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**Faculty of Electrical Engineering,
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How to Design an Interactive Installation for Concordia

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Creative Technology BSc Thesis
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Abstract

This is a bachelor thesis for the study Creative Technology at the University of Twente. Other stakeholders of this project are 100%FAT and Concordia. Concordia would like to have more visitors in their public art gallery. To achieve this they want to create more brand awareness with an interactive installation on their facade and 100%FAT will realize this for them.

The motivation for this research is to have a design of a successful installation. This project's goal is to make valuable design choices for an interactive installation on the facade of Concordia that provokes participation of passersby. The challenge is to find elements that are successful in getting the attention of passersby and provoke them to participate. The approach that was chosen is a literature research combined with an ideation in context. Additionally, a user test is performed in front of the art gallery with a prototype.

One result is a set of important elements for an interactive installation in public, applicable to the situation of Concordia. Another result is a set of elements of content that are generated for the installation for Concordia and are likely to be successful with provoking participation.

Important elements that stick out are a pro-active state, a layered approach, guidance and a flow experience. The report concludes that the tested design choices are successful.

Preface

First of all, I would like to thank you, the reader, for taking some time of your undoubtedly busy life to take a look at my masterpiece.

For a Creative Technology student, this research project was very challenging and interesting. The combination of design, human-technology interaction, art and smart technologies is very applicable to CreaTe. The space for exploration of these subjects and the facilities provided by 100%FAT formed a perfect research environment.

I had a nice cooperation with Jelle Wolbers with the user tests among other things, for that I am grateful.

One of the many things I have learned during this project is that being on a tight schedule is not necessarily an issue, until it starts to snow. The user test had to be postponed because of heavy snowfall, what are the odds? One thing I will definitely implement in my next prototype is snow resistance.

It goes without saying that if you do not understand something in this report, or if you think something is not correct, it is probably your own fault. You probably have not spent several months researching this subject, I have. If you have too, please contact me if you do see something incorrect.

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Introduction

Interactive installations are widely used by artists and museums. Not only can they provide a story or show a piece of art or design, they can give an entire experience. Artists have been using them for centuries, consisting of complex mechanisms to be able to create interactions. Nowadays, this is usually done with digital sensors and actuators attached to a computer. Due to the rapid developments of digital electronics and microcontrollers with open source software development kits interactive installations become more and more popular for hobbyists and school projects. Also companies are increasingly using interactive installations, mostly for marketing purposes. As people are getting tired of commercials and advertisements in the media, companies try to get brand awareness with interesting interactive experiences in public places. Bringing us to Concordia.

Concordia is an organisation that provides film, arts and theatre in Enschede. One of their locations is a public art gallery for modern arts at the Langestraat in the city centre (see Figure 1.1). The art gallery is free for everyone and also facilitates a shop. Their goal is to get people in touch with arts. Despite the fact that it is a free gallery, they are unsatisfied with the amount of people visiting their exhibitions. It is concluded that a reason for the low amount of visitors is that people are not aware of their existence, or their free exhibitions. They want to solve this with an interactive installation on their facade.

The company that will create the installation is 100%FAT. FAT stands for Fusion of Art and Technology. This company is specialized in custom installations for museums, galleries and festivals. These installations can have different purposes, however, all consist of technology implemented in a creative and artistic way. 100%FAT is the initiator of this project.

Early in the project, Concordia chose to have a kinetic game on their facade. This became the subject of the research, after which the questions were formed. The game needed to consist of several segments which are connected like a Rube Goldberg Machine. Rube Goldberg was a cartoonist that drew constructions that

Figure 1.1: Concordia's art gallery

performed simple tasks in a complex and redundant way. They consisted of several elements forming a chain reaction to perform the task at the end. The focus of this project, however, was not to design a gamified chain reaction. It focused on the participation and interaction of passersby with the installation.

The stakeholders of this project are Concordia (client), 100%FAT (initiator) and the Creative Technology department of the University of Twente. During the project the broader context of interactive installations in public was researched and interviews with experts were conducted. Relevant elements for the installation for Concordia were explored and a set of design choices was presented.

Jelle Wolbers was also involved with the installation for Concordia. We both had our own project and did our own research.

1.1   Motivation

This research is commissioned by 100%FAT. The motivation of this company is that this research can contribute to design choices that have to be made for the content and implementation of the kinetic game on the facade of Concordia. Furthermore, the research can be a tool for evaluation of their current methods and design choices in future projects.

The client for the project of 100%FAT is Concordia. They want to have an interactive kinetic game on their facade to create more brand and existence awareness, leading to more visitors eventually.

This project is a bachelor thesis graduation project for Creative Technology BSc at the University of Twente.

1.2 Goals and Challenges

Concordia wants to have more visitors in their free public art gallery for modern arts. To achieve this they want to create more awareness of people passing by their art gallery. Awareness that they exist and facilitate exhibitions for free. With the use of a kinetic game on their facade Concordia wants to get the bypassers' attention so they get aware of Concordia and their exhibitions.

Despite the fact that there are undoubtedly a lot of alternative methods to this end, the interactive kinetic game is given for this research. Prior to this project Concordia decided to have an interactive installation on their facade. In the early stage of this bachelor project, prior to the research still, several meetings and a first brainstorm resulted in Concordia choosing the kinetic game. After this moment the research subject and questions were formed.

The goal of this project is to make valuable and decisive design choices for the kinetic game on the facade of Concordia. This includes firstly to find ways to get the attention of people going from a to b, passing by in a busy street. Secondly, to find elements for the installation to feature that contribute to or are relevant for people's participation with an interactive installation in public. Lastly, to translate these elements into design choices that create Concordia's desired effects on the bypassers of their art gallery at the Langestraat. The project results in a design concept that is partially tested with a prototype.

Technical challenges include that the game must tell a story, and is successful in busy and quiet moments and in bright sunlight and poor light by night. The prototype needs to be as representative as possible of the final installation by including all the relevant design choices. The technical challenges that are brought by the fact that it will be an installation outdoors such as weather proof and vandalism proof are not incorporated in this project.

1.3 Research Questions

1. What elements must an interactive installation in the form of a kinetic game on the facade of Concordia have to provoke participation of passersby?

   1.1 What is the goal of the installation?

   1.2 What is the target group for the game or goal?

   2. What is needed to get the attention of passersby?

   3. What invokes people to participate with an interactive installation in public?

      3.1 What is needed to let passersby deviate from their current activity and
          step out of their comfort zone to start participating with an installation?

      3.2 What is relevant for the user's experience with an interactive installation?

      3.3 What sort of content is best suited for an interactive installation in public?

   4. How can this be translated into a design for the kinetic game for Concordia?

1.4 Methodology

The research method is conceivably different compared to a traditional bachelor
thesis. The thesis starts with the usual extensive analysis that describes a literature
research, resulting in a set of requirements. Then, the design and implementation
chapter describes the unusual conceptualize- and design process which involves
a lot of creative brainstorming and tinkering, which was ongoing during the entire
research project. Brainstorming and tinkering can be (and proof to be) powerful
tools for a Creative Technology student [1]. The final prototype, created according
to the requirements, was built, tested and evaluated in a CreaTe fashion. This de-
sign process of ideation, specification, realization and evaluation is a typical method
for CreaTe [2] and is proven to be successful for me. The functionality of several
elements of the final prototype were tested by creating prior prototypes. The thesis
ends ordinarily with a conclusion and recommendations.

1.5 Report Organization

Chapter 1 describes the context of the project and its goals and challenges. Chap-
ter 2 describes an in-depth research on interactive installations resulting in require-
ments that follow from the goals. In Chapter 3 an extensive ideation process is
documented, following by the development of a prototype. Chapter 4 reports the
evaluation of this prototype with a user test. In Chapter 5 the conclusions of both the
research and the user test are given. Lastly, Chapter 6 reflects on the results and
conclusions, and gives recommendations to 100%FAT.

Chapter 2

Analysis

In this chapter an in depth research is documented about important aspects of interactive installations in public. Important factors and elements for designing a successful installation are discussed. Relevant existing installations and technologies are explored. Finally, requirements have been made according to the research and goals of the project.

2.1 Terminology

Interactive installation An interactive installation is a physical construction which a person can interact with. The person interacting, in this paper referred to as user, can communicate with and/or control the installation with the use of touch, sound, movement, speech or gestures. Often the installation consists of a game of some sort or tells a story. Interactive installations are most commonly used with art expositions and museum exhibitions.

Participation Participation in the context of this report is meant as being involved with an interactive installation as user or audience. The user is participating by interacting or controlling the installation. The audience is participating by watching and listening to the installation. This can be with or without an active user (see figure 2.1).

2.2 Theory - Participation

This paper focuses on the interactive experience, the interaction between human and technology and how to trigger people to engage and participate. Several disciplines were explored such as Human Computer Interaction (HCI), Human Robot Interaction (HRI), Interaction Design (ID), Psychology and Social Philosophy.
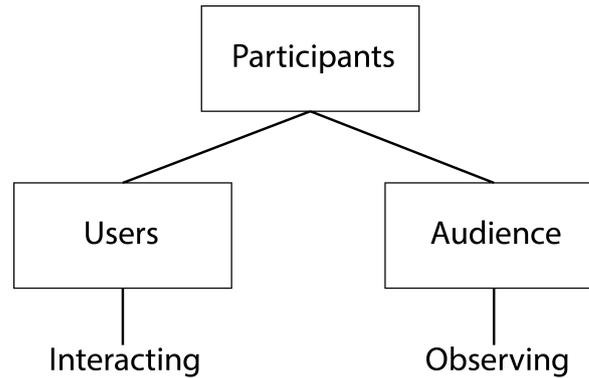
Figure 2.1: Participants

2.3 Relevant Models of Interaction and Human Behaviour

The Lens of Ludic Engagement Adds a way to add the intentions of an artist to a commonly used iterative design cycle in ID and HCI for designing an interactive art installation. This commonly used process starts with prior knowledge combined with fieldwork, out of which a design is made and deployed. This deployment is observed out of which a new improved design is made and deployed. The priorities of the artist are added to the 'field work' part of the iteration cycle (see figure 2.2). This way the design also gets adjusted by the intentions of the artist along the way, rather than only the findings about the users [3].
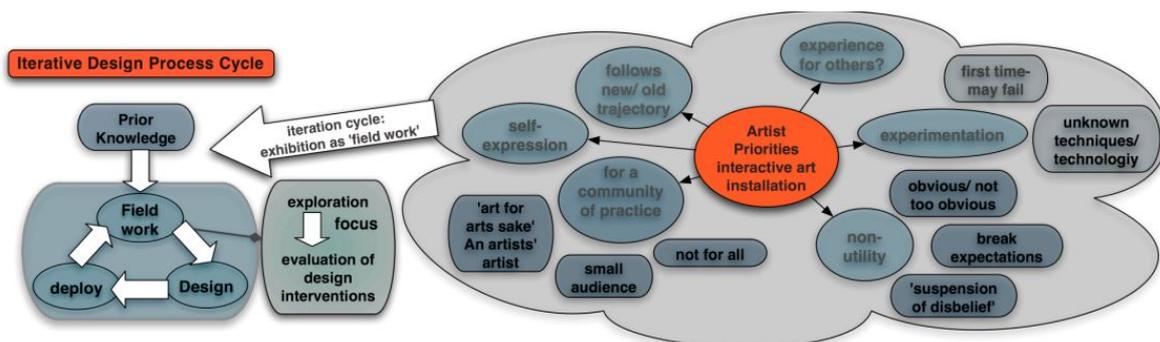
Figure 2.2: The Lens of Ludic Engagement

The Curiosity Process The Curiosity Process, developed by Tieben, Bekker and Schouten (2011), visualizes 5 main principles for evoking curiosity in a process of exploration (see figure 2.3). The 5 principles are; 1. Novelty, novel experiences. 2. Partial exposure, gap in knowledge or incomplete information. 3. Complexity, interpretation and exploration. 4. Uncertainty, surprise, doubt and

predictions. 5. Conflict, violation of expectations or incompatibility between ideas [4].
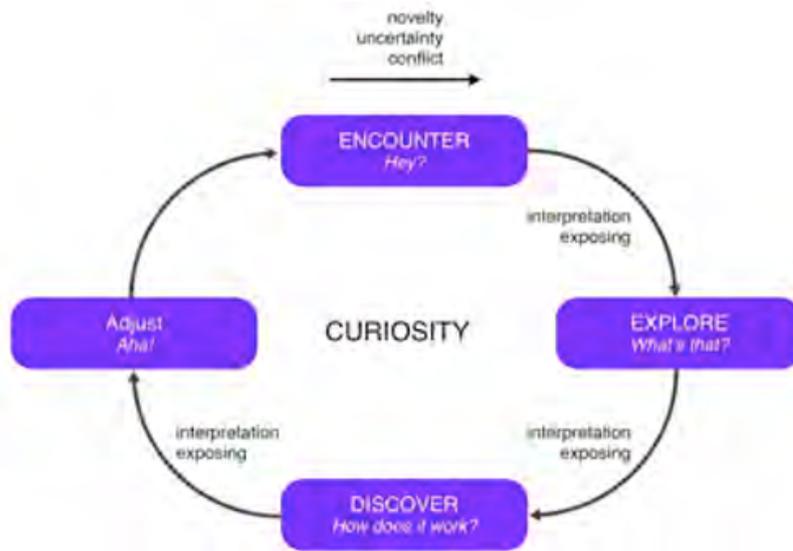
Figure 2.3: The Curiosity Process

Stages of Play   The stages of play model is developed by de Valk et al. (2012) for designing open-ended play (see figure 2.4). It describes three stages; invitation, exploration and immersion. In the invitation stage potential players are made curious with actions that indicate a possibility of interaction. In the exploration stage players start interacting and try out all possibilities. Lastly, the user enters the immersion stage, where players are entirely focused on the game. They are willing to follow game rules and lose sense of time [5].
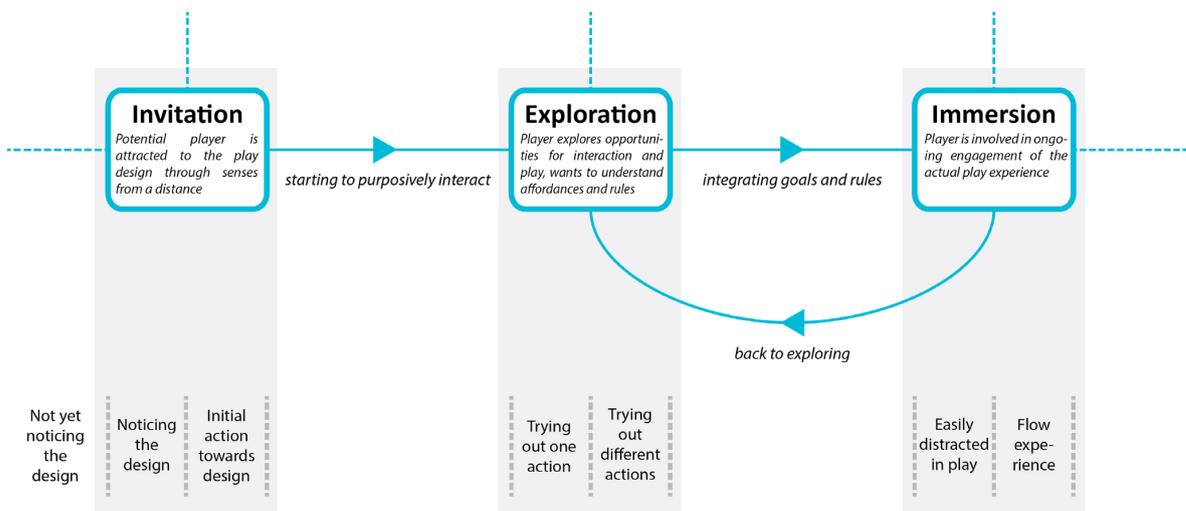
Figure 2.4: Stages of Play Model

Persuasive System Design   The Persuasive System Design model, developed by
Oinas-Kukkonen and Harjumaa (2009) is used to design persuasive technol-
ogy (see figure 2.5). With the model context based features can be designed
for a system to change human attitudes or behaviour. It is based on 7 pos-
tulates; 1. Information technology is never neutral. 2. People like their views
about the world to be organized and consistent. 3. Direct and indirect routes
are key persuasion strategies. 4. Persuasion is often incremental. 5. Per-
suasion through persuasive systems should always be open. 6. Persuasive
systems should aim at unobtrusiveness. 7. Persuasive systems should aim at
being both useful and easy to use.

With the use of a persuasion strategy and a selection of persuasive design
principles requirements are formed for a system [6].

Figure 2.5: Persuasive System Design model

2.4   Breaking interactivity apart - Strategies and Components

After studying interactive art installations in public spread globally, Jaccuci et al.
(2010) point out that there are two segments in interactive installation design; strate-
gies and tools. The strategies stipulate the interaction, engagement, participation
and experience of the user. The tools, in this paper referred to as components, can
be used to carry out a strategie. This paper analyses both segments. First strategies
to create an interactive content are discussed, then strategies to present this con-
tent. Last, commonly used components for interactive installations are discussed.

2.5   Strategies for the content

Jaccuci et al. (2010) found seven strategies and techniques that were used for the
content of interactive installations in public; affording connectivity, enabling author-
ship, interacting with artificial beings, reinterpreting the visitor world, engaging in
performative acts, use of space and playing with materiality [7]. These strategies
are discussed below.

2.5.1 Affording connectivity

The first and most obvious strategy for an interactive content is affording connectivity. Using sensing and signalling technologies to connect with the user. The installation 'listens' to the user with the use of sensors and 'talks' using sounds, lights and motion. The user listens and talks back with touch, sound, speech, movement and gestures. Understanding the user is important to give the right feedback. To create a successful interactive interface, it is necessary to sense and interpret the physical activity of the user, and learn as much relevant information as possible about her. However, it is important to keep in mind that people are not automatically willing to give a lot of information about themselves [8].

2.5.2 Enabling authorship

The user fills in the content of the installation. This can be done by collecting input from all users, letting the user interact with herself or a collaborative interaction (interaction between two or more users at the same time). Visitors of an interactive exhibition can have a more active participant role when they can contribute to it [9]. Content can also be provided with the use of social media [7]. A big problem with user-generated content is however, especially with collected input over time, the user participation inequality. A small part of the users creates the greatest part of the content [10]. According to Floris Schreuder, expert in interactive installations, enabling authorship can increase the commitment and involvement of users of interactive installations. However, when placed in public this effect can be different because of the user's fear of embarrassment. Dr Annemarie Braakman-Jansen, Senior Lecturer in Psychology at the University of Twente, states in an interview that the sense of privacy is an issue with this strategy in public. People are afraid to show something of their inner self to strangers. Still, she states that if users can be given a choice it could contribute to the willingness to participate.

