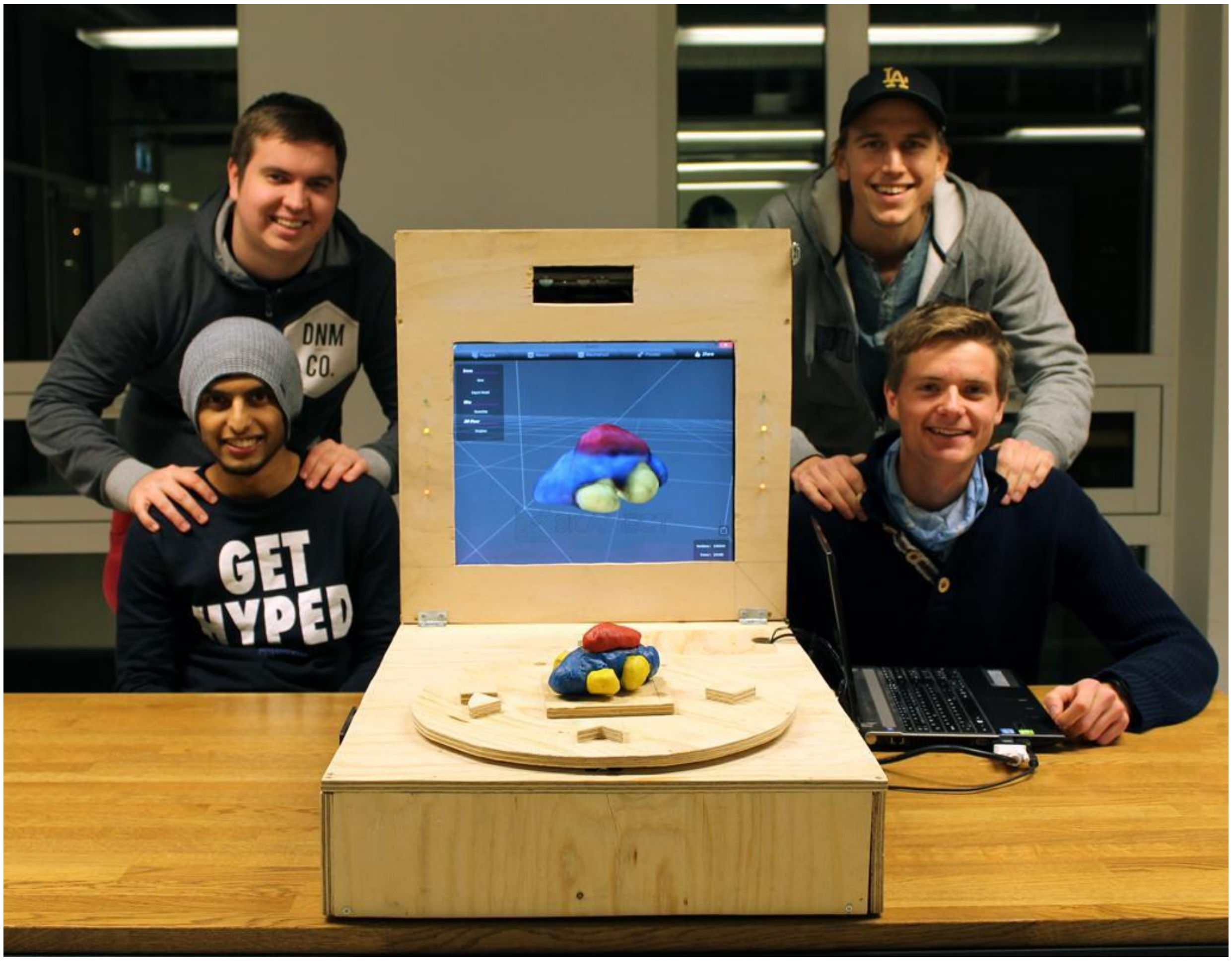
Project report - INF2260 - H2013



Play Power:

SKANNOMATØREN

Contents

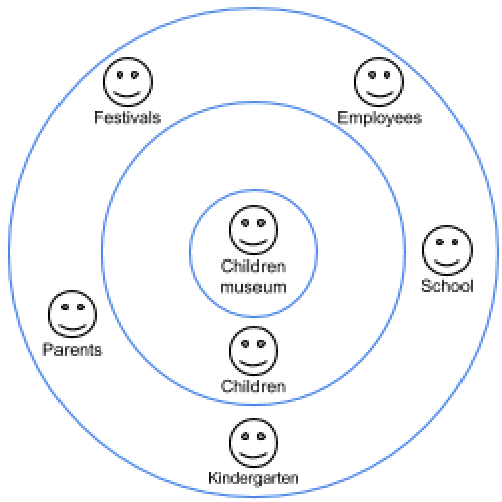
1. Introduction

1.1 Our assignment

Our main stakeholder is the Oslo Barnemuseum, a project with the aim of establishing a children's museum in Oslo. Currently they have a mobile museum traveling between schools, preschools and festivals inspiring kids to learn through playing with a variety of hands on activities. The project theme is called Play Power. The task itself is plain and simple: Design and prototype an activity for Oslo Barnemuseum's mobile museum.

