Communicating Art through Interactive Technology: New Approaches for Interaction Design in Art Museums

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ABSTRACT
This paper discusses new approaches to interaction design for communication of art in the physical museum space. In contrast to the widespread utilization of interactive technologies in cultural heritage and natural science museums it is generally a challenge to introduce technology in art museums without disturbing the domain of the art works. To explore the possibilities of communicating art through the use of technology, and to minimize disturbance of the artworks, we apply four main approaches in the communication: 1) gentle audio augmentation of art works; 2) conceptual affinity of art works and remote interactive installations; 3) using the body as an interaction device; 4) consistent audio-visual cues for interaction opportunities. The paper describes the application of these approaches for communication of inspirational material for a Mariko Mori exhibition. The installations are described and argued for. Experiences with the interactive communication are discussed based on qualitative and quantitative evaluations of visitor reactions. It is concluded that the installations are received well by the visitors, who perceived exhibition and communication as a holistic user experience with a seamless interactive communication.

Categories and Subject Descriptors
H.5.1 [Information Interfaces and Presentations]: Multimedia Information – augmented reality, audio output
H.5.2. User Interfaces - theory and methods.

General Terms
Design, Experimentation, Human Factors

Keywords
Interaction design, user experience, art museums, communicating art, audio augmentation, body as an interaction device.

1. INTRODUCTION
The research behind this paper has taken place within the context of a real museum setting, ARoS, a prominent art museum in Denmark. The museum had the ambition to try out a new way of communicating art in the physical museum space. The museum had considered communication means such as audio guides and PDAs. However, they found these means of communication too isolating for the individual visitor and too detached from the actual art experience. Instead they engaged a group of experience designers and interaction designers (including the authors who do research in these areas) to develop a new art communication experience for a specific exhibition. An exhibition with the Japanese artist Mariko Mori was chosen as the target for developing new art communication experiences, since Mori’s art has built-in high tech elements. The artist agreed to this new form of communication, and two of the museum’s curators participated in the development of the art communication installations. The artist participated in the production of audio tracks for some of the installations. The resulting installations were also reviewed by the artist herself before the opening of the exhibition. During this review one piece of audio, which she found in conflict with her overall ideas of the exhibition, was removed. The rest of the installations she found to be in concurrence with her art expression.

The development process for the Mori exhibition was considered an experiment to assess the feasibility of more general changes of communication means in the ARoS museum space. As researchers we took the opportunity to investigate and develop new interaction design approaches targeted at art museums. The technical aspects are described in [12].

The paper is structured as follows. Section 2 briefly reviews approaches to interaction design in museums. Section 3 gives an overview of the new approaches we developed for communication in art museums. Section 4 describes in detail how we applied these approaches for the Mori exhibition. Section 5 discusses the experiences from both a qualitative and a quantitative perspective. Section 6 summarises the lessons learned. Section 7 compares the new approaches to selected related work, and finally, section 8 concludes the paper.

2. INTERACTION DESIGNING FOR MUSEUMS
In cultural heritage and science museums [3][4][9][10][18][19][23] there has been documented many types of engaging interactive installations including tangible user interfaces (TUI) [22] and augmented reality (AR) [1] installations. In these types of museums this is acceptable since the communication is targeted at supporting efficient and engaging learning experiences within culture, history or natural sciences. Thus the interactive installations themselves become objects of the museum, revealing knowledge about certain immaterial subjects. In art museums, however, the artworks themselves should constitute the main visitor experience. Traditionally this has only left room for small additional discrete signs, a catalogue, or perhaps an audio guide explaining about the artist

1 http://en.wikipedia.org/wiki/Mariko_Mori
or an explanation of a specific piece of artwork and the inspiration behind it. A main issue in the communication strategy for art museums is to avoid disturbing the pure art experience with the communication means chosen.

Experiments on augmenting art museums with interactive technology have been documented. For instance, Terrenghi & Zimmermann [21] introduces the notion of 3D sound in headphones (LISTEN) for an art museum, providing the user with a contextual and spatial audio guide. This technology is an advanced version of more traditional audio guides. Thus the approach still provides only an individual and detached experience, since no conversation is possible while listening to the audio. This communication approach does not disturb the experience of purely visual artworks, however, it would be difficult to combine with artworks that contain sound by itself.

Another example is the use of projected overlays as illustrated by Bimber et al. [2]. Here the idea is to utilize computer graphics and augmented reality techniques to provide projected overlays on backgrounds with arbitrary colour and reflectance. Thus the pictorial artwork can self constitute the background for projected explanations or pictures of inspirational sources etc. The assumption is that the pictorial artwork is augmented with a projector similar to a spotlight directed at the artwork. This approach is advanced in its use of real-time computer graphics rendering. This approach does provide a shared experience for groups of visitors. However, the approach is problematic seen from a museum perspective, in particular when the focus is on modern art, due to the fact that the projections seriously disturb the experience of the original artwork. The high quality projection may partly or fully cover the original picture, and if the quality of the projection is sufficiently high it may not be possible to distinguish the projection from the artwork. We anticipate that most curators and artists will be sceptical towards such an augmentation of the artwork.