2.5.3 Interacting with artificial beings

Creating an environment in which the user interacts with an artificial being. This can be a (small) animal, human or some imaginary creature, both physical and virtual. The being reacts to the user with the use of an artificial intelligence, and could be self-learning to improve the interaction with each user. The user personalizes the being and can identify herself with it. Cramer et al. (2010) argue that emphatic response of a social robot to the experience of a user is key in creating trust and compliance of the user. However, they found that inaccurate responses can have negative effects on the user's attitude towards the artificial being, creating

distrust [11]. In order to create accurate behaviour the robot should be able to react responsively to the user's actions. Inter-predictability and common ground are important factors. An important tool for such a robot is a dialog manager. A great part of its behaviour is based on the progress of the social conversation with the user. A dialog manager uses a behaviour script such as the Behaviour Markup Language [1]. This dialog manager and other robot control mechanisms (e.g. sensing) must react and adjust instantly in order to have a well functioning social robot [12]. Cramer et al. (2010) conclude in their research that if there is a high uncertainty whether the response is accurate, social behaviour is best left out [11]. Making the artificial being only good for decoration. Still, allowance for personification by implementing a being in the design (social responsive or not) can have positive effects [7].

2.5.4   Reinterpreting the visitor's world

With the use of live video and audio footage the environment and the reality of the user can be altered. The user can be mirrored, placed in a virtual environment or the space the user is in can be altered using Augmented Reality.

2.5.5   Engaging in performative acts

The users participate in a collective performance. One will participate because the others do it too. The effect of the installation will depend on the number of people participating. Floris Schreuder argues that most of the times this will not work because adults are too reserved. He gives an example of one of their projects called Virtuescope[2]. A big problem they encountered was that adults were too reserved to grab the device and start using it. Annemarie Braakman-Jansen argues that people are unlikely to engage in collective performative acts. However, she states that modelling could help. For example if someone or something first demonstrates the act. Persuasive features (see section 2.3) could have positive effects.

2.5.6   Use of space

The experience of an interactive installation could be different when one is participating with it alone, or with other people. Also, the configuration of participants could influence the experience. For example, one user with a great audience could give a

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[1]*Behaviour Markup Language* Accessed on 15 January 2017 `http://www.mindmakers.org/projects/bml-1-0/wiki`

[2]*VirtueScope by 100%FAT* Accessed on 20 December 2016 `http://100fat.nl/portfolio/virtuscope/`

different overall experience than several users with a small or no audience. There-fore, the use of space can be very important. The key is to know exactly how many participants are desired in the total space and what their position must be in relation to the installation. Annemarie Braakman-Jansen argues that social pressure can cause for different behaviour and experiences.

2.5.7 Playing with materiality and forms

What kind of material and forms (raw, smooth, liquids, colours) are used can influ-ence the experience [7]. Some material could invite engagement, other material could scare people away. Karen Drost, specialist interactive museum presentations at Nederlands Instituut voor Beeld en Geluid (Dutch National Institute for Audio and Video), explains in an interview that she uses spectaculair forms to get people's at-tention. Kees de Groot, video-artist and organiser of interactive art festival Gogbot[3], states in an interview that people can easily be afraid, disturbed or even enraged by the choice of material. He gives an example of one of his own projects where he installed loudspeakers in an underground World War II bunker with loud explo-sions and shooting noises. Some visitors were literally afraid. Another example he mentioned was the graffiti-artist Hugo Kaagman that placed, alongside many other logos, the IS logo on one of his works. This work received a great deal of commotion after which the artist was forced to remove the logo [13] [4].

2.6 Strategies for the approach

Content is not the only decisive factor for interaction. Also the approach of pre-senting the content plays an important role. Research and interviews on HCI and ID revealed guidance, pro-activity, a layered approach, persuasive system design, flow experience, suspension of disbelief and choosing a target group as important strategies when designing an interactive installation in public. These strategies are all coherent with the Stages of Play model (see section 2.3). In section 2.6.2 and 2.6.3 the model is linked to the strategies.

2.6.1 Guidance

An interactive installation is unable to succeed in its goal if the user does not know what she has to do, or what the goal (for the user) is. Karen Drost shares that one of

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[3] *Gogbot Festival* Accessed on 27 January 2017 `http://2016.gogbot.nl/`

[4] *Commotie om kunst met IS-vlag* Accessed on 27 January 2017 `http://www.telegraaf.nl/binnenland/24104859/__Ophef_om_kunst_met_IS-vlag__.html`

their installations was unsuccessful because visitors did not understand the context and goal of the installation. Morrison (2007) observed that visitors with no experience with interactive installations had an interaction with the system that was more about how it worked, rather than what it did. This same audience also engaged the installation as if they had to perform a test [3]. Providing information on the context or goal, how to use the installation or what the user is expected to do could solve this problem. Kees de Groot states that it is necessary to guide visitors now and then. According to Floris Schreuder adults often do not even do anything, engage the installation, if they are not told to do something. This guidance, however, is best concealed in the installation, without any literally explanation. Dr ir Edwin Dertien, assistant professor and scientist in Robotics and Mechatronics at the University of Twente, argues in an interview that "the moment an installation needs an explanatory text, it is not a successful one". Elles van Vegchel, responsible for Presentation and Collection at NEMO Science Museum in Amsterdam, shares in an interview that people usually do not read any long texts. According to her the installation should work intuitive. Video game designers have to cope with the same problem. The moment a player has to read an explanatory text the flow of the game is interrupted. A common solution for this is that the user learns how the game works while playing. With each level, step by step, the game reveals extra information or functionality [14]. A similar approach is used in interaction design for public installations. This approach, further discussed below, is not only key for guiding the user during the interaction, but for the interaction as a whole; a layered approach.

2.6.2   Invitation: pro-activity and a layered approach

Suitable strategies to get the attention and provoke engagement are crucial for interaction. Dennis Reidsma, Assistant Professor Human Media Interaction, University of Twente, stated in an interview that in order to get awareness and provoke interactivity, an installation must be pro-active. It must perform actions even when there is no user interacting with it. Floris Schreuder too argues that action and motion are important in the idle state. He states that "it has to be cool even when nobody is pressing any buttons". De Valk et al (2015) call this provoking the invitation stage (see section 2.3). They argue that it has to be clear for potential users that they are supposed to interact with the installation. Sound, light and familiar shapes (they give an example of a wheel that provokes the action of turning it) can be tools to achieve this awareness [5].

Once the potential users are aware of the interactivity in the installation, they have to be tempted to participate. For this, the complexity of the interface is important. If the system is hard to understand, beginner users (no experience with the

installation, or installations in general) might not know where to start and stay away. If the system is too easy, experienced users might lose interest due to a lack of challenge. Additionally, when the design has a static middle way between simplicity and challenge there is a great chance that all the users lose interest. A layered approach can solve this problem. With the invitation stage as described above being the first layer, revealing the goal and rules as the next layer and later step by step adding challenges [14]. Edwin Dertien points out that an interactive installation must start with a low level of complexity for the first interaction, to increase the complexity along the way. He states that you have to "tease" the users on a subtle way, slowly revealing all the things they have to do. De Valk et al (2015) argue that there needs to be a guidance through the interaction process in a way that the user slowly gets to know the possibilities of the installation [5].

Oinas-Kukkonen & Harjumaa (2009) describe how to change an attitude or behaviour in their Persuasive System Design model (see section 2.3). In the case of the invitation stage the attitude of the passerby towards the installation needs to be changed from 'aware of interactivity but not engaging' to 'aware and engaging'. Applicable elements from the Persuasive System Design model to the invitation stage are that the system should be easy to use, it should seem unobtrusive, the goal or message should always be open and the persuasion should be incremental [6].

A layered approach can first provoke engagement by changing the attitude of passersby aware of the interactive installation due to a low level of complexity in the beginning. This way the system seems unobtrusive for people traveling from a to b and the potential user (experienced or not) immediately understands what she has to do. Next, by revealing functionality step by step the user is guided through the possibilities and by increasing the complexity and challenge the user stays interested and persuaded to keep on interacting.

2.6.3   Exploration and immersion: flow experience

After the invitation stage, the layered approach as described above brings forth an increase in interactions and challenges. De Valk et al. (2015) describe that the user first enters the exploration stage where she tries out the interactive possibilities of the design. Next, when focusing merely on (an interactive process of) the installation she enters the stage of immersion (see the Stages of Play model in section 2.3). In order to create a successful experience and keep the user interested the immersion stage should include ways to go back to the exploration stage to start exploring a new interaction process [5]. Karen Drost argues that in order to keep the user interested it is important to constantly add new activities with surprising elements and rewards. Polaine (2010) argues that interactive works are successful

when there is a continuation of new interactive actions. Additionally, if the user is not aware of this switching between stages and actions she will experience the interactions like an "intuitive flow experience" [14]. A flow experience implies that one is totally absorbed (immersed) in one's current activity. It is the ultimate state designers and artists want to achieve for their users or audience, since the attention for the installation and the experience are at its maximum. The most important element for such a flow experience is that the experience is rewarding in itself, satisfying the one experiencing without any additional rewards [15] [8]. Additionally, Elles van Vegchel states that the user should be rewarded instantly, without any wait. In the case of an interactive installation the rewarding part is a new, more challenging interactive process (a new layer) after having solved the previous one. This flow theory is first introduced in 1990 by Csikszentmihalyi. He describes eight conditions for the flow experience which, according to Nijholt et al (2005), every game should consist of. Brought into context of an interactive installation these conditions are [16]:

1. The user must have a chance of completing the action she has to perform.

2. The user must be able to concentrate while she is interacting.

3. The task of the user must have a clear goal.

4. The installation provides immediate feedback after each action performed by the user.

5. The user acts with such an involvement, that it removes the awareness of everyday worries and frustrations.

6. The user thinks she is in control over her actions.

7. The user has no concern for the self.

8. The user has an altered sense of time.

A ninth condition or factor for the state of immersion and flow could be the 'willing suspension of disbelief' [15]. The willing suspension of disbelief, introduced in 1718 by Samuel Taylor Coleridge, is originally the willingness of an audience to pretend a theater play or the story of a novel is the reality. Nowadays it is applicable to, and an important factor for, other disciplines as well such as film, gaming, interactive arts and live action role play [17]. When the interface of an installation is not coherent with the story or experience the installation is providing, or there are flaws reminding of the real world, the willing suspension of disbelief of the observer or user will disappear and she will be drawn out of the experience. When the user is out of the experience, she loses interest and the goal of the installation is unlikely to be

achieved. If an interactive installation has a certain goal, the design must enable the user to reach a flow experience.

2.6.4 Target group

How people react on an installation is different for each person. Floris Schreuder argues that there is for instance a big difference between adults, who often act reserved, and children who often spontaneously touch anything. It is important to implement this knowledge in the design.

It might seem self-evident that an interactive installation should reach as many people as possible. However, from psychological perspective this is not the best way to go. Annemarie Braakman-Jansen argues that narrowing the target group can increase the efficiency of the installation. That is, if the installation has a goal other than being seen. According to her it is best to first find the exact target group and their wishes and expectations. Then, the installation can be designed accordingly. Indeed, Jorge et al. (2015) observed that travelers on an airfield only looked at the installation with mechanical display because they thought it had some useful information on it. The moment they discovered it was not what they expected, they looked away. Making the goal or wish of the passersby decisive on whether they are interested in the story told by the installation [10]. Morrison (2007) found that the users' opinions about her installation were connected with their profession. She argues that the detailed feedback from her users with their backgrounds proved to be the most useful information she found [3]. Tieben et al. (2011) found in their research that the amount of curiosity for their installation depended amongst two context related factors (physical characteristics and social environment) mainly on the user characteristics, curiosity openness (occupation at that moment) and user expectations [4]. By defining a target group one can identify the specific corresponding properties of these factors and include them in the design.

Furthermore, when the target group is defined, one can predict their behaviour from their intentions using the Theory of Planned Behavior[5], first introduced in 1975 by Fishbein and Ajzen [18]. These intentions are formed by the attitude toward the behavior, subjective norm and the perceived behavioral control. The attitude depends on the knowledge and prejudices of, in this case, the installation. The subjective norm is about social pressure, when others are looking one could decide not to take the risk, in this case use the installation. Perceived behavioral control is about self-efficacy and confidence. When there is no self-confidence one is not likely

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[5]*Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research.* Accessed on 15 December 2016 `http://people.umass.edu/aizen/f&a1975.html`

to engage in an installation in public [19]. When these three aspects are known, it is possible to fine-tune the design for the target group and get high efficiency (see figure 2.6).

Still, this behavior prediction is only based on conscious intentions. Annemarie Braakman-Jansen argues that behaviour based on emotions, not included in this theory, is more decisive. Unfortunately, this kind of behaviour is unpredictable.
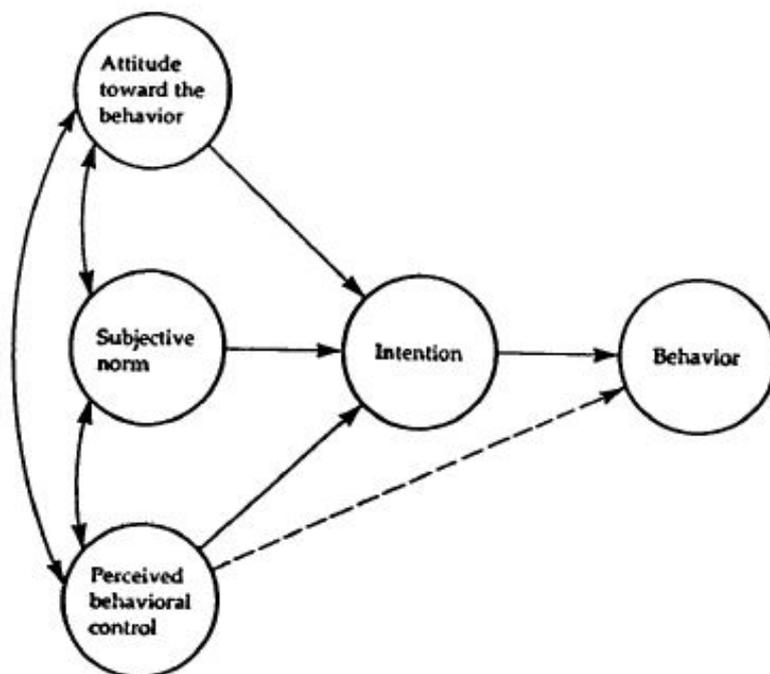
Figure 2.6: Theory of planned behavior

2.7   Components for interaction

In this section the components that are commonly used in interactive installations are discussed.

2.7.1   Sensing and communicating

Sense and communication technologies are essential for an interactive experience. Basic sense technologies that are used for interactive installations are touch, proximity, sound, light, pressure (physical), moisture and temperature. Often more advanced sense technologies are used as well such as motion tracking [7], brain imaging, gesture recognition, facial expression recognition and physiological information

processing to measure the user's experience. The latter three are often used to improve the communication to create a natural experience. Other technologies that contribute to this natural communication are speech recognition and language technologies such as the above described dialog manager [8]. Finally, wireless communication technologies can be used for user's input and functionality of the installation itself.

2.7.2 Video

In interactive art installations video feeds are often used to alter the experience of the user in her surroundings, by bringing the visible and invisible and the past and present together [7]. A way to alter the user's environment is Augmented Reality (AR). AR adds digital content to the real world. It is created with projectors, displays, head mounted displays and handhelds such as smartphones. Video in general can be a powerful tool to tell a story if, however, it is used the right way. The usage of video and displays in public brings a great number of practical challenges, such as visibility in bright light and using the right size [20]. In addition, there is another problem with displays in public; display tiredness.

Muller et al. (2009) found that displays in public are often ignored because the passersby expect uninteresting content (for them) such as commercials. They divided several displays in 11 public display locations spread over Munster, Germany which showed advertisements or informative shows. They conclude that whether the passerby finds the content interesting is of even higher importance to get the attention than the practical limitations such as visibility in bright light [21]. Which could mean for an interactive installation that the user must be made aware that the content on the display is about the installation. Making a screen in any case not the right tool for attraction or the first interaction. Jorge et al. (2015) argue that it is best to totally avoid digital displays or projectors for public storytelling, and to use mechanical displays instead [10].

Still, once the attention of the passerby or user is caught, a screen can provide a great deal of information in little time. If one should decide to implement displays, Bendinelli and Patern (2014) describe nine aspects that need to be considered when placing a display in public. The first is position. A lower placed screen for example, is more suitable for showing a long text than a higher placed screen. Second, time. The period the information must be shown depends on the kind of information (e.g. a text or an image). Third, the type of information. This must be carefully selected to meet the goal of the screen. Fourth, number of information items. The right balance between dull (low information) and chaotic. Fifth, the structure of the text. Sixth, the visual layout and dimension. The screen dimensions need to be carefully chosen

and fully utilized. Seventh, the colours. The colours need to be inherent with the message or the goal of the screen. Eighth, the font of the text. Lastly, dynamicity. The right balance between dynamic and static [22].

Considering a video screen for an interactive installation in public, all of these nine aspects could indeed be of influence to the user's experience. A tenth aspect then could be the practical challenge of visibility in bright light as mentioned above. When all ten aspects are covered (given that the screen or its content is not meant for the first interaction), one could say that video can be implemented successfully.

2.7.3   Sound

Another powerful tool to get the attention and share information is sound. Jorge et al. (2015) used a mechanical display to tell a story on an airport. They observed that a great deal of travelers passing by took a glance at the installation when they heard the, as they call it, "characteristic mechanical flaps sound". Nine out of 157 travelers, beside turning their head and read the content, also approached the installation [10]. A recognizable sound can carry a message about a situation that people apprehend instantly. The flapping sound of the mechanical display for instance, suggests that there is some new information displayed. A cheering sound tells people that there is something exciting going on. Recognizable sounds are commonly used as tool for getting attention and guidance. A phone ringing indicates that someone is calling, and that the user can pick it up for a conversation. A siren warns people in traffic to make way for the emergency services. Hearing the recognizable sound, people know immediately what it is and what they can or have to do.

2.7.4   Light

Undoubtedly light cannot be absent in the list of commonly used components for interactive installations. Adding light can boost messages. It can control the focus of the audience, like a spotlight in theatre for instance. It can be used for communication and simply for increasing attractiveness. A commonly used phrase among Creative Technology students is that "It is not a cool enough (CreaTe) project if it does not include LEDs". However, there is a great drawback with light, it is not always fully visible if there is another light source present. Karen Drost shared that one of their interactive exhibitions turned out to have a different experience than expected and designed because of too much environmental light. Kees de Groot states that light is often a pitfall for installations in public. The experience can easily be altered by bright daylight. Floris Schreuder and Lieven Maes, colleague of Floris Schreuder, state that light is useless in bright sunlight. For an installation in public

outdoors this would mean that light should not ever be used as the main medium for communication or functionality. Merely for support for messages and activities and decoration.

2.7.5 Mechanics

In order to create motion kinetic mechanisms and actuators are used. These actuators and mechanisms can be spiral springs, mass weights, hydraulic arms, pneumatic arms, pumps (also to drive the hydraulic and pneumatic arms) and other motors. Commonly these pumps and motors are electrically driven. Karen Drost shares that kinetic installations with physical interaction are rising in popularity and usage.

2.7.6 Gameplay and scenery

An interactive installation in public has its own scenery and gameplay in which the players or spectators play an important role. Both scenery and gameplay include important tools for the experience of the user. The scenery tells the story of the installation. The gameplay determines the involvement and roles of the participants of the installation. For creating the right scenery and gameplay for the desired experience one can look at traditional dynamic arts, the practice of performance arts (drama, theatre, dance and opera) and film. Theatre and performance theory are most relevant since they give understanding of how all the roles of participants work together and the perception of the user that is performing [23]. Elements of dynamic arts relevant for interactive installations are roles, attention spaces, stages, tension and storytelling.

