Judgmental Elevation: Designing a Sarcastic Smart System to Nudge Users Towards a Healthier Tomorrow

Graduation Project Creative Technology

Author: Ewoud Janus – s2395762 31/01/2025 Supervisor: Andrea Papenmeier

Abstract

Encouraging healthier lifestyle choices through interactive technology has become an increasingly relevant topic in human-computer interaction research. This study explores the effectiveness of an interaction installation designed to nudge individuals at the University of Twente towards choosing the stairs over the elevator. The main research question investigates whether a judgmental system, which applies subtle social pressure, is more effective than a friendlier system in influencing user behavior.

To evaluate this question, a prototype was developed and tested in a real-world setting at the University of Twente. The installation features two modes: a judgmental tone designed to create a form of social accountability and a friendlier tone that would encourage the user through positive reinforcement. A within-subject experimental design was used, where 25 participants interacted with both modes. The choices between the stairs and the elevator combined with the user perception of the system recorded in an online questionnaire. Additionally, semi-structured interviews were conducted with a subset of participants to further gain insights into user experiences.

The results showed that the installation successfully increased stair usage, with an average of 48% before interaction to 56% after interacting with the installation. However, the tone did not create a significant behavioral difference, indicating that the interactive aspect of the installation was the primary influence on behavior.

The study highlights the importance of interactive installation in nudging behavior, especially in environments with younger demographics, such as universities. These findings suggest that future research should focus on refining interactive installations by improving clarity, and more dynamic interactions.

The research contributes to the field of persuasive technology by demonstrating the potential of interactive installation in influencing health-related choices like taking the stairs or elevator. The study provides valuable insights into user behavior, engagement, design, and impact on behavior, offering information to further explore interactive nudging techniques.

Acknowledgments

I would like to express my gratitude to my supervisors, Andrea Papenmeier and Sebastian Schneider, for their continuous help, insights, and detailed feedback throughout this project. Their dedication and willingness to meet every week and always be available for help made a huge difference in this project, and I truly could not have done a lot of this without them.

A special thank you to Anouchka, Ruther, and all my other friends, who have been by my side during this project. Their encouragement and help made the process a lot more manageable. Finally, the deepest appreciation to my parents for their unwavering support throughout my life and encouragement during my academic career. This project would not have been possible without all of you, thank you!

Table of Contents

List of Figures

Chapter 1: Introduction

Although the difference between taking the elevator or the stairs seems trivial, it has big implications regarding physical activity and health for the public. Sedentary behavior has become one of the most important health issues worldwide, contributing to health risks such as obesity, diabetes, cardiovascular disease, and more [1, 2]. A simple and effective form of physical activity that can easily be incorporated into daily routines is stair climbing [3]. Taking the stairs has significant health benefits, such as reducing the risk of cardiovascular disease, obesity, cholesterol levels, diabetes, some forms of cancer, and much more [3, 4]. According to the WHO 2020 guidelines on physical activity and sedentary behavior [5], regular physical activity like stair climbing impacts cognitive function and the risk of cognitive decline. According to Sterling et al. [6], it could even help with focus and attention, highlighting the importance of taking the stairs for students and office workers.

Besides reasons on an individual level, taking the elevator instead of the stairs is also less environmentally friendly. Elevators on average use 5 to 25% of the total energy consumption of a building [7], which implies there is a lot of energy to be saved if more people are motivated to take the stairs instead of the elevator. For the owners of these buildings, it would also be beneficial to reduce energy costs and repair costs.

Encouraging stair use provides benefits on an individual, societal, and business level. Individuals improve their physical health, organizations will see a reduction in the costs for their total energy usage, and society will reap the benefits of a better environmental option, with a reduced strain on the healthcare system due to a healthier overall population.

Motivation and habit play important roles in why people climb stairs or pick up the elevator. According to Radtke et al. [8], individuals often know there is a better option and are aware of the health benefits resulting in cognitive dissonance when taking the elevator. Highlighting this phenomenon by making the user aware of their actions could result in more individuals climbing the stairs next time around.

This project aims to nudge users to reconsider the habit of picking the elevator instead of the stairs. This goal will be realized by building an interactive system that discourages users from taking the elevator and, in turn, promotes the health benefits of taking the stairs. The project follows a human-centered design (HCD) approach to ensure the final concept design aligns with the user requirements.

Alongside this approach, two user studies will be conducted to gain a further understanding of the users' preferences. First of all, a preliminary formative online questionnaire will be conducted to further understand the motivation and habits of students and employees of the University of Twente for picking up the elevator instead of the stairs. Using judgmental humor, effective prompts, and interactive challenges communicated using facial expressions and prompts on a screen and voiced via speakers, the system will try to educate and nudge users toward behavior change favoring the stairs.

The findings of this study suggest that interactive nudging interventions can effectively increase stair usage in university environments, highlighting the importance of human-centered nudging technology to promote healthier behavior changes in environments like a university.

Chapter 2: Background Research

2.1 Benefits

There are many benefits to taking the stairs instead of the elevator; the benefits that were most relevant to this project are highlighted in the following section exploring the physical, cognitive, and environmental benefits associated with stair usage.

Physical benefits: engaging in frequent stair climbing offers a multitude of physical health benefits, especially regarding cardiovascular diseases. Climbing the stairs has been shown to improve aerobic capacity, reduce waist circumference, decrease body weight, lower fat mass, and more [1, 3]. One study reported that individuals who climbed at least 55 stories per week had a 25% reduction in mortality risk of those who climbed less than 20 stories per week [4]. Several studies classify stair climbing as moderate-to-vigorous physical activity, helping prevent obesity, diabetes, osteoarthritis, and even certain cancers [2, 3]. Stair climbing is considered a form of exercise widely available, and it comes with a variety of health benefits.