3. NEW APPROACHES FOR INTER-ACTION DESIGN IN ART MUSEUMS

Based on the above examples we see special challenges for interaction design in art museums, if we wish to go beyond the pure individualized experience toward shared social experiences that do not disturb the art work. By shared social experiences, we are inspired by the ideas of aesthetic interaction [16] that argues for interaction techniques that are socially appealing, and involves more of the human senses in the interaction. These ideas have also been applied for an aquarium setting as described in [3].

To provide such shared and multisensory experiences for the art museum domain, we have developed four main approaches that were followed in the project we did with the ARoS art museum. We will briefly argue for the approaches before we describe how we implemented installations for the actual exhibition based on the approaches. The four approaches are:

1) gentle audio augmentation of art works;

Audio guiding based on headphones share the problems of depriving the user from being aware of conversations or sounds in the nearby environment. Moreover, headphone based systems only provide a single user experience. To overcome these disadvantages, we propose to utilize a gentle audio augmentation of the environment through the use of sensor controlled directional loudspeakers².

2) conceptual affinity of art works and interactive installations;

Making additional visual installations (e.g. projected overlays [2]) in close proximity of artworks may potentially disturb the clean experience of the artworks themselves. Instead we propose to develop interactive installations in separate locations, but with a conceptual affinity with the original artwork. This does not imply reproduction of the artwork, but making an interaction with a direct reference to the original artwork.

3) using the body as an interaction device;

Traditional touch screen and audio guide interfaces used in museums typically apply button and menu based interaction, which require users to focus and concentrate on the selection of relevant items in the interface. To avoid this need to focus on the interface rather than the museum experience, we propose to make interaction that utilizes the body as the sole interaction device. This approach is primarily inspired by the work on interactive floors ([6][7]), however, a larger range of interaction techniques ([14][15]) may also inform this approach. An overview of such techniques can be found in [11]. The body may work either as an implicit interaction device, e.g. a sensor just detects the appearance of the user; or as an explicit interaction device, e.g. sensors/cameras track precise movements by the user to select items or invoke actions.

4) consistent audio-visual cues for interaction opportunities.

Experiences from science and cultural heritage museums are that the interactive installations are very diverse and require a large number of different interaction techniques, thus requiring the user to spend time learning where and how to interact with the interactive installations. This may be an important part of the learning experience in such museums, however, in the art museum, it is important to allow the visitor to concentrate and contemplate in the artworks being exhibited. Thus we propose to expose simple and consistent audio-visual (or otherwise) cues to the user about where and how the interaction opportunities appear in the exhibition space.

4. APPLYING THE APPROACHES TO THE MARIKO MORI EXHIBITION

This section discusses how we applied the four interaction design approaches in a specific case. ARoS had set the stage for the development of new interactive communication initiatives for an exhibition with Mariko Mori. The objective was to intensify and expand the experiences of the artworks by means of interactive art communication encouraging the visitor to explore, play and communicate with co-visitors. The means of communication aimed to match the idiom and underlying basis of Mori’s art, which is a mixture between eastern spirituality, popular culture, futurism, technology and interaction, added a vast amount of historic references. The exhibition “Mariko Mori – Oneness” is about interrelationships and connections between human beings and between them and the world.

The target of the communication of Mori’s art has been to create new contexts and develop interaction design that increases the experience of art for the viewer who chooses to activate them, and not to make ready-made interpretations of the works. The result has been two interactive initiatives: “The Sound of Art” which is 25 audio spots that gently augments the art works, and “The Contemplation of Art” which consists of separate contemplation rooms that have conceptual affinities with the art works.

² http://en.wikipedia.org/wiki/Sound_from_ultrasound
4.1 Gentle Audio Augmentation - The Sound of Art Installations
The Sound of Art consists of 25 audio spots located in the exhibition next to the art works. Each spot consists of a visual silver circle at the floor and four meters above the circle a directional speaker and a PIR (passive infra red) sensor which registers when a user is entering the circle. The user’s movement into the spot triggers played back recordings with clips of Mariko Mori’s voice gently supplementing the artworks. Only when standing inside a circle is it possible to hear the artist’s whispering comments on the artworks. In this manner, the hearing experience is individual and somewhat intimate, even though it occurs in an open space with constant awareness of other visitors. The audio clips are randomly selected and can be heard independently. If the user makes a small movement a new audio clip is triggered until all the clips have been played an equally amount of times. Some of the art works are augmented by more than one circle. The silver circles are in three different sizes indicative of the type of material being communicated. Large circles contain overarching thoughts on the works, medium and small circles contain more specialized and specific ideas and considerations.

