Blurring the boundaries

Matthijs Jansen

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TU/e Technische Universiteit Eindhoven University of Technology

Project report

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Student matthijsjansen
S-number s080008

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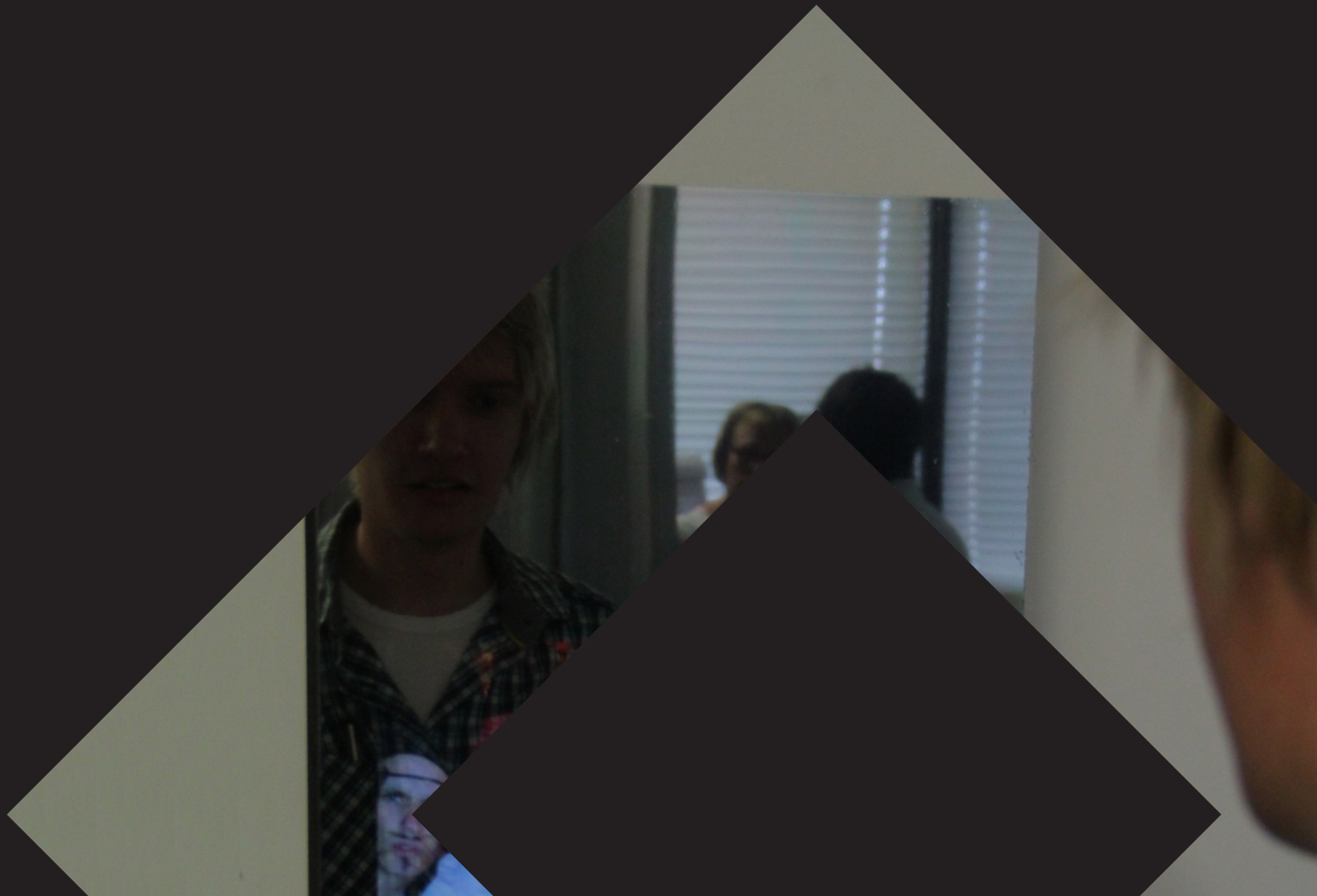
Coach dr. J. Hu PDEng MEng



ABSTRACT

This report covers the work of the final bachelor project of Industrial Design student Matthijs Jansen. It shows the design process of an adaptive photo mirror. With this mirror, a host can show his hospitality and care for his visitor through common photos of him and his guest inside the mirror, creating a fun and surprising experience when receiving guests in the hallway.

Matthijs Jansen Industrial Designer s080008 B3.2 m.g.jansen@student.tue.nl 06 57882690

TABLE OF CONTENTS

1. INTRODUCTION

In envisioned smart environments, enabled by future ubiquitous technologies, electronic objects will be able to interconnect and interoperate. Will it be possible to represent this digital world in the physical reality we live in, providing handles to control and clues to understand, build conceptual models of what is happening in this hidden reality?

Exchanging values between different realities can be viewed in the widest sense. Not only in computer games and other virtual communities we can cross boundaries, also in daily life we are often interfacing with another reality, like the digital reality in many electronic products. As the products and our environments become smarter and more complex, these connections between physical and digital reality are becoming increasingly complex and problematic. Often, we cannot make sense of what is happening in the digital world anymore. As industrial designers it is our job to make sense of this hidden digital world.

This project is called “Blurring the boundaries” and the main question this proposed project addresses is: How can we represent the digital world in the physical world? How can we exchange concepts and values between these worlds?

Matthijs Jansen Industrial Designer s080008 B3.2 m.g.jansen@student.tue.nl 06 57882690

2. DIRECTION

As the project description was very open and free there was a need for a clear direction. What problem is there to solve, or what design opportunity is there to explore? The project started with two iterations covering this journey.

2.1 FIRST ITERATION: DIGITAL PHOTOS IN THE PHYSICAL WORLD

2.1.1 PHOTOS

"Photo making has become an integral part of how families, with the use of film-based cameras, preserved their legacy and shared narratives of events and experiences with each other. Printed photos decorated homes in photo frames on fireplace mantles, bookshelves or coffee tables. A denser collection of photos can be found in family albums, or stored in multiple shoeboxes. People would give gifts of photo images on mugs or shirts as well as collages or duplicate photos. They could be seen adding messages to the photos in albums or even on the photos themselves as they shared and recorded their thoughts. Ultimately, people display photos in their homes to share narratives and stimulate social interactions."

This quote, taken from [1], describes the impact of photos on people in their home environment very well. Almost everyone has photos. Digital or physical, formal or informal, of activities or people, of their friends or from themselves, or a combination of the above. With the latest technological developments working with photos has become much easier and more accessible for everyone. But people are used to working with physical printed photos. They are easy to handle and well understood by everyone. In this traditional way multiple people can use and work with photos. Collocated sharing among users works because in essence photos are separate objects that can easily be exchanged.

2.1.2 VISION: NEW INTERACTIONS

Digital technology used today has restrictions. We have to admit the fact that digital photos need a medium; a screen. More and more digital photos are made, but they do not seem as separate objects anymore. If we want to remain working with digital photos in a way that it is efficient and that it makes sense, we need new ways to interact with them.

2.1.3 DESIGN OPPORTUNITY

In home environments there are so many devices that have a screen. So in fact there are so many opportunities to work, play and interact with photos. Why does this not happen in the spur of the moment? With physical photos it is easy to shift the principle of control. Giving a person a physical photo is easy and by doing so this person is in control of how he looks at it. With digital technology, there tends to be only one moderator. This could be improved in new ways of interactions.

2.1.4 SCENARIO

Several rounds of brainstorming and mindmapping of devices, information flows, locations and objects used in home environments, lead to a scenario that works towards the new way of interacting with photos, where multiple users can be in control.

2.1.5 EVALUATION

The digital reality of people's digital photos is an interesting direction to investigate further. Just moving a picture from one device to another is a very useful thing, but it doesn't mean that much to people. Therefore something with a higher semantic level of interaction is more desirable.

During a family meeting in Mary's house, Tom and Pete are talking about Tom's last holiday. Tom takes out his smartphone to show Pete a photo of their camping place.

On the other side of the room Sofia is watching Mary's digital photo frame (DPF) that loops through a wide selection of family photos.

Pete asks Sofia if she wants to see Tom's new pictures as well. Sofia says she would love to and Tom interacts with the system so that Sofia can also browse through Tom's photos on the DPF.

After a while Sofia comes across a photo of Mary. She says: "Hey that dress suits you well Mary!"

Mary interacts with the system so she also sees that same image on the TV.

Tom and Pete are still watching photos together. While browsing through the photos Tom notices a particular photograph that he wants to show to the group because it reminds him of a funny story.

Tom performs the action to let everyone see the image. Now everyone sees the photo on the device they were working on, listens to Tom's story and laughs. Afterwards Pete says: "Wow that's very easy. Even I could do that!"