The real challenge presents itself when we look upon the design criteria:

- No language or reading required
- No (or minimal) queues
- Engage multiple senses
- Bring strangers together for meaningful interaction
- Built in child-sized proportions
- Easy transport, low cost



(Figure 1: Onion model of stakeholders)

1.2 Stakeholders

Our key stakeholder is the Barnemuseum, in which Katie Coughlin has been our main contact providing with information and giving us insight on how to progress further and other relevant things relating to how similar museums around the world design and make their own exhibitions.

Our development has been in line with the design criteria's given to us by the Barnemuseum, but our main focus besides that has been designing for the children themselves, as they will be the main users of the product. Other stakeholders are the museum employees, schools, kindergartens and parents. These stakeholders have some things in common; safety for instance, is a vital design criterion for these "guardians". The museum employees will also be interested in how to properly operate the prototype, which means that in possible future iterations of the prototype testing and designing usability will be with them in mind.

1.3 Introducing the group

Our group consists of four members. All of us are currently enrolled in the Informatics: Design, use and interaction-bachelor program. We all started in the autumn of 2012 and this is our third semester. Benjamin and Eirik had previously worked together on a project last spring, but this would be the first real collaboration between the four of us. Combined this group has experience with everything ranging from web design to film and photo and beyond that some programming and work experience with children and some ski jumping.

All of us have taken the courses of INF1500 and INF1510 previously, which has given us some experience using Arduino-technology and designing with interaction in mind. The last project also gave us some experience in data gathering and analysis. Benjamin and Eirik is currently taking the PSY1000 (Introduction to Psychology)-course which is giving us some insight to the minds of children.

Together as a group we are very interested in doing these kinds of projects, and creating solutions to problems both known and unknown is a great motivator.

Audun Hokholt **Age:** 21 **Work experience:** Web Design, html, FireGuide-project.	Benjamin A. Thomas **Age:** 24 **Work experience:** Graphic design, Teaching, Teddy-project.
Eirik Ødegaard **Age:** 24 **Work experience:** Kindergartens, IT-systems, Teddy-project.	Harisan Uthayakumaran **Age:** 20 **Work experience:** Kindergarten, Auditorium-project.

(Figure 2: Group members)

1.4 Report-structure

Here in section 1, we continue to present milestones and the project hypothesis. Further in section 2 we will to some extent describe our design process and how we tested the prototype as this required much of our time during this project. The methods of evaluation, how we designed and executed our experiment and how we chose our participants will be thoroughly described in section 3. Section 4 provides the results from the experiment along with a risk analysis and an activity diagram. Section 5 will research our project limitations, while section 6 consists of a summary and conclusion of what we have learned throughout the project. Lastly section 7 will take a look on further development. Section 8 is our references, and section 9 is our attachments.

1.5 Milestones

Week	Activities	Other assignments
34	**M1:** Group-formation	General introduction in all courses
35	**M2:** First group meeting. Brainstorming	
36	**M3:** We brainstorm and create 15 ideas, both alone and as a group.	INF1000 - Oblig 1
37	**M4:** We boil the ideas down to 3 that we will continue to develop.	INF2260 - Oblig 1
38	**M5:** We present our 3 ideas. The unanimous response we	INF1000 - Oblig 2

	got made us focus on one idea: **Cybrix**.	INF1500 - Oblig 1
39	**M6:** Several iterations of prototypes lead us to conclude that our initial concept won't work with the limitations at hand. Severe brainstorming and research lead to the Cybrix morphing into **Skannomatøren**.	INF2260 - Oblig 2
40	**M7:** Project presentation. The response from both our fellow students and the "adults" are wholly positive, and serves as fuel for our continued development.	
41	**M8:** Building and testing	INF1000 - Oblig 3
42	**M9:** Building and testing	INF1500 - Oblig 2
43	**M10:** Building and testing	INF2260 - Oblig 3 INF1000 - Oblig 4
44	**M11**: Final prototype 90% complete	
45	**M12:** Experiments and evaluation	INF2260 - Oblig 4
46	**M13:** Report nearing completion	INF1500 - Oblig 3
47	**M14**: Report completion.	INF2260 - Oblig 5 INF1000 - Oblig 5
48	**M15**: Report delivery	

(Figure 3: Milestones)

1. 6 Goals, hypothesis and demands

As we in many aspects are designing a toy; concrete goals, hypothesis and demands can be troublesome to extrapolate, as looking at playing in a pure academic way, can be very counter-productive. We therefore devised two different sets of hypothesis, one for evaluation of fun and creativity, and one aimed towards evaluating if the activity can have some value in learning. If we were to sum up what our goal is, it would quite simply be; create a fun and engaging new activity and experience for children to interact with. We would like to develop the prototype to a point where it doesn't only engage children to have fun and be creative, but also to learn something along the way.

1.6.1 Play hypothesis

H0: The prototype will not affect children's playfulness or creativity in any way.
H1: The prototype will inspire playfulness and creativity in children.
H2: The prototype will adversely affect playfulness and creativity in children.

