1 Introduction

This report presents the project "Interaction Panel". We will present the development process, the considerations and evaluations made along the way, prototype construction, description and results of a user test, considerations on the technologies used in the prototype, and ideas for how the product could be further developed into a commercial product.

Briefly summarized, the Interaction Panel is a panel with flashing lights which generates different color patterns and sound/music based on user input by touching the panel or moving in the vicinity of the panel. The device is made with the intention of developing an exhibition for the Oslo Children's Museum. This report is a presentation of our results so far, and our thoughts of what the next steps in the development process should be.

1.1 The design process cycle

The design process has followed a lifecycle model which does not exactly match any of the ones described by Preece et al [1, p. 444], but aspects from several of the models are found in our model. The evaluation for each step in the lifecycle model may be considered as a small iteration, and this evaluation is a continuously ongoing process. The whole cycle, considered as a "major iteration" ends with a more thorough evaluation. This evaluation tells us what step to return to in order to continue the process. We have only made one full "major iteration" so we have not used it enough to evaluate the lifecycle model in itself, but this seemed like a useful approach for our project. We believe that in most cases one would return to either "Identify possibilities and limitations of the concept" or "Specify the interaction between the user and the product" if the necessary evaluations have been made along the way.
The peer-evaluations of our mid-term report asked for more details on why we made certain choices for the prototype (e.g. why we used a certain type of musical scale), hence we will also present a limited amount of ethnological, cognitive and sociological theory to explain the choices we made before creating the first prototype and doing the actual user test. The reader may want to criticize that this theory may seem to have been too much study at an early stage of the development process, but this is knowledge we already had before starting the development process, and thus it was natural to include it as part of our continuous evaluation of the concept.

When we were well on our way in the development process, we read about the Hello.Wall developed by Norbet Streitz which has several similarities to the Interaction Panel [1, p. 617]. In particular, the ideas of being a device where one of the main goals is for the user to explore the interaction, and the idea of "zones" (in the Hello.Wall called interaction zone and notification zone) are similar. We did not, however, know about the Hello.Wall during the first part of the process, and so the evaluations, considerations and ideas presented here are our own.
In the first part of this report, we will present some thoughts on the relevance of theories of Interaction Design to this project. Then we will talk about the context before we go to the conceptualizing phase and prototyping phase. We will end by describing an observation study and finally our evaluation of the whole process.

1.2 Reflections on interaction design theory

Theory on the interaction design process is a valuable tool for developing and evaluating any product intended for use by humans. However, we believe that the relevance of several of the considerations from methodically oriented interaction design literature is very dependent on the product that is to be designed and the context in which it will be used (e.g. who it is designed for, in what situations it will be used, etc.). Sometimes the theoretical considerations, such as for example those described by Rogers, Preece and Sharp [1], are highly relevant and accurate, but sometimes parts of the theory may be irrelevant, and the priority and importance of the different parts of the interaction design process needs to be revised, as we will show in our project.

We will return to this discussion throughout this report, and for now provide a preliminary example, an example that shows what is perhaps the biggest difference between the Interaction Panel and most Interaction Design projects. Most projects have a clearly defined task management focus. In such projects the products have clearly defined goals of being productive and efficient. The Interaction Panel, on the other hand, is not made for productivity. It is meant as an expressive interface where the exploration of the interaction itself is the main goal. This means that learnability is a very important goal, in the sense that it should be fairly easy to use the product, but by rehearsing it should always be possible to improve the interaction and the "skills" using the interface.