4.2 Conceptual Affinity - The Contemplation Room Installations
The Museum’s Special Exhibitions Foyer contained two Contemplation rooms with interactive installations communicating the sources of inspiration behind the exhibited works. The contemplation installations are thereby spatially detached from the art works they refer to, however, with a clear reference to the art works, which makes an affinity between artworks and interactive installations. Thus “The Contemplation of Art” differs from “The Sound of Art” in that the latter to a certain extent is more an integrated part of the art experience. In the following, we describe the installations and how they represent a conceptual affinity with the original artwork they should communicate inspirational material for.

4.2.1 Contemplation Installation – “Esoteric Cosmos”
The first installation displays inspirational material behind the artwork “Esoteric Cosmos” which consists of four 6 meter long photographic collages inspired by the four elements wind, fire, water and earth (depicted in Figure 3). The conceptual affinity between the “Esoteric Cosmos” art piece and this contemplation installation is that it similar to the art piece exposes four visual areas. Each of the visual areas provides inspirational material related to each of the four elements that have inspired the original artwork.

The interactive installation uses camera tracking to detect when users approach a silver circle projected on the floor. Inside the silver circle four circles are displayed representing the four elements. When the user stands in front of one of the circles his or her silhouette is used as input (using camera tracking) and a sound starts to play inspired by the element selected. Further, an image of one of the inspirations behind Esoteric Cosmos is displayed. After a few seconds the image fades away and background information about the inspiration appears as text. A few seconds later the element goes back to its starting point and can yet again be activated.

4.2.2 Contemplation Installation – “UFO”
The second installation (shown in Figure 4 together with the artwork it is communicating about) is meant to communicate inspirational material for Mariko Mori’s piece “Wave UFO” (2003) which is a stunning sculptural object in which three people at a time can explore the relationship between the individual and being interconnected, through real-time computer graphics and brainwave sensing technology. The UFO installation is a staircase with built-in pressure sensors located underneath a 42” screen displaying inspirational material behind the artwork. The staircase is a direct reference to the UFO artwork which contains a ladder. The user can scroll the material by stepping up or down the stairs.

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A third room with analog materials is not covered.
Each part of the staircase (left, middle, right) displays material from three different categories; sketches from the building process of the UFO, brainwaves and patterns displayed inside the UFO, and architectural drawings and 3D models. When multiple users stand on the staircase at the same time, the screen is split in two or three “tracks” allowing multiple images from two or three different types of background material to be displayed at the same time. The visual feedback is accompanied by a rumbling sound from a subwoofer in the staircase.

The conceptual affinity is achieved through the utilization of a staircase and a monitor which constitute a hole that one can look into. The staircase is the only art piece with a staircase and the monitor on the wall displaying graphics from the UFO should remind of the hole in the actual UFO art piece showing computer graphics on the ceiling.

4.2.3 Contemplation Installation – “Oneness”

The third installation (shown in Figure 5 together with the artwork it is communicating about) is meant to communicate inspirational material for the piece “Oneness” which is six green aliens standing in a circle holding hands. When all six aliens are hugged at the same time by the audience, the floor lights up and the users can feel the heartbeats of the aliens. The conceptual affinity in this case is represented by the fact that the number six and pictures of aliens recur in the second contemplation installation. The installation is a floor with six built-in pressure sensors placed in a circle around a projection of inspirational material. The pressure sensors providing the interaction opportunity are visually indicated by six silver circles and a projection of an alien in the middle.

When a user stands on one of the pressure sensors, the alien disappears and one sixth of an inspirational picture behind Oneness is displayed. Further, six different sounds indicate each time someone steps on a silver circle. In the rim of the circular display a text is revealed with the inspirational picture. When the entire image and text has been revealed, the sound intensity increases and after a short period of time an animation of another one of Mariko Mori’s aliens appears. Thus the users would have to communicate and work together in order to find out what happens when all six pieces of a picture are revealed.

4.3 The Body as an Interaction Device – Reacting on User Movement

The interactive installations all utilize the body as the only interaction device. The audio spots utilize a coarse grained PIR sensor to detect the appearance of a visitor within a silver circle marked on the floor. Appearance triggers play of an audio clip, when the clip is finished a slight movement will invoke the next audio clip in a random sequence. In Contemplation Installation “Esoteric Cosmos”, we apply camera tracking as in [6][7] to detect explicit user selection of inspirational material belonging to each of the four elements. In contemplation installations “UFO” and “Oneness”, we apply pressure sensors embedded in the floor and the staircase to invoke actions in the two installations. This interaction technique is very explicit; the user simply selects an action in the interface with a light
pressure by his/her foot in the center of a silver circle marked on the floor.

(a) "Oneness" artwork (Photo: Ole Hein)

(b) Communicating “Oneness”: All pieces of the picture are revealed when all six silver circles are activated.

Figure 5: Contemplation Installation – “Oneness”.