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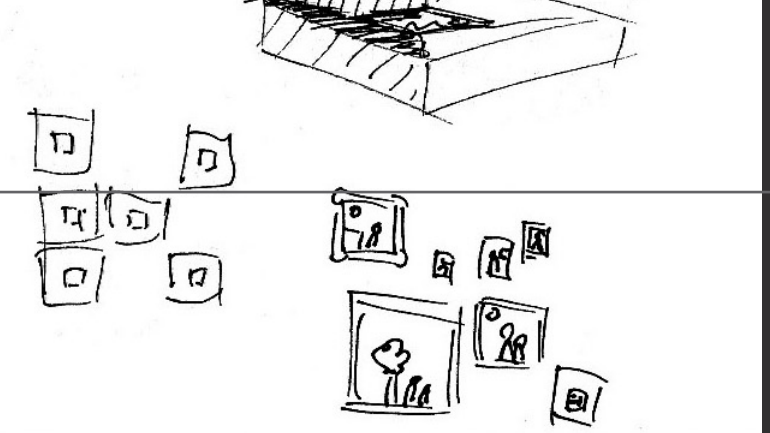


2.2 SECOND ITERATION: PHOTOS IN THE HALLWAY

2.2.1 OBSERVATIONS

The hallway is found to be an interesting place to design for. Personal experience in this place guided this choice. Here visitors regularly talk about photos hanging on the wall and standing on a cabinet. Photos support our memories. And our digital libraries keep expanding. What to do with all these memories?

2.2.2 INTERACTIVE PHOTO FRAME SYSTEM

From ideation phases an interactive photo frame system concept emerged. This system makes it possible to explore relations to digital photos in a physical way and consists of separate digital frames that can be freely moved on the wall. Users can rearrange photo frames and by doing so they manipulate what is shown on the screen. In a way users can literally fade boundaries between the objects and make sense of them. At this point two types of interactions and meanings to these interactions were ideated:

1. Moving frames closer to each other means the frames will show photos of events that relate more to each other.
2. Positioning a frame above another frame of a particular person creates a photo family tree showing photos of the parents of that person.

Positioning a frame right or left to that frame will cause the frame to show photos of their brother(s) and/or sister(s).

With cardboard modeling a lo-fi prototype was made to support user experiments and user input. What these relations would eventually mean and whether these two types of interactions were meaningful, was yet to be found out.

2.2.3 EVALUATION

The hallway is indeed an interesting location. This due to the fact visitors are welcomed there. However people do not want to spend that much time in their hallways talking about only the host's photos. Why is it only about your photos? It is more interesting to look at the relation between the host and the visitor.

2.3 THIRD ITERATION: HOSPITALITY

2.3.1 VISION

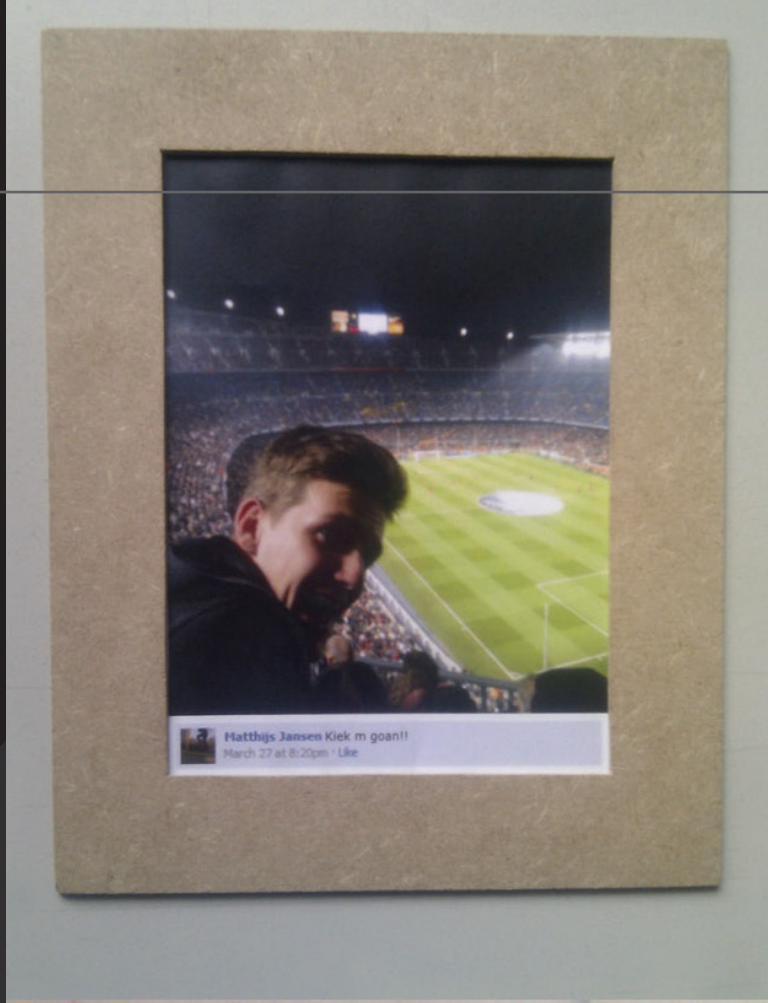
The first two iterations lead to a vision; change the way people interact at the hallway when receiving guests and do this with the use of personal photos. And my vision as industrial designer; make people's everyday lives pleasant and enrich it using technology supports this. Commenting on a photo on Facebook means something. It is a gesture of showing that you care. With the idea of improving the feeling of hospitality through showing pictures of your guests, the project started rolling.

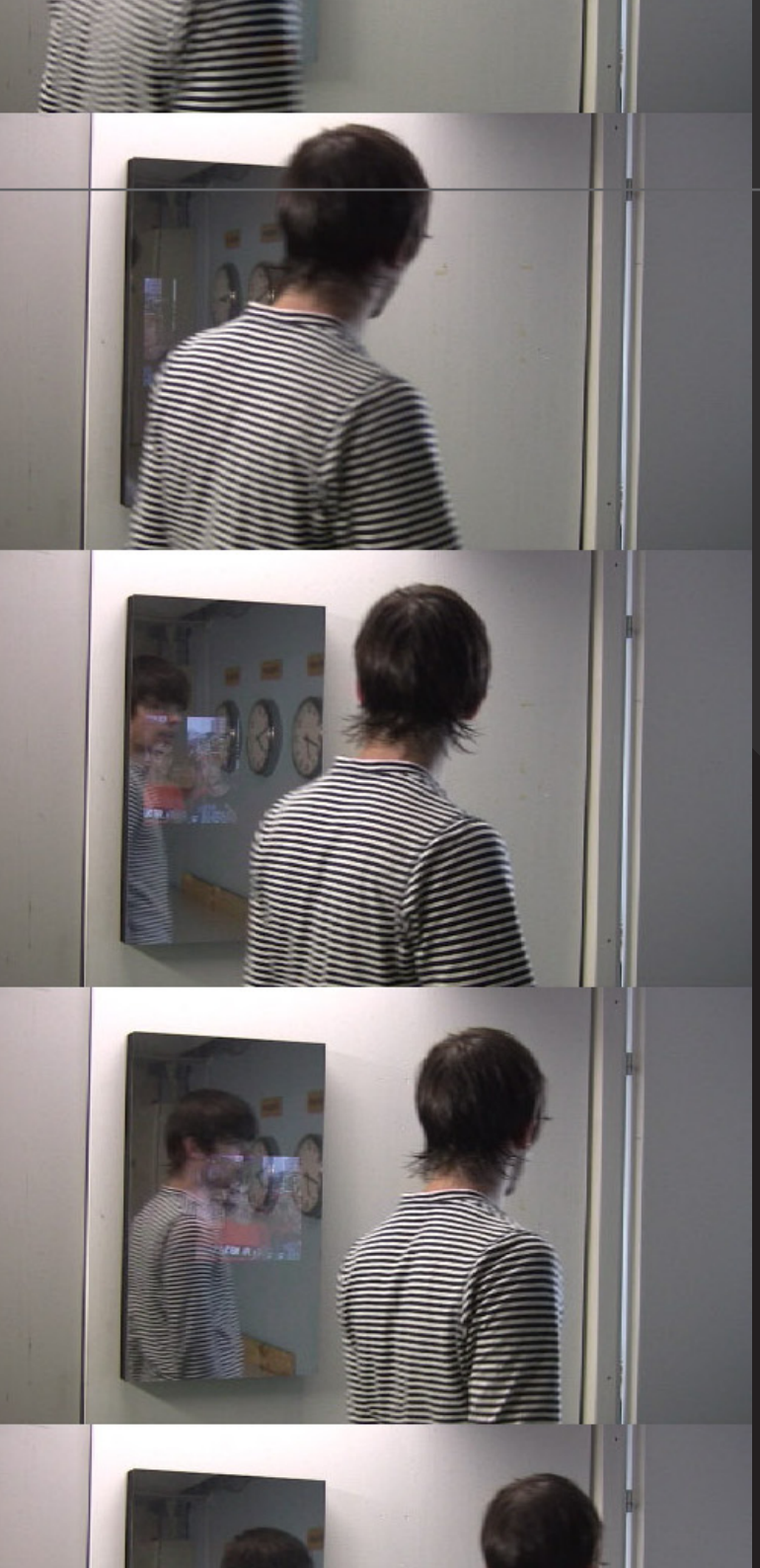
2.3.2 USER EXPERIMENTS AND EVALUATION

When the pure idea was born, the first user experiments began. These user experiments were focused on gauging people´s opinion and ask for input on the idea. They were conducted with 5 persons each. Initially people were invited to a particular place where one of their Facebook pictures was hanging on the wall. Reactions include "What are you doing with that photo?!" and "Where did you get that one?". They concluded showing their photos in the host's house could lead to awkward situations.