2 Understanding the context

2.1 The physical domain - the Children’s Museum

The physical domain of the installation is the Norwegian Children’s Museum. Within this safe environment children are supposed to explore the exhibitions of the museum themselves. This is to encourage children to investigate and to use their curiosity. This will enhance their ability and interest for learning new things. Another uttered goal for a children’s museum is to encourage children to interact with each other and learning new ways to interact with the technology from each other [6]. This type of interaction is helpful for developing social skills and will enhance the process of children learning to interact with the exhibitions of the museum.
2.2 The users

The target group of the Children’s Museum are children from infants to elementary school age. We do not want to exclude any parts of this target group, and so this relatively wide gap in age and maturity is a challenge for the design of the Interaction Panel. It should both be fun and encouraging for a small baby and for a second/third grader that has taken its first steps of learning written language and math/logic. We believe an installation at the Oslo Children’s Museum should appeal equally to girls and boys, and that children with different social and cultural background should have the same prerequisites for taking part in the activities and interacting with the installations.

We assume the following about the users:

- Children are curious
- Children enjoy when their actions result in a feedback
- Children are fascinated by flashing lights
- Children like funny sounds
- Children are creative and enjoy exploring

Based on these assumptions we claim that:

- In order for the children to want to start using the device, they must be attracted to it by something that evokes their curiosity, (e.g. mildly flashing lights and sound)
- In order to keep children wanting to use the Interaction Panel, it should always be possible for them to improve their performance using the device. It should provide challenging aspects.

2.3 Goals and needs

Many of the usability goals proposed by Preece et al [1, p. 20] are made for a different domain area than designing an installation for the Children’s Museum. In the reference book, these goals are discussed as goals for a product designed for increasing productivity in a results-oriented context. In the context of the children’s museum, the problem space is different from this, and the very interaction with the device is a goal in itself. As an example illustrating the difference, consider a product made for writing a person’s signature on a piece of paper. This product will need to meet certain productivity goals. If the product is less effective, less efficient or less pleasurable than the plain task of picking up a pen and writing a signature, the person would never use the device. In the case of an installation at the children’s museum, some of these
user experience goals and usability goals are irrelevant, and some of them are
the fundamental reason for making an installation at the museum.

Of the goals mentioned by Preece et al [1, p. 20], the usability goal "safety"
is of course an important goal. The goals of efficiency or effectiveness are not
necessarily goals that need to be payed much attention to in an installation at
the Children's Museum. However, for the children to start using the interface,
these usability goals should be kept in mind, as it should not require much effort
to initially start using the device. The usability goal "memorability" may also
be a good thing, as it will enable the children to keep going where they left
off, if they leave the museum and come back another day. However, we do not
consider memorability to be an important usability goal.

In our opinion, the major goals for the installations at the Children's Museum
are a combination of the user experience goals enjoyable, pleasurable, fun, chal-
 lenging, expressive and encouraging exploration. And one of the major chal-
genges in this combination of user experience goals lies within the combination
of fun, challenging and expressive. We believe all of these user experience goals
may be met by properly defining the learnability usability goal. For any child,
it has to be very simple to start using the Interaction Panel (low-threshold).
It also needs to be possible for the children to rather quickly understand the
basic concepts of how they can interact with the panel. Yet, it should always
be possible to improve the interaction with the interface, and thus be possible
to more sophisticatedly control the expressions made with the Interaction Panel.
These considerations were the most important aspects in the conceptualizing
phase, which will be covered next.

3 The Conceptualizing phase

When considering the goals and needs presented in the previous section, music
and colour patterns were among the first things that came to mind as possible
ways to solve the demand for a low-threshold, culturally independent, expressive
and challenging interface. Many musical instruments may be used right away
with little previous knowledge, even though the sounding result is not necessarily
pleasant. Most (if not all) musical instruments have an almost infinite range in
terms of how skilled a performer can get on the instrument, both technically
and when it comes to repertoire/expressivity. However, the learning curve for
how fast it is possible to learn new playing techniques and expressions varies
between instruments. Take for instance the violin where the performer needs
several years to learn how to play a pure tone.