The underlying idea of emphasizing the use of the body stems from a wish of the museum. They wanted to experiment with the visitors’ art experience. By introducing interactive elements to the communication of art, the users would be given the role of active participants. Hence, the art experience would not just be about passively receiving information about the works, but also about taking an active part in acquiring the knowledge. Further, by using the body as an interaction device, the communication of art makes better use of the human's sensory and motor systems, and allows the user to experience the art through physically and socially engaging activities.

4.4 Consistent Audio-Visual Cues - Silver Circles/Audio Response at Interaction Spots

In order to provide a walk up and use experience without guidance by a manual or a human, we strived to make a very simple indication of spots for interaction opportunities.

Throughout the exhibition silver circles glued to the floor have indicated the possibility of interacting with the communicative installations. This goes both for the audio spots and for the contemplation installations. The simple visual cue is meant to make the visitor intensify and expand the experience of art. The shape and colour of the visual cue was chosen to be consistent with Mariko Mori’s art, as she also uses silver and circular forms in the idiom of her universe.

We utilize audio response to make the visitors always experience a reaction from the environment when entering a silver circle with a part of his/her body. The reaction can be repeated by moving in and out of the silver circle and it is thus supposed to be easy to infer the principle of the interaction.

Having described how the interaction design principles have been applied to the Mariko Mori exhibition, we will discuss how the users experienced the installations.

5. EVALUATING USER EXPERIENCES

The project has been evaluated quantitatively through questionnaires and qualitatively through video shadowing and interviews. The aim of the evaluation has been to examine the users’ experiences of the art communication. In the following, we describe how we evaluated the user experiences and what results we got from the evaluation.

5.1 Evaluation Method

The exhibition was visited by approx. 70,000 visitors over a three and a half month period, and the main reactions from the press and the public were positive both towards the art and the interactive communication approach. In order to make a more structured evaluation we conducted both a qualitative and a quantitative evaluation. The focus in the evaluation has been on the physical, social and cultural aspects of the communication, as well as how these aspects interrelate. The physical aspect is the specific form of the installations and interaction (appearance). The social aspect is the manner in which the users act towards the installations and interaction (performance) and the cultural aspect is the experience the users have with the communication (perception). The purpose of the evaluation is to investigate how these three aspects interrelate.

We developed a set of hypotheses regarding target group, interaction, specific installations, and communication of art. Based on the confirmation or rejection of these hypotheses we reflect on future modifications of our four approaches. To address these hypotheses four qualitative group interviews and a questionnaire were made. The interviews and the questionnaire based investigation were due to a limited time frame (in which the museum allowed us to conduct the investigation) conducted simultaneously. The material from the investigations is extensive, and we expect to be able to extract more findings from the material, in particular the qualitative data.

5.1.1 The interviews

The explorative interviews uncover social and cultural aspects and investigate the relationship between the visitors’ interaction and experience and yield of the communication. We addressed ourselves to the visitors by the staircase from the exhibition area to aim at the visitors who have already seen the exhibition. Four groups consisting of 2-3 visitors were interviewed and the interviews were recorded on a Dictaphone. In order to give all the interviewees the opportunity to make themselves heard, we found it important that the groups were not too big. Additionally, we picked four groups that represented different segments; three teenage girls, two brothers in their late thirties, two senior citizens and three guys in their mid twenties. We would also have liked to interview a family with young children, and a group of middle-aged women, who are the primary users of the museum. Unfortunately, we were not able to do so.

The interviews lasted approx. 30 minutes and the visitors were rewarded with coffee and cake during the interview and afterwards they received a free catalog from the exhibition. The interviews were semi-structured. First, the visitors were asked factual questions; e.g. name, age, frequency of visits to the museum, duration of the visit to the exhibition, and their overall impression. After the introductory questions approximately 20 minutes were spent on a "guided debriefing tour" in the sense...
that the interviewees were encouraged to tell about their experiences, where they went, and what they did, based on a floor plan. On the floor plan they could put green stickers if their impressions of that place were predominantly positive, and red stickers if they had had a negative impression. The interviewees were asked if they had encountered any information on their way, and were told that our primary focus of interest was on the communication of art. Through the dialogue the interviewers learned whether or not the interviewees had tried the audio spots and the installations in the contemplation rooms, and the interviewers were able to enquire about specific remarks from the visitors. At the end of the interview, the interviewees were asked if they had any suggestions for improvement.

5.1.2 The questionnaire
A questionnaire was made with 32 multiple-choice questions. The major part of the questions could be answered by checking choices among statements and factual data, and in a few places there were openings for freestyle text writing. The questionnaires were over a three day period handed to 150 visitors who were promised free cake and coffee when delivering back a filled in questionnaire. This gave us 91 filled in questionnaires in return. The age distribution of the respondents was as follows: 0-10 years: 6%, 11-20 years: 21%, 21-30 years: 9%, 31-40 years: 15%, 41-50: 25%, 51-60: 13%, 61-70 years: 11% and 70+: 1%. The answers have been keyed into a statistical processing package for analysis. Below we discuss findings from the interviews and subsequently the questionnaire based evaluations.