Roles In performance arts there are different roles for participants: operators, performers and spectators. It is important that these roles all are provided during the performance process of an interactive installation in public [24]. The operators interacting with the installation could also be the performers at the same time. When the installation itself performs an action, the operator becomes a spectator as well (someone pushes a button after which the installation shows an animation for instance). These roles can be switched very often and very quickly. Dalsgaard et al. (2008) discuss that the user of the installation often is all three roles at once, with a constant social tension between the user and the other spectators (audience). Further, they argue that it is important for the interactive experience to incorporate in the design an ability for the user to easily alternate between the different roles [23] (see figure 2.7).

Attention spaces Different attention spaces; foreground, midground and background, are used to control the attention of the spectator. In an interactive installation,

dividing the spaces can help getting the attention of the people standing in a busy environment [24].

Front stage and backstage Discussing a front stage and a backstage for an interactive installation in public may seem irrelevant, since all participators of the installation are on the front stage. However, adding a backstage, where other participants give input causing some actions on the front stage, could give a different experience for the participants on the front stage [24].

Tension Normally in a theatre performance or film, there is a clear beginning and end with tension building up from the beginning until there is some sort of climax. This is the way of storytelling that has been used over a long time and is very effective. Interactive installations usually have no clear beginning and end, making the tension build-up difficult to implement. A solution could be to have a build-up to a certain climax, after which the tension builds up again to iterate the process [24].

Storytelling The storyline is of high importance. Just like a play or film an interactive installation provides a story. This story can be implemented by the designers or, as discussed earlier (partly) by the users themselves. Storytelling is important for the message or goal, understanding and the above discussed immersion and flow experience [7] [15]. The storyline must be coherent with the rest of the design. Karen Drost argues that an incoherent story or context can have negative effects on the participation. According to Jorge et al. (2015), not only the story itself is important for storytelling, also the medium in which it is transferred and visible cues in the surroundings. They used an old-fashioned mechanical travel information display at an airfield, observing reactions of travelers that understood and reacted on the display because they recognized it from the old days. Still, they found that the story being told on
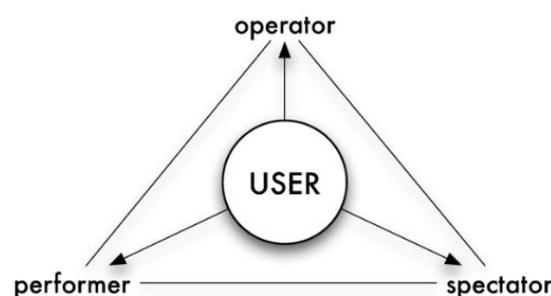

Figure 2.7: User Roles

their display was the most decisive for the overall impression of the travelers that approached the installation [10].

2.8 State of the Art

2.8.1 Tools for the components for interaction

In this section some of the most innovative and leading products available are described that can be used for advanced applications of above described components for interaction.

Sensing and communicating

MoCap Motion Capture (MoCap) is a tool for digitally record human movements, developed by Xsens. It is used mainly in the entertainment industry for films and games. The motion capture data can be mapped on a digital model in 3D software such as Unity 3D, Maya and 3D Studio Max.

S.M.A.R.T. Camera Super Matchmoving Automatic Reliable Tracking Camera is a 3D camera, developed by Inventive Designs, that can be used for real time motion tracking.

Infrared 3D cameras IR cameras are cameras that can detect distance and movement with the use of triangulation and infrared light. Examples are Kinect and LEAP motion. Kinect is a motion tracking camera for the game console Xbox, however, with an extra software development kit (SDK) it is also used for other purposes such as interactive installations. LEAP motion is used mainly for Virtual Reality.

Real-Time High-Fidelity Facial Performance Capture A software developed by Disney Research that can track facial expressions in high detail with the use of a single (normal) camera.

EMOTIV Epoc The EMOTIV Epoc is a wireless headset that senses brain activity with EEG technology. It can sense activities linked to movement. With an accompanying SDK it can be used for all kinds of purposes such as brain imaging and gaming. The unique feature is that the headset is portable and it can be used without contact gel.

Google Cloud Speech A speech to text converter. It can recognize over 80 languages and uses the same technology Google uses for their own products.

Google is one of the leaders in speech technologies. The advantage of this tool above others is that it is a very easy to use API and cloud based.

BML Behavior Markup Language is a dialog manager that can be used for humanoid conversational agents. It is easy to use since it is XML based.

Video

HoloLens HoloLens is a head mounted display developed by Microsoft for AR applications. With an extended SDK it is used in gaming, science and even interior design.

Meta 2 The Meta 2 is an AR development kit. It is also a head mounted display which also makes use of hand tracking technologies. It has a 90 degrees high resolution display making it able to filter the entire view of the user.

Light

NeoPixels NeoPixels is a LED strip technology developed by Adafruit that is controllable with all kinds of digital microcontrollers and computers. It uses 5050 LEDs and can have up to 144 LEDs on 1 meter strip. The benefit of these LED strips compared to others is that NeoPixels are easy to power and easy to control, each LED separately addressable, with only one digital input.

2.8.2   Existing projects

Granary Squirt - Snake on an London Fountain By connecting a smartphone one can play the classic video-game Snake on a fountain at Granary Square in London. The snake is made out of several hydro jets and colored light. Every jet is an adjustable pixel. The game is developped by The Fountain Workshop [6].

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[6] *Play Snake on an App-Triggered London Fountain. Emma Hutchings. 24 march 2015.* Accessed on 29 December 2016 `http://www.psfk.com/2015/03/granary-square-snake-granary-squirt-app-london-foundtain.htmlarticles-pane-close`
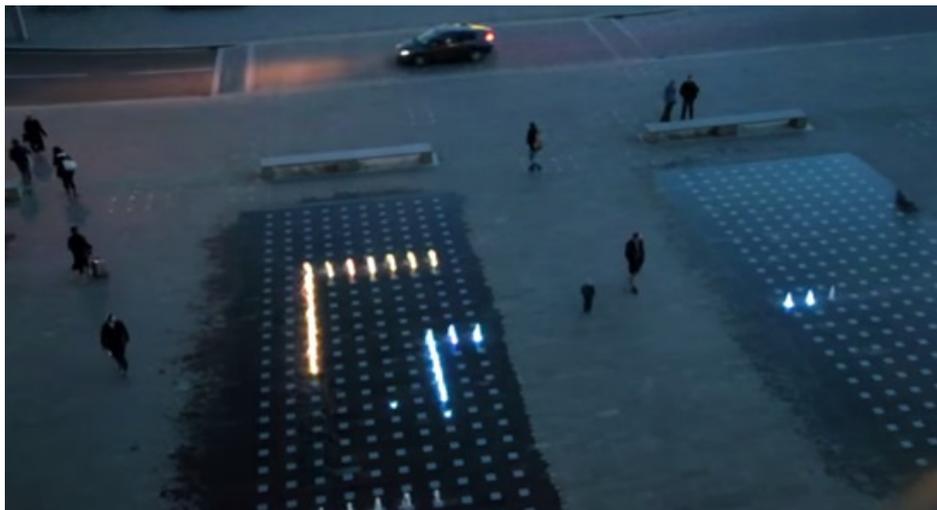
Figure 2.8: Granary Squirt

De Machine - NEMO Science Museum De Machine[7]. shows the world behind package delivery. It is an interactive display where children can find out and try out for themselves how a package delivery works. The installation consists of several segments where visitors can interact, this is similar to the project for Concordia. It is displayed in NEMO, a museum in Amsterdam with interactive displays about science. Visitors can see, feel and experiment how normal things in society work.

Figure 2.9: De Machine - NEMO Science Museum

Ben ik in beeld - Nederlands Instituut voor Beeld en Geluid Ben ik in beeld (am

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[7]*De Machine. NEMO Science Museum.* Accessed on 29 December 2016 `http://www.nemosciencemuseum.nl/nl/wat-is-er-te-doen/tentoonstellingen/de-machine/`

I on screen?)[8] is about the growth of the world of television. Famous tv shows are displayed. Visitors can join these shows themselves and make a recording. The aspect of showing a part of history and allowing the visitor play with it is similar to the goal of the project for Concordia. Nederlands Instituut voor Beeld en Geluid (Dutch National Institute for Audio and Video) is a museum in Hilversum about video, film and television.

Figure 2.10: Ben ik in beeld

Science Night Church Game - 100%FAT and Sefrijn Langen A gesture based game projected on the church at the Oude Markt in Enschede, made for Twente Science Night. By moving their hand in the air above a sensor users can control the player[9].

Figure 2.11: Science Night at the Oude Markt, Enschede

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[8]*Ben ik in beeld. Beeld en Geluid.* Accessed on 29 December 2016 `https://www.beeldengeluid.nl/dossier/7157/ben-ik-beeld`

[9]*Science Night. 100%FAT* Accessed on 25 January 2017 `http://100fat.nl/portfolio/science-night/`

Ecco Luce at University of Twente - Edwin Dertien and Jonas Samson Light pan-
els that show patterns and animations of light in a hallway of the university.
The animations react on people passing by. This is one of several Ecco Luce
projects, in which a unique way is created to integrate led-lights in a wall[10].

Figure 2.12: Ecco Luce at University of Twente

Piano Staircase - The Fun Theory, Volkswagen A staircase that makes piano sounds
when people walk on it[11]. The goal of the project was to get more people taking
the stairs by making it fun to do.

Figure 2.13: Piano Staircase

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[10] *Ecco Luce. Lucept. Brad Koerner. May 27, 2013.* Accessed on 25 January 2017 `https://lucept.com/2013/05/27/ecco-luce/`

[11] *Piano Staircase. The Fun Theory.* Accessed on 25 January 2017 `http://www.thefuntheory.com/piano-staircase`

Flow - Studio Roosegaarde Hundreds of ventilators form a wall of illusive winds. The winds react on people. Remarkable of this installation is that it interacts with the use of air[12].
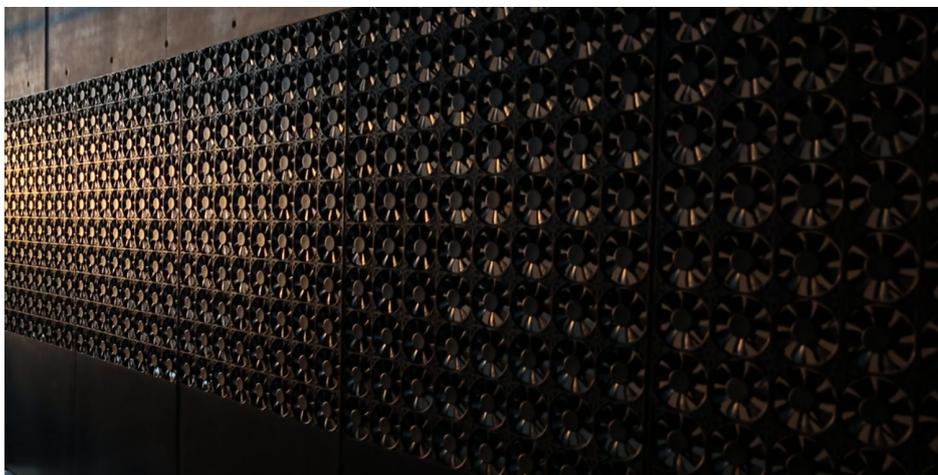
Figure 2.14: Flow - Studio Roosegaarde

This Too Shall Pass - Rube Goldberg Machine - OK Go The video clip of the song This Too Shall Pass by OK Go[13]. Although this is not an interactive installation, it is relevant since the chain reaction in the video clip is based on a Rube Goldberg Machine.

Figure 2.15: Movie clip of This Too Shall Pass - OK Go

[12]*Flow. Studio Roosegaarde.* Accessed on 25 January 2017 `https://www.studioroosegaarde.net/project/flow/`

[13]*This Too Shall Pass - Rube Goldberg Machine. OK Go.* Accessed on 25 January 2017 `http://okgo.net/2010/03/10/this-too-shall-pass-rube-goldberg-machine-official-video/`

2.9 Requirements

In this section the requirements for the final kinetic game are stated. The requirements are formed according to the project goals and the results of the research in this chapter. In the design process in Chapter 3, these requirements are used as a filter to converge the results of the ideation. Since some requirements are more important than others, a score from 1 to 3 was assigned to each. The requirements with 3 points are most important, and directly related to the project goals. This are requirements that the end product must have. Requirements with 2 points turn out to be important, but are not directly related to the project goals. This are requirements the end product should have. Requirements with 1 point could be a nice addition. This are requirements the end product could have.

#	Requirement	points	MoSCoW
1	Get the attention of passersby by being pro-active	3	Must
2	Get the attention of passersby with spectacular forms		
3	Get the attention of passersby with recognizable sounds		
4	Invoke participation with a layered approach		
5	Create a flow experience by constantly adding new actions		
6	Tell a story		
7	Work on a busy street with bright sunlight		
8	Aim at the right target group	2	Should
9	Implement guidance		
10	Afford connectivity		
11	Enable authorship	1	Could
12	Interact with artificial beings		
13	Reinterpret the visitor's world		
14	Engaging in performative acts		
15	Use video as contribution to the experience		
16	Use light as contribution to the experience		
17	Use kinetic elements as contribution to the experience		

Table 2.1: Requirements

<div align="right">

Chapter 3

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Design and Implementation

In this chapter, the ideation, specification, realization and prototyping process are described. The first brainstorm in the ideation was held in the early stage of this project, prior to the research. Concordia chose the first idea, kinetic game, after which the research subject was formed and the ideation continued. The ideation resulted in a central story theme, central apperance theme and 50 ideas for the content that were generated in context of the real life situation. Next, these ideas for content were filtered with the requirements. The results of this filter were used in the design specification and prototype design.

3.1 Ideation

In this section the ideation for the concept and content of the final kinetic game is described. Together with 100%FAT and Jelle Wolbers and in consideration with Concordia, two brainstorms and several meetings were held and concepts and mood boards were made.

3.1.1 First brainstorm

The first brainstorm was solely about 'an installation on the facade of Concordia that will get noticed by and attract passersby'. The brainstorm resulted in three main concepts, to be presented to Concordia.

1. Kinetic game on the facade; a gigantic mechanical installation which people can play with. The game consist of several segments like a marble track or The Incredible Machine (see figure 3.1).

2. Interactive reception; when approaching the building several fascinating elements start acting and reacting. Examples are illuminating stones and mirrors that follow a person (see figure 3.2).
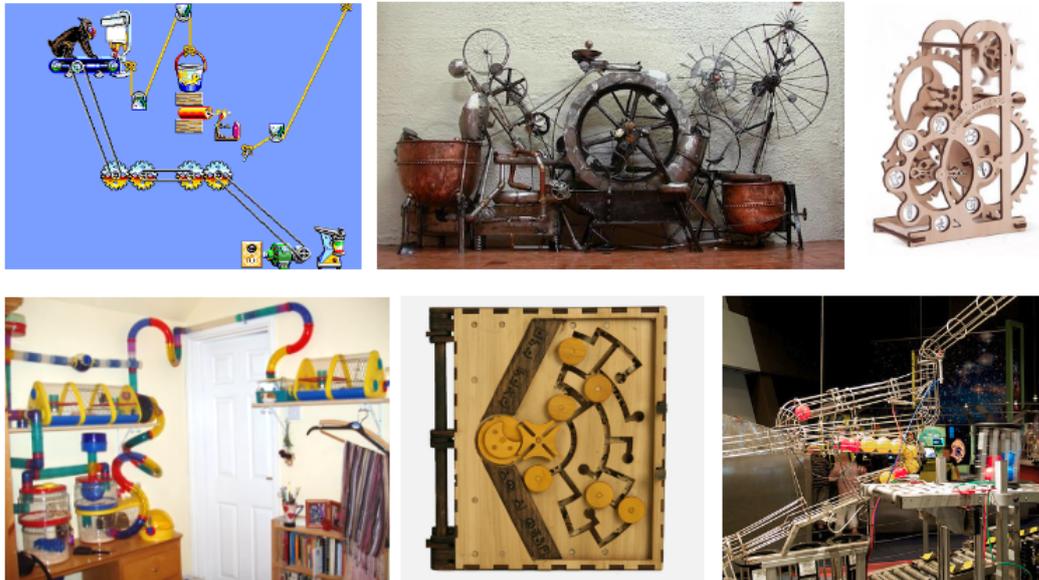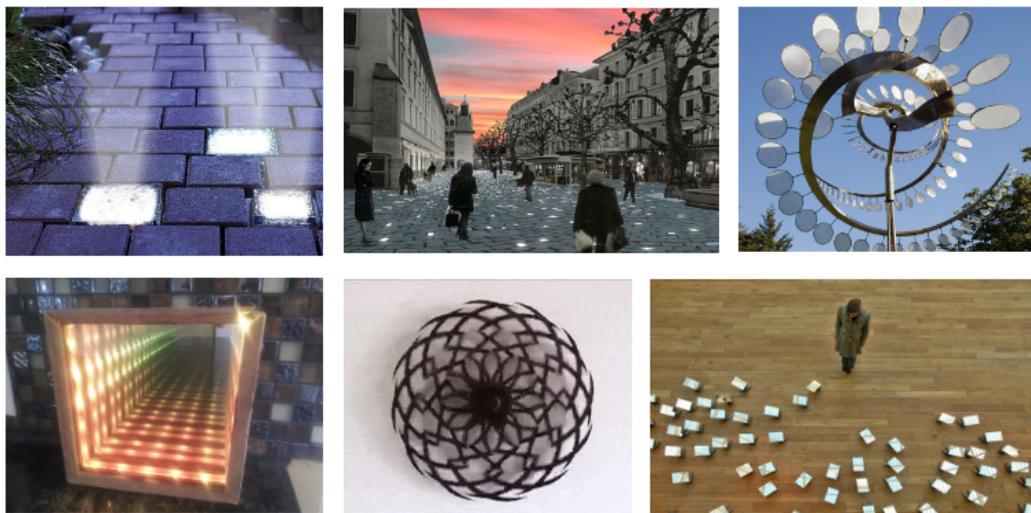
Figure 3.1: Concept 1: Kinetic Game

Figure 3.2: Concept 2: Interactive Reception
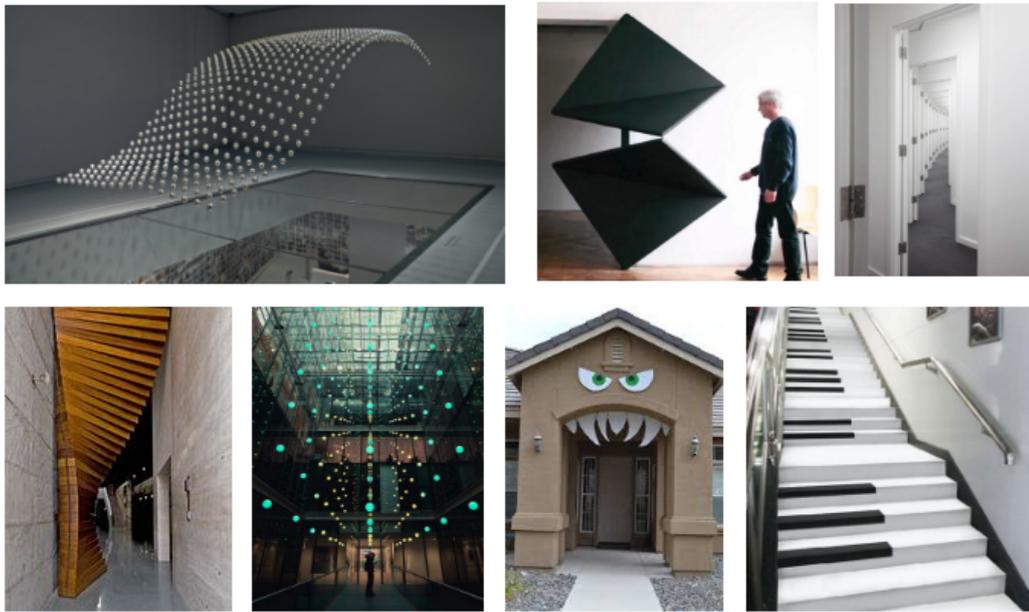
Figure 3.3: Concept 3: Interactive Entrance

3. Interactive entrance; adding a curious, fascinating door to the entrance. The door reacts when someone is approaching. The effect can be amplified with the use of light and audio (see figure 3.3).