Through music, it is possible to communicate without words, and the challenges
regarding our goal of a culture-independent interface could be solved. Children
from different cultures use very similar musical phrases when it comes to sponta-
neous singing as part of playing [7, p. 108]. The Norwegian researcher Jon-
Roar Bjorkvold presents several examples of how children sing when they play,
and how certain musical structures seem to contain certain semantic meaning independent of culture [7, p. 104]. Music is abstract enough to be language-independent, and at the same time it is concrete enough to be understood at some level independent of culture. Bjørkvoed emphasizes the importance of musical expression to a child, and he even goes as far as borrowing Descartes’ famous claim "cogito ergo sum" (I think, therefore I am) and stating "canto ergo sum" (I sing, therefore I am) and "salto ergo sum" (I dance, therefore I am) [7, p. 63].

3.1 Conceptualizing the model

As we have already touched upon, this project differs from many other HCI design projects. It would not be easy to ask the users what they needed or what they thought about their earlier experiences with musical interfaces. Children are probably not mature enough to give a good description of what they "need" in the described problem space. They could probably describe some elements they would like in the device, but their suggestions would probably not touch our goals of making a challenging, explorative and expressive device. Though it would be interesting to have asked simple questions to the users about their "needs" and "ideas", this was not done because of time constraint and that we did not see this as a main feature of the process.

In a way, our conceptualizing phase has some similarities to an experimental art piece. Though the artist has the audience as its main users, he/she will probably not include them in the whole process making the art piece [8]. Another aspect is that the goals are somewhat unclear and experimental, which again makes the concept rather unclear until the end of the process.

What we wanted was a device with the following key properties:

- **Interactive.** That is that the user should be able to control the device while getting some feedback that is strongly connected to the control actions/commands performed by the user.

- **Low-threshold.** Since it should be low-threshold it should be easy to use for the user without need of any guidance or user guide. It should be self explorative. Since the users are defined as children from 0 to 8 years, this will probably be our biggest challenge.

- **Culturally independent** means that we should strive not to include what can be seen as cultural aspects in our device. Both the interface and the feedback should contain as little as possible of culturally dependent elements. In this way we would not favorize or exclude any cultural background.

- **Expressive.** The device should not only give boring and banal simple feedback. While staying low-thresholded, it should also include rich opportunities of expressiveness that makes it possible for the users to express
themselves in a "rich way". This means that there should be a many-to-
many mapping between user action and the feedback given by the device. 
The mapping should also be in such a way that it enables the user to get 
a unique and exciting feedback with their actions.

- **Challenging** is highly connected to the expressive aspect. But alone it 
means that it should be expressive and sophisticated enough to not bore 
the users. This could be further defined to make the mapping between 
actions and feedback interesting enough to the users, so that they are 
encouraged to explore these connections further.

With these constraints and goals in mind we started our brainstorming about 
different simple interactive musical instruments. Our first sketches involved 
simple sound balls that would give certain feedback to certain user actions. We 
soon realized that we wanted to include both sonic and visual feedback, here 
visual in the form of color feedback. It was also soon clear that the device should 
be technology transparent.¹

Further we experimented with the idea of making some sort of a new modern ac-
tivitv box/busy box (see figure 2) that encouraged the exploration and provided 
the challenging and expressive moments we wanted. We took this idea further 
and wanted to include some properties of today’s most used device for visualiz-
ing - the computer screen. This highly used item can deliver a flat "abstraction" 
of many things.

¹The used technology should be as invisible as possible, only the intended abstract interface should be visible.

Figure 2: A busy/activity box
3.2 The conceptual model

We ended up with the idea of an interaction panel. The form and concept of a panel\(^2\) is used in several user interfaces for controlling different applications. Many, if not all, cultures use the signs and posters as a way to communicate information to people. In the arts, painting has stood as the main form for many years. In later years the technical advances have made it possible for dynamical information screens. And with the development of touch screens it has been possible to make them interactive. But these panels have seldom been used as interactive expressive multimodal instruments (except the previously mentioned Hello.Wall).