5.2 Results from the User Evaluation
The analyses of the evaluations have brought about some general lessons regarding the four approaches and the user experiences that can be fruitful in future projects. In the following, we present some of the results in order to confirm or invalidate our seven hypotheses.

Hypothesis 1: The interactive communication approach makes it more engaging and fun to visit an art exhibition with interactive communication than traditional exhibitions.

In the beginning of each interview, we asked the visitors what their overall impressions were of the exhibition. The teenage girls thought the communication seemed more “alive”. “You’re not just supposed to stand still and analyze what you see. It’s interesting to be a part of what’s being created”. A guy from the group in their twenties said, “I think it is very rare that you at an exhibition are obliged to work with others to make the installation work. It is very different and makes it even more social”. “The technological aspect is great fun”.

The two brothers thought it was “interesting and entertaining”. They rarely visited art museums, but liked the fact that they could explore the content, and found that it was an advantage that the communication was playful.

The two senior citizens liked the audio spots: “The communication at art museums should be something not too binding. It shouldn’t be something where you have to put on head phones, because it doesn’t act like an easy approach”. “The directional speakers are great because they can actually tell people a story without binding them”.

Turning to the questionnaires, we asked, “How do you like the fact that the visitors are forced to be active in order to gain knowledge about the art works?” Here a total of 91% of the respondents thought it was either “Good” or “Very good”. Moreover, 66.7% of the respondents said that they would be more likely to visit future art exhibitions if they were augmented by interactive communication.

As shown in Figure 6, there is no significant difference in the views on interactive communication among the different age groups. The only remarkable difference is that there is slightly fewer in the top category “Very good” among the 1-10 years, however, the sum of the two top categories “Good” and “Very good” is very stable across all age groups. Surprisingly perhaps is also the fact that 90% of the 51-60 years old find it “Very good”, thus the interactive communication seem to appeal also to the older groups of visitors. There is no significant difference either between men’s and women’s answers to the questions in the questionnaires.

Figure 6: View on the new communication relative to age

With respect to negative aspects: Only 5.7% of the respondents said that there was too much play and too little communication of information. Only 17.1% expressed that they get more out of traditional signs than the interactive communication.

The overall picture of the questionnaires indicates that the visitors indeed do find it more interesting to visit an exhibition with interactive communication. Further, at the end of the interviews we asked the visitors if they would be more likely to visit future art exhibitions if they were augmented by interactive communication, and most of the visitors said, that they would. Thus, there are good prospects in augmenting art exhibitions with interactive communication, and it seems fruitful to look more into designing and developing interactive systems for the domain of art museums.

Hypothesis 2: The gentle audio augmentation is easy to grasp and provide a useful supplement to the art.

The users were quite enthusiastic about the audio spots as they found them to be an exciting manner of gaining knowledge of the art works. When interviewing the teenage girls, one stated, “It’s pretty cool, that you are spoken to, and that you don’t have to read it, because you just don’t want to spend time on reading; it can be tiring. It definitely appeals to lazy high school students like us. It’s very innovative”. Later on another one said, “You are somehow dragged into them [the silver circles] because you are curious. You want to know what’s going on in there”. “It’s like it’s another world, because you are the only one, who can hear it.”

83% of the respondents of the questionnaires have answered, that they have tried either 1-2 audio spots for each art work or all of the audio spots in the exhibition; and 83% of the respondents thought it was either “Good” or “Very good” that the art works were augmented with the voice of the artist in the audio spots.
In the interview the teenage girls said, “I think, every time we discovered one [silver circle], we went to it”. One of the senior citizens said, “I tried almost all of the silver circles. I wanted to hear if there were different stories, and I think there were.” “The idea in it is very good”.

The two brothers had tried all of the circles on one of the other floors, however, they had not seen the entire exhibition yet when interviewed.

The group of guys in their mid twenties agreed that, “The sound circles fit better if you are visiting the exhibition alone wanting to lose yourself in the art, because only one person at a time can stand in a circle, and we would like to be able to talk about it [what the saw] and experience it with each other”.

However, observations have shown, that even though the audio spot size fits perfect for one person, couples or people who visited the exhibition accompanied by others would sometimes share an audio spot and thereby making it a social experience. In addition, hearing the voice of the artist while standing in front of an art work gave the guests a sense of proximity.

Moreover, some users found Mariko’s voice too monotonous and droned resulting in a perception of the audio clips as background sound rather than info. In the interview the senior citizens said, “She drones out short messages which could be clearer. It is too chanting and weak. Some of the words, you don’t get”. “But then again, the voice of the artist is part of the experience”. The teenage girls said, “It was more an experience than actual information. I think some of it - her voice - was a little hard to understand, but it was a very nice experience”. One of the guys said, “The silver circles were nice and pretty informative. They explained concisely, what it was about”.