Something had to be changed. When testing again with photos of the host and the visitor together, this issue became less apparent. It became clear that it is very important to look at what is on the picture. And when using a digital screen the issue was almost completely gone with 5 new people. This idea was worked out in a low fidelity prototype. This device was a 17 inch monitor with a border of cardboard to make it look like a photo frame. Many more chances to experiment the concept were taken, mainly to investigate the awkwardness issue, the user interaction and what people expect from such a device.

Users explained a digital screen made it feel less permanent, so the awkwardness issue became even less. But next to that, the selected point where people were asked to evaluate the idea was a bit unlucky. While standing in front of the device, people had ideas about showing the weather, shopping lists and to do lists on the screen, totally forgetting the initial pure idea of showing care and hospitality through photos. This result was simply asking for a real user test, one in a real setting, by performing the whole scenario.





3. CONCEPT DEVELOPMENT

Before testing this concept in a real setting a new design iteration took place. This chapter covers the further development of the concept and how the final prototype was constructed.

3.1 INTERACTION AND ACTIVATION

A very simple interaction was chosen. The studies of human processes teach us that people spot movement much easier than static objects or images. Therefore the photos follow the movement of the user, in a horizontal direction. The interaction is there to track attention, to create just a little bit more fun when watching the photos and to let the guest feel they are in control. It also makes it more power efficient as no photos are displayed if there is no one standing in front of the display. Users will not spend hours in the hallway watching photos; therefore the maximum amount of five is selected with a delay of 2 seconds before showing the next one.

How will the system know who is standing in front of it? What happens if there are several people visiting? These were very valid questions during this stage of the project. Face recognition seems like a suitable option but choosing this option also has some issues. The whole point of showing care and doing something extra for your guest disappears completely when everything goes automatically. The host and owner of the mirror must actually do something for his guest to show that he cares for him. By updating their Facebook status owners can activate their mirror. It is envisioned a status update like “My friend Tom will be visiting me to watch a movie.” or a Facebook plugin will be suitable to activate and prepare the device. When activated, the device will search for up to five photos to display. For this to work, the adaptive mirror must be linked to the host´s Facebook account. Or another (online) digital photo library that enables tagging persons. The best photo library is found to be Facebook as the people who are tagged have the possibility to ‘untag’ themselves when they do not like their photo to be pointed back to them as a person. Facebook also is a social media platform that features status updates and offers photo album solutions. Therefore Facebook will be used in all further examples.

3.2 DESIGN

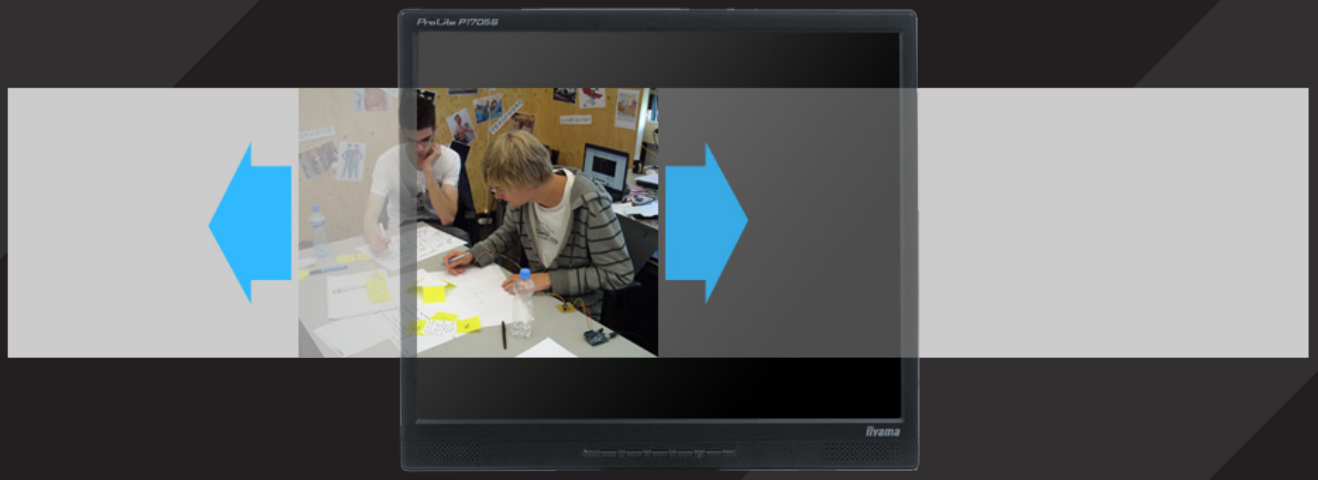
The used metaphor for the concept is very simple. The principle of a mirror is also very simple; in a mirror one can see himself. The adaptive photo mirror also works like a normal mirror. But it also reflects the relation between visitor and host and shows this with digital memories; photos. A mirrored image of a person standing in front of a mirror also moves with him when he moves from left to right, that is why in this design photos move in the same direction as the person moving in front of it. The separate choices; the interaction and the form of a mirror strengthen each other. As it will not be likely for visitors to touch the screen, an interaction using movement fits well.

3.3 SCENARIO

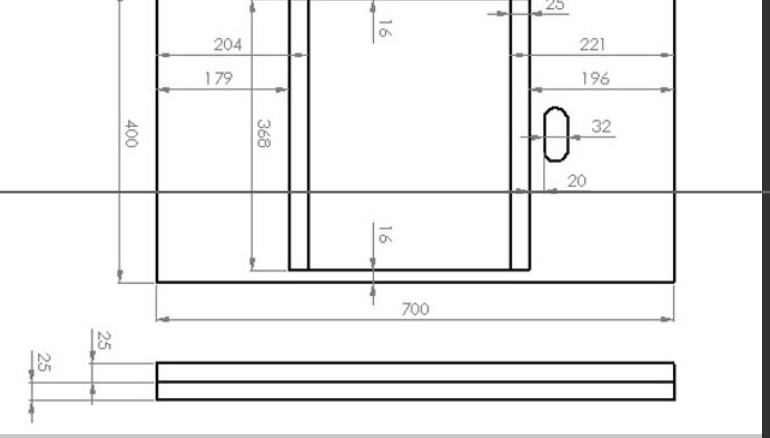
In this scenario the concept shows its value:

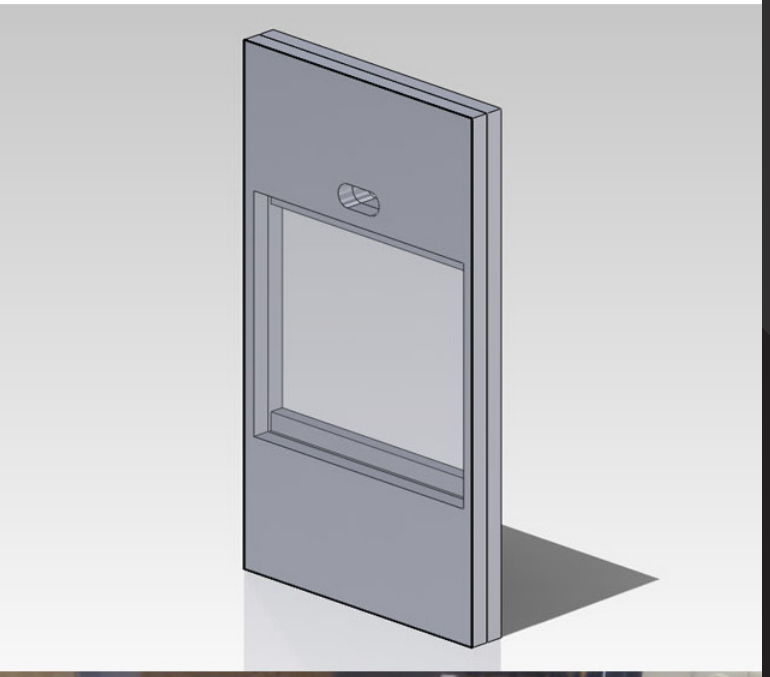
Matthijs invited Sven to come to his house and watch a movie. He is waiting for his friend to arrive. He updates his Facebook status: "Sven is coming to my place to watch a movie."
By doing so he activates his adaptive photo mirror.
In the hallway Sven notices something moving in the mirror. When he takes a closer look he is surprised to see photos of him and Matthijs.
Sven says: "We should go out again just like that time!"
Then Matthijs recognizes a photo from an earlier ID project and laughs.
They continue their way to the living room and will have fun watching the movie.