1.6.2 Pedagogical hypothesis

H0: Seeing something pass from reality and into the virtual will have no influence of children's understanding of the real vs. the virtual.
H1: Seeing something pass from reality and into the virtual will aid the children's understanding of the difference and connection between the real and the virtual.
H2: Seeing something pass from reality and into the virtual will diminish children's understanding of the difference and connection between the real and the virtual.

2. The Design Process: From Cybrix to Skannomatøren

We started our development as soon as the group was created. In the first week of our project we brainstormed and created around 15 ideas that we played around with for a few days. We then took a second glance at the criteria's given to us by the Barnemuseum, and excluded ideas that wouldn't work well enough under that regime. After this, and more brainstorming, we had 3 ideas left. We presented it to Alma Culén, Katie Coughlin and several fellow course-groups. Their unanimous response favored one idea: Cybrix.

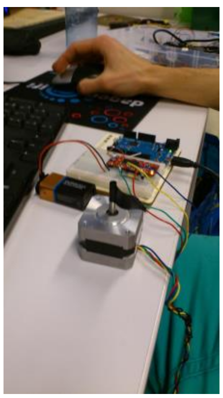
This concept originally consisted of *smart* building blocks. The idea was that these blocks would be connected to one another and to a screen of some sort. So when one started building anything with these blocks, a corresponding 3D-image of what was being built would appear on the screen. This opens up for several fun interactive ideas, like making it possible for children to "design" a new building for the Oslo skyline, by making the blocks appear in a vacant lot in a 3D rendition of Oslo.

2.1 Prototype-evolution

Sadly though, after a week of research and experimentation, we could not find a technical solution to the problems posed by the Cybrix-idea, or the limitations of time and budget we had. This was a big problem, our chosen and thoroughly vetted idea fell short. For a few days moral was low as we explored possible solutions to our concept-crisis. For a while we considered alternate ideas, but a fellow student from another group gave us a piece of information that lessened our distress. He linked us to a short article on a piece of software that could be used with the kinect to create 3D-images. This gave us an important realization. Our technical issue could be solved fairly easily if one looked at the problem from another angle, *and* by the lens of a kinect. Instead of making smart blocks that generates 3D when they are used together as building blocks, we could make a rig with a kinect and an arduino that simplifies the relatively complex process of 3D-scanning objects to a press of a button. This would for the first time, as far as we know, make the process available for children. Another advantage of this solution is that it lifts some restrictions from the original idea, where as in the original where one would have no other choice than to build with the bricks, now the choice of building material is free, which is certain to inspire more creativity.

2.2 Code and components

For this project we used a kinect for Xbox to use as a scanner. This led to some implications because we were required to buy a licensed version to get the full fidelity on our exported 3D models. As this would cost us a larger sum of money than we foresaw, we chose to use the unregistered version. We used a stepper motor to rotate the platform at an agreeable speed to let the kinect be able to respond and record the model. For this we used an EasyDriver board and an additional 12V adapter to provide enough power. We had to place a power strip into the box because we use a pc-screen, kinect and the EasyDriver board who all needs their own power source. We have also created a built in room to keep the geometrical figures required for the scanner to keep focus and be able to understand that the platform is actually spinning. This helped a lot because the kinect is originally an instrument for recording human sized shapes, and not small objects.



Because we had to use a stand-alone program to scan the figures, we had to buy an Arduino Leonardo, which is more of a human interaction device (HID) than the other Arduinos. This meant that we could easily control the mouse and keyboard of the computer, and with this navigate through the program, with the Arduino code. The code consists of several states we set the “Skannomatøren” in. It starts of at an idle state, in which we show an image of an instructable providing easy understandable direction for the usage. At the same time we wanted the prototype to be more intriguing and interesting. Therefore we added several LED lights that blink at random to gain the children’s attention.

When the figure is placed on the platform, the child may press the start button once. This prompts a second state which will make the LED lights start blinking simultaneously for 10 seconds. This is a sort of error check to make sure everything is ready before the scanning process starts. If they wait, and don’t press start again, the program will go back to the idle state. The scanning process requires the platform to spin at least 360 degrees and may take a few seconds. The children will be able to see their 3D model take shape right in front of their eyes. At the same time, the LED lights on the side of the screen will indicate how far in the scanning process they have come. When the scan is done, the HID takes over and by controlling the mouse with code we made an automatic tool to customize, crop and colorize the scanned object.

2.2.1 Technicalities

For our prototype we used:

- Microsoft kinect-camera (360 xbox) with a 2.0 usb port.
- Arduino Leonardo microcontroller board with 20 input/outputs, 16 MHz crystal oscillator, micro usb-connection and an ICSP header.
- Xerox 700p 17 inch monitor with a power output and a DVI input.
- Cooler master case fan 120mm black.
- Easy Driver 2.4 Stepper Motor Board with a Mercury Stepper Motor.
- Two breadboards, 8 LED's, a button, and lots of jumper-wires.
- 3D-printed universal mounting hub, for a more stabilized platform.