The concept that was chosen by Concordia is the kinetic game on the facade.

3.1.2 Personas and Themes

Three themes were generated for the appearance of the kinetic game installation on the facade of Concordia. Three personas with a possible scenario were created that each correspond with on of these three themes. Personas can help to create an image of how the user's experience could be.

Steampunk - Old man Steampunk is as if it's still 2016 but without the invention of electricity. Gears, steam, windmills and oil represent important parts of this world (see figure 3.4).

Persona Jan is 67 years old and has difficulties with walking since he got a surgery for his knee. His doctor urges him to take a walk for a half hour each day. Jan follows his doctor's advice and walks every day through the city center. He has time to do so since he retired 2 years ago, after working as a plumber.

Figure 3.4: Theme 1: Steampunk
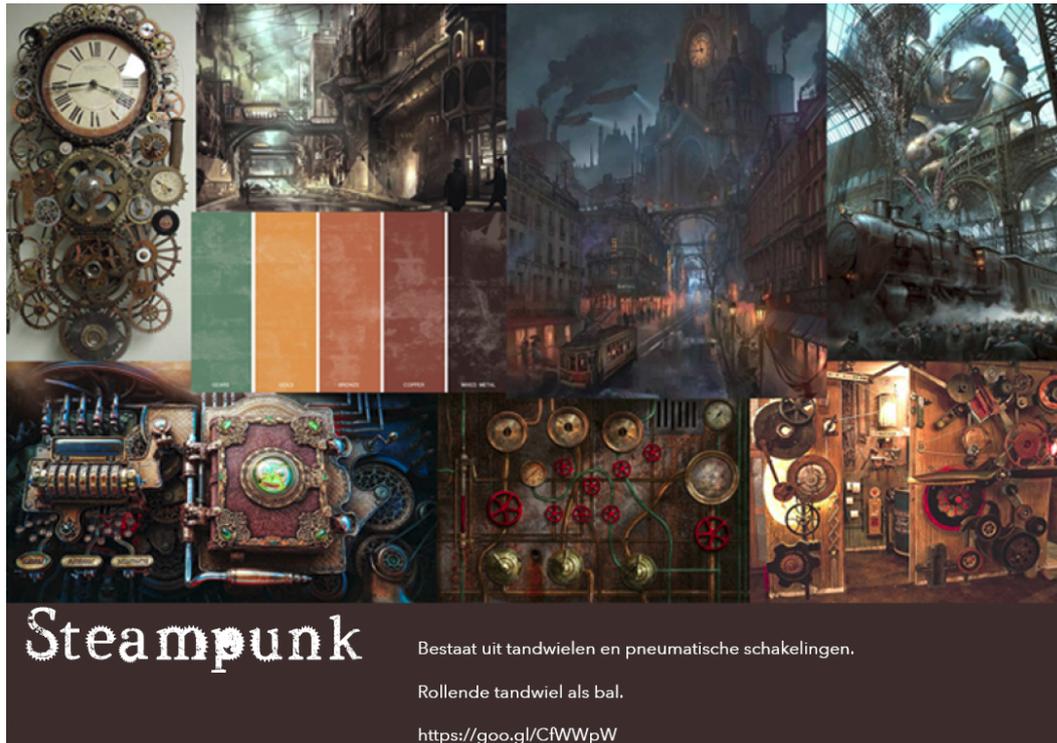
Scenario Jan follows his daily routine and walks around midday through the center of Enschede. His eye catches something on the wall he never have seen before. Jan tries to walk a different route each day. He is intrigued by some big pipes of lead that lead to a gigantic gearbox. He recognises the colour of the pipes from his old job. When he looks further he sees that the gearbox drives a big clock. The only thing is, the clock is not moving, though it has a hand for the seconds. His technician mind immediately starts to look for a reason why the gears are not turning. Then, he spots a big lever on the bottom of the gearbox. He gets it. He needs to pull the lever. However, he does not feel like to walk all the way to the lever. Still, somehow, his technician heart tells him that he wants to see the gears in motion. He walks over and pulls the lever. Then he spots the gallery. "Ah! This is the art gallery of Concordia. I almost forgot it was here!", he thought. "Maybe I can bring the misses tomorrow, she likes these things", and he walks home.

Clean - Student This theme consists of simple geometric shapes, forms and surfaces. It's as minimalistic and clean as possible (see figure 3.5).

Persona Jim is an Industrial Design student at the University of Twente. He lives in the city centre. As designer he is interested in nice shapes, cool designs and new products. Tesla is his favourite car.
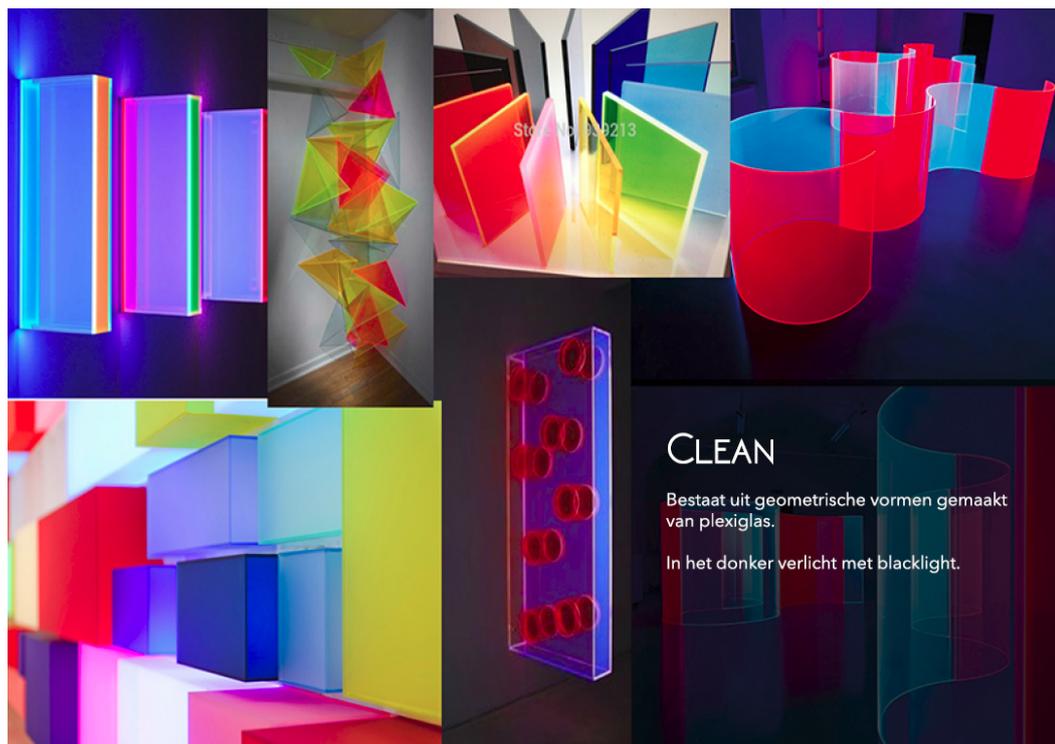
Figure 3.5: Theme 2: Clean

Scenario Jim walks through the Langestraat to go for groceries. His eye catches blinking colours on the wall. When he looks he sees a cool structure of geometric forms in all sorts of colours. Some of the forms are lit, some are not. Searching for the reason why he sees a pattern in the blinking lights. They all go to one panel. He is curious why and approaches the panel. The closer he comes the faster the panels start to blink. Suddenly, all panels start blinking in nice animations. The animation stops just below a sign with Concordia. Then the panels around the windows start blinking. Jim sees the art gallery, a thing he never noticed before. As he looks through the window he sees interesting pieces of modern art. Unfortunately he needs to get going, his roommates are waiting for diner. He makes a picture of the Concordia sign and sends it to his friend with the text: "He, shall we go to this gallery tomorrow?". Then he continues his way to the supermarket.

Toys - Little child This theme is based on existing modular toys such as LEGO, K'nexx, Duplo, Domino and marble tracks (see figure 3.6).

Persona Jitske is a 10 year old girl. She likes playing with her toys and mac n' cheese. She lives with her parents in Enschede and goes to school all by herself. She is not afraid of anything and is attracted to colorful things.

Figure 3.6: Theme 3: Toys

Scenario Jitske is shopping with her mother in the city center. As they pass
Concordia's public art gallery Jitske stops to look at the new contraption on the
front wall. The contraption got her interest because it had nice bright colors
and it looked like a marble coaster she has at home. She spots a lever with
a sign next to it which says: "pull me". She does not hesitate and walks to
the lever to pull it. A Ferris wheel starts to turn and a ball drops out. The ball
drops in a tube and makes a looping. After that it gets stuck. A tile in the
sidewalk starts to blink and making noise. It looks like a button, so she steps
on it. The ball gets released and goes through a few other elements based
on LEGO. K'nexx and Duplo to finally disappear through the main entrance.
She pulls her mother's hand and together they enter the building to look for the
ball. Jitske is merely focused on getting the ball. She is not interested in the
art gallery. Her mother looks around and sees some pieces of art. However,
before she get curious Jitske already pulls her back outside because she wants
to play again.

3.1.3   Final theme of content and appearance

A final theme for the content was generated for the installation. The game must tell
a story while it is played about historical highlights and important persons of Twente.

The name is 'Heroes of Twente'. The game must consist of several segments which each tell a little story about one of these heroes or highlights. All segments must be connected to each other like a Rube Goldberg machine or The Incredible Machine, a video game inspired by Rube Goldberg.

The theme of appearance is a combination of all three above mentioned themes (see figure 3.7). It includes large mechanical and industrial kinetic elements combined with coloured and smooth surfaces and playful components. User's input is accomplished with large levers and turning wheels. Actuators consist of large gearboxes with visible gears and strings. Components can be derived from games and toys, persons (figures) and industrial machines. The components can be in all colours and modular like a marble track or LEGO. Light can be used to create colourful surfaces. Furthermore, gamification is important for all segments.

Figure 3.7: Final Theme of Appearance
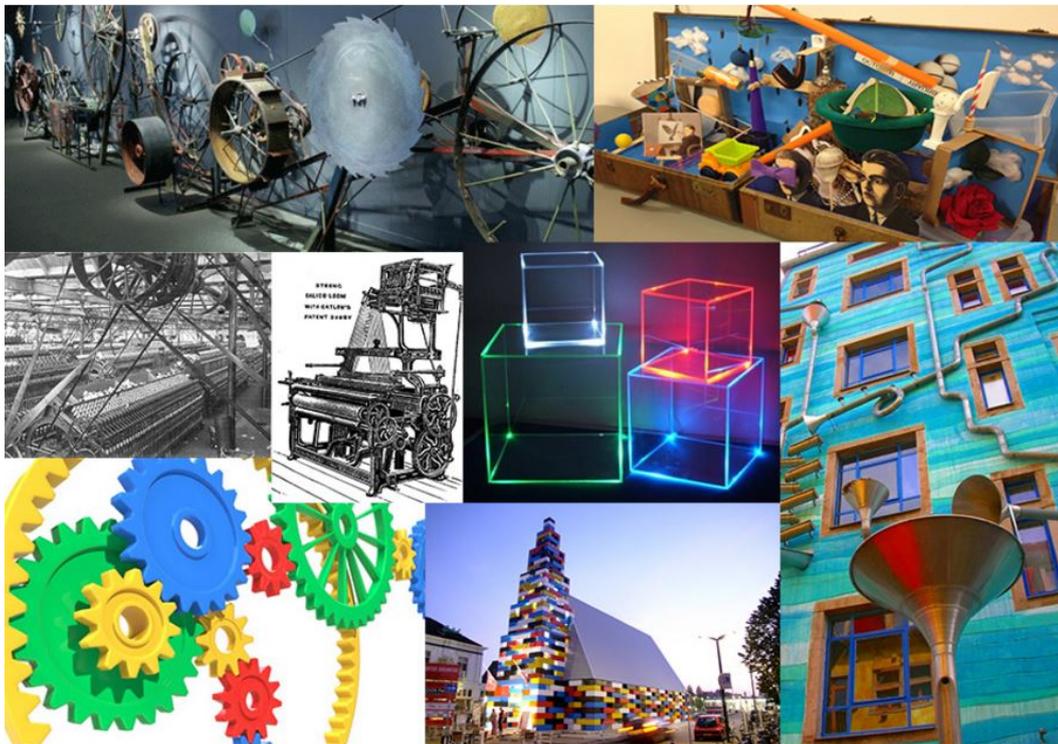
3.1.4   Second brainstorm - 50 elements of content

The second brainstorm was about the content of the installation. As mentioned above, 50 ideas for content segments were created to be evaluated with the requirements later on. Several focus points were used. The focus points were the professions and disciplines that correspond with the above described theme for content

'Heroes of Twente'. For each focus point a list of ideas is created (see figure 3.8). See Appendix B for the full list.
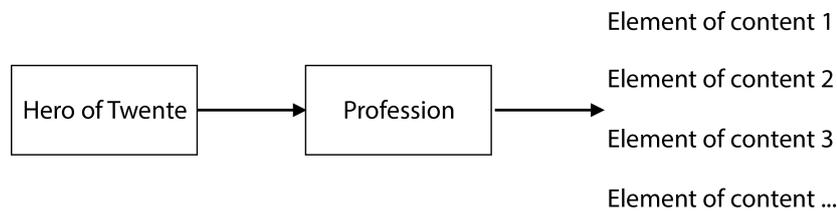

Figure 3.8: Approach of the second brainstorm

3.2   Specification

In this section a set of design choices for the kinetic game is defined, consisting of the target group and elements of content for the kinetic game to feature. The elements follow from the requirements that are conceptualized and brought into context with the results from the ideation. The target group is based on the project goals and user scenarios. One of these elements of content is translated into a design of a fully functioning prototype, to test which effect it has on passersby.

3.2.1   Specification of the target group

As described in the project goals, Concordia wants to have more visitors, and therefore they want to create more awareness. However, it is important to aim at awareness of the people that are potential visitors. Creating awareness of existence to one that is not interested in art, and thus definitely will never visit, is redundant and a waste of energy. Therefore the target group must consist only of people that are interested in modern arts. Furthermore, cyclists or other drivers should not be in the target group since they are not likely to stop and participate with the installation.

Defining the target group more accurately by exploring the average age, interests, expectations, and predict their behaviour with the Theory of Planned Behaviour remains future work. Nevertheless, in the remainder of this research it is assumed that children below the age of 16 are not interested in modern arts and therefore not in the target group.

3.2.2   Filter with the requirements

The 50 elements of content, results of the ideation, that were generated in context are evaluated with the requirements. If a requirement was applicable to an element

of content, the element received the accompanying points. See the full table in Appendix C. The average score is 19.34. All 15 elements that received a score above average are listed below.

- Visualize a poem on the facade with an mechanical display. This display shows one word or sentence at a time (writing).

- Users write something with a big typing machine on a piece of paper (writing).

- A kettle that gets filled when the user is pumping (Grolsch/beer).

- A cork cap pops when a user is makes an opening movement (Grolsch/beer).

- The bottle orchestra makes music when a user fills opens one bottle (Grolsch/beer).

- The user(s) play notes on instruments on the wall on a 'guitar hero' way. If they are too late to play a note the music is false (music).

- A figure that comes to the front sometimes, when someone pushes a button he tells a joke (comedy/theatre).

- A physical visualization of a well-known piece of comedy by a comedian when someone activates it (comedy/theatre).

- A big spinning wheel spins by input of the user. While spinning a shirt is being made with spinning sound (textile).

- A big steam-engine runs while people pass by. With the steam engine sounds (industry).

- Pneumatic actuators move and run with big bangs, when the user pulls a lever photo's are shown of the industry of Twente (industry).

- A pumpjack pumps oil and fills a train wagon. When the wagon is full the train starts moving when the user pulls a lever, or switches the stop sign from red to green (industry).

- The TET train can be controlled by the user (accelerate, break). With flute and train sounds (industry/TET).

- A clock with big gears that doesn't run. Users have to set it right (industry).

- Famous building is build up from little pieces when user is interacting with it (architecture).

- Unfold a pop-up book of a famous building when someone approaches (architecture).

These elements contain a great deal of important requirements and are therefore expected to be successful when implemented in the design of the kinetic game.

3.2.3   Specification of the prototype

The content of the prototype is selected out of the 15 elements of content with highest score. This way 1 of these 15 elements could be tested. Additionally, extra requirements are implemented into the prototype. This way the theory behind the requirements could be tested. These extra requirements are 'must have' category requirements with 3 points that were still missing, since these are most important and directly related to the project goals.

The selected element of content is; *a comedy figure that comes to the front sometimes, when someone pushes a button he tells a joke*. This element is selected for its feasibility to make a prototype of it in relationship with the available resources and time. It misses 2 'must have' category requirements; *Get the attention of passersby with spectacular forms* and *Create a flow experience by constantly adding new actions* (see Appendix C). These will be implemented by adding extra features. Furthermore, in order to generate test data the prototype must be able to count the times a user interacts with it, and the total amount of passersby. In the realization (section 3.4) all features are described and their relation with their corresponding requirement is explained.

3.3   Prototyping

In this section the design and functionality of the prototypes are described. Four preceding prototypes were created to test the functionality of several elements of the final prototype. The design of the final prototype follows from the specification of the prototype, theme of appearance and state of the art.

3.3.1   Prototype 0

In order to create the slot machine rolls three actuators were needed for rotation. Standard DC motors that can be connected to a microcontroller such as Arduino or Raspberry Pi rotate much too fast for the rolls. Therefore, several existing products with a rotating element, using a small DC motor, were explored (see image 3.9). These cheaply made products provide a fully assembled gearbox that lower the rotation speed of the motor.

The revolving flashing light was selected for its right rotation speed and operation voltage of 4,5 volts, making it easily connectable with a microcontroller (see

Figure 3.9: Products with DC motors

figure 3.10). The motor with gearbox was connected to a Raspberry Pi and controllable. However, the gearbox consisted of low quality rubber bands, instead of gears, resulting in low torque and skidding.