A video of this scenario is available on vimeo [8].



Matthijs Jansen Industrial Designer s080008 B3.2 m.g.jansen@student.tue.nl 06 57882690





3.4 PROTOTYPING

3.4.1 COMPONENTS AND DIMENSIONS

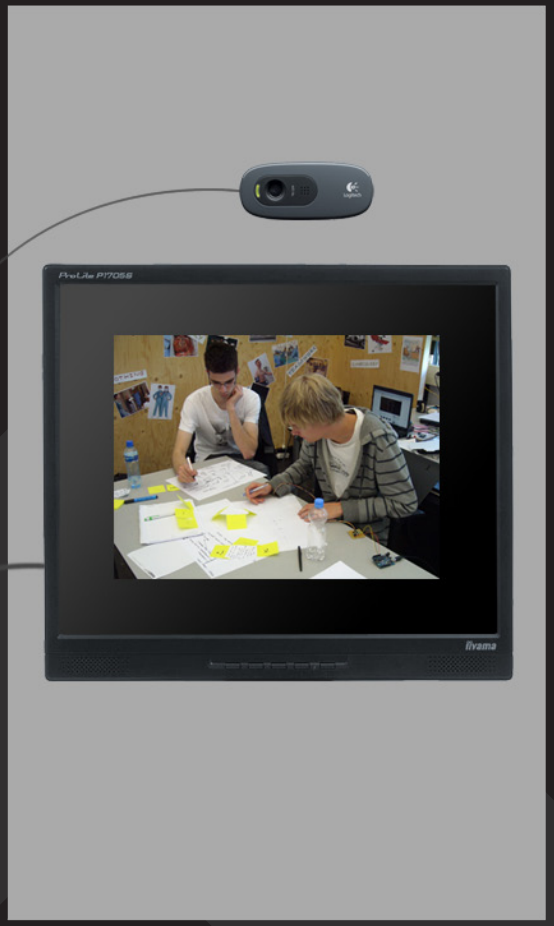
To create a working prototype that supports displaying photos and moving them according to detected movement, several components were needed. The final prototype was realized with a 17 inch Iiyama TFT monitor and a Logitech HD webcam. Processing power comes from a typical student's HP laptop that is connected with the components. The prototype is made as functional as possible. The dimensions of the object and the fact that it is vertically oriented depend on a few factors. A person should be able to see his complete upper torso in the mirror, just like any other mirror in one's hallway. And the complete casing should have room for the monitor and the webcam. With these requirements it was chosen to make the complete device 700 by 400 mm and 52 mm thick.

3.4.2 MIRRORING EFFECT

To create the mirroring effect on the front side a semitransparent shiny foil was applied on the surface. The monitor's screen, positioned right behind the 2 millimeter of Plexiglas, becomes visible when powered on. If the screen is black, the mirror works as intended and no edge is visible.

3.4.3 PROGRAMMING

The program was developed to be used in user testing and demonstration purposes. The Processing language [2] was used because of its wide support and easy prototyping solutions. For the prototype to work as intended, a few things need to be prepared and set up. In the beginning of the code the name of the participant of which photos will be selected must be entered. (Photos need to be prepared and put in folders for this to work.) Then one static image of the background is necessary to detect objects later on. After starting the code this image should be made once. With this setup, the program will track objects that are different from the background image. After that a center position of this object is calculated. The X-position of this object is used for the horizontal position of the looping photos. A special algorithm makes sure small distortions in the tracking and movement are filtered out, making the photos move significantly smoother. This smoothing function does cause a slight delay in the overall interaction, but this effect is found to be less troublesome than a choppy image. For easy troubleshooting a few key bindings are created. For example to quickly see whether the webcam is working correctly only one button needs to be pressed. Libraries used in the program are OpenCV [3] for processing video and FullScreen [4] to display the output in full screen. The full processing code can be viewed in appendix A.



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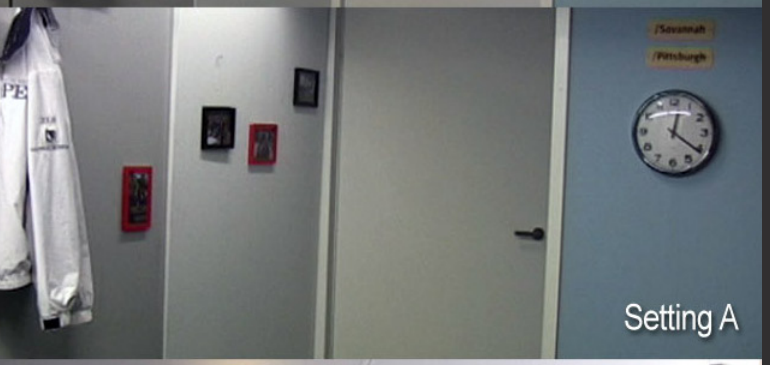

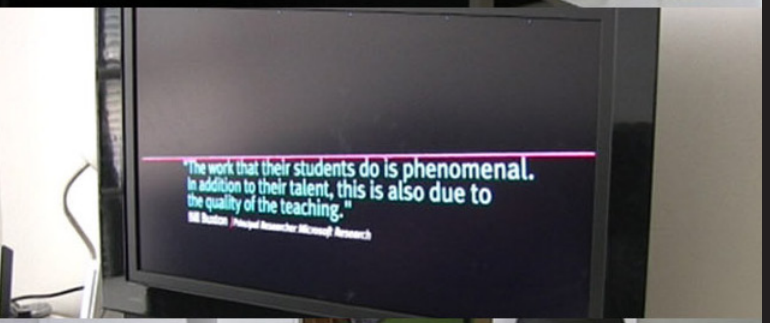

4. USER EVALUATION

4.1 GOAL

The goal of this research is to validate the concept on the aspects that were designed for; whether the concept elicits a stronger feeling of hospitality and whether the experience with the concept is fun. This feeling of hospitality is defined as; the guest feels like the host:

… comforts him.
… makes him feel equal.
… makes him feel like home.
… takes care for him.
… shows his care for him.

4.2 RESEARCH QUESTION AND HYPOTHESIS

This experiment explores the effect on hospitality and fun in a hallway setting where the host welcomes a guest with and without use of the concept. Two hypotheses were selected:

H1: Feeling of hospitality scores higher with use of the concept.

H2: Fun scores higher with use of the concept.

In order to answer this question an experiment was conducted.

4.3 PARTICIPANTS AND MODERATOR

For this experiment 12 participants were invited in which 9 were male and 3 were female. The participants were aged between 20 and 29 years. Because of the nature of this experiment, all participants were friends of the tests moderator (Matthijs). They were selected on the availability of digital photos where both Matthijs and his friend were present. The moderator's role in this experiment includes of course performing the whole experiment and being the host that is a friend of the participants.

4.4 PROCEDURE

The host will invite a participant to the living room for an event. Upfront, participants will have read the following introduction in the informed consent form:

"You and Matthijs have been friends for some time and as you know he studies Industrial Design at the TU/e. To show and tell you what his daily life at ID looks like he invited you to his house to watch a movie about his study. You accepted the invitation and you are almost at his house…"

The full informed consent form can be viewed in appendix B. In the hallway the host will welcome his guest and ask him to take off his jacket like usual. During this short period in the hallway participants will either be able to spot:

A. Normal photo frames of the host and his family.

B. A mirror that will show photos of the host, his visiting friend and things they have in common. Next to that it will react on visitor's physical movement. (The designed object.)

After continuing to the living room, visitors are asked if they would want something to drink. Next the movie, the introduction video of the Department

of Industrial Design is watched. At last guests are asked to fill in a questionnaire, describing their feeling based on the complete experience.

4.5 LOCATION

The location of the experiment was the Context Lab 'Home' located in the main building of TU/e that represents a real home environment.

4.6 DATA GATHERING

Both quantitative and qualitative data are collected:

4.6.1 QUANTITATIVE DATA

Due to several practical reasons a between study was performed. There was only a small sample of the population available. It was also undoable to invite every participant twice at this time. By performing an independent t-test with this small sample size it is assumed that the population is randomly divided over the two groups, that variances in these populations are roughly equal and that scores are independent, because they come from different people.

4.6.2 QUALITATIVE DATA

Qualitative data include participant's physical and facial reactions that are recorded on both video and audio material. Next to that there are the extra notes given by participants after the questionnaire.