The main conceptual idea of the Interaction Panel was to let a highly visible device encourage an exploration of users. To not completely exclude the visually impaired we wanted to include several feedback possibilities like auditory\(^3\), visual and haptic feedback. In this way we let users and their actions interact with the panel. The actions could be both direct, that is touching the panel, and indirect, that is doing actions in the surroundings of the panel. In addition to these concrete interactions, the panel should somehow "sense" that people are in its surroundings, and initiate an interaction process by producing inviting sonic and visual features, this to encourage the user to explore it. The conceptual process ended up in a simple sketch showing the main features (see figure 3).

\(^2\)We define panel as a physical visible thing you can hang up on a wall, and that is intended to display some content

\(^3\)With multi channel sound system it is possible to give the user a rich spatial sound experience [15]

Figure 3: The conceptual sketch
The concept of an interaction panel suits well with Jordan’s pleasure model [1, p. 209ff]⁴, and we believe this model shows that the Interaction Panel concept has the potential of becoming a device which it is fun to interact with:

- **Physio-pleasure** should be gained by the visual and auditory feedback as well as the feeling of touching the panel. This means that the sounds and the lights displayed on the panel should be pleasant.
- **Socio-pleasure** is gained by showing other children how you can interact with the device.
- **Psycho-pleasure** is reflected in the possibility of generating melodies and harmonic musical patterns
- **Ideo-pleasure** is harder to define up front, but we believe that children have no or little prejudice against using new technology for music generation. This pleasure may be different for adults who may have some more or less justified reason for not wanting to use new devices for making music.

As we will show next, the prototyping phase both restricted and expanded our initial ideas in many ways.

### 4 The Prototyping Phase

#### 4.1 The phase

The main aim with the prototype was to make a device which enabled us to test our conceptual model on users. With the evaluation we wanted to see if some of our goals would succeed. After our initial conceptual sketch it was apparent that to be able to test out the core of our wanted interaction concept, it would not be enough to make a simple low-fidelity cardboard prototype.

We wanted to test out if our users would be able to interact and play with our conceptual model. We had questions like: is the threshold low enough, is it expressive enough, will children like to play with it, and perhaps our main concern, will they understand the mapping between sound and actions?

A low-fidelity cardboard prototype would not be advanced enough to test out these questions. First of all the children would probably recognize the cardboard as boring materials, and this would destroy our goal of exploration. And our wanted feedback would be close to impossible to reach with a low-fidelity prototype. We could have hidden a sound synthesizer and manually given auditory feedback to the users’ actions. In this way it could, with some serious synchronization problems, have been possible to make a simple prototype version

---

⁴A model that explains some main features of how to get something to be pleasureful
of the concept that would only give auditory feedback when user touches the (cardboard) panel. But this would only enable us to test out a small proportion of what we wanted to evaluate.

Luckily with the versatile personal computer, a touch screen and an integrated sound card it is easy to make a higher-fidelity prototype that includes but visual and auditory feedback. This and the graphical programming environment Max/MSP made it doable for us to make what we believed would be a sufficient prototype that could test out many of the aspects we wanted to study.

At first we were restricted to only one user input - the touch screen (the touch interface). We wanted to expand this further to include the conceptual model of a user action "listening" interface that would capture distant actions in the surroundings of the device. The easiest and most versatile interface we saw for this was the web camera. With the device we could use widely available video processing algorithms to do analyses of the device surroundings and measure user actions in front of the device.

4.2 The prototype

We ended up with a prototype consisting of a laptop computer (easy to move), a touch screen, a pair of active loudspeakers with high fidelity sound producing capability, web camera and a software patch (program) made in MAX/MSP that couple these features together. A video of the prototype can be seen at our web page [16]. The description of the program and different elements follows.

![Prototype setup at the kindergarten](image)

**Figure 4: Prototype setup at the kindergarten**

4.2.1 The MAX/MSP environment

We chose to design our prototype in the graphical programming software Max/MSP [10]. Max/MSP is well suited for real-time sound and video processing, and
provides the necessary framework for implementing a functional prototype on a computer in a relatively short time.

