 [1,5]. Even before the personal computer came into existence, Ascott embraced interactivity in computer-based art as an emerging and promising prospect [16].

Developments and accessibility of computer technology have enabled a new kind of interactive art — and with it the possibility for an art-experience in which audience and machine enter into a dialogue that is more than just psychological [13]. Gaining a better understanding of this 'dialogue' – the audience-artwork interaction – has gained growing interest in the arts, technology and science. A

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structural model for interaction in interactive art will inspire artists to break out of existing habits and facilitate the development of novel forms of interaction, help curators and art experts when comparing artworks as well as support museums and institutes in archiving and categorizing their collections. Modelling the interaction between artwork and audience will furthermore be relevant to research in human-computer interaction (HCI) and elucidate possible differences between interaction in general multimedia applications and interaction in an art context. Most importantly, the development of models describing audience-artwork interaction will go hand in hand with a deeper understanding of interaction in interactive art. Gaining this understanding can be considered one of our main goals.

In this review paper, we survey relevant publications on interaction and interactive art (Section 2), discuss shortcomings of existing research to serve the purpose of describing audience-artwork interaction (Section 3) and conclude necessary directions for future research (Section 4). The paper is written from the perspective of media art research and considers publications by scientists, artists as well as well as contributions by media art institutes. Sociological and psychological studies on interactivity are beyond the scope of this paper. The main selection criterion for the inclusion of publications in the survey has been their applicability for describing audience-artwork interaction.

2 Literature Survey

A prominent figure in interactive art research is the artist and scientist Ernest Edmonds. As early as 1973, Edmonds and Cornock responded to the advent of computer-based interactivity in art and proposed a new concept describing possible relationships between artist, artifact and audience [3,13]. Notwithstanding the age of the publication, the topics addressed and models described are still relevant in interactive art research today. Their categorization which differentiates between *static*, *dynamic-passive*, *dynamic-interactive* and *dynamic-interactive (varying)* art systems has often been used, also in more recent publications. In [5], Edmonds, Turner and Candy outline and extend the originally proposed categories: in *static systems*, the artwork does not change while in *dynamic-passive systems* the art object changes in response to the physical environment or the artist's program. Audience-artwork interaction is reflected in *dynamic-interactive systems*, where the viewer/participant has influence on the art system. The same holds true for *varying dynamic-interactive systems*. Additionally, their behaviour changes, as the systems specifications are modified by a human or software agent. Next to illustrating the categories with artworks by Edmonds, their publication promotes collaborations between technologists and artists and points out that the field of designing interactive art systems can provide a substantial area for future research in user interaction.

The fact that research in user interaction can likewise be relevant to the genre of interactive art has been discussed by Edmonds as well: [6] considers HCI methods and knowledge important to interactive art and suggests that a critical

language is needed that can be used to describe, compare and discuss interactive digital art. The text identifies the practice and research known as *experience design* as especially important for interactive art as this field – unlike early HCI – does not focus on interface design but provides a collection of methods that focus on understanding user/audience experience.

A similar strong focus on audience experience is found in [4]. Costello et al. describe a study into the experience of the artwork Iamascope and focus on four categories of what they call 'embodied experience', originally proposed by the creator of the work, Sidney Fels: *response*, *control*, *contemplation* and *belonging*. Their publication identifies different classes of movements, vocabulary and behaviour associated with the different categories/stages and adds another stage – *disengagement* – which encompasses patterns that occur around the participant's decision to leave the exhibit.

A rather specific perspective has been taken by two artists, Sommerer and Mignonneau, whose computer installations integrate artificial life and real life [19]. Their text proposes the principle of what they call *non-linear or multi-layered interaction* – interaction which is easy to understand at the very beginning but at the same time rich "so that the visitor is able to continuously discover different levels of interactive experiences." Considering existing interactive artworks, the authors distinguish two types of interaction. Firstly, *pre-designed* or *pre-programmed* paths of interaction, where the viewer can choose a path but where the possibility of discovering unexpected paths of interaction is rather limited. Secondly, interaction in which *evolutionary* processes play an integral role, creating unpredictable and open artworks.