4.7 QUESTIONNAIRE DESIGN

The questionnaire should reflect participant's attitude in the given environment and experience with or without the designed object towards hospitality and fun factors. A search began for literature describing a quantitative test to measure either factor.

It is envisioned the designed object will have an effect on certain aspects of hospitality. The choice over these aspects came from this vision or own definition of what hospitality in this setting means. The following aspects were chosen to be important: comfortable, pleasant, safe, at ease, equivalent, I feel like home, the host is helpful and the host cares for me. Some aspects were taken by [5]. This study seeks to investigate the service interaction behaviors that elicit a sense of comfort for the customer in the service encounter.

For the fun factor, an existing scale was found [6]. They present a 7 Likert scale for use in further empirical research measuring the hedonic value that a person associates with a product or service. Although hedonism is quite a different term than fun the scale's aspects are found to be where the object is designed for.

In the final design questions H1 till H8 reflect hospitality and F1 till F8 reflect fun. The full questionnaire can be viewed in appendix C.

4.8 QUANTITATIVE ANALYSIS METHODS

All methods described here are taken from [7]. In the designed questionnaire 8 questions reflect


Questionnaire

Age: ____ years

Gender: O male O female

Question: in the context of this experiment, I evaluate the complete experience as:

Uncomfortable							
Unpleasant							
Unsafe							
Awkward							
Unequal							
I don't feel like home							
The host is unhelpful							
The host doesn't care for me							

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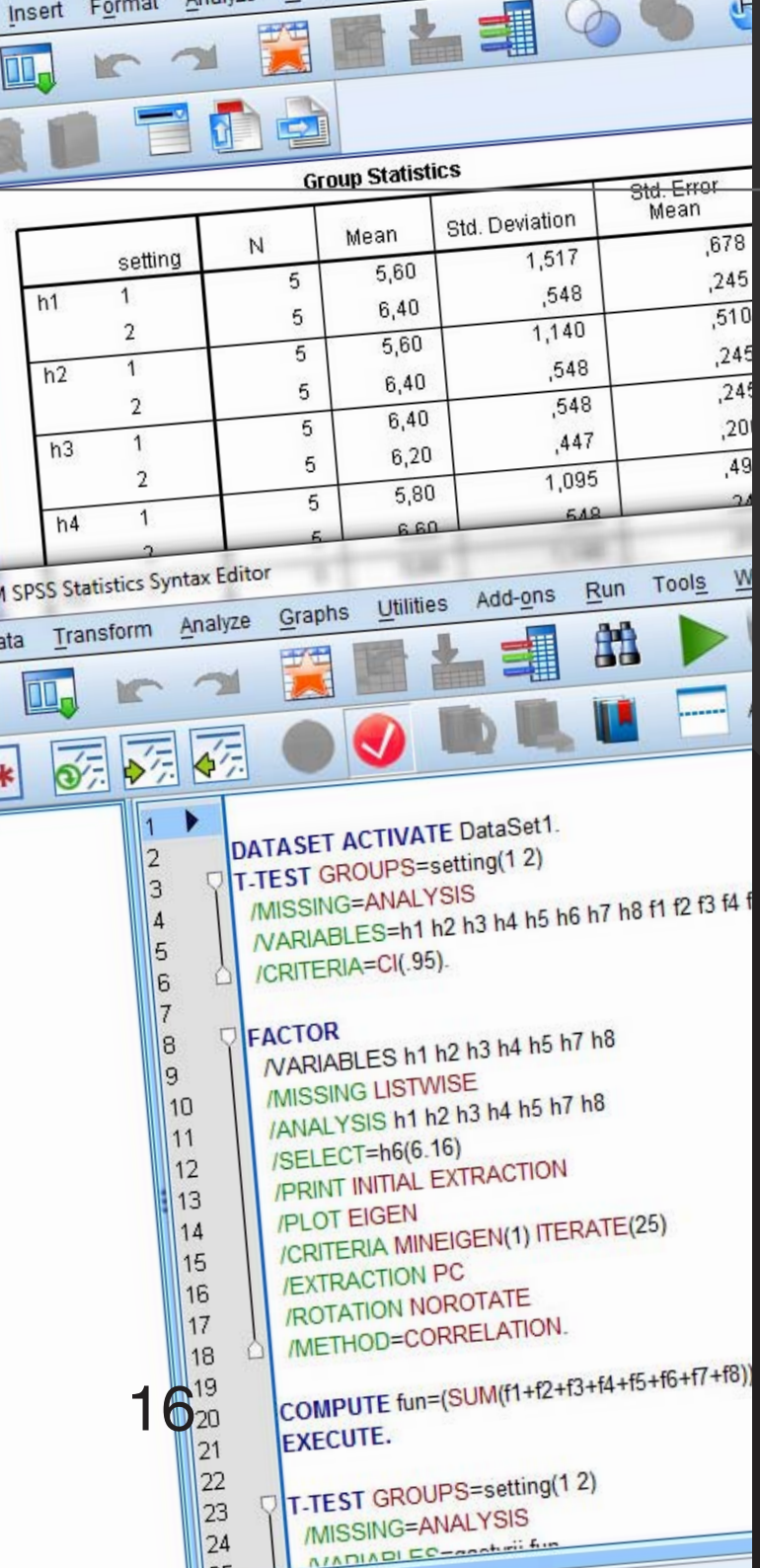


hospitality, and 8 questions reflect fun. Before analyzing the data with an independent t-test, factor analysis will be done to see if there are really two factors and whether the concepts of fun and hospitality are really represented in the questions.

An Independent t-test will give insight on whether people value the device to have an influence on their feeling of hospitality and fun. It is a simple method and if there is a clear demonstrable difference this test will show it.

Correlations between age, gender, the average of hospitality and of fun will be investigated. This because it might give insight on why we get the results that we will get.

4.9 RESULTS

4.9.1 QUANTITATIVE RESULTS

Factor analysis shows that the questions regarding hospitality and fun relate to each other, so at this point no questions from the questionnaire were left out. See appendix D for details.

The initial independent t-test showed no significant differences when comparing group A to group B. To try getting a significant result out of the data some extra things were tried out. First of all the one person who did not see the device at all was left out of the measurements. Then it was looked whether only the male participants could make a difference. (There were only 3 females so this group could not be tested alone.) Unfortunately all of the above trials did not lead to a significant change.

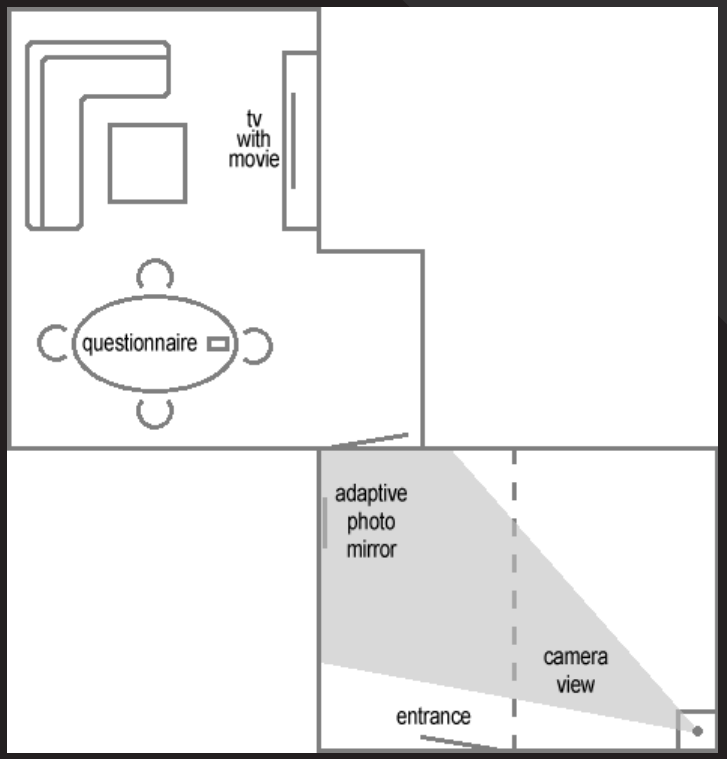
Also no significant correlations between either age, gender, hospitality and fun have been found using the sample. This means they are not related at all. This also has to do with the fact the t-test showed no significant result.

4.9.2 QULITATIVE RESULTS

As the quantitative results show no clear sign of improvement from setting A to B, there were certain insights gained from observations and video material. Unluckily one participant did not see the device at all. Therefore qualitative insight was only gained from 5 participants using the adaptive photo mirror.

From the movements we see that 2 of 5 participants pointed to photos while talking about them.
All participants also talked about the photos, which is a wanted outcome.

Almost all participants, 4 to be precise, saw directly that they were causing the movement of the photos. The last one needed a small tip to be aware of this feature. From the audio material we learn that 4 users also talk about this interaction and say only positive things about it.