Figure 3.10: Prototype 0

3.3.2   Prototype 1

The first real prototype called 'the activity mixer' was an Arduino program that, when a button was pushed, randomly picked a name, a verb and an object out of three arrays (see figure 3.11). The randomly picked words formed a new sentence. Three

28BYJ-48 stepper motors were connected to the Arduino. Each motor represented one of the arrays (an array consisted of 6 elements). The motors rotated according to the word that was chosen in their corresponding array. For example, when the program picked the third word from array 1, motor 1 rotated (360 / 6) * 3 = 180 degrees. The motors have 64 steps per revolution, and a gearbox with a 1/64 ratio. Therefore, each full rotation is 64 * 64 = 4096 steps. The program saved the current position by counting the steps. This way it knew the starting position for the next time. At first, 5V motors were used. However, these had not enough power to reach the desired rotation speed. Replacing the motors with 12V versions (same type) was successful. These motors would later drive the rotating rolls of the slot machine (see Final Prototype).

Figure 3.11: Prototype 1

3.3.3 Prototype 2

The second prototype was to count passersby. An ultrasonic range sensor HC-SR02 was connected to an Arduino (see figure 3.12). The program measured the time of a bounced sound wave response. It counted the times the response was suddenly less than normal, implying someone was crossing its line of 'sight'. Unfortunately, the range of the sensor was significantly less than the datasheet described, not enough to reach the other side of the street.

3.3.4 Prototype 3

The third prototype, called the 'Finkers Mixer', mixes three random quotes from Herman Finkers, selected out of 18, to create a new combined quote. These quotes are

Figure 3.12: Prototype 2
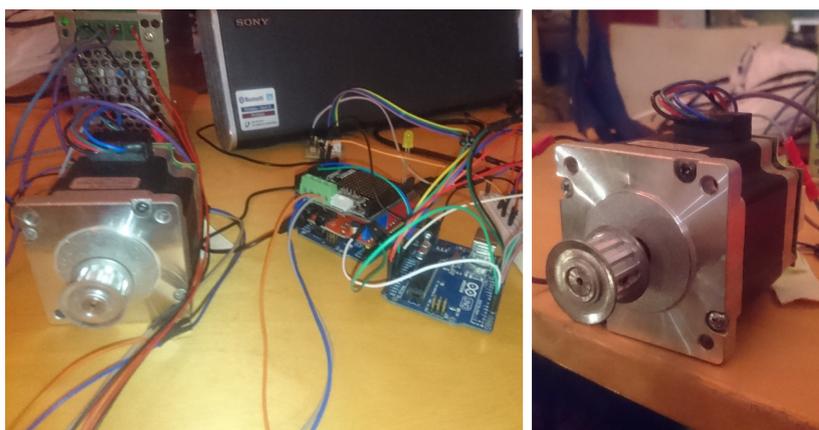
Figure 3.13: Prototype 3

stored on an SD card and played on a speaker connected to an Arduino. A PANdrive stepper motor is connected to the Arduino and rotates when the quotes are played (see figure 3.13). This motor would later rotate the gear with miniature Herman Finkers on it (see Final Prototype). Another Arduino with the three stepper motors from prototype 1 are connected as well. When a button is pushed, first, the three stepper motors rotate a certain degree, then, the PANdrive motor rotates and the quotes are played (according to the degrees the three stepper motors rotate). The prototype has a pro-active state, in which every 60 seconds the PANdrive rotates while a cheering audience sound sample is played.
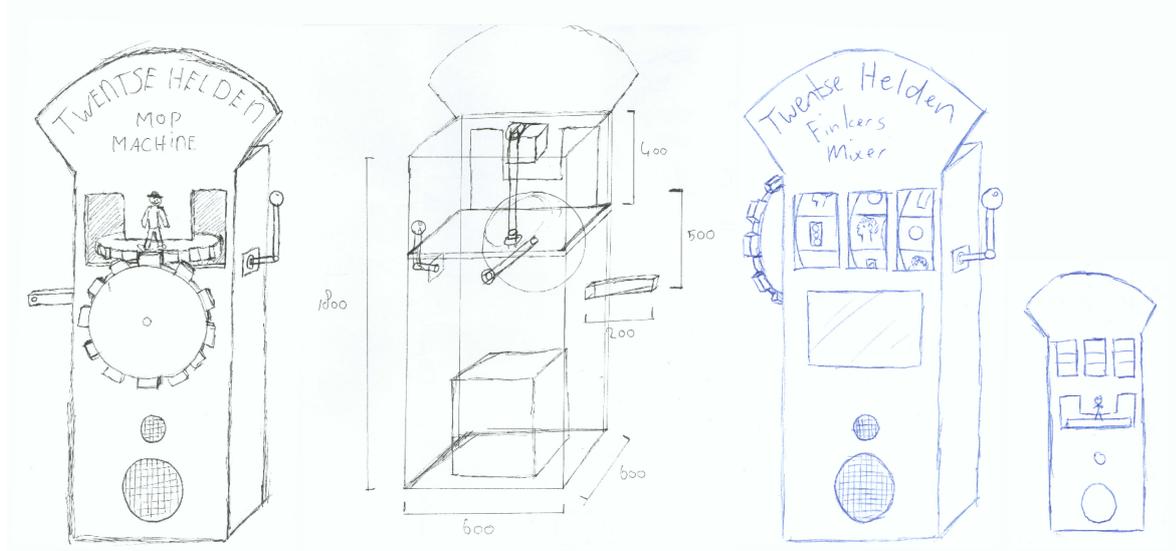
Figure 3.14: Early designs Final Prototype

3.3.5   Final Prototype

The design of the final prototype follows from the specification of the prototype, theme of appearance, state of the art and the findings in the preceding prototypes. It is a combination of a One Handed Bandit slot machine, used for gambling, and a miniature theatre with miniature comedian Herman Finkers figure (see figure 3.14), created with appearance coherent with the chosen theme of appearance. When the user pulls the lever, the rolls start rotating to form a combination of symbols. Each symbol represents a quote from a theatre show of Herman Finkers. Each roll has 6 different quotes, resulting in a total of 18 quotes and 216 different combinations. The figure of Herman Finkers rotates on a gearbox and appears to tell the quotes. It disappears when the quotes are finished, after which the user can pull the lever again for a new combination. The prototype consists of a pro-active state in which the figure appears every 30 seconds with a cheering audience sound. The passersby counter is left out, since prototype 2 was not successful.

The components of prototype 3 are implemented. From the state of the art is learned that light can be a nice addition to an interactive installation. Therefore, additional led strips are connected to illuminate the name on top, the background, the rolls and to create spotlights when the figure is 'performing'. The ledstrips are powered with a seperate 5V voltage source. The motors and Arduinos are powered with a 12V voltage source. The speaker with amplifier is powered directly to the 230V AC of the mains. For the schematics see Appendix D.
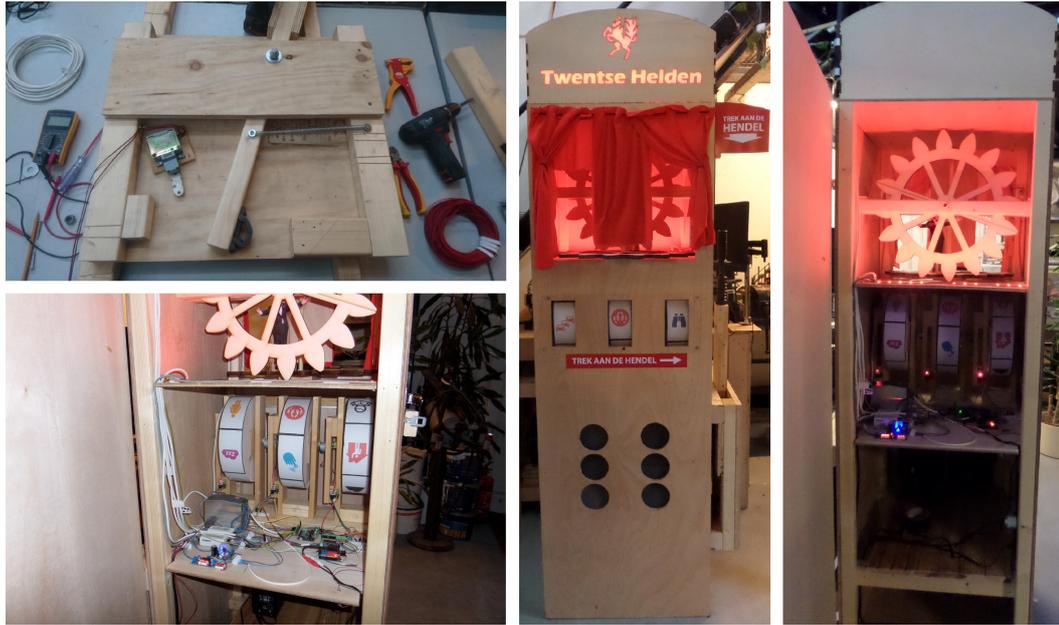
Figure 3.15: Final Prototype

3.4 Realization

Below the realization of the design and its functionality of the final prototype is explained. The corresponding requirements are indicated with their index number of table 2.1.

The figure is Herman Finkers. Finkers is a nationwide known comedian from Twente, making his jokes very recognizable for the target group. Furthermore, quotes are used from an article called '15 hilarious quotes by Herman Finkers' [25] (requirement 1, 8). Additional recognizable sounds are cheering and laughing audiences (requirement 1). The figure will be hided in a cabinet, and appears when someone interacts with the prototype (requirement 10, 17).

A lever on the side of the cabinet is chosen as sensor since it is coherent with the generated theme of appearance in the ideation (section). To make it clear that the lever needs to be pulled (to guide the user), and to add gamification, the cabinet will look like a 'One Handed Bandit', the slotmachine used in casinos for gambling, well known by people with the age above 16 (requirement 9). When the lever is pulled, three rolls start rotating to make a combination of three quotes/jokes of Herman Finkers, after which the figure tells the quotes (requirement 12). The first action, pulling the lever after which the slot rolls start rotating (for a few seconds), is very simple and quick, making it a perfect first layer of action for passersby. The next layer will be the figure telling the first quote (of a few seconds), the second layer is the second quote and the last layer is the third quote (requirement 4). Since after the quick gamble game the figure appears to tell the first quote, the user's attention

is kept with a new action. The same holds for the second and third quote. When the three jokes are told, the user can pull the lever again, to watch and hear a new combination (requirement 5).

On the top the name 'Twentse Helden' (Heroes of Twente) will be visible. Combined with the Herman Finkers quotes and figure this will tell a story about one of the heroes of Twente. Additionally the hero himself will tell three very short stories (requirement 6). To add spectacular forms, the figure will be driven by a gearbox consisting of two large gears. These gears are coherent with the theme of appearance. To make the comedy theme complete, red theatre curtains will be added (requirement 2). The prototype has a pro-active state, in which the figure appears with cheering sound once every 30 seconds (requirement 1). Additionally, light is added to improve the appearance (requirement 16).

Chapter 4

Evaluation

In this chapter 3 user tests and their results are described and discussed. The tests were performed with the above described final prototype to test whether the selected and implemented elements are successful with provoking participation. The tests were spread out over 3 days with each day a test in the afternoon. Observations of functionality errors in test 1 and 2 are dissolved or improved with adjustments in test 2 and 3 respectively. All three tests were quantitative, however, test 3 also included a qualitative part. The qualitative part was mainly performed as a confirmation tool and to make recommendations for future work. In the tests a distinction is made between passive state and pro-active state, and active and idle state. Active state is when a user interacts with the prototype. Idle state is when no user interacts with it. Both pro-active and passive states can be activated when the prototype is in idle state (see figure 4.1).
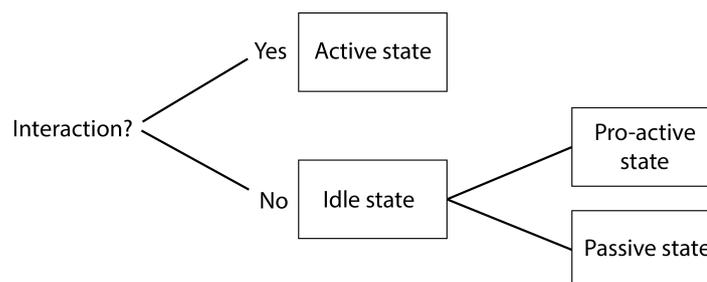
Figure 4.1: Active, Idle, Pro-active, Passive

4.1   User test 1

The prototype is tested on the street in front of the Concordia building (see figure 4.2). This way it would get the same audience as the final kinetic game on the facade. The test consisted of two phases, the pro-active and passive phase. As

Figure 4.2: User test setup

described above the prototype consists of a passive state, and pro-active state. For both states a quantitative test is performed.

In the quantitative test the amount of passersby, the amount of passersby that had a look at the prototype and the amount of passersby that started interacting were count. These three categories were defined as follows:

- Passerby: a person that passes the prototype by foot.

- Passerby that looks: a walking person that stops to have a look at the prototype or slows down to have a look at the prototype. Or a person that at least stops her current activity (besides walking) and shifts her attention to the prototype, and thus also looks at the prototype, the entire time she is passing by. Enough to be able to observe the prototype to find out what it is and what it does. This category represents 'the audience'.

- Passerby that started interacting: a person that stopped at the prototype and pulled the lever. This category represents 'the user'.

The users and audience combined is referred to as 'participants'. The participants were divided into four estimated age segments; 0-15, 16-30, 30-50, 50+. This was to have an indication whether the test subjects could be in the above discussed target group.

In order to determine the right sample size, a calculation is performed with the average street visitors a day. The average amount of people passing by the Langestraat 56 in 2016 is 10807 a day. This amount is derived from the results of the City Center Monitor of Enschede 2016, made by the municipality of Enschede [26]. Knowing this average the nescecary sample size can be calculated with the test

sample calculator[1]. This calculator makes use of the Central Limit Theorem[2].

With the user test the 'success' proportion of the population (total amount street visitors) is estimated, where 'does interact' and 'does look' are successes towards 'does not interact' and 'does not look' respectively. These individual tests are binomial distributed. However, since it is a large population with large sample size the total proportion can be approached with a normal distribution. Using the normal distribution a 'safe' or secure sample size can be determined with the population size, the estimated proportion and the z-value, which is expressed in standard deviations of the population mean and dependent on the confidence interval one maintains [27]. The test sample calculator adds an additional margin of error of 5 percent. Since the proportion could not be estimated, a proportion of 50 percent is used as estimation, resolving in the largest (safest) test sample possible. With a 95 percent confidence interval this test sample should be 371. Meaning that the measured success proportion of 371 passersby, thus the chance that a passersby will interact with the prototype, will be the same with 95 percent of all 10807 people visiting the street (on average) a day. For both the pro-active and passive phase of the test a sample size of at least 371 was used.

4.2 Results test 1

Passive state

During the first test in passive state a total of 581 persons passed the prototype, of which 403 by foot. 73 of 403 passersby participated, giving a participation of 18,1% (see figure 4.3).

68 of the 403 passersby looked at the prototype (16,9%), 5 of the 403 passersby started interacting (1,2%). 330 of the 403 passersby did nothing (81,9%) (see figure 4.4).

28 of 68 passersby that looked did so when another was interacting with the prototype (active). The rest looked when the prototype was idle in passive state (see figure 4.5).

1 of the participants was in the age category 0-15 and also interacted, 38 in the category 16-30 participated, of which 2 also interacted. 24 in the category 31-50 participated, of which 2 also interacted. 10 in the category 50+ participated, of which 0 also interacted (see figure 4.6).

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[1] *Test Sample Calculator* Accessed on 10 January 2017 http://www.allesovermarktonderzoek.nl/steekproef-algemeen/steekproefcalculator

[2] *Central Limit Theorem* Accessed on 10 January 2017 http://www.math.uah.edu/stat/sample/CLT.html

Test 1 - Passive - Participating

● Not-participating
● Participating

18,1%

81,9%
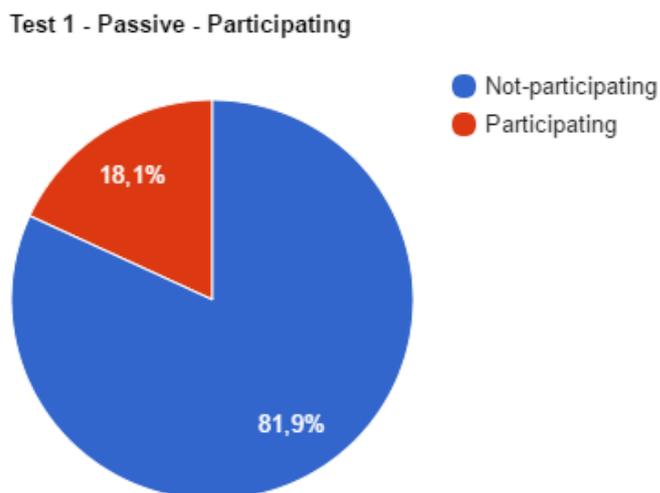
Figure 4.3: Test 1-Passive-Participating

Test 1 - Passive - Looking and interacting

● Nothing
● Looking
● Interacting

16,9%

81,9%
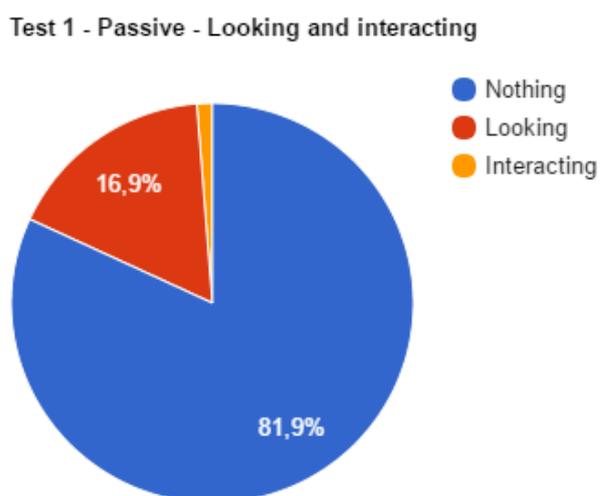
Figure 4.4: Test 1 - Passive - Looking and interacting

Test 1 - Passive - Active and idle
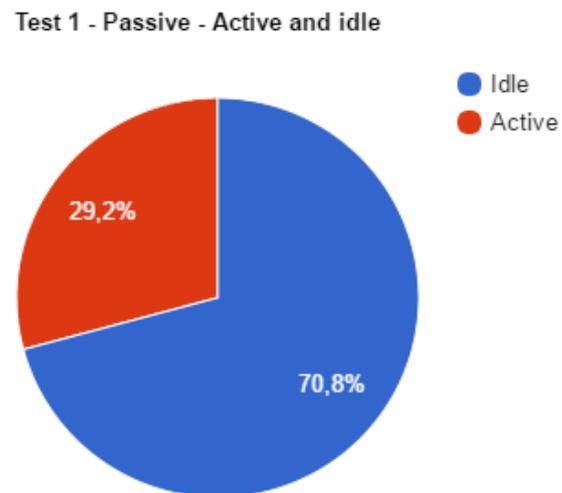
Figure 4.5: Test 1 - Passive - Active and idle

Age categories with participation
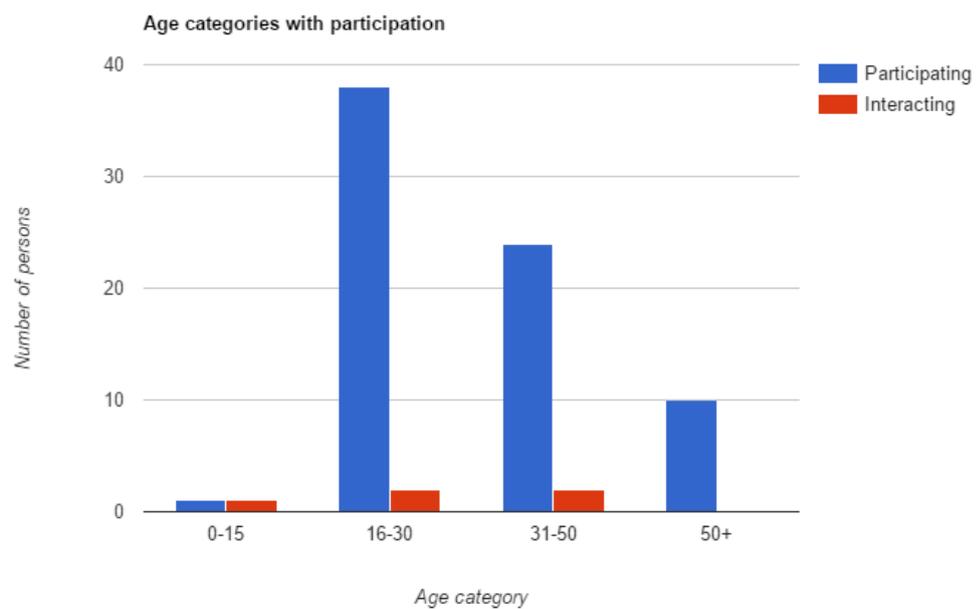
Figure 4.6: Test 1 - Passive - Age categories

Pro-active state

During the pro-active state a total of 653 persons passed by the prototype, of which 390 by foot. 126 of 390 passersby participated, giving a participation of 32,3% (see figure 4.7).