According to the questionnaires 31% of the respondents found it hard to understand Mariko’s voice. Further, some users – also beyond senior citizens - found it difficult to hear the sound clips, especially in the larger rooms and in transition areas. Additionally, language was an issue for the elder generations.

The position of the audio spots is also an interesting issue as it is essential to the experience of the art works and use of the audio spots. Placing audio spots in transition areas is less ideal than placing them in rooms that afford absorption or rooms where the spots had been staged. Some of the interviews revealed that some users would walk past some of the audio spots without being aware of the presence of the spots.

Some of the interviewed people would have liked a description of what to expect from the audio augmentation. The three guys said “If only you knew what the premises for the silver circles were. First time I was here, I didn’t know that the circles had anything to do with sound, but then I went to one and looked up. On one hand it is pretty cool that it is discreet, but on the other hand it would have been nice to know when entering the exhibition, that the circles will explain some short sequences, and that the speak is the artist herself”. Further, they suggested a visual marking of an arrow towards the circles and that the length of the sequences could be indicated on the floor in minutes. In this manner they would know how much time to spend on each circle, and thus being able to coordinate their visit with others.

One of the senior citizens uttered, “Maybe there could also be a cone of light to emphasize that you can hear the artist”. The suggestion of using arrows also came up in the attempt to visualise the possibility of retrieving information. These remarks emphasize that not all the visitors found the audio augmentation easy to grasp. This could be due to the visitors not being used to retrieving information in this manner.

### Hypothesis 3: The conceptual affinity between artwork and interactive installations

In general 77.5% of the visitors think that there is sufficient information about the works present at the exhibition. Since there is very little written information, the interactive installations must have contributed to fulfilling the visitors’ needs for information.

The user evaluations have revealed that most visitors found the contemplation installations intriguing and they were approached with curiosity. In average around 50% of the respondents claim that they got “much knowledge” or “some knowledge” out of the installations.

<table>
<thead>
<tr>
<th>Understanding of the affinity between artwork and installation</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did you discover which common meaning the number 6 has to the Oneness piece and the Contemplation room installation?</td>
<td>74.70%</td>
<td>25.30%</td>
</tr>
<tr>
<td>Did you discover that the staircase in the Contemplation room shows three different categories of WAVE UFO material (1: Sketches, 2: Architectural models, 3: Brain waves from the UFO ceiling)?</td>
<td>65.60%</td>
<td>34.40%</td>
</tr>
<tr>
<td>Did you discover that the installation in the Contemplation room illustrates the four elements?</td>
<td>36.00%</td>
<td>64.00%</td>
</tr>
<tr>
<td>Did you discover that the Esoteric Cosmos is inspired by the four elements (air, soil, fire and water)?</td>
<td>44.40%</td>
<td>55.60%</td>
</tr>
</tbody>
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**Figure 7: Understanding of the relationship between artwork and communicative installations**

However, when we tried to investigate the hypothesis about affinity, we did that in the questionnaire by asking indirectly about certain aspects of the visitors’ understanding of the relationships. The results are shown in Figure 7, and they actually indicate that the understanding of the affinity between artwork and installation is generally poor. Only the WAVE UFO and the interactive Staircase relationship are significantly better understood than the others. This may be due to the fact that the indirect questions in the questionnaire were too hard to answer or that people have experienced the installations more superficially.

Contemplation installation “Esoteric Cosmos” was the least commented, which may be due to the lack of staging. Half of the interviewees stated, that they either hadn’t noticed the installation or that they didn’t know what to do with it. 62% of the respondents of the questionnaires had tried the installation. Unfortunately, the Esoteric Cosmos installation is slightly susceptible to changing light intensity, which can make the installation unstable and the interaction opaque.

Contemplation installation “UFO” was the most visited and commented. 64% of the respondents had tried the installation. The UFO installation also harvested plenty of positive feedback from the users. One of the girls said, “I jumped at it – being a bit of a child. It’s a bit video gameish”. “I thought it helped me to understand, what was going on in there [in the Wave UFO art work]”. Another one of the girls said, “I could see the relation between the art work and the staircase, but I didn’t know what to make of it”.

The three guys found the installation a bit too “arty”. Presumably, this is partly due to a lack of text and maybe partly because the task of the user (to climb the stairs) doesn’t concordant with the content of the visual feedback. The guys
Hypothesis 4: Using the body as interaction device is engaging not get the chance to try the installation themselves. The Oneness installation was in particular accentuated as a social installation where strangers get to talk to each other to make someone step on all the circles at the same time. All of the interviewed visitors had tried the installation and found it fun to interact with. However, most did not know what the purpose of the installation was. “What does it mean when the alien is spinning around?” asked one of the girls. Surprisingly, only 58% of the respondents of the questionnaires had tried the Oneness-installation. This relatively low amount may be due to the fact that the interaction could only serve a few people at a time compared to the large amount of visitors. Consequently, the doorway was often full of spectators, many of whom did not get the chance to try the installation themselves.