One of the most extended and comprehensive attempts at describing characteristics of interactive artworks yet has been made by Bell [2]. In his dissertation the author identifies 40 characteristics of participatory works of art that use computer technology. Relevant in our context is for example his approach of describing the time based relations between actions. Bell differentiates between two main temporal relationships – *synchronous* and *asynchronous* interaction – and points out how temporal relations relate to the perception of cause and effect. In *synchronous* interaction, events taking place at the same time. *Asynchronous* interaction is characterized by events occurring at different times and is likely to bring about cause-effect reasoning. Regarding interaction between humans and computers in the arts, the author follows a machine-independent approach based on "the input/output (I/O) routes of humans": sound, vision, taste, smell and touch. As those are less likely to change than technology, he proposes different combinations of those inputs and outputs as a defining characteristic of the interaction. Aiming for an easily remembered method to evaluate individual artworks, Bell summarizes the proposed characteristics of participatory works by the degree of control a participant has. An important aspect of this approach concerns the development of a score which describes the change of control over time by plotting the changes in degree of control on a horizontal line like a musical score.

The idea of using a score in order to describe digital artworks has also been explored by Rinehart who presents a formal notation for scoring digital media art [18]. Rinehart builds upon the analogies between digital art and music and considers a score-like mechanism to formally describe media artworks. His proposed Media Art Notation System (MANS) has three levels of implementation that are progressing from simple to more complex. It uses descriptive metadata, XML markup, text, images and other media to document a specific work and ideally could serve as a guide for re-creating the described works.

Important contributions to our field of interest furthermore come from media art institutes with an interest in categorizing and archiving (interactive) media art. One classification of media art relevant to interactive art is provided by the V2_ Institute for the unstable media [22]. Their research on '*capturing unstable media*' has resulted in an interaction model which describes several parameters. *Time flexibility or interaction synchronicity* indicates whether the interaction can be experienced at any time or needs to take place at a specific moment and distinguishes between scheduled and not-scheduled. The *interaction location* is classed either as specific or undefined and so indicates whether the interaction has to happen at a specific location or can be experienced at any location. The *user number* takes three possible values: single user, group user and audience. The user number is further classified by defining the *minimum number of users* and *maximum number of users*. The intensity of interaction is described by the *interaction level*; the parameter can take the following values: observational, navigational, participatory, co-authoring and intercommunication. The last parameter, *sensory mode* indicates which senses of the user are involved in the interaction process and distinguishes visual, auditive, olfactory, tactile and gustative. Their study also points out important areas for future research as for example the inclusion of more complex parameters such as *input and output of the interaction*, the *direction of the communication* and a precise description of the user's actions.

A complementary research project has been conducted by the Ludwig Boltzmann Institute Media.Art.Research. [10,11,12] in the context of the Prix Ars Electronica [17]. Working towards detailed differentiations within interactive art, several versions of a taxonomy have been presented. The taxonomy of interactive art builds upon a comprehensive study of existing vocabulary; categories and keywords have been developed and evaluated based on entries in Ars Electronica's archive and competition as well as based on expert feedback. Furthermore, additional keywords used by artists to describe their submitted works have been collected. In the taxonomy presented in 2008, nine keyword categories serve to describe interactive artworks. Interaction is primarily addressed by the categories *interaction partners*, *the performer (visitor) does* and *the work (project) does*. Keywords for the participant's/performer's actions include: observe, explore, activate, control, select, participate, navigate, leave traces, co-author, collaborate, exchange information and create. The corresponding category *the work (project) does* considers: monitor, serve as an instrument, document, enhance perception, offer a game, enable communication, visualize, sonificate, transform, store, immerse, process,

mediate and tell/narrate. It is noteworthy that the keyword category *interaction partners* is not limited to interaction between audience and artwork but allows for several different constellation such as interaction between audience members.

Another notable contribution to taxonomies of interaction in the arts has been presented by Beryl Graham as part of her doctoral thesis [7]. In the chapter *Taxonomies of 'kinds of interactivity' within art* Graham summarizes existing approaches, and consequently develops her own re-interpretation of an unpublished model by Cornock and Edmonds using the metaphor of *conversation*. Her resulting common-language taxonomy uses descriptions of different verbal exchanges and collates audience-artwork interaction with having a real conversation.