### 4.2.2 User inputs

We chose the following technologies as input to our device

- **The touch screen** is a relatively simple device to explain. The area where you touch on the screen is sent to calibrated software that again communicates with the computer which area of the screen that was touched or clicked.

- With **the web camera** we could implement a simple motion tracking system in MAX/MSP that follows changes in the captured image frame. We can for instance use the centre of motion area as a coordinate that is the controlling factor for this interface.

### 4.2.3 Visual design

We have not done much research on the aspect of our visual design of the prototype. Besides our assumptions that children like colors and the idea that the visual feedback should have be connected to user input and feedback, did we not perform any studies of which color to use etc. This would though be interesting in a further study.

In our design, the Interaction Panel prototype is experienced by the user as a black screen with a colored square. This square is moving in a five-by-five grid and displays different colors according to where on the screen the square is displayed. There are also color nuances within each of the 25 positions in the grid, e.g. if the screen is activated near the edge of a certain cell in the grid, the color will be more similar to the color in the cell next to the currently active cell. We believe these nuances would make the interface more pleasureful; it spices up the visual feedback. In addition to this, the motion detected by the web camera is projected onto the screen. This is done by mirroring the video from the web camera, and projecting any pixel that changes more than a certain threshold as white, and all other pixels as black. For example, if the camera captures a full body moving, this would project a silhouette of the body. This visualization was made so that the user could more easily understand how its own movements is interpreted as control actions.
Figure 5: Sketch of different screen displays

Figure 5 shows three examples of what the screen may look like when it is being used. The leftmost figure shows how the screen appears with no movement detected. The yellow square appears where the screen is touched. If the device is not touched, and the user is moving in front of it, the square is positioned at the mean point of the movement (to illustrate; in the x direction this is the mean value of the highest and the lowest x value where movement is detected). If movement is detected and the screen is touched, the movement will still be projected onto the screen, but touching the screen will override the movement detection in terms of positioning the colored square.

4.2.4 Sound design

When designing sound for the interaction panel, our main attention was directed towards the goals of a fun, expressive and culture-independent interface. We also wanted to keep in mind the well-being of the employees at the museum, trying to keep the sound from being too "annoying" when played all day long. In the sound designing process we went through several minor iterations in the project lifecycle by evaluating the sound against our goals of an expressive, challenging and fun device. Here we only present the most prominent of these iterations.

As previously stated, sound/music provides the necessary framework for cross-cultural communication. Most of the examples presented by Bjorkvold have very simple melodies which very rarely have more than five different tones [7, 104ff]. Pentatonic scales (i.e. musical scales with five tones within an octave) is commonly used in many cultures around the world, therefore using a pentatonic scale seemed like a good idea. Theoretically, there is an unlimited number of possibilities for pentatonic scales. We chose to use a type of scale that is common in western music with traditional western tempered tuning: F#, G#, A#, C# and D#. This scale has a simple harmonic relationship between all tones and the intervals which are possible to generate from these tones are what most people consider to be the most consonant (i.e. the least "disturbing") [12, p. 175]. If we had the time, it would have been interesting to investigate whether the use of a tempered scale would limit the appeal to children from non-western cultures.
Before implementing the restriction of a pentatonic scale, we started by designing a simple synthesizer based on FM-synthesis with a mild tremolo effect and control input for carrier frequency and modulation frequency (see [13, p. 277] for details on FM synthesis), and restricted the pitch to a low register. This sounded round and mellow, and through the control input it was possible to adjust base pitch and timbral richness. These tones were placed corresponding to the five-by-five grid of the visual feedback from the screen as in the following table:

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>D#</td>
<td>F#</td>
<td>G#</td>
<td>F#</td>
<td>D#</td>
</tr>
<tr>
<td>C#</td>
<td>D#</td>
<td>F#</td>
<td>D#</td>
<td>C#</td>
</tr>
<tr>
<td>A#</td>
<td>C#</td>
<td>D#</td>
<td>C#</td>
<td>A#</td>
</tr>
<tr>
<td>G#</td>
<td>A#</td>
<td>C#</td>
<td>A#</td>
<td>G#</td>
</tr>
<tr>
<td>F#</td>
<td>G#</td>
<td>A#</td>
<td>G#</td>
<td>F#</td>
</tr>
</tbody>
</table>

In our prototype we only used two loudspeakers. The sound was programmed to come more from the speaker on the side where the user activated the screen. We should later try using more sound channels to increase the spatial [15] experience, especially for visually impaired.