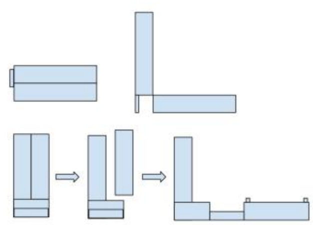
2.3 Testing

First off we had to test the Kinect's ability to record smaller objects. Then we did different tests on whether it should be on ground level or higher up, to get the best possible outcome. With this in mind, we had to measure the appropriate range, lighting, and background movements as the children surely will like to see themselves in the background of the scan.

We got a few kids at Fridheim Kindergarten, from ages 4-6, to create different objects of play-dough. We later tested two of them with our prototype setup, using boxes to get the kinect at a preferred height and a cut out cardboard platform. With this low-fi prototype we could see how well the scanner could record and approximately how fast the platform had to spin.

2.4 Building the final prototype

When it came to building the final prototype, we looked at the criteria relating. As Skannomatøren is a rather large prototype we had to make it easy to move with little effort required while at the same time it needed to contain the right scale for the kinect to be able to scan.



(Figure 4: Design options)

2.4.1 From paper to wood, the outer shell

Eirik's house turned out to be our building "headquarters" where we stashed all the material and plans. With extensive testing we found the necessary width and length of the lower box. We also figured the height at which the kinect could get the best overview and where we needed to put our monitor. This lead us to the measurements required for the whole prototype.

2.4.1 Inner components

While building the outer shell, we tried thinking ahead by drawing off where we needed our components like the Arduino, the stepper motor and many of the wires required to power up Skannomatøren. We frequently used Sonen for soldering, programming, and getting input from the expertise of Sonens frequents.

2.4.2 Meeting the criteria of easy transport

One of our challenges was to make the prototype transportable. As the prototype looks like a pinball machine without legs, we figured the best option would be to add a few hinges and locks to be able to easily pack it up. The second solution to make it more transportable became a set of four wheels underneath. This turned out to not only make Skannomatøren easy to transport, but also as a stabilizer for the box containing the screen and kinect.

2.5 Our target group

We want to reach out to children of any age with Skannomatøren. We want everyone to have the chance to create something and see how it evolves into a graphical model. It may be hard for children under a certain age to understand the concept. Piaget's stages of cognitive development (Holt et al. 2012) shows us that our target group is under the three stages; sensorimotor stage, preoperational stage, and concrete operational stage. However, the youngest stage (sensorimotor stage) consists of the years 0-2. Here the children have yet to grasp questions, formulate and evaluate an answer and present that to others. They will still be able to create something and see what happens, but no more. The pre-operational stage, from 2-7 years, Piaget states that they are still somewhat egocentric and have problems with the abstract, but they are starting to grasp more and more concepts and getting a much larger understanding of symbols and the world around them. The last stage of our target group is the concrete operational stage, with ages ranging from 7-11 years. More logical thought processes are taking place and the children have a more think-outside-the-box stance on issues they face.

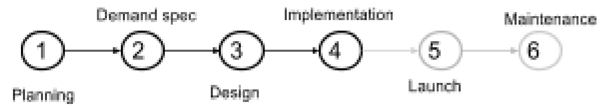
With today's technology even younger children are active users of technology, and the concept of virtual models has been presented to them in one way or another. Either it's from children's TV shows or games on their tablets/smartphones, the children will have more understanding when it comes to animated figures. This leads us to believe that even the younger children of the pre-operational stages have a better chance of grasping the concept of Skannomatøren.

2.6 Budget/spent

For our final prototype we spent roughly about 1900 kr. Since some of the essential parts were provided by our group members, the cost of making the prototype was cut notably. We did however need to spend money to buy a few important parts for the finalization of our project.
Those include:
Kinect - 900kr
Plywood - 400kr
Components - approx. 200kr

Arduino Leonardo - 400kr

We weren't given a set budget to stay within, although the criteria stated that the project should be "low cost". Because of the functionality and the task of our device, some larger sums had to be spent to get the parts we needed and to make the device work as we envisioned it.



(Figure 5: Lifecycle model)

Some industrial 3D-scanners starts at around 23 000 euro's, and this has to be taken into account when accessing our budget.

2.7 Universal design

The process to make a 3D-scanned model is a quite advanced task. Because our project is directed towards children, we decided to make the interaction with the prototype as easy as possible. We made most of the tasks automated so that minimal skill and knowledge is required to use the prototype. Our goal was that almost any child would be able to use the prototype with only a short briefing.

Children with physical disabilities, that may be unable to make their own figure to scan, can use their own toys or objects with the prototype. Another great thing about the prototype is that it can be as fun and educational to just be a spectator when someone else is using it. Since the prototype delivers feedback and results through the screen, there will be problems for children with decreased vision. We have not been able to find a solution to this problem as of now.

3. Methods of evaluation

Since our prototype needs to be tested in its current high fidelity state, we chose to undergo *summative testing*. With this we will evaluate among others the effectiveness of some of our design choices. We will do a test with approximately 4-5 children. Virzi (1992) explains that with a sample of 5 users, approximately 80% of usability problems will be detected. Keep in mind, that our prototype does not solve an existing problem. It is a new activity for children, the world of scanning and 3D modeling so far belongs to the adults. We will discuss ethical aspects of this process throughout this part of the report.