Hypothesis 5: The consistent audio-visual cues made it easy understand the interaction across the interactive installations. As reported under the previous hypotheses, people in general (>= 40%) found that the installations with the silver circles per se invited them to interact. Another 30.5% said that seeing others interact invited them self to try it out. About the UFO installation, 53.6% of the visitors said that the installation per se invited them to interact, whereas another 14.3% indicated that seeing others interact invited them to try. About the Esoteric Cosmos installation 41.5% of the visitors said that the installation per se invited them to interact, whereas another 34.1% said that seeing others interact invited them self to try it out. The visual cue and the installation per se seemed to attract the majority of the users in all the installations, but many were also inspired to try out the installations because they saw others move and jump around in the installations using their bodies as interaction devices.

Hypothesis 5: The consistent audio-visual cues made it easy understand the interaction across the interactive installations. As reported under the previous hypotheses, people in general (>= 40%) found that the installations with the silver circles per se invited them to interact. In total 81.8% of the visitors said that they understood that the silver circles always indicated interaction opportunities. There is slight inconsistency in the use of the silver circles which was noted by a few users. In the audio spots and in Contemplation Installations “UFO” and “Oneness”, the users have to stand or push with their feet within the silver circles. However, in the “Esoteric Cosmos” installation the user could stand outside the silver circle and look at the pictorial/textual material which is displayed in the projected silver circle. This difference confused some users’ interaction in the “Esoteric Cosmos” Contemplation Installation. Due to the fact that the visitors at art museums are not used to these new ways of communicating art works, some visitors mentioned that they would have liked some meta info when entering the exhibition area regarding the means of communication and what to expect.

Hypothesis 6: The interactive communication is particularly appealing to children. As seen in Figure 6, we cannot conclude that the interactive communication is significantly more appealing to children, in fact it appeals to all ages. However, we also asked people who visited the exhibition together with children and youngsters how the accompanying children and youngsters received the exhibition. These adults for instance said:

- 50% of the children from 0-9 years found this exhibition more fun than other art exhibitions
- Between 54% and 64% of the children aged 6-13 actively explored and played with the technology, and 75% of the 14-17 years did the same

These numbers are slightly higher than for the adults above 18, and the qualitative evaluations and observations also point to the fact that many families used the interactive installations for a playful exploration of the inspirational material. This supports that the use of interactive technology for the communication of art may appeal to children and youngsters, in ways that make them more willing to explore art museums.

Hypothesis 7: The artwork and the interactive installations create a coherent holistic experience. This is the case, since many users were not able to tell the difference between art works and the communication of the art works. In the case of the audio spots the communication became an integral part of the art experience. By choosing Mori’s voice instead of a distanced narrator’s voice enhances a notion of integration. One of the three guys said, “Are the silver circles a part of the art works - or not?” It is confusing because it is her [Mori’s] voice. Am I supposed to hear this in order to experience the art work in full, or is it just some background information?” The guys even found it a bit disappointing that the audio augmentation were not a part of the art works.

As regarding the contemplation rooms it became evident that even separate rooms with the words “Non art zone” printed on the wall could be mistakenly assumed as being art. This could be due to the fact that the communication as well as the art works utilizes technology and interaction. Whereas some (including the group with the three guys) found it disappointing to learn, that some of the installations were merely art communication, others (the twin brothers) thought it was a success when you couldn’t tell the difference between art and art communication. Thus we have indeed succeeded in creating a holistic experience [12] at the exhibition, the distinction between art works and art communication is blurred. Many visitors believe all of the installations are made by the artist rather than the curator and the design team.

5.3 User comments from the questionnaire
In addition to the structured questions we provided the visitors participating in the evaluations the opportunity to raise issues on their own. Below we illustrate some of these issues.

Even though the audio spots in general were very well received, some visitors found it hard to understand what was said in the audio clips either due to low volume or due to the artist’s use of difficult sentences. This may partly be explained by the fact that the language in the audio clips was English and the main audience had Danish as their mother tongue.

Some visitors said that they would prefer larger silver circles for the audio spots, making it easier to get a shared experience for more than two visitors at the time. It is common for groups of three or four to experience the exhibition together.

Some visitors found the texts in projections and on walls hard to read since they were made in silver colors on white backgrounds. The choice of silver colors was made in order follow the aesthetic expression utilized in the exhibition as a
whole; however, it was not optimal for communication purposes.  

The contemplation rooms were placed inside the exhibition area close to two art works in the exhibition, and that was given as explanation by some visitors when they thought the contemplation installations were art pieces in their own right.

Some visitors were also asking for more introductory information about the choice of interactive communication and more information about the artist herself. The interactive communication only focused on the artist’s inspirational material and not on her background, other works, and the like. The senior citizen interviewees said, “It would have been nice to have some overall information in the beginning of the exhibition – something about why she [Mori] does what she does.