To add another dimension of expressivity to the device, we added another synthesizer set to produce tones with a higher pitch. The reason for using a higher pitch than in the other synthesizer is that spectral components that are far from each other in frequency are more likely to be distinguished as sound objects, and two distinct sounds are easier to control than sounds that are harder to define as separate sound objects [14][12, p. 8]. This synthesizer was based on a simple subtractive synthesis where the user controls the base frequency of the tone from low to high in the vertical direction on the screen, and the cut-off frequency of a resonant low-pass filter is controlled in the horizontal direction with five frequency peaks along the horizontal direction. This way, it is possible to adjust the timbre of the high pitched tone freely while playing several different bass tones.

Our evaluation of the interface after implementing these control possibilities and the sound and color display was that it was easy to start using it and getting a pleasant and fun combination of auditory and visual feedback, at the same time as it was expressive enough and seemingly challenging, but fairly easy to start using. We did not try adding more complex feedback like more synthesizers or more control possibilities, as we believe it would easily have made the device too challenging. But this is clearly an area which would be very interesting to study further.
5 User test

"This was much more fun than we had thought!"
- girl in kindergarten

Interviewing children is a challenging process and demands special techniques [1, p. 300]. We therefore chose in our user evaluation to use an observation study where we only observed how the children used the Interaction Panel.

An alternative to using an observation study as a basis for evaluation would have been to do a heuristic based evaluation [1, p. 686]. But since our observation study incorporated four of the five features of what children likes do to as stated in [1, p. 697], we claim that we got a good overview of these features in our observation study. It has therefore in our opinion not been necessary to form our own heuristic set of rules for evaluating the interaction panel.

5.1 The observation test objectives

We did a small user observation of our prototype in a kindergarten. We wanted to observe and study the following:

- Does the device meet the most basic usability goals, i.e. are the users able to use the device?
- Will users understand how to play with it and use it as we intended?
- How is the user experience and appeal?
- Do users enjoy using the device?
- Are users encouraged to explore expressivity, or is the device only a new way to make a lot of sound/noise?
- Do we reach our essential goals?
- And of course, inspiration and new ideas for what we can do to further improve the device.

5.2 The observation Study Problem and Children’s Approach

We did a direct observation study, with the intention of being passive observers. We thought that our presence most likely would destroy much of the safe environment needed for children to explore freely [1, p. 323], but doing indirect observation (e.g. with a video camera) would require too much work, both in
setting up the observation environment properly and in getting the proper consent from the parents to make video recordings of the children. We believe that better results may have been attained by observing the children interacting with the device as a permanent installation in a safe environment. But this was not possible within our restricted time constraints.

The kindergarten staff selected 10 children for the experiment. First, one girl tried using the device alone, but that did not really work since she was too reserved and shy, and as a result she did not really want to do anything. This confirmed our suspicion that our presence would affect the way children used the device. When we let more kids at the same time try the device, they were more confident, and when they cooperated it seemed to give them more of the safe environment needed explore freely. But even in groups, their immediate response was more reserved than we had hoped.

As can be seen of picture of the prototype setup in figure 4, we tried to hide most of the technology that was used to make the prototype. But it was clear that the children recognized the touch screen. It gave them a prejudice of what to expect of the device. Several of the children sat down in front of the screen and waited in passive manner to be entertained like if it was a TV-screen [1, p. 33]. This destroyed some of our goals of technology transparency and cultural independence.