3.1 What do we want to find out?

We want this to be a playful experience, but will the children find it that way? And will it spark their imaginations? When we set out to constructing the shape of the Skannomatøren, we set *visibility* as a high requirement. Our usability test will show if the children automatically understand the concept of their task at hand.

If we try to look for educational purposes in our prototype it could be possible that seeing real world objects enter the 3D world in a matter of seconds, may help them understand the connection and difference between the real and the virtual. (As mentioned earlier in section 1.6.1)

3.2 Choice of method

An important factor with our project was that we don't know how the children would use the prototype. To find the right evaluation methods for our user tests, we strategically went through the most commonly used methods.

Method:	**Positive +**	**Negative -**
Usability testing	Controlled environment, detailed data	Test subject acting unnatural
Field studies	Natural environment, better understanding of us in real life	Can't control variables
Interview	Detailed feedback, flexible	Limited participant, need some interviewing skills, lot of work with data
Observation	Flexible, "insider" view	Biases in behavior, time consuming, difficult to record everything
Survey	Easy data collection, many participant, low cost	undetailed feedback, no follow-up questions, impersonal
Focus groups	More participants, open for discussion, low cost	difficult to analyze

(Rogers et al. 2011) **(Figure 6: Methods of evaluation)**

This gave us an idea on what to do when testing our prototype with children.

Children pose some challenges when it comes to choice of evaluation method. Ethically one must protect children more, one reason being that they are generally not capable of making good choices in their own interests. Some safety valves are also in play, as one has to get the parents permission. All this makes having children the main target group, logistically more difficult to maintain. This made us ultimately choose usability testing combined with observation, focus group and survey our choice of method. This allowed us to get qualitative data from fewer children, as opposed to reaching a larger group at a higher cost in time and effort. We did not have to go into ethically grey areas which includes the recordings of names, pictures, video and sound of children, as it was possible doing these four methods without that. The largest con by choosing to do it in this way, was that our sample group was small. It would be possible to make our experiment more quantitative by repeating with different groups of children.

3.3 Designing the experiment

Stages of usability testing:
(Lazar 2006)

1. Select representative users

Eirik on the group works with helping children with their homework, so through this connection have we got a hold of 4-6 pupils in the age between 10-11. Due to Eiriks connection, we have also talked with their parents and gotten their permission.

2. Select the settings

A homely setting. The machine is mobile, so the experiment will be conducted either at school or in one of the participants/members home.

3. Decide what tasks users should perform

Task 1: Create a car using either playdough or lego. It should not be smaller than a soda can, or larger than a soda bottle. Use this figure with the prototype.

Task 2: Do what you want! (This allows us to see if interaction with the prototype inspires children’s creativity).

4. Decide what type of data to collect

Observation of activity and failure rates. Smiles and other behavioral markers are also known to be a way of seeing children’s real reactions, as opposed to their answers to questions. This is elaborated further down. After the experiment we will also conduct a focus group/group interview asking the participants of how their experience was and in general their opinions and ideas.

5. Before the test session (informed consent, etc.)

Participants will be briefed in what we have built, what we are testing and their involvement will help us. Parents will also be briefed in this, and will be asked to sign a consent form. We will not ask anything extraordinary, and be ethically mindful as this is an experiment with children. This is why have chosen not to take any pictures, video or sound recordings of the experiment.

6. During the test session

We will briefly show the participants how to work the prototype. They will then be asked to first do task 1, and when that is complete they will be asked to do task 2.

During the test session we will also look at the children's expressions, this to capture emotional responses which will lead us to the direction of what they think about the project.

> Gauge how much children like a program by observing signs of engagement such as smiles and laughs or leaning forward to try things, and signs of disengagement such as frowns, sighs, yawns, or turning away from the computer. (Hanna et al. 1997, 13)

7. Debriefing after the session

We will give the children a survey containing likert-scales, with frowns on one end and smiles on the other, to get an idea of what they think about Skannomatøren. “We have found it helpful to use a vertical scale with a smiley face on the top end and a frowny face on the bottom end to make the end markers clear.“ (Hanna et al. 1997, 14). Also, we will show our instruction-prototype and try to figure out if it helps them understand how to operate the prototype.

3.4 Choosing the participants

In selecting participants, you should strive to find people with personal attributes and goals appropriate for your study (Lazar et al. 2010, 369). As our project is based on playing, we concluded that most children will have the mindset to at least give Skannomatøren a try. Lazar et al. (2010) also states that each individual’s background and motivation may play a role in determining how appropriate they are for the study. By giving them tasks to get them going, and a promise of a virtual model of what they have created, we hope that this will be sufficient enough to motivate the children in participating with the project usability test. As all children enjoy playing and enjoy creating within the age span of our project targets, Skannomatøren is made in a way that there is no extra expertise needed. ”Participants should have expertise that is comparable to that of the expected users.” (Lazar et al. 2010, 369).