It was assumed people would not touch the screen, as it is property of the host and as it is a mirror that easily leaves smudges. In practice it turned out participants also never touched or tried to touch the surface. A full overview of the video observations can be found in appendix E.

4.10 CONCLUSION

Unfortunately, from the quantitative data we cannot say anything about our hypotheses. And from quantitative data it is also hard to defend a solid conclusion. But with this data, it can be said people were surprised and had fun watching the photos with the host. Whether they actually felt more at ease and at home is hard to say with these measurements.

4.11 DISCUSSION

To strengthen the quantitative data results of the test, three future scenarios are proposed. They cover the validation of the made assumptions and one of them gives better insight on different aspects of the design:

1. Increase the sample size. For quantitative research like this, it is advised to have a minimal sample of 30 participants.

2. Change the setup by making it a within study. This can be done by re-inviting the participants letting group A do setting B and group B do setting A. An independent T-test with both groups doing setting A can tell something about the made assumption.

3. Add setting C: A photo frame that will show photos of the host, his visiting friend and things they have in common, without the mirror and it's user interaction. Then change the setup of the test to a within study, just like with option 2. Except group A will now do setting C instead of B. With this option, new conclusions can be drawn about what function of the design, the fact that it shows personal photos with the host or the fact that it moves because of user interaction, causes an effect on hospitality, fun or maybe on both.
The best one is to make it a within study.

In this test the host is the same with every participant. The influence of this effect on this data sample is unknown at this point. As for future research, it can be considered to remove this constant factor and take a look at the global host-visitor relation by choosing different hosts.

While performing the test other possible improvements were noted if the study were to be done all over again:

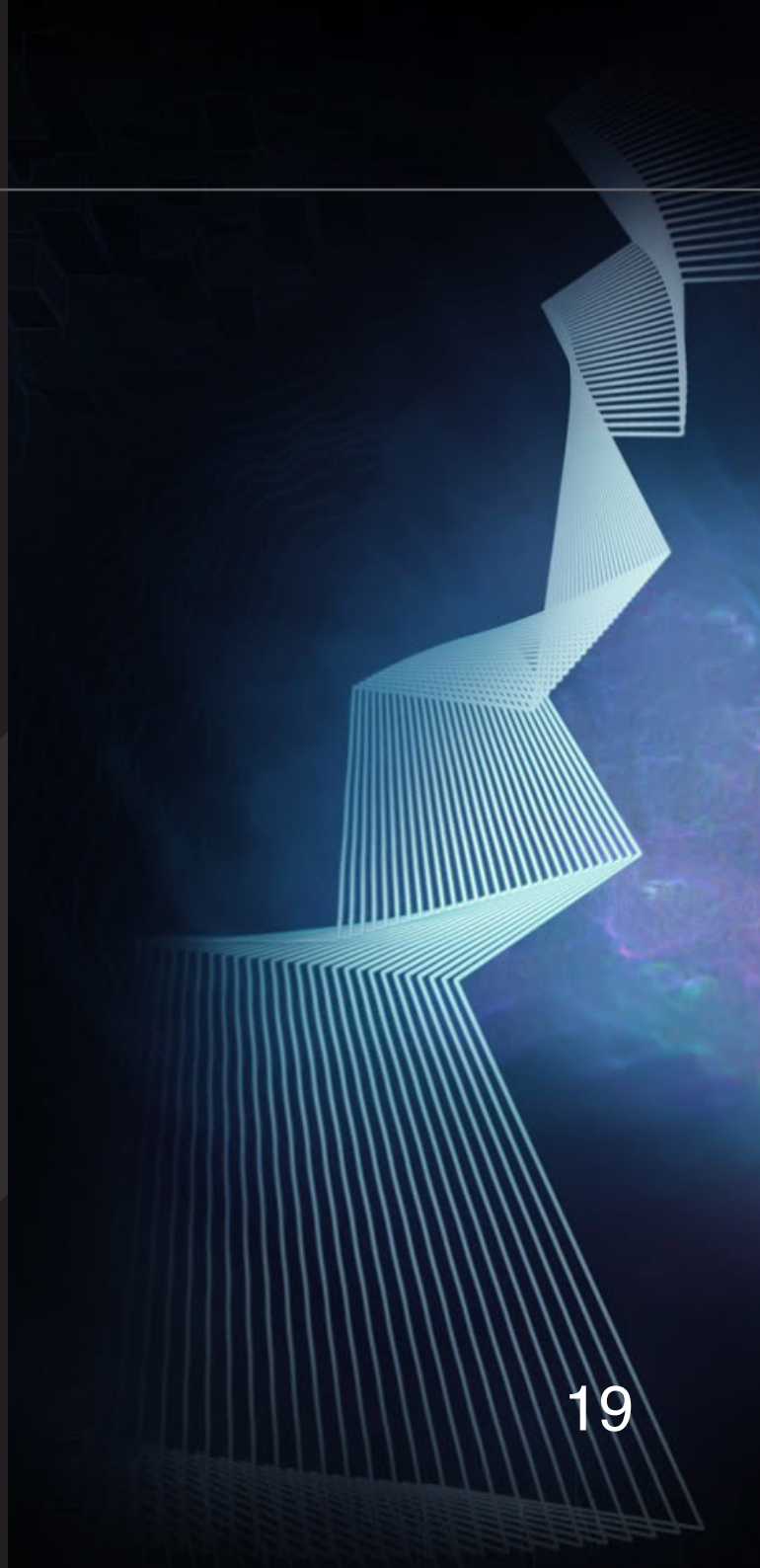
Ask people for their experience in the hallway instead of the overall experience.

Position the mirror in such a way they will definitely mention it.

5. PROSPECTS

Concerning the Sofia project, if the scenario and/or concept as proposed in this report is of interest of other researchers working in this project, it is thoughtful to look at the data streams, the way other products and this device work together and how users can or should make sense of this.

This section will end with some questions. Because further testing is needed to what this concept will do in future guest visits. People will probably not be surprised that much, but they will wonder what pictures the host has prepared for him next time. Will it count that certain photos have already been showed, and if so, how will this work? And what if guests are leaving instead of entering? Also the choice and details from where is the information, the photos, is coming from still is an important question.



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LINKS

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thank all participants for performing my user test.

Matthijs Jansen

Matthijs Jansen Industrial Designer s080008 B3.2 m.g.jansen@student.tue.nl 06 57882690