The two problems mentioned in the paragraphs above, combined with time limits, made it difficult not to give the children simple instructions on how to use the device. To fully see how they would react to some of the functionality we had to push them a little before they dared exploring the device and discovered new ways of interacting with it. But their engagement rapidly increased when they dared to start exploring it.

5.3 Observations made regarding the motion camera interface and the touch screen interface

We had high expectations to the motion tracking system. But after the observation we had to conclude that the users had problems understanding the mapping between movements in the cameras area and the auditory and visual feedback. As a result we tried giving simple instructions. When the children were instructed to e.g. "wave to the camera" or "wave/flap like a bird" they seemed to get some understanding of it. We had expected that the connection would be more apparent to the users. Implementing a more clearly defined relationship between movement and feedback could improve this, and this feedback should also be made different than the feedback from touching the screen, making the motion camera interface more related to attracting the users, and touching the device being the main interaction domain.

The probably biggest problem with the touch screen as a technology transparent interface was user's prior knowledge that they are not allowed to touch screens
(most children are taught not to touch the TV or computer screen). But when
they first discovered the immediate response of touching the screen and that
this was allowed and safe, they lost their inhibitions and played freely. They
soon began to scratch and tap the screen with a high frequency.

A problem we noticed was that the younger kids had difficulties touching the
screen hard enough to get a result from the system. This may be a problem for
the touch screen used as an interface for the youngest children. There are some
sensitivity adjustment possibilities in the touch screen software that might have
helped but we did not investigate this further.

When the children began to attain a deeper understanding of the two different
interaction approaches, they also showed different approaches to incorporate
both in their play. Two of the girls cooperated and let one play with the camera
while the other was in control of the touch screen, and another pair of girls
alternated in running towards the screen and back. One child took advantage
of the web camera in a new way; he detached the web camera and pointed it
towards the screen, hoping that it would do something joyful.

5.4 Reaction towards the sonic feedback and the visual
feedback

The sonic and visual feedback of the touch screen interface was clearly satisfac-
tory and encouraged the children to play with the device. The mapping between
the touch and the feedback was apparently so strong that the children had no
problem using it. They also seemed to recognize the connection between the
auditory and the visual feedback. However they did not react or comment the
auditory feedback other than referring to it as "playing music".

As previously mentioned, the connection between motion tracking system and
the feedback was apparently not strong enough. They did not fully understand it
and therefore they were not that eager to explore this system. The functionally
control of the motion control system was in this manner clearly "out of sight"
and made it difficult to understand and use it [1, p. 29]. To increase the degree
of exploration of this system one should probably make the connection between
actions and feedback more apparent to the user. In other words, one should
try to increase the visible connection between the motion tracking system and
the feedback (i.e. the visual display and the generated sound). Increasing this
connection is though not trivial. Not only is it nontrivial in a technical manner to
do this mapping. We also find it difficult to balance between the pleasurefulness
of the auditory feedback and the strength of the connection to the user action.

We chose to show the movement seen by the camera as a visual white shadow
on the screen. It was apparent that this feedback was not easy recognisable
as a result of the users’ movement. We could try to make this abstract visual
feedback more recognisable, with color or by adding the real picture as seen by
the camera. The question is also how visible the functionality should be. But
since the motion tracking interface does not give any direct physical (haptic) feedback, we are heavily dependent on a good visual and auditory feedback. As mentioned before we ended up giving instructions to the users, which we initially wanted to avoid.

5.5 Conclusion of the field study

In conclusion we have to say that the device worked in several ways and had a significant appeal. When the users got to know the device they played with it with great enthusiasm. They did not seem to get bored with the device. We actually had to stop them so we could go on with the next set of users. They laughed, were pleased with it and had fun. One of the, in the beginning, very reserved girls exclaimed: "This was much more fun than we had thought". But as we have seen did the observation also reveals several aspects that needs improvement, and that has to be taken into consideration in the evaluation after of the first major iteration in the project’s lifecycle model.