In [20], Sparacino et al. discuss authoring techniques for interactive spaces. The authors provide a taxonomy of interactive systems which classifies interactive media applications as *scripted*, *responsive*, *behavioural*, *learning*, and *intentional*. In *scripted systems* the interaction is often restricted to triggering the presentation of new material. In *responsive systems* the system is defined by a series of mappings between user input and system output. In those systems, the same action of the user always results in the same response by the system. In *behavioural systems* the response of the system is dependent on the sensory input as well as on its own internal state. Here, the same sensor measurement does not always result in the same response — the interaction depends on the interaction context which affects the internal state of the system. *Learning systems* are able to learn new behaviours and to modify existing ones. Finally, *intentional systems* are introduced by the authors as a new modelling technique for creating interactive experiences. In intentional systems a perceptual layer is added between the sensory input and the response of the system, which provides the software agent with an interpretation of the audience's actions and intentions. Here, sensor data is first interpreted and then mapped to a response action.

A rather unique taxonomy for media art has been envisioned by Gwilt [8]. The author argues that "a visual taxonomy for New Media Art is an interesting benchmarking device that might be used to establish the parameters of this new genre." Accordingly, he proposes a set of visual icons which can be divided into symbols that describe the composition of the work and those documenting the intended interaction between the viewer and the work.

Taxonomies of interaction in the broader field of multimedia are also of interest, as they can be applied to interaction in the interactive arts. A classification originally proposed in [14] and later applied in [9] distinguishes between different levels of interactivity in multimedia applications: *passive* interaction, in which content is presented linearly and users can only start and stop the presentation of the content; *interactive*, where users can navigate through the content and *adaptive*, in which users can contribute content and control how their content is used. This broader classification has in return influenced the more specific attempts of categorizing interaction in interactive art. Trifonova, Jaccheri and Berguast [21] build upon the latter categorization [9], the differentiation between pre-designed and evolutionary interaction presented in [19] and the varying relationships between artwork, viewer and artist described in [5]. By using the three properties *interac-*

tion rules, *triggering parameters* and *content origin*, they provide a table which covers all of their refereed interaction types. The resulting model considers static and dynamic *interaction rules*; human presence, human actions and the environment as *triggering parameters*, and user input, predefined content by the artist and generated/algorithmic content as possibilities for *content origin*.

A similar approach is followed by Nardelli [15]. The author characterizes and compares interactive digital artworks by approaching "Digital Artworks as Information Technology intensive systems for which spectators are involved in the production of the artistic output." He looks at an artwork as an information system which processes a given input in order to produce a desired output. Nardelli's proposed classification frameworks knows three dimensions: the *content provider*, who produces the raw material which is then processed by the artwork; the *processing dynamics*, describing the variability of the processing itself and the *processing contributors*, the sources which are affecting the processing dynamics.

3 Discussion and Future Directions

The variety and richness of existing approaches suggests the relevance of interaction in interactive art as a broad and interdisciplinary field of research. Although widely discussed, many important aspects of audience-artwork interaction have been left untouched or require further investigation. The following discussion points out those aspects and illustrates the need of a structural method for describing and thereby better understanding interaction in interactive art.[1]

Many of the surveyed publications can be seen as a valuable basis for future models of interaction in interactive art. Research by Edmonds and Cornock [3] has already served this purpose and constitutes a foundation in several succeeding works (see e.g. [5] and [7]). Although remarkable in envisioning and describing interaction in art as early as 1973, their work only provides very generic classifications and does not yet facilitate finer differentiations within the proposed categories. Considering our interest in audience-artwork interaction, differentiations within *dynamic-interactive systems* and *varying dynamic-interactive systems* form a desirable goal of future research.

Another aspect open for future investigations lays in the integration of research focusing on specific aspects, such as audience experience (e.g. [4]), within a comprehensive model of interaction.