APPENDIX A: PROCESSING CODE

```
import hypermedia.video.*;
import java.awt.*;
import fullscreen.*;

OpenCV opencv;
FullScreen fs;

String participant = “name”;
int monitor = 0; // 0 = primary monitor, 1 =
external monitor

int wCamera = 320;
int hCamera = 240;

int threshold = 40; // possible to edit this
by dragging mouse

int w = 800;
int h = 600;
int offScreen = 500;

float photoPosition;
int smoothness = 8;
int[] gem = new int[smoothness];

PImage[] photos;
int photoId = 0;

String path;
boolean start = false;

float zoomOffset;
boolean zoomable = false;

int frame = 0;
int fps = 50;
float seconds = 2; // how many seconds for the
photo to change?

boolean troubleshoot = true;
```

```
void setup() {
  size(w, h);
  frameRate(fps);

  fs = new FullScreen(this, monitor);
  fs.setShortcutsEnabled(true);
  fs.setRefreshRate(70);
  //println(fs.getRefreshRates(w, h));

  opencv = new OpenCV(this);
  opencv.capture(wCamera, hCamera);

  imageMode(CENTER);
 path = sketchPath + “/../data/” + participant
+ “/”; // in main sketches folder
  File[] files = listFiles(path);
  photos = new PImage[files.length];
  for (int i = 0; i < files.length; i++) {
     photos[i] = loadImage(path + files[i].
getName());
  }
}

void draw() {
  background(0);
  opencv.read();

  if (troubleshoot) {
   image(opencv.image(), wCamera + wCamera/2,
hCamera/2); // RGB image
          image(opencv.image(OpenCV.MEMORY),
wCamera/2, hCamera/2); // image in memory
  }

  opencv.absDiff();
  opencv.threshold(threshold);
          //image(opencv.image(OpenCV.GRAY),
20+wCamera, 20+hCamera); // abs difference
image
```

```
  // working with blobs
     Blob[]   blobs   =   opencv.blobs(   100,
int(wCamera*hCamera/1.5), 1, false );

  // for each blob
  for (int i = 0; i < blobs.length; i++) {
       Rectangle  boundingRect  =  blobs[i].
rectangle;
    float area = blobs[i].area;
    float circumference = blobs[i].length;
    Point centroid = blobs[i].centroid;
    Point[] points = blobs[i].points;

    if (zoomable) {
     float zoom = map(area, 1, 30000, 0.5, 1);
      zoomOffset += (zoom-zoomOffset)*0.5;
    }

    // map centroid.x into photoPosition
     photoPosition = int(map(centroid.x, 0,
320, -offScreen, w + offScreen));

    if (troubleshoot) {
      // rectangle
      noFill();
      stroke( blobs[i].isHole ? 128 : 64 );
       rect( boundingRect.x, boundingRect.y,
boundingRect.width, boundingRect.height );

      // centroid
      stroke(0, 0, 255);
    line( centroid.x-5, centroid.y, centroid.
x+5, centroid.y );
           line(  centroid.x,  centroid.y-5,
centroid.x, centroid.y+5 );

      // purple fill
      fill(255, 0, 255, 100);
      stroke(255, 0, 255);
      if ( points.length>0 ) {
        beginShape();
         for ( int j=0; j<points.length; j++
) {
          vertex( points[j].x, points[j].y );
        }
        endShape(CLOSE);
      }
    }
  }

  // fill up the gem array
  for (int i = 0; i < gem.length - 1; i++) {
    gem[i] = gem[i+1];
  }
  gem[gem.length-1] = int(photoPosition);

  int total = 0;
  for (int i = 0; i < gem.length; i++) {
    total += gem[i];
  }
  int average = int(total / gem.length);

  // photo array etc.
  if (start) {
    if (frame == fps * seconds) {
      if (photoId == photos.length - 1) {
        photoId = 0;
      }
      else {
        photoId++;
      }
      frame = 0;
    }
    frame++;
    // print photo
    if (troubleshoot) {
      // a bit smaller so we can see blobs
      image(photos[photoId], average, h / 2,
320, 240);
```

```
    }
    else {
      // normal size
      if (zoomable) {
        // zoom function on
       image(photos[photoId], average, h / 2,
w * 0.8 * zoomOffset, h * 0.8 * zoomOffset);
      } else {
        // without zoom
         image(photos[photoId], average, h /
2, w * 0.8 , h * 0.8);
      }
    }
  }
}

void keyPressed() {
    if  (key  ==  '  ')  opencv.remember();
photoPosition = -offScreen;
  if (key == 'f') fs.enter();
  if (key == 'g') fs.leave();
  if (key == 'n') troubleshoot = true;
  if (key == 'm') troubleshoot = false;
  if (key == 'z') zoomable = true;
  if (key == 'x') zoomable = false;
  if (key == 's') {
    if (photos.length > 0) {
      start = true;
    }
  }
}

void mouseDragged() {
   threshold = int(map(mouseX, 0, width, 0,
255));
  println(threshold);
}

public void stop() {
  opencv.stop();
  super.stop();
}

File[] listFiles(String dir) {
  File file = new File(dir);
  if (file.isDirectory()) {
    File[] files = file.listFiles();
    return files;
  }
  else {
    return null;
  }
}
```

APPENDIX B: INFORMED CONSENT FORM

Informed consent formulier

Technische Universiteit Eindhoven
Faculteit Industrial Design

Datum
31 mei of 1 juni 2011

Onderzoeker
Matthijs Jansen

Introductie
Allereerst natuurlijk hartelijk dank voor je medewerking met mijn onderzoek. Jij en Matthijs zijn al enige tijd vrienden en zoals je weet studeert Matthijs Industrial Design op de TU/e. Om nou eens precies te vertellen waar hij zich dagelijks mee bezig houdt, heeft hij je uitgenodigd bij hem thuis om onder andere een filmpje over zijn studie te bekijken. Je accepteerde de uitnodiging en je bent nu bijna bij zijn huis...

Daarnaast moet ik je formeel nog wijzen op het volgende:

Vrijwillige participatie
Je deelname aan dit onderzoek is geheel vrijwillig, en je mag je op ieder moment uitsluiten van verdere deelname. Als je wenst te stoppen met het experiment is het niet noodzakelijk om een reden te noemen voor je besluit.

Vertrouwelijkheid
Alle informatie die tijdens het experiment verzameld zal worden, zal in vertrouwen worden behandeld. Je persoonlijke gegevens zullen niet worden gebruikt in een rapport of openbare publicatie. Daarnaast zullen je persoonlijke gegevens voor geen enkel ander doeleinde gebruikt worden dan gedurende dit onderzoek. Verder zullen je gebruiksgegevens worden geanonimiseerd voordat er statistisch analyse mee wordt uitgevoerd. De informatie die je verschaft tijdens het onderzoek, zal dus op geen enkele manier kunnen worden teruggeleid tot jou als persoon.

Wat je gevraagd zal worden te doen tijdens dit experiment
Op een gegeven moment zal de onderzoeker duidelijk maken dat het experiment voltooid is. Hierna wordt je verzocht een vragenlijst in te vullen.

Risico en ongemak
Voor zover de onderzoeker kan voorzien, zal deelname aan dit onderzoek geen enkel risico of ongemak inhouden.

Bij het ondertekenen van dit formulier bevestig ik het bovenstaande doorgelezen en begrepen te hebben.

_____	_____	_____
Naam	Handtekening	Datum

APPENDIX C: QUESTIONNAIRE

The mentioned items in this quationnaire are part of a 7-Likert scale.

QUESTIONNAIRE

Age: ____ years
Gender: O male O female
Question: in the context of this experiment, I evaluate the complete experience as:

Uncomfortable	Comfortable
Unpleasant	Pleasant
Unsafe	Safe
Awkward	At ease
Unequal	Equivalent
I don't feel like home	I feel like home
The host is unhelpful	The host is helpful
The host doesn't care for me	Host cares for me

Dull	Exciting
Disgusting	Delightful
Boring	Fun
Serious	Playful
Unthrilling	Thrilling
Unenjoyable	Enjoyable
Unamusing	Amusing
Cheerless	Cheerful

APPENDIX D: SPSS DATA RESULTS

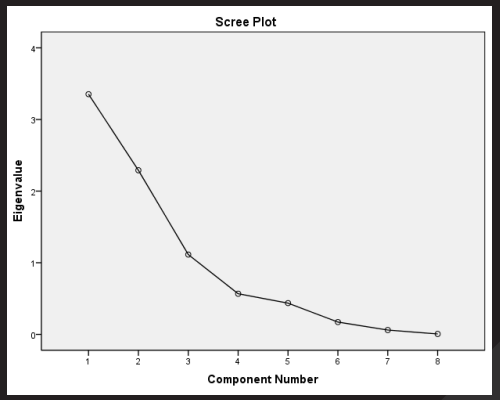
	setting	age	gender	h1	h2	h3	h4	h5	h6	h7	h8	f1	f2	f3	f4	f5	f6	f7	f8
1	2	29	1	7	7	7	7	7	7	7	7	4	4	6	5	4	6	6	6
2	2	23	1	6	6	6	7	6	6	6	6	5	6	6	4	5	6	6	5
3	2	23	1	7	7	6	7	7	6	6	7	6	7	7	5	5	6	6	6
4	2	23	1	6	6	6	6	6	6	7	7	4	5	5	5	4	5	6	6
5	2	24	2	6	6	6	6	7	6	7	6	5	5	6	4	4	6	7	5
6	3	20	2	6	6	6	6	6	6	6	4	4	4	5	5	4	5	4	5
7	1	23	1	6	4	7	6	6	6	6	6	4	4	6	6	2	6	5	6
8	1	21	2	7	7	7	7	7	7	7	7	4	4	7	4	1	7	7	7
9	1	21	1	6	6	6	6	5	6	7	6	5	5	6	4	4	6	6	5
10	1	27	1	6	6	2	5	5	6	7	6	5	6	6	4	3	6	6	6
11	1	22	1	3	5	6	4	4	6	7	7	7	6	6	1	6	3	6	7
12	1	22	1	6	6	6	6	6	6	6	6	5	4	6	4	4	5	5	5

Hospitality

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3,353	41,912	41,912	3,353	41,912	41,912	3,067	38,332	38,332
2	2,291	28,635	70,547	2,291	28,635	70,547	2,185	27,311	65,643
3	1,115	13,932	84,479	1,115	13,932	84,479	1,507	18,835	84,479
4	,567	7,091	91,570						
5	,436	5,455	97,025						
6	,172	2,148	99,174						
7	,060	,756	99,930						
8	,006	,070	100,000						

Extraction Method: Principal Component Analysis.

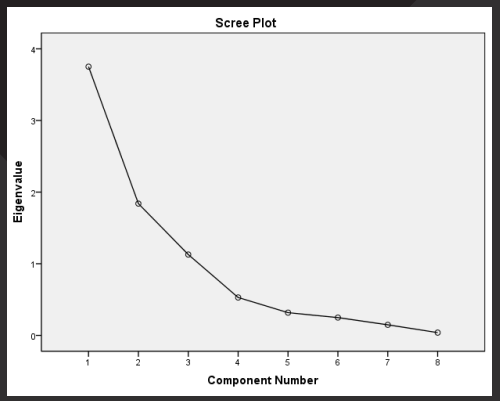


Fun

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3,751	46,892	46,892	3,751	46,892	46,892	3,387	42,342	42,342
2	1,840	22,997	69,889	1,840	22,997	69,889	1,910	23,876	66,218
3	1,129	14,109	83,998	1,129	14,109	83,998	1,422	17,780	83,998
4	,529	6,610	90,608						
5	,317	3,964	94,572						
6	,248	3,104	97,676						
7	,147	1,839	99,515						
8	,039	,485	100,000						

Extraction Method: Principal Component Analysis.