3.4.1 Recruiting

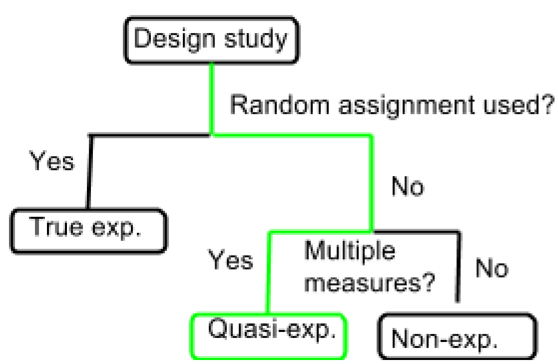
First of all we chose testing the prototype with children around the age of 10, as Hannah says:

> “Preschoolers require the most extensive adaptations of usability testing because their attention span, their motivation to please adults, and their ability to adjust to strange surroundings and new people may change from one moment to the next. “ (Hannah et al. 1997, 10)

On the other hand children in the age between 6 and 10 years are more accustomed to sitting with a task and receiving instructions from and adult. (Hannah et al. 1997, 10) Our sample consists of 5 children in our targeted group: 1 girl and 4 boys. These subjects were all from Uranienborg Elementary School. As some of these children are known to one of the group members and the travel distance is not too far, this is regarded as a *convenience sample*. This is because we chose the participants out of practical reasons, compared to strategically or using a randomized sample (Rogers et al. 2011, 224).

We measure multiple variables, but all the participants are given the same tasks and conditions. Thereby we cannot call this an experiment, but rather a quasi-experiment (Lazar et al. 2011, 42).

By the end of the experiment we will compensate the children for added motivation and giving them a more satisfactory experimental experience.



(Figure 7: Defining the experiment)

Gifts can be more appropriate for some participants, particularly children (Lazar et al. 2010, 375).

3.4.2 Concerns

Lazar et al. (2010) states that although you should make every reasonable effort to help participants feel as at ease as possible, you should also be aware that your presence may have an impact on observed performance. One of these impacts is referred to as the Hawthorne effect. The Hawthorne effect goes to show when test subjects improve or modify their aspect of behavior, which is being measured, in response to the fact that they know they are being observed. This must be taken under special consideration when experimenting with children.

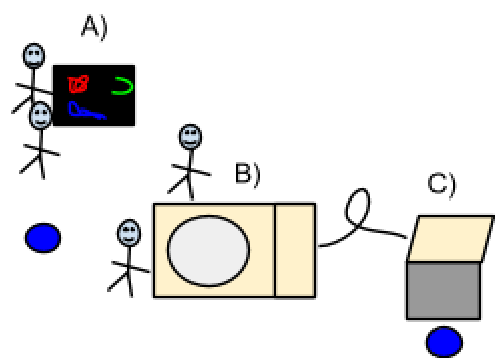
3.5 Equipment needed for the test

To keep our budget low, we tried to keep the components required for the user test as low priced as possible.

- Homemade play-dough ("Trolldeig" in Norwegian).
- Likert scaled surveys for debriefing and focus group.
- Reward; Chocolate and buns.

3.6 Describing the experiment

As you can see on figure 8 we kept Skannomatøren and the station where the figures were being made separate. A is a station consisting of homemade play-dough (a.k.a "trolldeig"). B is the prototype, which has to be connected to a laptop, C. The blue dots are our observers, trying to stay as much out of the way as possible.



(Figure 8: The set-up)

We also had a test-leader, giving the participants their tasks and answering questions during the test. We started off with two leaders, hoping that would speed up the process, but it didn't take long before we decided to withdraw one of them to a more observatory role. This was because the children didn't require more than one leader to answer their question and guide them through their objectives.

Lazar et al. (2010) states that we can increase the reliability by having at least two observers. This is caused by multiple observers registering the same situation. At the same time, they have to think about staying out of sight to prevent the participants from losing focus of their task at hand. Since we conducted this experiment at one of the group members apartment, this was a slight problem, but by doing other work related stuff the other members managed very well to stay out of sight. The main targets of the two observers were the participant's responses, actions, facial reactions, and interest. Also when the participants were chatting together and sharing ideas, we had an observer to try to write down the main subjects and what the participants thought of their tasks. A lot of interesting results came with this, and will be further explained under the results and analysis section.

We started off by setting up the equipment at Eirik's apartment. He had made an agreement with the participants guardians to come pick them up at a given location. When they entered the apartment and saw the prototype they were fairly amazed. They were given tasks to perform and later went on to try and scan them, during the test-leader asked a few questions to get a bigger perspective on their thoughts. One by one they got to try the prototype and look at their 3D model when it was finished.

As a little bonus, we created a Sketchfab account for the participants to share. Here they could upload their model with a click of a button, for show and tell when they got home. By adding this method, the children will not only get a bigger sense of achievement, but also be able to discuss and share their experience with 3d modeling with their friends and family.

