Evaluating audience experience with interactive art

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Protocol analysis is used as a method to analyse verbal and non-verbal data. Interactive art experience protocols involve both types of information; behaviour of the individual interacting with the artwork and her retrospective report of what she was thinking during the primary experience. Interactive experience protocols are analysed by the use of a coding scheme in order to maintain a rigorous and replicable analysis process. The aim of this paper is to describe the development of this generic coding scheme for analysing audience experience with interactive artworks.

The aim of this paper is to present an analysis framework for evaluating audience experience. The question of how we access information about audience experience is at the core of this analysis framework. What we evaluate is not all aspects of the experience but some qualities of interactivity as part of the art experience. In a similar way interactive artists evaluate their works on the basis of the type of experience the audience had through the interaction, or whether the interaction is creating the qualitative criteria they initially set out for that particular experience. Evaluation of interactive experience is also an interest to human-computer interaction (HCI) researchers and interaction designers. Although interactive art generally ignores HCI methodologies, this evaluation can be done with retrospective techniques of questionnaires, interviews and/or focus groups. These techniques can help the artist or the interaction designer to understand to what extent her expectations are met and how to further develop the artwork or the interaction design, by creating a second or third version.

Maintaining a certain quality of experience is an important factor to keep the audience engaged with the artwork. Level of engagement is one of the observable indicators during the experience of an artwork. A straightforward technique to test the level of engagement is measuring the elapsed time for interacting with an artwork, however this does not indicate the quality/nature of engagement; whether it is frustration, curiosity, play, pleasure or relaxation. Another technique is to video-record participant's face expressions, body movements, mimics and gestures in detail to analyse and conjecture about the audience's emotional states and level of engagement from this data. The analyses can also be supported by questionnaires where one can ask the participants to rank their experience based on some criteria, or by semi-

structured or structured interviews. Then the researcher might be able to say that final version of the artwork was more engaging, more playful, more pleasant, frustrating than the previous/prototype version. Yet, the mentioned methods of post-enquiry produce little information about the quality or characteristics of the actual experience.

Another approach is focusing on the primary experience and collecting as much real-time information as possible. Methods of usability testing combined with eye-tracking and motion tracking responses, think-aloud or co-discovery protocols as employed in HCI research can serve for evaluating interactive systems to achieve user-centred designs. Höök et al. (2003) showed that the HCI evaluation methods can be useful for improving the design of interactive artworks. They developed a two-tiered evaluation model, where the artwork was placed in a laboratory setting and affective computing indicators were used for user testing. Their evaluation approach responded to concerns of the interactive artist and has improved the design of the interactive artwork studied. Resonating with Höök et al. (2003) study, we acknowledge artworks are not computer programs; they involve aesthetic appreciation and various engagement qualities of the audience which cannot be determined by standardized user testing. Through interacting with an artwork, each individual creates his/her own meaning. That is why audience experience with an artwork is a complex construct and each experience is unique to the artwork itself.

Background: Analysing design activity

Thinking through doing is an important theme for (interaction) design. Unlike theories of information processing and cognitive views that primarily consider that "thought is in the head", the theories and research in embodied cognition regard bodily activity and perception as being essential to understanding human cognition (Clark, 1998; Wilson, 2002). For example the process of producing a building design is a human activity involving diverse form of thoughts and bodily movements. Schön and Wiggins (1992) describe architectural designing as:

> "...a kind of experimentation that consists in reflective 'conversation' with the materials of a design situation. A designer sees, moves and sees again. Working in some visual medium - drawing, in our examples - the designer sees what is 'there' in some representation of a site, draws in relation to it, and sees what has been drawn, thereby informing further designing. In all this 'seeing', the designer not only visually registers information but also constructs its meaning - identifies patterns and gives them meanings beyond themselves" (p.135).

The view of designing as a "reflective conversation" as described in Schön and Wiggins paper has been accepted as a term to refer to the interactive nature of the design process. Design researchers further explored cognitive mechanisms that are related to this dialogue (Goldschmidt 1992, Goel 1995, Suwa and Tversky 1997). In design research, protocol analysis (Ericsson and Simon, 1993) is used to analyze and understand the design process. In design context, a protocol consists of verbal and non-verbal data; concurrent or retrospective verbalization in parallel to physical actions of the designer including drawing, doodling, gesturing etc. A design protocol involves the video-recording of this verbal/non-verbal behaviour, which represents the design activity. As a next stage in protocol analysis, collected protocols are coded. Coding refers to assigning pre-defined (and agreed) meanings to verbal/non-verbal/ behavioural events. A coding system is usually developed based on a cognitive model (referring to an ideal representation of an activity such as problem solving) through an iterative analysis of several protocols, whereby the coding system is refined. The audio/video protocols are usually coded by two analysts and a final coded protocol is achieved by using a process of arbitration based on the Delphi method.