Group Statistics

	setting	N	Mean	Std. Deviation	Std. Error Mean
h1	1	6	5,67	1,366	,558
	2	6	6,33	,516	,211
h2	1	6	5,67	1,033	,422
	2	6	6,33	,516	,211
h3	1	6	5,67	1,862	,760
	2	6	6,17	,408	,167
h4	1	6	5,67	1,033	,422
	2	6	6,50	,548	,224
h5	1	6	5,50	1,049	,428
	2	6	6,50	,548	,224
h6	1	6	6,17	,408	,167
	2	6	6,17	,408	,167
h7	1	6	6,67	,516	,211
	2	6	6,50	,548	,224
h8	1	6	6,33	,516	,211
	2	6	6,17	1,169	,477
f1	1	6	5,00	1,095	,447
	2	6	4,67	,816	,333
f2	1	6	4,83	,983	,401
	2	6	5,17	1,169	,477
f3	1	6	6,17	,408	,167
	2	6	5,83	,753	,307
f4	1	6	3,83	1,602	,654
	2	6	4,67	,516	,211
f5	1	6	3,33	1,751	,715
	2	6	4,33	,516	,211
f6	1	6	5,50	1,378	,563
	2	6	5,67	,516	,211
f7	1	6	5,83	,753	,307
	2	6	5,83	,983	,401
f8	1	6	6,00	,894	,365
	2	6	5,50	,548	,224

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
h1	Equal variances assumed	1,250	,290	-1,118	10	,290	-,667	,596	-1,995	,662
	Equal variances not assumed			-1,118	6,400	,304	-,667	,596	-2,104	,771
h2	Equal variances assumed	1,800	,209	-1,414	10	,188	-,667	,471	-1,717	,384
	Equal variances not assumed			-1,414	7,353	,198	-,667	,471	-1,771	,437
h3	Equal variances assumed	3,061	,111	-,643	10	,535	-,500	,778	-2,234	1,234
	Equal variances not assumed			-,643	5,480	,546	-,500	,778	-2,449	1,449
h4	Equal variances assumed	1,359	,271	-1,746	10	,111	-,833	,477	-1,897	,230
	Equal variances not assumed			-1,746	7,606	,121	-,833	,477	-1,944	,277
h5	Equal variances assumed	2,500	,145	-2,070	10	,065	-1,000	,483	-2,076	,076
	Equal variances not assumed			-2,070	7,538	,074	-1,000	,483	-2,126	,126
h6	Equal variances assumed	,000	1,000	,000	10	1,000	,000	,236	-,525	,525
	Equal variances not assumed			,000	10,000	1,000	,000	,236	-,525	,525
h7	Equal variances assumed	,625	,448	,542	10	,599	,167	,307	-,518	,851
	Equal variances not assumed			,542	9,966	,600	,167	,307	-,518	,852
h8	Equal variances assumed	1,612	,233	,319	10	,756	,167	,522	-,996	1,329
	Equal variances not assumed			,319	6,880	,759	,167	,522	-1,071	1,405
f1	Equal variances assumed	,000	1,000	,598	10	,563	,333	,558	-,909	1,576
	Equal variances not assumed			,598	9,245	,564	,333	,558	-,923	1,590
f2	Equal variances assumed	,034	,858	-,535	10	,605	-,333	,624	-1,723	1,056
	Equal variances not assumed			-,535	9,715	,605	-,333	,624	-1,728	1,062
f3	Equal variances assumed	1,712	,220	,953	10	,363	,333	,350	-,446	1,112
	Equal variances not assumed			,953	7,707	,369	,333	,350	-,478	1,145
f4	Equal variances assumed	,983	,345	-1,213	10	,253	-,833	,687	-2,364	,698
	Equal variances not assumed			-1,213	6,028	,271	-,833	,687	-2,513	,846
f5	Equal variances assumed	4,923	,051	-1,342	10	,209	-1,000	,745	-2,661	,661
	Equal variances not assumed			-1,342	5,863	,229	-1,000	,745	-2,834	,834
f6	Equal variances assumed	2,538	,142	-,277	10	,787	-,167	,601	-1,506	1,172
	Equal variances not assumed			-,277	6,376	,790	-,167	,601	-1,616	1,283
f7	Equal variances assumed	,026	,875	,000	10	1,000	,000	,506	-1,126	1,126
	Equal variances not assumed			,000	9,363	1,000	,000	,506	-1,137	1,137
f8	Equal variances assumed	,625	,448	1,168	10	,270	,500	,428	-,454	1,454
	Equal variances not assumed			1,168	8,288	,275	,500	,428	-,481	1,481

Group Statistics

	setting	N	Mean	Std. Deviation	Std. Error Mean
hospitality	1	6	5,9167	,62082	,25345
	2	6	6,3333	,43060	,17579
fun	1	6	5,0625	,20540	,08385
	2	6	5,2083	,49160	,20069

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
hospitality	Equal variances assumed	,236	,637	-1,351	10	,207	-,41667	,30845	-1,10393	,27059
	Equal variances not assumed			-1,351	8,907	,210	-,41667	,30845	-1,11554	,28220
fun	Equal variances assumed	1,422	,261	-,670	10	,518	-,14583	,21751	-,63047	,33880
	Equal variances not assumed			-,670	6,694	,525	-,14583	,21751	-,66496	,37329

Correlations

		age	gender	hospitality	fun
age	Pearson Correlation	1	-,354	,193	,265
	Sig. (2-tailed)		,258	,548	,406
	N	12	12	12	12
gender	Pearson Correlation	-,354	1	,227	-,291
	Sig. (2-tailed)	,258		,478	,359
	N	12	12	12	12
hospitality	Pearson Correlation	,193	,227	1	,258
	Sig. (2-tailed)	,548	,478		,417
	N	12	12	12	12
fun	Pearson Correlation	,265	-,291	,258	1
	Sig. (2-tailed)	,406	,359	,417	
	N	12	12	12	12

APPENDIX E: VIDEO OBSERVATIONS

#	MOVEMENTS	TALKING (TRANSLATED FROM DUTCH)
1	Starts by standing right in front of it. Moves a little from left to right. Points to a particular photo with his finger.	No way! How cool is that, it follows you. Yes! Check. Yeah I know them all and I see myself passing by every time. It's good to see Thijs on it as well with his tie around his head. Yeah I actually also do not know what the idea was behind that. Cool man! Yes true, we should do such a LAN again.
2	Is surprised to see something moving. Moves a few steps back to see it clearly. Then stands right in front of it. Swings his arms a lot to tell a story. Tries to manipulate the image on the screen with both his hands from left to right and wonders about if that is the right way.	Yess... Ha ha ha. *laughter* Yes, these are nice pictures. Cool thing man! Did you put that one on Eetlijst (a Dutch website) or not? Yes yes. It also moves with you pretty nice. Yeah great man.
3	Notices something moving in the mirror. Stands in front of it. Moves back to see if it was his action. Moves a little from left to right. Walks one step closer to see the photo.	Hey I'm on it. Why am I on it the whole time? Ha ha ha. *laughter* Hmm. Nice.
4	Notices something moving and stops walking. Points to a photo with his finger. Points to another photo with his finger. Moves a little from left to right. Points to the last photo and leaves.	Cool. I am on it. Awesome. I think that photo is from the complex barbeque of two years ago. You made that one. It moves with you pretty nice. Hey, you're on it. You're standing right there dude!
5	Notices something moving in the mirror. Laughs and walks past by moving to the right. Takes a step back to the left. Moves her hand from right to left to explain she thinks it's weird the photo is only shown half. Moves to the left because she is told to try it out. Notices she is causing the photo to move and is surprised. Moves a little from left to right.	Cool! Oh also from the carnaval. And this one! Ha ha ha *laughter* Yes, yeah those are pretty blurry. Oh yes, I was just gonna say that I've been cut off on this one. Ha ha ha. *laughter* Huh. Oh. Hey! Cool. Yes most of the time it's like that.
6	This participant did not see the device at all.	And also did not talk about it.

MOVEMENTS LEGEND
Orange = Notice the device.
Red = Try out the interaction.
Green = Point to a particular photo.
Blue = Take a step closer to see it more clearly.
Black = No clear pattern.

TALKING LEGEND
Orange = Notice the device.
Red = Talks about the interaction.
Green = Talk about a particular photo.
Black = No clear pattern.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