118 of the 390 passersby looked at the prototype (30,3%), 8 of the 390 passersby started interacting (2,1%). 264 of the 390 passersby did nothing (67,7%)(see figure 4.8).

25 of 118 passersby that looked did so when another was interacting with the prototype (active). The rest looked when the prototype was idle in pro-active state (see figure 4.9).

4 of the participants were in the age category 0-15, of which 3 also interacted. 81 in the category 16-30 participated, of which 3 also interacted. 33 in the category 31-50 participated, of which 2 also interacted. 10 in the category 50+ participated, of which 0 also participated (see figure 4.10).
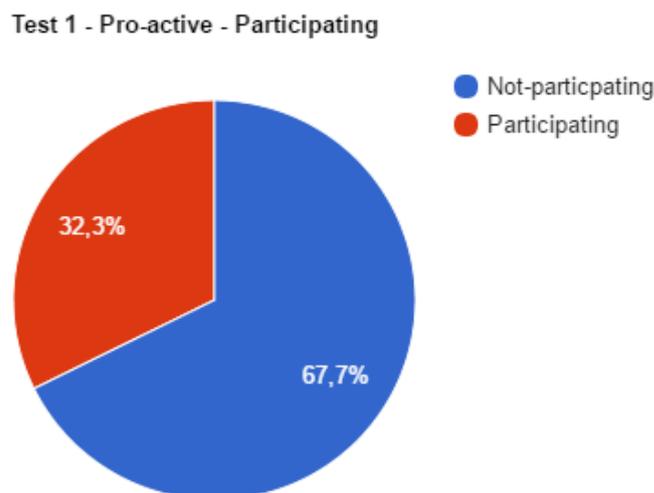
Figure 4.7: Test 1 - Pro-active - Participating

Test 1 - Pro-active - Looking and interacting
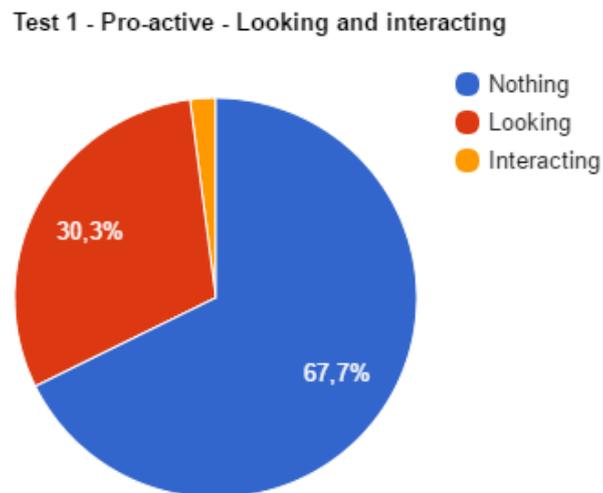
Figure 4.8: Test 1 - Pro-active - Looking and interacting

Test 1 - Pro-active - Idle and active
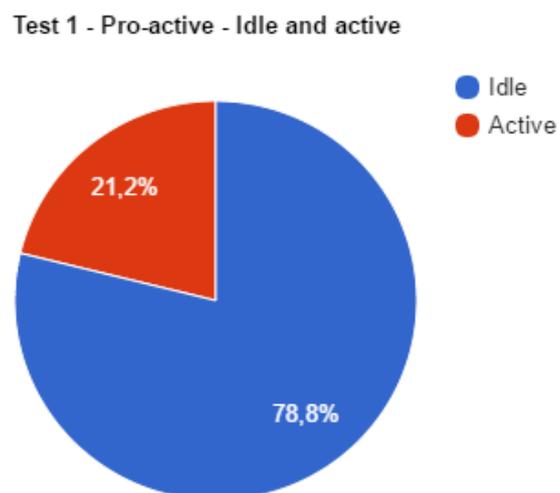
Figure 4.9: Test 1 - Pro-active - Idle and active
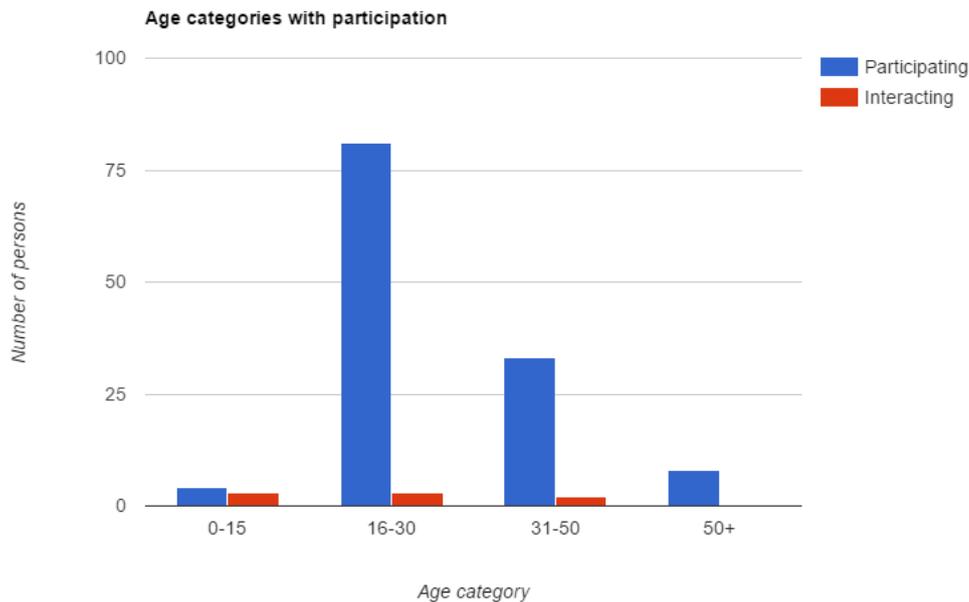
Figure 4.10: Test 1 - Pro-active - Age categories

Other observations

- Some passersby touched and turned the rolls.

- Some passersby searched for a way of interaction, and did not see the lever.

- The turning of the rolls took too long. Some users walked away before the first joke was told.

- A mom took a picture of her daughter with the prototype

- It was very cold

4.2.1 Discussion of results

There is a significant difference between the participation in passive and pro-active state. The difference between the interaction is not as great, still, there is an increase. Further, the participation in the pro-active state is not increased by people that were looking while someone was interacting with it, this is even slightly less. Indicating that the increase in participants was not a result of the increased interaction.

This all indicates that the concept elements are successful to provoke participation and the pro-active state is more successful in both provoking interaction and

creating an audience. Still, even in passive state the prototype was successful to provoke participation. A flow experience could not be reached, due to the rolls that rotated too long. The lever was not always located instantly, which could have been of influence on the amount of interactions.

The age categories are estimations, and therefore can be inaccurate. 4 age categories were measured, however, only the first one (0 -15) is relevant for the defined target group of this project. The participation in this category is very low, indicating that the content could be well adjusted for the target group of this project since this category is not in the target group. Still, almost all the times a child did participate it was interacting. Probably because of their spontaneous behavior (see Target group, section 2.6.4). Although the child itself was not in the target group, a lot of people that started looking at the prototype because it was active were in the target group. Thus, when a child starts interacting this could be useful after all. The other categories could be relevant for a test with a more accurately defined target group in future work.

Furthermore, the results indicate that most of the participants were 16 - 30. Some persons of 50+ did participate, however, none of them started interacting. This could mean that the content was not inviting enough or that this age category is not suitable for interaction.

A great part of the total visitors of the street was on a bike. Meaning that the total amount of visitors that are on foot (and thus in the target group) are less than used in the calculation of the sample size. This would mean that the sample size could have been smaller for the 95% confidence interval. Still, the sample size will be remained the same in the following tests. Including the cyclists is not relevant for this research.

Lastly, the weather could have been of influence to the participation. Cold weather could give a different effect compared to hot weather. This cannot be tested in the scope of this project.

4.3   User test 2

In test 2 the same setup as in test 1 was used. Plexiglass is placed in front of the rolls to avoid people touching the rolls. The rotating time of the rolls is shortened. Since some people did not see the lever, a sign with "pull me" and an arrow pointing to the lever is placed. Furthermore, a logo on each side, explaining what it is, is placed. The logo says "Finkers grappen Mixer" (Finkers joke mixer).

4.4   Results test 2

Passive state

During test 2 in passive state a total of 645 persons passed by the prototype, of which 433 by foot. 62 of 433 passersby participated, giving a participation of 14,3% (see figure 4.11)..

57 of the 433 passersby looked at the prototype (13,22%), 5 of the 433 passersby started interacting (1,2%). 371 of the 433 passersby did nothing (85,7%) (see figure 4.12).

18 of 57 passersby that looked did so when another was interacting with the prototype (active). The rest looked when the prototype was idle in passive state (see figure 4.13).

3 of the participants were in the age category 0-15, of which 2 interacted. 35 in the category 16-30 participated, of which 2 also interacted. 19 in the category 31-50 participated, of which 0 also interacted. 5 in the category 50+ participated, of which 1 also interacted (see figure 4.14).
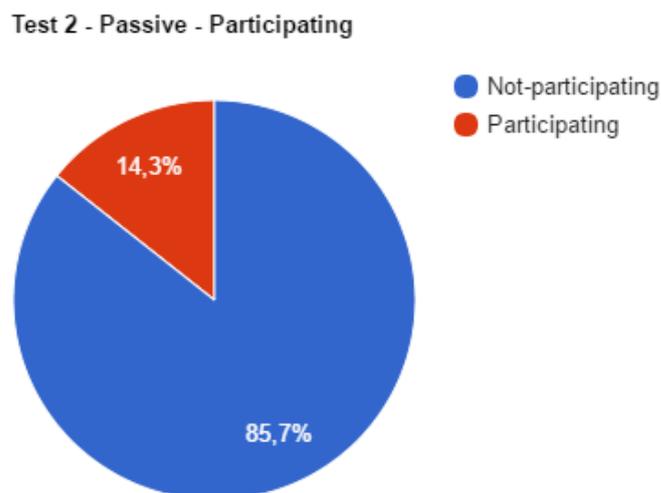
Figure 4.11: Test 2 - Passive - Participating

Test 2 - Passive - Looking and interacting
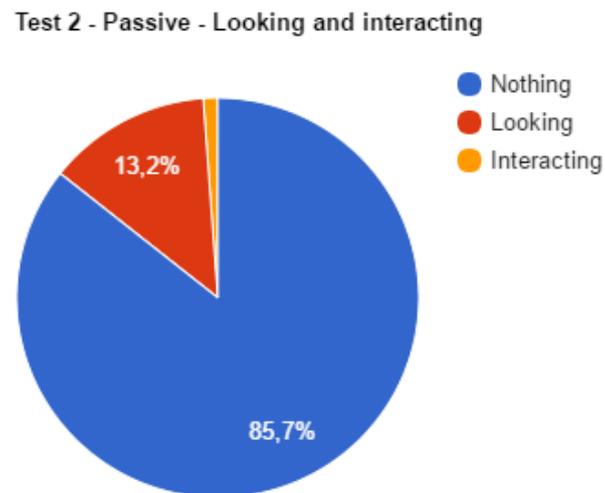
Figure 4.12: Test 2 - Passive - Looking and interacting

Test 2 - Passive - Active and idle
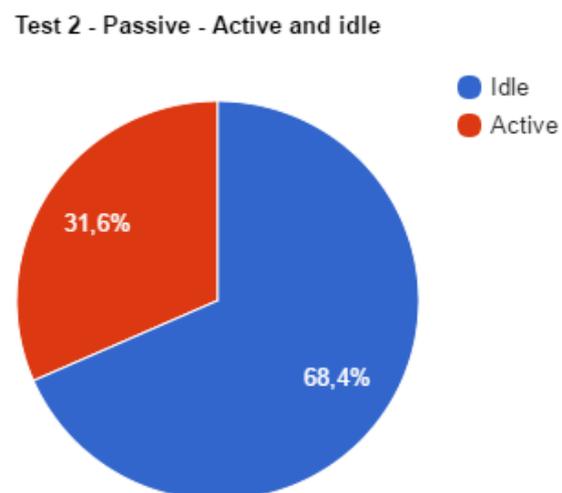
Figure 4.13: Test 2 - Passive - Active and idle
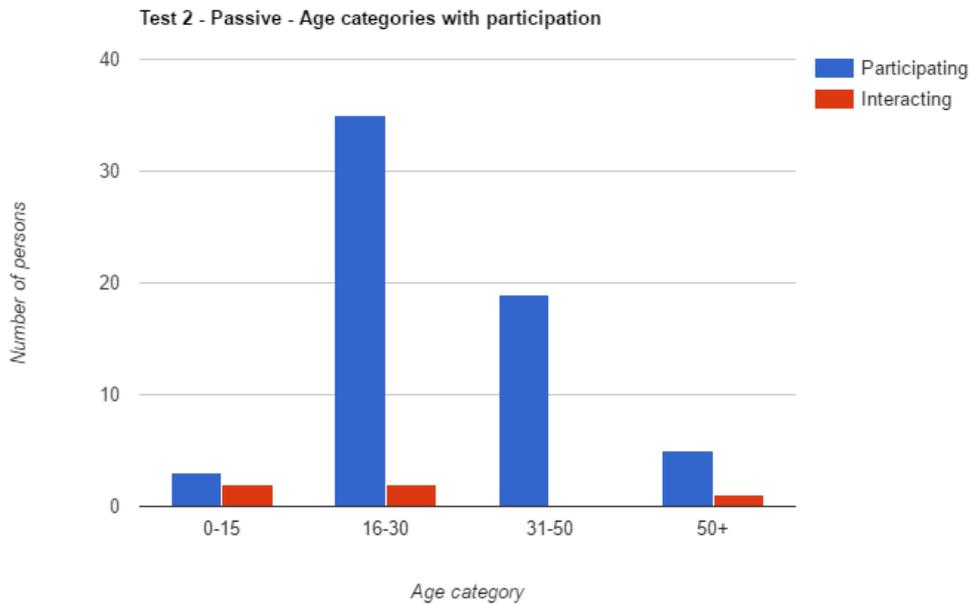
Figure 4.14: Test 2 - Passive - Age categories

Pro-active state

During the pro-active state a total of 549 persons passed by the prototype, of which 349 by foot. 115 of 349 passersby participated, giving a participation of 33% (see figure 4.15).

103 of the 349 passersby looked at the prototype (29,5%), 12 of the 349 passersby started interacting (3,4%). 234 of the 349 passersby did nothing (67%)(see figure 4.16).

27 of 103 passersby that looked did so when another was interacting with the prototype (active). The rest looked when the prototype was idle in pro-active state (see figure 4.17).

3 of the participants were in the age category 0-15, of which 2 also interacted. 69 in the category 16-30 participated, of which 6 also interacted. 36 in the category 31-50 participated, of which 2 also interacted. 7 in the category 50+ participated, of which 2 also participated (see figure 4.18).

Other observations

- Some participants saw us observing from a distance

- 2 users at first pulled the sign which said "pull me" with an arrow pointing at the lever but still found the lever eventually

Figure 4.15: Test 2 - Pro-active - Participating
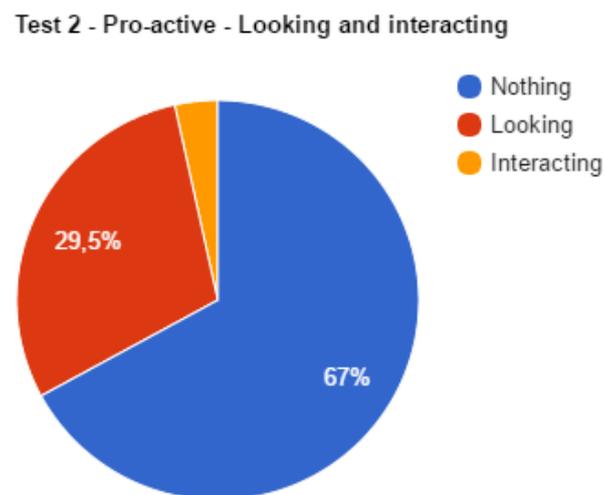
Figure 4.16: Test 2 - Pro-active - Looking and interacting

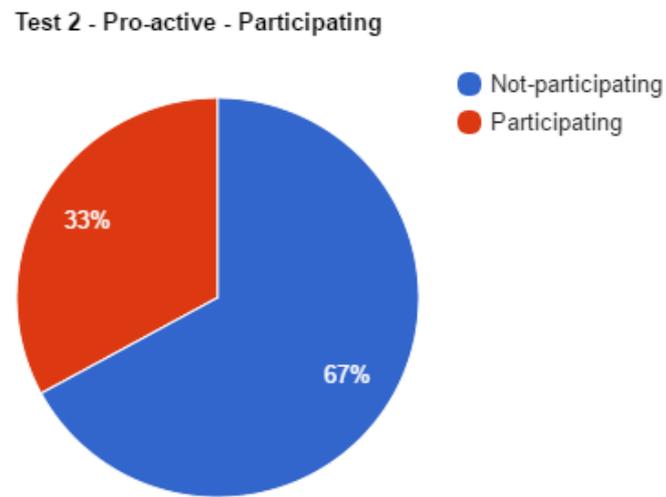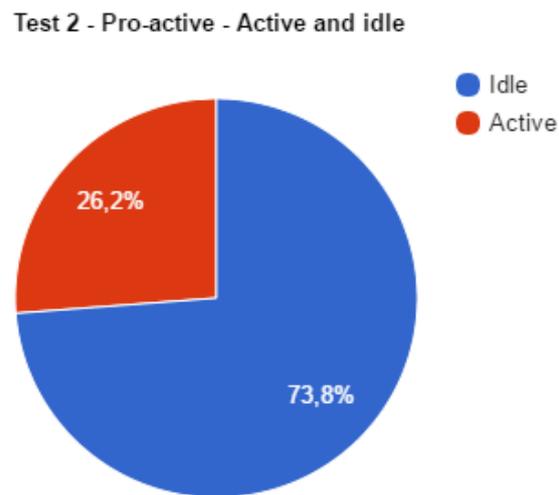**Figure 4.17:** Test 2 - Pro-active - Active and idle
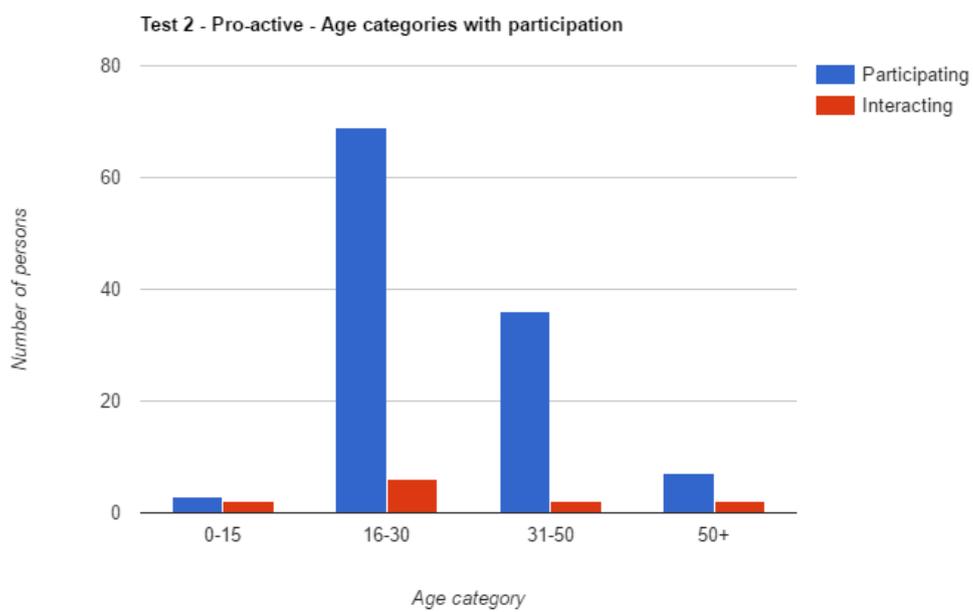
Figure 4.18: Test 2 - Pro-active - Age categories

4.4.1 Discussion of results

In test 2 the passive state provoked slightly less participation compared to test 1. The interaction remained unchanged. In pro-active state the participation also remained unchanged. However, the interaction increased quite a bit. This could indicate that adding the logos and sign did not contribute to getting attention. However, potential users that were interested and wanted to interact could find the lever more easily. The increase in interactors is directly linked to the difference in idle and active ratio. Since the prototype now was active for a longer period of time, a greater part of the participants saw the prototype in active state. Furthermore, these results could indicate that there is no difference between active state and pro-active in idle state in terms of provoking participation, since the amount of interactors increased and the participants remained the same.