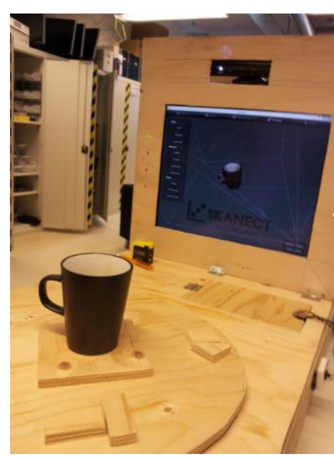
4. Results and analysis

A lot of qualitative data was acquired using pure and simple observation. For instance; By using thematic content analysis (Lazar et al. 2010). This type of analysis is most often used with a text, music or videos but we found that it works just as well with the variables we observed. Looking at how the children behaved, facial expressions, outbursts and the discussion between the group, we could identify certain themes and topics. By gathering these examples we could see what our main focus in further iterations should contain. This led us to new and encouraging discoveries, and semi-confirmations of our hypothesis.

The original user guide displayed on the screen while the prototype is in standby mode, was effective in some areas but not in others. The guide is composed of both symbols and text, to facilitate understanding. While the participants quickly grasped the instructions, some of the wordings were clearly unclear to them. As a gimmick, we had the word "3D-model" written in a 3D-font, but this proved hard to understand for the 10-year olds.

One good sign was observed immediately as the children entered the room, as one of them exclaimed "Wow! That thing is cool looking!" as all the participants immediately flocked around the prototype "big eyed" and enquiring.

As the children started building, they clearly let their imaginations run wild. While the task we gave them was to build a car, several of them started building projects that quickly escalated, one of which ended up as some sort of gigantic frog car, almost twice the size we instructed would be maximum size. This illustrates the need for more tactile ways of informing children of the limitations



of the prototype, while also showing that putting limitations on their creating won't necessarily stop the flow of imagination.

As they finished, we moved to the concrete interaction with the prototype. Excitement was visible in their constant focus on the prototype, and as we geared up to do the first scan slight jumping was visible in some of the participants, a known sign of excitement in children.

As the first scan started, all participants watched constantly while maintaining some distance to the prototype itself. Response to the first scan: "Cool!" As the second scan started, smiles were still plentiful, and the participants seemed to have gained some confidence, as they now flocked the machine, with their faces as close to the prototype as possible without disrupting the scan. This scan was of the larger frog car, and as a consequence its fidelity was not as high as the first which resulted in comments from the participants: "This was not as correct as the first one.", "Shouldn't it look cooler?" After this there were several more scans, and we could observe that for 5 consecutive scans in short succession the participants full and undivided attention was held.

One scan of a teddy bear the participants wanted to try scanning, resulted in a discussion concerning the quality of the scan, with comments about the scan not being able to discern between the hairs of the bear. After this was done, we sat down for a conversation about the prototype and the experiment. The participants voiced several wishes in this discussion, including: Painting the prototype, or making it more stylish and more building materials! Including: Lego, plastelina, their own toys. When asked if this inspired thoughts about 3D and how 3D is made the participants, confirmed but did not elaborate, though Eirik on the walk back after the experiment overheard a more elaborate discussion about this subject.

When we brought up our future ideas of further interactions and interactive play with the prototype, the children lit up and blurted out surged positive comments. Especially favored by them were the idea of making a car, scanning it and then using it later in a racing game, and the idea of making a building, scanning it, and then have it placed in a 3D map of Oslo.
They also expressed wishes of more high quality scans, and though most of the scans during the session were fairly successful in our eyes, the children seemed to focus on those that did not fare as well. This was also a small mistake on our part, as the environment chosen for the experiment did not have the necessary lighting for the prototype to operate to its full potential.

One of our concerns was children's inbuilt aim to please, but when we asked them to fill out the survey, we observed them being more positive in their first answer than what we had overheard before we gave it to them. After the test leader approached them, and told that their honesty was more valuable to us than only positive feedback we could see their attitude change. This included discussions among them, and weighted decisions when evaluating their experience.

When we asked if the participants would want to play with Skannomatøren again, all unanimously answered yes.

4.1 Conclusion

The experiment has given us a whole lot to grasp and improve in our prototype. For the whole activity the participants seemed engaged, and smiles, as mentioned earlier one way of truly gauging how the child's experience of the activity is, where continuous and often, except in one instant where a scan failed because of one participant disturbed the prototype in action. The participants also seemed interested in the mechanics and technical aspects of the prototype and the 3D modeling, which led to questions to us and discussions between themselves. While not conclusive, this seems to support our two hypotheses outlined earlier, and might be an indication of our goals of making a fun activity that also has some educational value being met.

4.2 Risk analysis and activity diagram

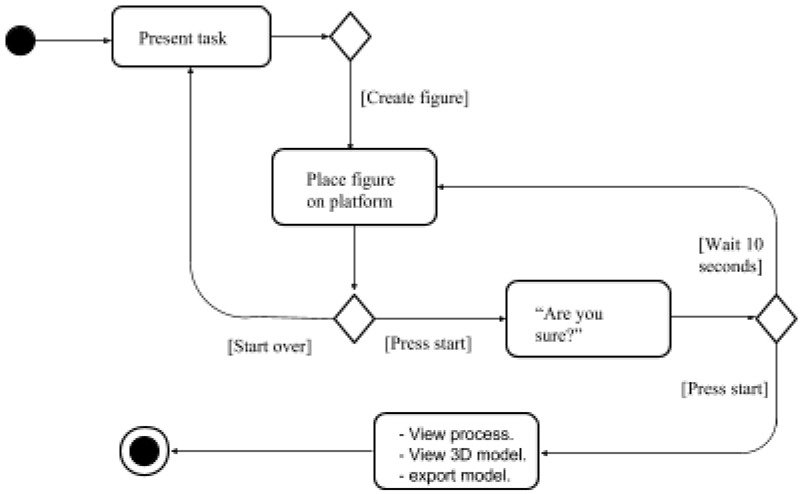
4.2.1 Risk analysis

Probability	Risk points				
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5
	1	2	3	4	5
Consequence	Insignificant	Less serious	Significant	Serious	Very serious