6 Evaluation of first run through the project lifecycle

As mentioned in the beginning of this report, we have only completed one full loop through the lifecycle model. The final step of the lifecycle circle suggested for this project is to evaluate the whole run through the cycle, based on our experiences from conceptualizing, prototyping and user-testing of the device. This evaluation is the basis for the next major iteration in the project lifecycle, and determines how much time and resources that would have been spent on each step in the next cycle. The observations made in the user test serves as the main foundation for this evaluation, and the main focus for the evaluations is to see if we have met the goals that are specified for the Interaction Panel. Hence, this evaluation is a combination of usability testing and field study [1, p. 591].

6.1 The user experience goals.

We believe that the user experience goals of an enjoyable, pleasurable and fun device has been fully met through the first Interaction Panel prototype. The children seemed to have fun using the device. The goal of encouraging exploration was also met. Even though some of the children needed to be instructed to try and touch the screen, when they tried this they seemed to notice that they could decide where the colored square should be positioned, and that different sound was coming from touching the screen in different places. We had to stop
children from using the device to make room for another group of children, and this also proves that these user experience goals were met.

The goals of a low threshold and technology transparency were not met. In particular, the touch screen interface, and our presence in the room made the threshold for starting to use the device too high. The children’s prejudice towards the screen interface made them passive, and our presence in the room made some of them reserved. The low-threshold may be regarded as a first part of the learnability goal. The next parts of the learning process are best observed through the experience goals of being a challenging and expressive device. If the device seemed to be both challenging and expressive we would have met this goal. We noticed that the device definitely is challenging, as most users had problems in distinguishing between the two different input approaches. It seemed like this caused some confusion and hindered the expressive potential of the device. However, one user said that he “played music” with the device, which indicates that the expressivity goal is met to some extent. We believe a possible solution to this could be to deviate the feedback of the two interface approaches more making it easier to distinguish the different feedback when touching the device and moving in front of it. Also, the same movements should produce the same feedback, only with different intensity, no matter where the user is located in the room.

6.2 Plans for the next major iteration

The next major iteration through the lifecycle model would in this case start at (re-)specifying the interaction between user and product. We have already mentioned that the mapping between camera-detected movement and feedback needs redefinition. This could be done by modifying the software for the current prototype, and investigate what seems to be more functional. Also, the idea of a device that initially attracts the user needs to be addressed here. These re-specifications of the interaction between user and device would be one of the major considerations when making the next prototype. The other major consideration is the concept of technology transparency and affordance. The device should not afford passivity, but activity, and thus the touch screen interface would need to be changed to something that looks less like a TV or a computer screen. The web camera should also be less visible to the users or incorporated in a more artistic way (like a panel-eye).

When doing the next test of the prototype, the device should be positioned as a stationary installation in a place where children usually play. The interaction between the children and the device should be observed indirect observation through a camera, rather than by observers who are present in the interaction zone. This type of user test would require more preparations, such as getting parental consent for the participating children, and making sure the prototype is safely positioned and designed without danger of hurting the children.
6.3 Evaluation summary

The moments that need to be worked with are summarized below.

- Experiment with different ways to invite users to move in the motion tracking system area, in this way increase the affordance, and give them a clue of how to use it [3]. However this is somewhat a difficult task since it can conflict with our goal of making the interaction panel knowledge and culturally independent.

- Improve usability and effectiveness of the motion tracking system by restricting the area so that it is easier to understand where to move. Experiment with other motion tracking technologies.

- Improve sonic and visual feedback of the motion tracking system.

- Deviate the feedback of the two different devices to make it clear to the user that it is two different interface approaches.

- Experiment with consistency for the motion tracking interface, i.e. have the same movements make the same sound no matter where you are standing in the room (auto scaling). Also try to make the mapping between motion and feedback more sophisticated [5].

- Improve the next observation setup to overcome the observation study problems.
References