Amongst other approaches to coding, Suwa et al. (1998) developed a content-oriented coding scheme which focuses the cognitive activity content as opposed to a process-oriented coding scheme which focuses on the process of design problem solving in terms of strategies or decision makings. A comprehensive cognitive model has been proposed by Suwa et al. (1998) for analyzing architect's reflective conversation with the design situation. According to this model physical actions demonstrated by a designer are parallel to her perceptual actions and they both are dependent on each other; this was emphasized by Schön (1987) as seeing-moving-seeing cycle. During this cycle designer attaches a meaning to the drawn elements; which is referred to as the function of the element (functional actions). Construction of meaning through drawing is assumed to be supported by two other classes of cognitive activities: conceptual and recall activities. Conceptual actions include planning of actions (setting up goals) and appreciative judgments of quality; while recall actions include recollecting previous knowledge and experience. Suwa et al. (1998) developed a coding scheme to represent the "reflective conversation" in terms of micro-level action codes which may be dependent on each other. Five action categories were summarized as:

- Physical actions: Drawing actions, moving hands over the sketch, gestures etc.
- Perceptual actions: Attention to things and their relationships the external world
- Functional actions: Attaching meaning to perceived elements
- Conceptual actions: Goals, judgments and evaluative actions

- Recall Actions: Recollecting experience and knowledge

Design problem solving sessions are conducted as quasi-experimentally where an expert architect initially is given a hypothetical but realistic design brief and asked to come up with a design solution in a limited amount of time. This approach to studying design have been proved to be valuable to analyze and understand the conceptual phases of designing (Christaans and Dorst 1996), although different from real designing practice of the architects. In this study method, the architect is required to read the brief and look at the photos of the site and commence sketching his ideas on the papers provided. The design session is video-recorded until the end of the given time. Immediately after the designing session, the architect is required to report on his thoughts and actions while he watches the recorded video of his design session. This retrospective reporting session is also video recorded and it becomes the primary resource for the protocol analysis. It is important that the designer reports in detail, for example why he drew that line/box and what he was thinking while he was drawing it. The visual cues in the video help the architect to recall her actions and thoughts, so that a rich design protocol is generated at the end of the session. This technique is also called video-cued recall and is used for observational research studies in other disciplines.

Development of a coding scheme

The coding scheme for the interactive art experience was developed based on three resources:

1. Codes from Suwa et al. (1998) coding scheme were barrowed assuming that there are parallels between interactive art experience and designer's reflective conversation with the design situation.

2. Iterative analysis of the videos of audience experience of interactive art done by CCS (Creativity and Cognition Studios) researchers. Data collection and analysis stages of this research required collaboration between a team of researchers with different backgrounds and views. A rigorous method was needed to bring these multiple viewpoints together into a shared analytical understanding of the rich and complex dataset that the interactive art experience provided.

3. Discussions and coding sessions amongst the CCS coding team. The collaboration involved an iterative process of coding development before the analysts could reach agreement on what to code, how to code and what to expect from the outcomes.

Method of data collection

The four interactive artwork experience studies that were used to develop and test the coding scheme were conducted at Beta_Space (a public exhibition space in Powerhouse Museum in Sydney) between November 2004 and February 2006. Each study was conducted on a single interactive artwork with each of the works being produced by a different artist (or artists in some cases). Although the studies each recruited different types of participants and had a diverse range of research goals, they all used the same method of data collection. Data is gathered in three stages: 1) observation method using video recording, 2) retrospective reporting using video-cued recall and 3) semi-structured interviews.

For each of the case studies the data collection process began with the video-recording of a participant's interaction with the artwork. For privacy reasons we did not allow the general public to enter while the camera was recording. This meant that, apart from the person operating the camera, participants were alone in the space while data was being collected. The participants each spent between 4-10 minutes interacting with the exhibit.

For the next stage of data collection participants were taken into a private room nearby. The setting of the room is shown in Figure 1. The video footage of their interaction was replayed to them on a computer screen and they were asked to report retrospectively on what they had been thinking whilst they were interacting. Participants were asked to try to recall only what they were thinking at the time and to refrain from making evaluations. There was approximately an 8-12 minute gap between the participants experiencing the exhibit and then giving their verbal reports.