This test the interactors all watched at least one full active cycle. Meaning the first action, rotating the rolls, is followed quick enough by the second action.

In the age categories the only noticeable change is that some participants in the 50+ category also started interacting. About the same frequency as the 0-15 category. This means that this category is good for (some) interaction after all.

The sample size of the test in pro-active state was slightly less than 371, meaning the confidence interval is slightly less than 95%. However, as mentioned in test 1, a lot of cyclists passed by the prototype too which were not included in the calculation of this sample size. Meaning the sample size could be smaller. Still, since this is not calculated it is more safe to assume that the confidence interval in this case is a little below 95%.

4.5 User test 3

The setup of test 3 was the same as in test 1 and 2. Since participants were pulling the 'pull me' sign, it is replaced with a 'pull that lever' sign. Two extra 'pull that lever' stickers are added, one at the front, the other on the right side, to make sure each potential user can find the lever. We observed form another place this time, to make sure the participants could not see us.

Test 3 also included a qualitative part. In the qualitative part the question "Why did you not pull that lever?" was asked to persons that did not interact with the prototype and were estimated to be in the target group. A set of standard answers was formulated beforehand. These answers were estimated to be the responses that would occur most frequently. If the response was different, it was still noted. See table for the standard responses. This method was chosen to be able to rapidly question bypassers. For the full test form, see the Appendix E. Note that in the form

the option 'didn't see it' refers to the prototype as a whole (the second response in table 4.1), rather than only the lever. If the response was that the person in question could not find or did not see the lever itself, this would be count as 'other'.

Why did you not pull that lever?
"I had no need for it"
"I did not notice the installation"
"I did not have the time"
Other

Table 4.1: Standard answers

4.6   Results test 3

Passive state

During the first test in passive state a total of 432 persons passed the prototype by foot. 77 of 432 passersby participated, giving a participation of 17,8% (see figure 4.19).

68 of the 432 passersby looked at the prototype (15,7%), 9 of the 432 passersby started interacting (2,1%). 355 of the 432 passersby did nothing (82,2%) (see figure 4.20).

17 of 68 passersby that looked did so when another was interacting with the prototype (active). The rest looked when the prototype was idle in passive state (see figure 4.21).

2 of the participants were in the age category 0-15 and also interacted, 52 in the category 16-30 participated, of which 3 also interacted. 13 in the category 31-50 participated, of which 1 also interacted. 10 in the category 50+ participated, of which 3 also interacted (see figure 4.22).
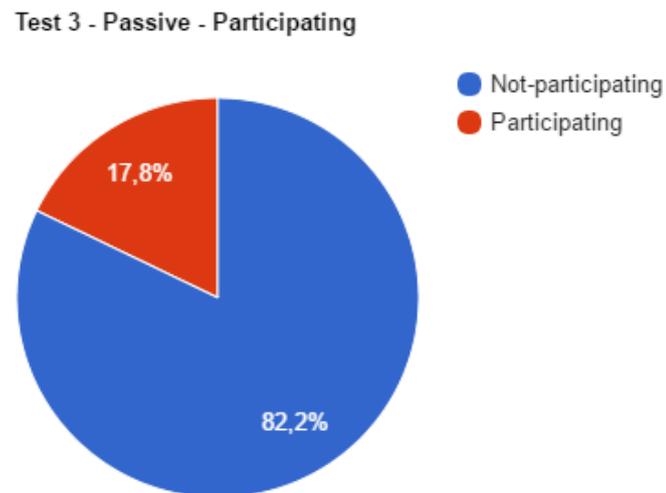
Figure 4.19: Test 3 - Passive - Participation
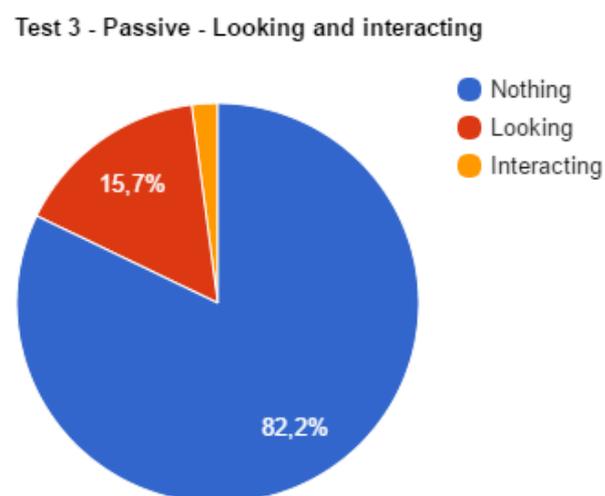
Figure 4.20: Test 3 - Passive - Looking and interacting
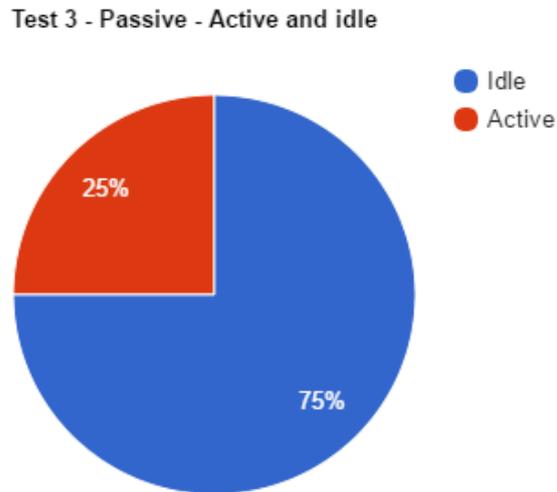
Figure 4.21: Test 3 - Passive - Active and idle
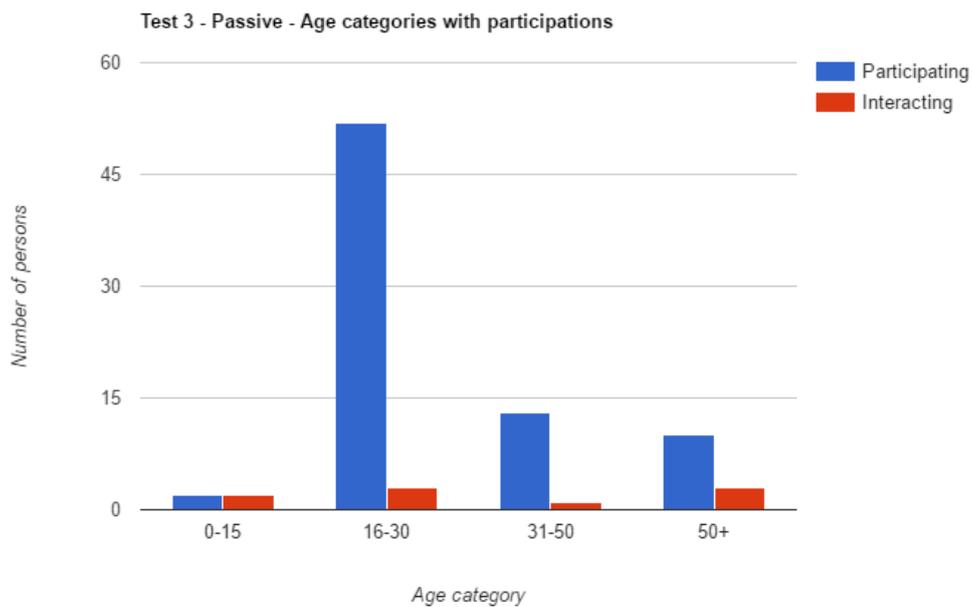
Figure 4.22: Test 3 - Passive - Age categories

Pro-active state

During the pro-active state a total of 474 persons passed by the prototype by foot. 164 of 474 passersby participated, giving a participation of 32,3% (see figure 4.23).

149 of the 474 passersby looked at the prototype (31,4%), 15 of the 474 passersby started interacting (3,2%). 310 of the 474 passersby did nothing (65,4%) (see figure 4.24).

51 of 149 passersby that looked did so when another was interacting with the prototype (active). The rest looked when the prototype was idle in pro-active state (see figure 4.25).

2 of the participants were in the age category 0-15, of which 0 also interacted. 89 in the category 16-30 participated, of which 10 also interacted. 36 in the category 31-50 participated, of which 3 also interacted. 37 in the category 50+ participated, of which 2 also participated (see figure 4.26).
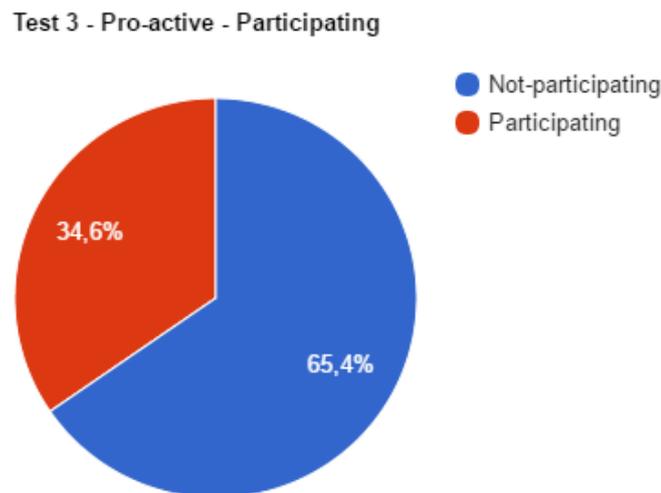
Figure 4.23: Test 3 - Pro-active - Participating
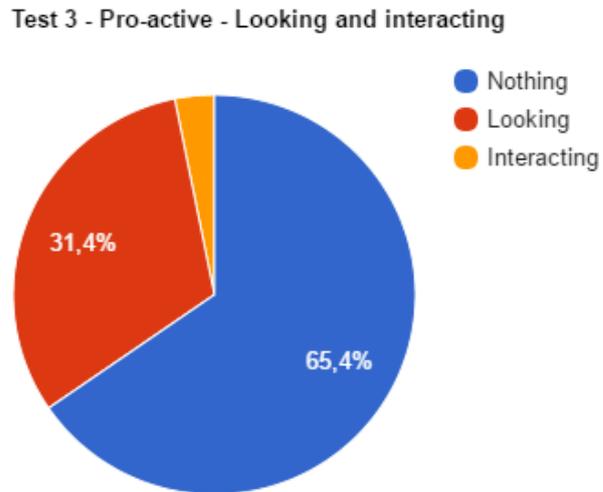
Figure 4.24: Test 3 - Pro-active - looking and interacting
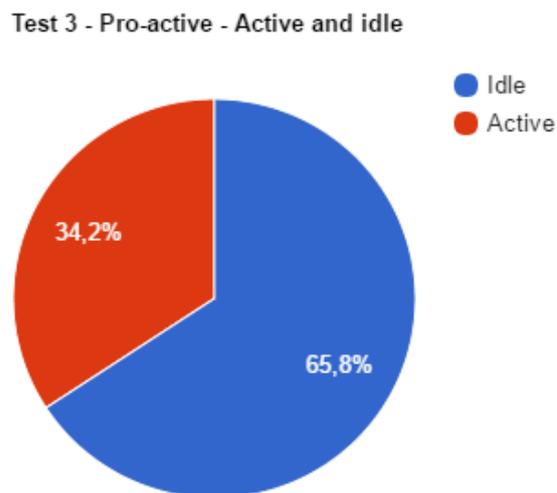
Figure 4.25: Test 3 - Pro-active - Active and idle
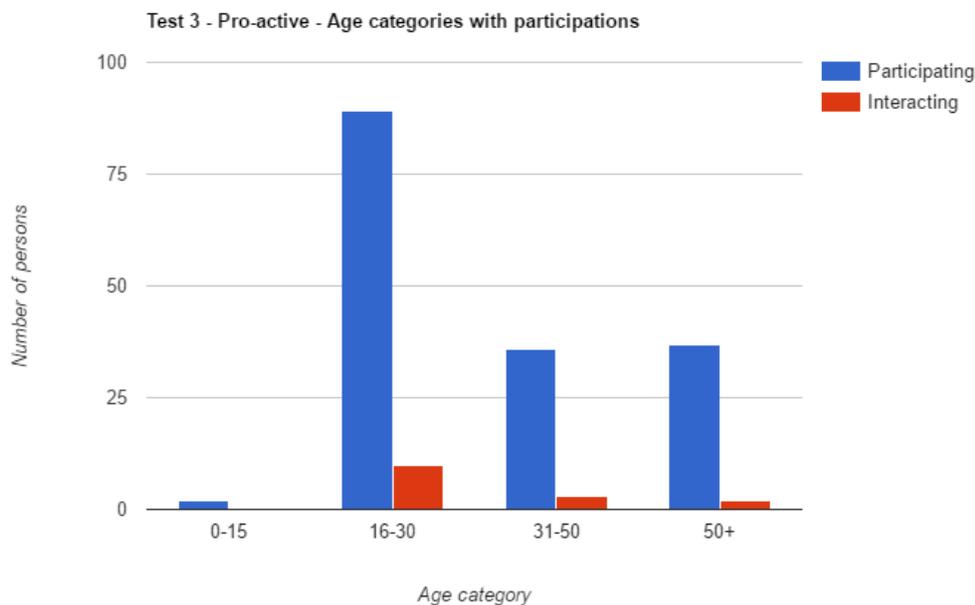
Figure 4.26: Test 3 - Pro-active - Age categories

Other observations

- A man made video and pictures for a long time

- Several users tried the lever a second and even a third time after the first active cycle (this was counted as one interactor still)

Qualitative test

A total of 30 different people, estimated above 16, are questioned. 15 during both passive and pro-active state. Remarkably all persons that answered with none of the first three answers, answered with "No idea" (see figure 4.27).

4.6.1   Discussion of results

Again the difference in participation in passive state compared to previous test is minimal. The interaction is slightly increased. In the pro-active state both the looking and interaction remain unchanged. It appears that adding the extra signs and changing the observation spot did not have effect on the participation.

However, it appeared that changing the observation spot did have effect on the user's experiences. It occurred several times that users tried the lever a second

or third time after the first active cycle. Indicating they could have reached a flow experience.

Another noticeable difference is the amount of participants in the age category of 50+. The interaction, however, remained unchanged.

In the qualitative test during the passive state 10 of 15 subjects answered they did not see the prototype. This is a big difference compared to the answers of the subjects during the pro-active state, which were more evenly divided. It appears that without the pro-active state, the installation is likely to be overlooked. This is coherent with the results of all other tests.
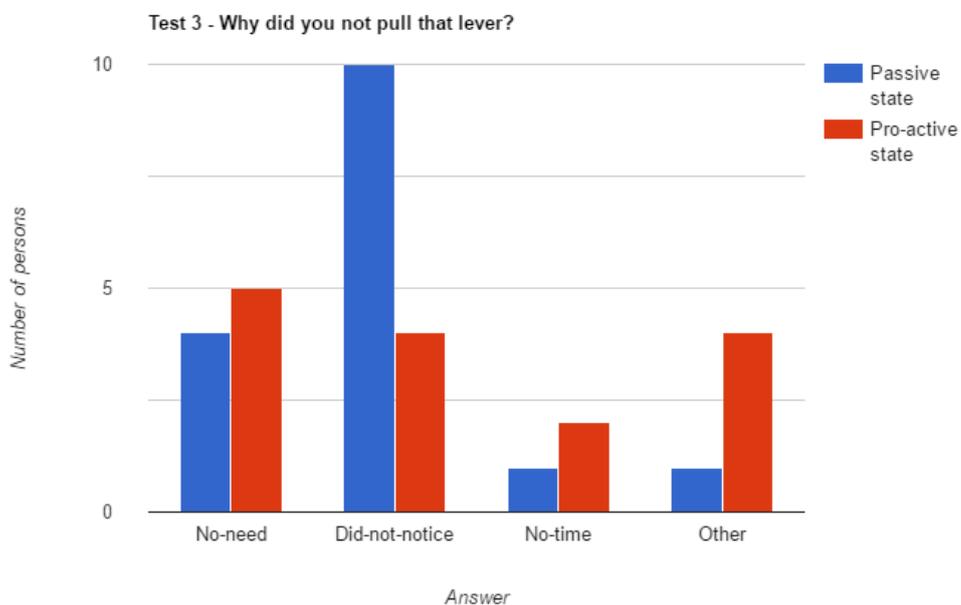
Figure 4.27: Test 3 - Qualitative test

Chapter 5

Conclusions

This project was initiated to make valuable design choices for an interactive installation in the form of a kinetic game on the facade of Concordia's art gallery. The installation must provoke participation to create more awareness of the existence of Concordia. The ideal form of participation is interaction while the user is fully focused on the installation. Several interviews and literature research on interaction, participation and interactive installations resulted in a set of requirements. These requirements are used to evaluate elements of content which are the results of a parallel ideation in context. The best elements of content are presented as potential successful content for the final kinetic game installation. The requirements, which are now conceptualized, are tested with a prototype. The results of these tests combined with the other results conclude the following for an installation on the facade of Concordia.