6. LESSONS LEARNED

In general we find that the four approaches seemed to work in order to communicate information about the artworks, and they worked with respect to engaging the visitors in active exploration. They also worked in conveying the interaction techniques to the visitors without further explanation. It is particularly remarkable to see that they appeal to the entire range of age groups and not just to youngsters or children.

We have succeeded in creating a holistic user experience, however, seen from an art critics point of view we have blurred the borders between the art per se and the communication of the art. However, it is important to notice that the interactive installations have been developed in concordance with both the artist and the curator on the exhibition. The only adjustment of the installations that have been made in order to not compromise the artwork is that we had to remove a specific background sound from the Contemplation Installation “Esoteric Cosmos”. This removal was requested by the artist. However, neither the artist nor the curator find the blurring problematic, in fact they perceive the holistic experience a quality of the exhibition.

This blurring is almost forced to happen in this kind of exhibition where both the artworks themselves and the interactive communication apply advanced interactive technology. It is of cause much easier to make a clear distinction between art and interactive installation, if it is classical art which is exhibited and communicated by means of interactive technology. In this case of classical art the borders between artwork and interactive installations are very strict and easy to discover.

7. RELATED WORK

Our project uses audio in art museums in a radical different manner than the traditional audio guides utilized in numerous museums, e.g. the Guggenheim art museum in Bilbao. Even though Terrenghi & Zimmermann [21] introduces the notion of 3D sound in their communication in art museums it still relies on headphones, and thus deprives the visitors from conversation and shared experiences from listening to the same audio clips. Thus we claim that our gentle audio augmentation approaches can provide both personalized experiences similar to the ideas of [4] and shared experiences.

We claim that the utilization of projected overlays proposed by Bimber et al. [2], are developed mainly from the technical perspective, proving that advanced computer graphics can produce overlays on arbitrary surfaces. However, seen from the artist’s or the curator’s point of view, this visual augmentation would provide a non-acceptable disturbance of the original artwork. We thus claim that detached interactive installations with a conceptual affinity with the original artwork expose several advantages: They do not disturb the original artwork, they provide a clear link back to the artwork, and they allow more playful interaction to engage visitors to engage in the understanding of the art work.

Many researchers have focused on the role of interactive technologies for children experiences within the museums ([7],[8],[9],[18]), and even though we cannot say from our evaluations that our interaction design principles approaches appeal more to children than adults, we can definitely conclude, that they do appeal to children as well. Moreover, the manner in which they appeal to children in addition also supports shared playful experiences within families.

8. CONCLUSIONS AND FUTURE WORK

This paper introduced four new interaction approaches for communication of art. The four approaches are: 1) gentle audio augmentation of art works; 2) conceptual affinity of art works and interactive installations; 3) using the body as interaction device; 4) consistent audio-visual cues for interaction opportunities. The approaches have been tried out in the communication of inspirational material for a Mariko Mori exhibition. Visitor reactions on the interactive communication has been evaluated both quantitatively and qualitatively evaluations. We have discussed experiences from the evaluation in terms of seven hypotheses. The results support that the approaches have worked in the particular case, however, there are of course issues for further discussion related to most of the hypotheses. One particular issue is how we can develop the approaches of gentle audio augmentation and conceptual affinity in ways that make it more clear when an installation is art and when it is “just” communication of art.

Another issue is how to stimulate even more social interaction in the museum space, e.g. by making larger silver circles for shared augmented audio experiences, or by making more contemplation installations that require presence of multiple visitors to reveal its material.

We will in near future get the opportunity to try out the approaches for more traditional exhibitions, where the form of expression is less close to the interactive communication. Thus we expect to get new experiences and in particular we will experiment on ways to make distinctions between art works and the communication of the art. One of the new features to add is an active ticket that carries profile information about the visitor, which may be entered by choosing different ticket types or by specifying a profile through a computer interface. One obvious profile parameter is the spoken language of the visitor allowing the installations to speak the visitor’s language. Another parameter may be age, and e.g. make the audio spots to raise the volume for elderly visitors. An active ticket will thus add new value to our art communication approaches.

ACKNOWLEDGMENTS

We thank the entire team behind the “Mariko Mori – Oneness” exhibition at AROS, in particular we would like to thank Curator Gitte Ørskou and Curatorial Assistant Niels Povlsgaard Jensen at AROS, and Asta Wellarus and Pernille Nielsen, Zentropa Interaction. Further, we thank our colleagues at Center for Interactive Spaces (www.interactivespaces.net), in particular Kaspar Rosengreen Nielsen, Jesper Nielsen, Rasmus Gude, Jonas Breum Jensen and Marie Højlund. Finally, we thank the Alexandra Institute Ltd. (www.alexandra.dk) for funding the research in the project.
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