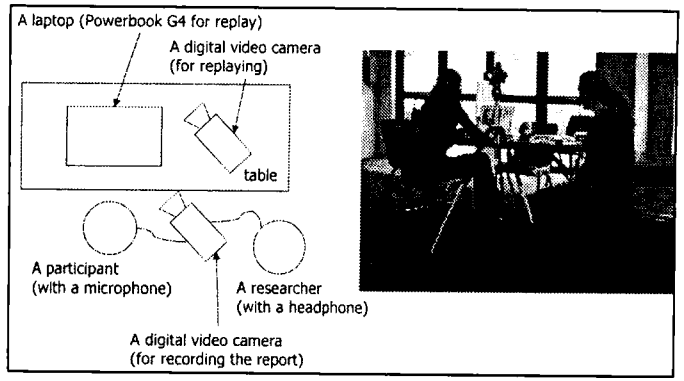

Figure 1 - The setting for the retrospective reporting

After each participant had completed his or her retrospective report we conducted a brief informal interview. Participants were asked if they had any opinions they wished to express about the exhibit and, depending on their answers, some further questions were asked. Finally, in cases where participants were recruited from existing museum visitors, they were asked several questions designed to ascertain their level of expertise. The whole data collection process took around 45 minutes per participant.

Cognitive components of interactive experience

Each time a person starts to interact with the artwork, we assume her/his experience is constructed simultaneously via four components (Figure 2):

• Actions: Physical moves observed under two categories: 1. Static actions (for eg. staring/looking at, holding the position etc.) and 2. dynamic actions (such as walking, running, waving hands, hand gestures, etc.). Actions differ for each individual depending on her intentions (purpose of the actions)

• Perceptions: Recognition of objects (including people) in the environment, actively perceiving spatial information, sound, image, or both. Perceptions differ for each individual depending on his specific knowledge of the world.

• Circumstances: Defined by the parameters of the environment which change over time (for eg, a blue circle appears on the screen, a rhythmic sound heard in the background, etc.). These changes are created by the audience interaction.

• Reflections: Defined by an individual reflecting on her/his actions and/or her/his perceptions. Reflections can trigger recollection of past experience and knowledge, the individual also is assumed to set up goals, explore, understand, and to create meaning through his/her reflections.

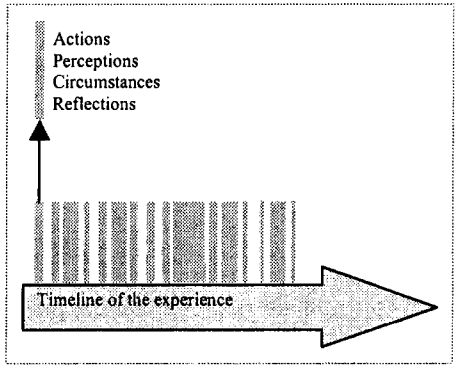

Figure 2 - Cognitive components of interactive experience

In Figure 2 Actions – Perceptions – Circumstances – Reflections are represented within a vertical slot, where the slots represent the smaller events along the timeline of the interactive experience. In each event there might involvement of one or more of the cognitive components. The experience for each individual will be different depending on the type and complexity of the interactions between the four cognitive components (Figure 2). The type and complexity is determined by what actions occur, what perceptions are constructed, how circumstances have changed and how the individual reflected on these components in a particular situation.

A generic coding scheme for interactive art experience

This section briefly describes the codes within the coding scheme for interactive art experience (Table A1). The scheme is divided into the seven categories of physical, purpose, state, object, perceptual, conceptual, and recall.

The physical category is for the coding of any observed behaviors of participants in the space. For example, walking back and forth, waving hands, breathing and any other actions related to the body. This category also codes passive actions such as staring, holding the body still or holding the breath. These observed actions are generally coded directly from the video data and are only coded when the participant is engaged with the artwork (i.e. not when they are reading any signage). In some artworks the type of physical interaction may not be easily observable from the video, for example the breathing interaction in Cardiomorphologies. In these cases, physical actions are coded from information gained from the participant's report.

For many physical actions there is an associated purpose or intention of that action. This information is revealed only in participants' retrospective reports and is coded in the purpose category. In keeping with our generic intentions, this category contains only two codes, trying to discover and trying to control. Discover/Experiment refers to an exploratory state, where the participant is learning the capabilities of the artwork, while Play refers to a more purposeful explorative/playful state. Trying to control refers to a participant's intention to cause or maintain a desired effect on the artwork.

Participants frequently described how they felt and what state they were in during their experience of an artwork. The states category represents these descriptions with five codes. There is a code for emotion (e.g. I felt scared), and a code for generic state descriptions (e.g. I was anxious). The participant's movement into and out (In/OUT) of engagement with the work is also coded, as is their being in the state of reading or listening to external information about the artwork and not understanding this information. The final code in this category relates to participants describing themselves as realizing or noticing something about the artwork. In the pilot study it was noted that this state is often associated with participants' shift from and explorative state to a state where they are more in control.