Possible risks	Probability	Consequences	Range	Countermeasures
Child does not know what to do.	3	5	15	A more intuitive idle screen, with less characters and more explaining images.
Electrical components does not work.	1	5	5	Use better wiring and make sure everything stays in place. Lots of testing.
The aftereffects gets wrong configuration.	2	4	8	Revise the code. Look for other possibilities, like other programs.
Biased data when user testing.	2	3	6	Use only a part of the group members to undergo the test. Give reward before test begins.
Don't get enough test-subjects.	4	3	12	Contact other schools/kindergartens. Use a lab in which everyone can get to easily.
Illness within the project group.	2	2	4	Device a good plan of the future, so another member can for instance be a group leader. Work from home.
Loss of data (code).	1	5	5	Save data both locally and online (Google Drive, GitHub)

(Figure 9: Risk analysis)

4.2.2 Activity diagram



(Figure 10: Activity diagram)

5. Project limitations

The finalization of the project was exciting and fun, but we didn't get to do everything we set out to do. After several meetings with Alma Culén, we were told to focus on the interaction. We discussed the possibility of making a 3D-environment where the children's creation could be placed, although the time, budget and experience we had did not suffice for completing all of the above tasks.

Another problem we faced was that our concept demanded a technically advanced prototype to showcase its usability. This meant that while we had created several low fidelity prototypes early in the project, we would not be able to test our main functionality before the high fidelity prototype was finished. In building our prototype, the whole group was treading totally new ground most of the time. As a consequence of this we had to device several technical solutions from scratch and then make it all work together. This complicated process proved to take more time than we originally planned, which left less time for user testing and evaluating than originally planned.

6. Summary and conclusion

Our project started by four semi-affiliated students forming a group, and getting handed an assignment. Following some ups and downs in development we ended up with the concept of Skannomatøren, a 3D-scanner made for children, our concept prototype and design pitch received very positive feedback from our fellow students. The project marched on at a steady pace, with many incremental technical developments that grew to be the finished and fully functional prototype, with only some lacks in aesthetics and the exclusion of desirable interactive functions that were not feasible to implement because of time, cost and skill limitations.

Concisely put, our goal was to make a fun activity for children, with learning as a bonus. In the analysis of our prototype we tested it with children, though our sample group was small and as a consequence our data not as reliable or with lower validity than we might have wished. The quantitative data we gather showed us that we are heading in the right direction. By the feedback and observation we wrote down, it also goes to show that our goals are being met. Further experiments, data gathering and triangulating will though be necessary to conclude this in a more assured manner. Looking at the whole picture, the children involved seemed to have an overall fun time. Playing with the prototype seemed to inspire and engage them in ways beyond our initial hopes, with discussions and thoughts on improvements.

To summarize our project, we think it is safe to say that we might have bitten off more than we could chew. Still we are very satisfied with our high fidelity prototype, although it came at a price. Treading new ground in the way we did, with a technically demanding concept proved difficult to manage time wise. In retrospect, one of the things we can retain is that early risk analysis is not always accurate enough to gauge the projected time required to develop a prototype. This miscalculation cost us some of the time originally dedicated to evaluation. Nearing the end of the project we at times felt that a simpler concept would have better solved the conflict of interest of both working towards a client, Oslo Barnemuseum, and the demands of the course. After this last and perhaps bleak statement, we would like to end this conclusion by stating again that we are very happy with our final prototype, and that this has been a fun and educational journey.

7. Further development

Since we had a limited budget to develop our prototype, further development is possible. If we had purchased the full version of Skanect, the resolution could have been better. If we had more time and experience, we also could have developed a 3D-environment for the scanned model to be placed in after the scanning process. Placing a computer inside the prototype is also something we thought about. This would make the prototype more independent and we wouldn’t have to operate it with a computer from outside the prototype. We planned to paint the prototype in child friendly colors, but we didn’t find the time to do it. Sonen at IFI has also expressed interest in the prototype. This could make an opportunity to work on these improvements even if Oslo Barnemuseum were to reject it.

There are many possibilities for further development. We did talk about the idea of making a game where the children's creations could be used as a model for the character in game. As of now, we have a high-fidelity prototype with the main focus being functionality and not necessarily the aesthetic part of the project. Further developing the aesthetics could provide increased user experience and make it more enticing children.

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9. Attachments

Consent form

We chose to use Norwegian language in our consent form. This can be found in our folder at the INF2260-website.

Link GitHub:

https://github.com/Skannomatoren/Skannomatoren-code