In order to provoke participation, first, a target group must be selected, as narrow as possible. The target group for Concordia should only consist of people that are interested in modern arts. The interests and expectations of this target group must be implemented in the content of the installation. Spectacular shapes, recognizable sounds and content and lights can be used to get the attention of passersby. The most important thing for getting the attention, however, is a pro-active state. Without a pro-active state the installation simply does not get noticed.

Once a potential user is interested, she must be made aware of the possible interaction. This is done with guidance. A fully optimized design does not need any explanatory text, and is guiding in itself. A good way to achieve this is by using universal shapes and concepts of interaction, such as a steering wheel that needs to be turned. When the design turns out to be not fully optimized an explanatory sign can do the trick. This sign, however, must have a text as short as possible and often deteriorates the appearance of the installation. A long explanatory text is never successful. Assuming a pro-active state is used, guidance only contributes to the amount of interaction. The total participation remains the same.

Next, a layered approach is necessary to make the interactive experience a successful one. The first layer (first action) must be easy to understand and quickly give results in the form of a reward. The next layers, each increasing challenge and demanding slightly more attention and patience, must follow rapidly. Iteration must be possible to explore new interactive processes or cycles. With an optimized layered approach, the user gets more and more immersed to reach a flow experience eventually. In the flow state the user is fully focused on the content of the installation, is willing to 'play along' with all elements and has an altered sense of time. It is the perfect situation to tell a story, give a message or in the case of Concordia, to create awareness. Not only of Concordia itself, also of the content Concordia is providing. Still, the story that is being told must be coherent with the rest of the content (or the other way around). An incoherent storyline can break the flow experience.

Lastly, the usage of space is of influence on the user's experience. In this case, there is a great audience of which a very small part are interactors. Even though all space is public and there are a lot of people passing by, the user must be placed on a spot at which she has the feeling she is in a safe environment. The moment she has the feeling she is being watched, or that her actions could be of influence to others somehow, the immersion is blocked and a flow experience cannot be reached.

Invitation, exploration, immersion
Pro-active
Spectacular shapes
Layered approach
Usage of space
Universal shapes and concepts of interaction
Light animations
Guidance
Recognizable sounds
Rewards
Storyline
Target group
Flow experience

Figure 5.1: Important elements for an interactive installation in public

Chapter 6

Discussion and Recommendations

6.1 Discussion

The content of the prototype proves to be successful for provoking participation of people passing by Concordia's art gallery. The requirements implemented in the prototype prove to be valid. The list of requirements combined with the set of design choices answer research question 1 (the main question) and the accompanying questions 1.1 and 1.2. However, the prototype is not representative enough to the final installation to say with certainty that the tested content will definitely also work with the final installation. Most likely there will be placement, size and appearance differences, creating a chance the outcome is different. Further, only 1 of the 15 selected elements of content was tested. Although the other 14 elements are selected with the same criteria, a chance remains that these elements turn out to be unsuccessful. Testing all elements, plus the effect when they are combined, remains future work.

Getting the attention of passersby was solved with a more general approach. The theory turned out to be coherent with the results of the user test. This answers research question 2.

The report extensively describes important factors for the participation, interaction, content and user's experience of an interactive installation in public. This answers question 3 with accompanying questions 3.1, 3.2 and 3.3. However, most of the conclusions are formed with results gathered in the context of the public street in front of Concordia's art gallery. Another place could have other results.

Research question 4 was formed with the idea to have a fully executable design for the kinetic game at the end of the project. Although enough design concepts and choices are presented, including appearance and content, a full final design could not be realized. It must be noted that this was an additional question, not directly related to the project goals, to make the project more valuable for 100%FAT. Unfortunately, this remains future work. Still, all ingredients are collected. The only

thing left to do is baking the pie.

6.2   Recommendations

It is recommended that 100%FAT, in consideration with Concordia, defines an accurate image of the target group. According to this image extra elements of content can be generated. These elements should be evaluated with the use of this paper. The combined best elements of content of this paper will create an even more suitable content for the final installation. It is recommended that several of these concepts are tested first, in the same way as is done in this project.

Children are considered not part of the target group. Therefore, it is recommended that the theme of appearance is somewhat less based on toys. At least the story that is being told should not consist of elements that are too much like a children's toy. However, the first layer of action, such as the lever in this project, should still also be designed for children. The spontaneous behavior, causing them to start interacting without hesitating, can never have negative effects on the overall participation.

In the ideation phase, scenarios are considered in which users entered the building to see what is inside as a result of the interactive process. This, however, is unlikely to occur since it deviates too much from their original activity; going from a to b, even if they indeed are interested. Furthermore, it is not necessary for creating awareness for existence and the exhibitions. This can be done as described in this report. Once the people that are interested are aware of the exhibitions, it depends on other factors such as their available time whether they take a visit. Nothing an interactive installation can provide. Therefore, it is recommended that the installation only aims at an optimized participation, not to lure people inside.

Lastly, on a more technical note, it is recommended that the user's input is accommodated with the sensors coherent with the theme of appearance; big levers and turning wheels. More advanced sensing technologies can normally have a nice effect, however, in this case will probably not work since the installation has to deal with a busy street.

Acknowledgments

Bibliography

[1] E. Dertien and A. Mader, "How to educate for creativity in creative technology?" *International Conference on Engineering and Product Design*, vol. 16, pp. 563–567, Sep 2014.

[2] A. Mader and W. Eggink, "A design process for creative technology," *International Conference on Engineering and Product Design Education*, vol. 16, p. 209, Sep 2014.

[3] A. J. Morrison, P. Mitchell, and M. Brereton, "The lens of ludic engagement: Evaluating participation in interactive art installations," in *Proceedings of the 15th ACM International Conference on Multimedia*, ser. MM '07.   New York, NY, USA: ACM, 2007, pp. 509–512.

[4] R. Tieben, T. Bekker, and B. Schouten, "Curiosity and interaction: Making people curious through interactive systems," in *Proceedings of the 25th BCS Conference on Human-Computer Interaction*, ser. BCS-HCI '11.   Swinton, UK, UK: British Computer Society, 2011, pp. 361–370.

[5] L. de Valk, T. Bekker, and B. Eggen, "Designing for social interaction in open-ended play environments," *International Journal of Design*, vol. 9(1), pp. 107–120, 2015.

[6] H. Oinas-Kukkonen and M. Harjumaa, "Persuasive systems design: Key issues, process model, and system features," *Communications of the Association for Information Systems*, vol. 24, no. 28, 2009.

[7] G. Jacucci, M. Wagner, I. Wagner, E. Giaccardi, M. Annunziato, N. Breyer, J. Hansen, K. Jo, S. Ossevoort, A. Perini, N. Roussel, and S. Schuricht, "Participart: Exploring participation in interactive art installations," in *2010 IEEE International Symposium on Mixed and Augmented Reality - Arts, Media, and Humanities*, Oct 2010, pp. 3–10.

[8] A. Nijholt, B. van Dijk, and D. Reidsma, *Design of Experience and Flow in Movement-Based Interaction*.   Berlin, Heidelberg: Springer Berlin Heidelberg, 2008, pp. 166–175.

[9] L. Ciolfi, "Place-centred interaction design: situated participation and co-creation in places of heritage," in *Museum and design principles, Proceedings of the conference*, M. Ballarin and M. D. Mura, Eds. Venezia: Fondazione di Venezia, 2012, pp. 57–68.

[10] C. Jorge, V. Nisi, J. Hanna, N. Nunes, M. Caldeira, and A. Marinho, *MStoryG: Exploring Serendipitous Storytelling Within High Anxiety Public Spaces*. Cham: Springer International Publishing, 2015, pp. 335–353.

[11] H. Cramer, J. Goddijn, B. Wielinga, and V. Evers, "Effects of (in)accurate empathy and situational valence on attitudes towards robots," in *Proceedings of the 5th ACM/IEEE International Conference on Human-robot Interaction*, ser. HRI '10. Piscataway, NJ, USA: IEEE Press, 2010, pp. 141–142.

[12] D. Reidsma, D. Davison, and E. Dertien, "Heterogeneous multi-modal mixing," 2016.

[13] Telegraaf, "Commotie om kunst met is-vlag," June 2015.

[14] A. Polaine, "Developing a language of interactivity through the theory of play," 2010.

[15] ——, "The flow principle in interactivity," in *Proceedings of the Second Australasian Conference on Interactive Entertainment*, ser. IE '05. Sydney, Australia, Australia: Creativity & Cognition Studios Press, 2005, pp. 151–158.

[16] M. Csikszentmihalyi, *Flow : the psychology of optimal experience*. Harper and Row, 1990.

[17] B. Jansen, *Suspension of Disbelief*. Brechtje Jansen Photography, 2016.

[18] M. Fishbein and I. Ajzen, *Belief, attitude, intention, and behavior: An introduction to theory and research*. Addison-Wesley, 1975.

[19] I. Ajzen, "The theory of planned behavior," *Organizational Behavior and Human Decision Processes*, vol. 50, no. 2, pp. 179 – 211, 1991, theories of Cognitive Self-Regulation.

[20] H. Kukka, H. Oja, V. Kostakos, J. Gonçalves, and T. Ojala, "What makes you click: Exploring visual signals to entice interaction on public displays," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, ser. CHI '13. New York, NY, USA: ACM, 2013, pp. 1699–1708.

[21] J. Müller, D. Wilmsmann, J. Exeler, M. Buzeck, A. Schmidt, T. Jay, and A. Krüger, *Display Blindness: The Effect of Expectations on Attention towards Digital Signage*. Berlin, Heidelberg: Springer Berlin Heidelberg, 2009, pp. 1–8.

[22] A. Bendinelli and F. Paternò, *Design Criteria for Public Display User Interfaces*. Cham: Springer International Publishing, 2014, pp. 623–630.

[23] P. Dalsgaard and L. K. Hansen, "Performing perception; staging aesthetics of interaction," *ACM Trans. Comput.-Hum. Interact.*, vol. 15, no. 3, pp. 13:1–13:33, Dec. 2008.

[24] J. Hu, J. Gu, Y. Zhang, J. Frens, M. Funk, K. Kang, Q. Dong, Y. Wang, F. Wang, and M. Rauterberg, "Learning from traditional dynamic arts: Elements for interaction design," *2013 International Conference on Culture and Computing*, vol. 00, pp. 165–166, 2013.

[25] Gelderlander, "15 hilarische uitspraken van herman finkers," *Gelderlander*, 2015.

[26] "Binnenstadsmonitor enschede," *Kennispunt Twente*, 2016.

[27] J. Mcclave and T. Sincich, *Statistics*. Pearson Education (Us), 2012.

Interview questions

Interactieve installaties

- Wat is jouw favoriete manier van brainstormen? Wat werkt en wat niet?

- Hoe ga je verder in je voorbereidingsproces?

- Test jij je installaties? Veel prototypes? Hoe evalueer je deze?

- Wat wil je bereiken met interactie in jouw installaties?

- Werk je vooral uit intutie of uit onderbouwd onderzoek? Waarom? Heb je dit al eens anders gedaan?

- Heb je wel eens meegemaakt dat mensen je installatie niet begrepen? Hoe kwam dit?

- Zijn jouw installaties vaak gericht op een bepaalde doelgroep?

- Werkt alles altijd zoals je verwacht? Wat zijn je ervaringen?

- Wat is uit jouw installaties gebleken dat altijd werkt om de aandacht te trekken? En wat juist niet?

- Blijven mensen hierna automatisch genteresseerd (ongeacht de content)? Zo nee, wat is daar voor nodig en wat werkt vooral niet?

- Heb je bij installaties wel eens mensen over moeten halen om een actie te ondernemen? Hoe heb je dit gedaan?

- Evalueer jij of iemand anders jouw installaties?

- Wat zijn veel voorkomende valkuilen bij interactieve installaties?

- Zie je op het gebied van interactieve installaties bepaalde trends?

<div align="right">

Appendix B
</div>

Elements of contents

Wilmink - Writing:

1. Visualize a poem on the facade with beamers and screens. This poem appears when somebody activates it.
2. Visualize a poem on the facade with an mechanical display. This poem appears when somebody activates it.
3. Visualize a poem on the facade with an mechanical display. This display shows one word or sentence at a time.
4. Visualize a poem on the facade with figures. This poem appears when somebody activates it.
5. Users can fill in their name, after which a poem with their name gets visualized.
6. A big piece of perkament on which a big pencil writes something.
7. Users write something with a big typing machine on a piece of paper.

FC Twente - Soccer:

8. The ball of the installation is a FC Twente ball which at the end makes a goal with load cheering.
9. Typical offensive choruses that get activated when people pass by.
10. Typical offensive choruses that get activated when people pass by, and stop and turns into cheering when users make a goal by interacting.
11. Cheering audience making a wave when people pass by.
12. A toilet where money gets thrown in. (FC Twente fiasco).

Grolsch - Beer:

13. A part of the Grolsch factory. A kettle that gets filled.
14. A kettle that gets filled when the user is pumping.
15. A cork cap (Grolsch beugel) pops with the pop sound. Then closes again and pops again.
16. A cork cap pops when a user is makes an opening movement.
17. An entire bottle orchestra makes music when someone passes by.
18. The bottle orchestra makes music when a user fills opens one bottle.

Ilse de Lange - Music:

19. A ball rolls while activating music notes making a song. While someone passes by.
20. Balls fall on drums making a song.
21. The user(s) play notes on instruments on the wall on a 'guitar hero' way. If they are to late to play a note the music is false.

Finkers, Elsink - Comedy/Theatre:

22. Playing pieces of comedy when people pass by.
23. A figure that comes to the front and speaks, when someone pushes a button.

24. A figure that comes to the front sometimes, when someone pushes a button he tells a joke.
25. A visualization of a well-known piece of comedy by a comedian.
26. A physical visualization of a well-known piece of comedy by a comedian when someone activates it.

Ten Mors - Ice skating:

27. A skate that moves when someone pushes it.
28. A plate on which ice skaters skate with music, like a christmas thingy
29. A plate with ice skaters that can be controlled by users.

Vuurwerkramp - fireworks disaster:

30. Reenact the 'Vuurwerkramp' with video, light and sound.
31. Reenact the 'Vuurwerkramp' with physical rockets and sound.

Textile industry, van Heek, ten Cate - Textile:

32. Passing shirts on a line.
33. A textile lord passes and tells a story with text
34. A textile lord passes and his story is told with video
35. Weaving-looms go back and forth when the user turns a big wheel.
36. A big spinning wheel spins by input of the user. While spinning a shirt is being made with spinning sound.

Industry, TET - Industrial:

37. A big steam-engine runs while people pass by. With the steam engine sounds.
38. Pneumatic actuators move and run with big bangs.
39. Pneumatic actuators move and run with big bangs when a user pulls a lever.
40. Pneumatic actuators move and run with big bangs, when the user pulls a lever photo's are shown of the industry of Twente.
41. When the user pulls a lever a steam-engine train drives by. With sound.
42. The train and sound drives by once in a few minutes.
43. A pumpjack pumps oil and fills a train wagon. When the wagon is full the train starts moving.
44. A pumpjack pumps oil and fills a train wagon. When the wagon is full the train starts moving when the user pulls a lever, or switches the stop sign from red to green.
45. The TET train drives by while a big gear is turning making a lot of noise.
46. The TET train can be controlled by the user (accelerate, break). With flute and train sounds.
47. A clock with big gears that doesn't run. Users have to set it right.
48. A clock with bells and pendulum running with a lot of gears and noise.

Friedhoff - Architecture:

49. Famous building is build up from little pieces when user is interacting with it.
50. Unfold a pop-up book of a famous building when someone approaches.

Filter with the requirements

If an important requirement could be implemented this is counted as a yes. For instance, guidance is not implemented in any of the ideas, however, could be implemented in a lot of cases.

	Requirement and their rating																	Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
	3	3	3	3	3	3	3	2	2	2	1	1	1	1	1	1	1	
1		x				x		x	x						x	x		15
2		x	x			x	x	x	x								x	17
3	x	x	x		x	x	x	x	x								x	23
4		x				x	x	x	x								x	14
5		x				x	x	x	x	x					x			16
6	x	x			x	x	x	x									x	18
7		x	x	x		x	x	x	x	x	x						x	23
8			x	x			x		x	x							x	14
9	x		x			x											x	10
10	x		x	x			x		x	x	x						x	18
11	x	x	x							x		x					x	14
12	x	x	x			x	x										x	16
13	x	x	x			x	x	x									x	18
14		x	x			x	x	x	x	x	x						x	20
15	x	x	x			x	x	x									x	18
16		x	x	x		x	x	x	x	x							x	22
17	x	x	x			x	x		x								x	17
18		x	x	x	x		x	x	x	x	x						x	23
19	x	x	x			x	x		x								x	18
20	x	x	x			x	x	x									x	18
21			x	x	x	x	x	x	x	x	x			x	x		x	25
22	x		x			x	x	x		x								16

23			x	x			x	x	x	x		x					x	17
24	x		x	x		x	x	x	x	x		x					x	23
25	x		x			x		x				x		x				13
26		x	x	x		x	x	x	x	x							x	22
27		x		x			x	x	x	x							x	16
28	x		x			x	x	x									x	15
29				x	x		x	x	x	x		x					x	17
30	x		x			x								x	x			11
31	x	x	x			x	x										x	16
32	x	x				x	x	x									x	15
33	x		x			x	x	x				x					x	16
34	x					x		x				x		x				10
35		x		x		x	x	x	x	x							x	19
36		x	x	x	x	x	x	x	x	x							x	25
37	x	x	x			x	x	x		x							x	20
38	x	x	x				x										x	13
39		x	x	x			x		x	x							x	17
40	x	x	x	x	x	x	x	x	x	x				x			x	29
41			x	x		x	x	x	x	x							x	19
42	x		x			x	x	x									x	15
43	x	x	x			x	x	x									x	18
44	x	x	x	x		x	x	x	x	x							x	25
45	x	x	x			x	x	x									x	18
46			x	x	x	x	x	x	x	x	x						x	23
47		x	x	x			x	x	x	x	x							22
48	x	x	x				x	x									x	15
49		x		x	x	x	x	x	x	x	x					x	x	24
50	x	x		x		x	x	x		x						x	x	21

Schematics of the final prototype

M1 Roll 1   M2 Roll 2   M3 Roll 3

ROB-08420   ROB-08420   ROB-08420

DC1 12V   DC2 5V

Arduino 1

Arduino Uno (Rev3)

PA button   R2 220Ω

Lever   R1 220Ω

RGB ledstrips are digitial with 3 pins: 5V, DIN, GND

LEDs Rolls   LEDs Spots   LEDs Background   LEDs Name

PANdrive Motor is controlled with Serial Comm. and connected to 12V

Arduino Motor Shield (Rev3)

Arduino with motor shield and mp3 shield

fritzing

User test

Passing by	Passing by and look	Interacting

age: **1** = 0-16, **2** = 16 - 30, **3** = 30 - 50 **4** = 50+

Why **didn't** you pull the lever?

No need	Didn't see it	No time	Other	Age	Gender