More encompassing attempts on the other hand are not necessarily directly applicable either — they quickly result in very complex models which can not easily be used. One example of a comprehensive approach – the study by Bell [2] – solves this by summarizing the complex possible combinations of characteristics by the degree of control a participant has in an interactive artwork. Unfortunate

[1] We want to point out, that many of the publications summarized above were not intended to serve the purpose of providing a comprehensive model of interaction in interactive art. Therefore, showing shortcomings in serving this purpose should not be understood as critique of the works per se.

for our purposes, this introduces a strong focus on the human contribution to the interaction and does not include aspects such as the level of control the computer has. Coping with detailed descriptions of interaction while remaining applicable is one of the challenges of future studies on the topic.

Another motivation for future research is the fact that often only few interactive artworks have served as a reference (see e.g. [4]). Consequently, further research is needed in order to evaluate the general applicability and relevance of results gained when studying interaction with a small amount of artworks.

Research done by artists in the context of their art practice (see e.g. [19,20]) raises similar issues. Frequently, such studies are primarily relevant in their specific artistic context. It still has to be shown whether the specific approaches are meaningful and applicable in more general contexts as well. Either way, research realized in the context of artistic practice proposes interesting differentiations and points out possible dimensions to be considered in the future.

An important shortcoming of many classifications lays in the fact that they describe interaction purely by its 'parameters' and thereby disregard the possible relationships between them (see e.g. [22]). A crucial instance is found in [12,10,11], which acknowledges the artwork's and viewer's actions as defining factors, but lacks possibilities to describe the inherent relation between them. Nevertheless, these studies provide a strong basis of keywords and parameters to incorporate in future research and illustrate the remaining challenge of describing their relations and dynamics.

When considering models intended to describe interaction in a multimedia context such as [9], we have to be aware that those – although applicable to interaction between artwork and viewer – do not necessarily provide a level of detail suited for the often rather special aspects of interaction in interactive art. As we are interested in understanding the specific characteristics of audience-artwork interaction as well as in highlighting distinctions between different types of interaction in the arts, those more general approaches can serve as starting points but have to be refined in order to facilitate meaningful classifications in the art context. In line with this, [9,14] call attention to the relationship between interaction and content and can help us identifying pieces belonging to the interactive art genre. Adapting their taxonomy, we can distinguish between art in which interaction serves as a means of accessing the artwork's content on the one hand and works, in which interaction has been used as artistic material and constitutes an integral part of the artwork on the other hand. In our opinion, the latter works form the emerging genre of interactive art relevant to future research on audience-artwork interaction.

A last common shortcoming of existing research for our purposes is the understanding of interaction as a one-way process. One example is found in [21], which considers how the artwork is influenced by the audience and the surroundings but not how the artwork might influence audience reactions in return. Similarly, Nardelli [15] looks at an artwork as an information system which processes a given input in order to produce a desired output and thereby ignores that interaction is a continuous bi-directional process. We consider the feedback loop

and continuous process between audience and work important aspects of many interactive pieces and recognize their relevance in future research.

Looking at the presented collection of existing research with respect to its applicability for better understanding and describing audience-artwork interaction, we find – although not conclusive on their own – the presented divergent approaches have the potential to compensate for each other's weaknesses and complement one another in their strengths. As a next step, possibilities of incorporating results from the presented publications in a comprehensive model could be explored.

4 Conclusion

In the course of the presented review, we have highlighted the need for future research into audience-artwork interaction and pointed out possible future directions. In addition to summarizing publications which can serve as a strong foundation for further studies, we have recognized challenges and identified the necessity for future research looking at interaction as a continuous and bi-directional process. The lack of models describing the relationship between defining parameters such as the actions and reactions of audience and artwork has been recognized. By distinguishing between artworks with interaction as integral part of the work and artworks that use interaction to facilitate their contents, we have provided a criterion for identifying pieces belonging to the interactive art genre.

Concluding our review of relevant literature in the knowledge that existing studies as a whole form a good basis for future research, we want to point out that much relevant work in interactive art is actually shared not by means of (scientific) publications but by artworks themselves. Future work should therefore not only build upon existing research but at the same time derive information from examining interactive art pieces and interacting with interactive artworks directly as well as draw from exchange with practising artists and conducting experiments.

We have promoted the term 'audience-artwork interaction' and hope it will serve as a unifying label for future work addressing the discussed topics and thereby foster accessibility as well as exchange among the variety of disciplines contributing to this field of research.

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