Object of attention refers to either things around the self or the body itself. Objects around the self provide information to a person about the interactive environment, such as the image, sound, people in the environment, and other physical components of the art work such as screen, equipment, floor etc. There are nine codes in this category. Image refers to any visual aspect of the artwork, often the visuals on the "Screen" and "Sound" refers to any aural aspect. In many of our case studies the visual and aural aspects of the artwork were so intertwined that participants frequently referred to them simultaneously. "People" applies to any references that are made about other people within the space, if there are any. Signage code refers to the exhibition signage that might be present in the space and Equipment is used to code any references to technical parts or tools in the Room/Space (which comes as another code). The final code, Art-Work, is used to code any references to the whole target artwork or any non-specific artwork references (e.g. it was overwhelming).

In the perception category, visual (Visual feature) and aural (Sound feature) perceptions are coded individually and include static and dynamic features. As mentioned above, it is common for participants' comments to relate to the relationship between sound and image. "Spatial Relations", is used to code any such comments and also to code any perceptions about the relationship between specific visual objects, geometries (e.g. two shapes on the screen). This category can only be coded from information given by the participants in their retrospective

reports. As such, it is coding the participants' perceptual memory rather than their primary perceptual experience. Recording what the participants do remember is, however, very valuable in terms of understanding the quality of the interaction between the audience and the artwork.

The conceptual category has six codes relating to participants' thought processes. The category distinguishes between the setting of goals and the questioning of ideas. This category also includes codes for aesthetic or experiential evaluations and for explanatory comments related to how the system works, or how the experience is constructed. Comparison refers to metaphors, analogies reported about the experience (for e.g. the image was like a flower). The final conceptual code relates to thoughts the participant may have about the relationship between herself and the artwork.

It is quite common for participants to reference their past knowledge or experience in their reports. For example, a participant may talk about his or her occupation to explain why he or she is particularly interested in a certain feature. The recall category is used to code this kind of retrieval of knowledge from participants' long-term memory. This category has two codes, a code for the recall of past experience and a code for the retrieval of past knowledge.

This coding scheme is designed so that it can be applied generically to any artwork that might be exhibited in Beta_Space. While we have tried to allow for artworks that might be very different from the four in our case studies, the scheme does not code every possible aspect of a work. It is anticipated that researchers who are studying a particular artwork will need to devise additional codes for any important aspects of the experience that are not covered by the generic codes. For example, the types of physical movement in each work are quite varied and could be coded in more detail. Other works try to engender a specific emotional response and researchers could create a code for this emotion.

Outcome

This paper described a coding scheme for analysing audience's interactive art experience. The CSS coding team is currently conducting full-scale analyses using the scheme and is continually testing its generic nature by applying it to new and different artworks. These will result in further refinements to the scheme and lead us closer to our goal of developing a deeper understanding of the experience of interactive art.

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Appendix

Table 1 A coding scheme for interactive art experience

Codes	Content
	Observed Actions of Body Parts
Mbody	Move the body - (describes movement e.g. hands wave, walk back and forth, breathe in and out etc)
Mhold	Hold/ Maintain a movement
	Purpose of Actions/ intentions
Tcontrol	Trying to control (manipulate or maintain)
Pl	Playing with something
Ex	Exploring or trying to discover/ Experimentation
	Self States
Gstate	Describing a current state of yourself (e.g. I became
In/Out	Disengagement/distraction and moving into the
Real	Realising, noticing, recognizing
Read/Listen	Read or listen to external information about work
NU	Not understand, not being able to figure out or give
	Object of attention
Img	Image
Snd	Sound
Body	Body awareness, sense, posture, comfort, internal
Peop	Other person/ audience in the space
Scr	Screen
R/S	Room or space
Sgn	Signage for explanation
Equip	Tool/ equipment
Wk	Whole target artwork, unspecified part of an artwork
	Perception
SndFeat	Perceiving sound feature
Vis Feat	Perceiving (a) static features of images (shape, light, colour, musical tone, volume, etc.) (b) Perceiving dynamic features of images (animated image, moving
Sreln	Perceiving relations among objects / relative positions in the space/ orientation/ perceiving one's body wrt to the
	Conceptual
Goal	Setting up new goals, or revisiting goals
Question	Questioning (only if the participant explicitly mention "I
Eval	Evaluation/judgement/preference
Explain	Explanatory statements (figuring out how the system
Comparison	Metaphor, simili
Self Work	Mention the relationship between the self and work.
	Recall
Rp	Recall personal experiences/ events
Rk	Recall previously learned knowledge