Cognitive benefits: besides physical benefits, stair climbing also improves cognitive performance, especially among younger adults, a demographic prevalent at the university. Research suggests that short sessions of stair climbing can improve cognitive health, like executive functions and mood states; one study involving university students found that stair climbing led to cognitive improvements in increased feelings of energy [6]. These benefits are particularly important in an academic setting, where students and staff could benefit from ways to enhance focus.

Environmental Benefits: Reducing elevator use by promoting a healthier option like taking the stairs contributes to environmental sustainability. Elevators are estimated to consume between 5% and 25% of a building's total energy usage, depending on the operational intensity and the number of floors [7]. Encouraging the use of stairs can help decrease a building's total energy consumption, helping reduce energy consumption, which in turn leads to lower costs for building owners.

2.2 Motivation and habits

The moment a user decides to go with the elevator instead of the stairs is more than just convenience and laziness. Understanding these factors offers insights into the preference for elevators despite the clear health benefits of climbing the stairs.

Habits are one of the main parts of shaping people's behavior, especially in seemingly unimportant situations like picking the stairs or the elevator. According to Wood and Rünger [9], habits are formed through repeated behavior in a recurring context. Once these habits are formed, they become automatic and will continue without much thought. As long as elevators remain accessible and convenient, users will quickly fall into a habit and ignore the option of taking the stairs.

Besides motivation, there are other factors at play to create long-lasting behavior change for individuals. According to Fogg's [11] behavior model, three elements must converge at the same time for a behavior change to occur, and if a behavior change does not occur, at least one of these three elements is missing: motivation, ability, and trigger [10, 11]. Technology can combine these three elements to successfully persuade people. One example of persuasive technology being used is the Piano Staircase, where interactive steps played music when people walked the stairs. Successfully persuading and motivating 66% more people to use the stairs instead of the escalator throughout a full day they shot the video [10]. This showcases how technology can work as a trigger to enhance motivation and take the stairs.

Researchers suggest motivation alone is not always enough to change behavior. Radtke and Rackow [12] discuss that autonomous motivation alone may not always lead to behavior change. Individuals can often experience cognitive dissonance when faced with opposite behavioral options like taking the stairs or the elevator [12, 13]. Individuals strive to maximize their pleasure and minimize disadvantages. When individuals choose to take the stairs, their conflicting beliefs to stay healthy and choose for the stairs will induce cognitive dissonance. Compensatory health beliefs (CHBs; [14]) are a strategy to reduce the amount of cognitive dissonance. Individuals will tell themselves that it is okay to engage in the unhealthier option because they eat healthy in general or that they will go to the gym later in the day, counteracting cognitive dissonance for taking the unhealthy option at the moment. This means that compensatory behavior is used to justify the low resistance to an unhealthy option [12, 14].

In conclusion, environmental factors and habits play a crucial role in motivation and behavior. This must be combined with the right trigger and the ability to act on this. Finally, to truly promote long-lasting behavioral change, CHBs could be addressed by highlighting the user's cognitive dissonance, resulting in a form of trigger and motivation.

2.3 Nudging Techniques

In recent years, nudging techniques have become increasingly popular to promote healthier choices, like encouraging users to take the stairs instead of the elevator. The appeal of nudging consists of low cost and simplicity; it often does not require legislation, and it can be applied to a wide array of problems [15, 16]. A method that relies on slightly altering the physical and social environment to guide decision-making and change habits. Several studies have explored how nudging techniques can effectively be utilized to promote stair use, which can help in designing interventions that create long-term change without restricting freedom of choice [16].

One effective and widely used aspect of nudging is point-of-choice prompts. These are informational or motivational signs near the critical decision point to nudge the user [17, 18]. For example, Andersen et al. [18] found that simple, health-focused signs in a shopping mall quickly had a significant impact on the number of visitors who went for the stairs. However, these signs had a larger impact on the younger generation than the older generation, most likely due to physical limitations often present in older people [18, 19]. This is also shown in educational settings, especially on a university campus, where nudging techniques are successful and effective strategies to promote physical activity. Bachert et al. [20] conducted a study at a university. Here, motivational signs were placed to encourage stair use among students, tailored to their interest in health benefits, environmental impact, or preferences.

Another nudging strategy that has shown effectiveness in group settings is the use of social accountability, which can create the feeling of “climate shame” to promote better options. Research by Aaltola [21] points out that climate shame can effectively be utilized in social scenarios to create moral reflection and behavior change.

However, some research has pointed out that nudging has some flaws. Hansen et al. [22] see nudging as a form of “libertarian paternalism," a way to help individuals make choices that align with their interests while keeping the freedom of choice. Some argue that nudging subtly manipulates users, removing their freedom of choice. The study also warns about the "backfire effects", where nudging can harm users because they feel judged or disrespected. Nudging is a tool that requires careful consideration to ensure that all stakeholders are respected and feel dignified.

2.4 Interactive interventions

As mentioned before, traditional nudging interventions that tried to promote stair use have usually relied on simple, static point-of-choice prompts to encourage users to choose the stairs instead of the elevator. While they are effective, the impact is often limited, particularly among young adults. Research by Engelen et al. [26] emphasizes that static signs have had moderate success and suggests that interactive, engaging, and novel stimuli are a better form of intervention in a university environment, where they could better grab the attention of the students.

One famous and notable example of interactive interventions relating to improving stair usage is the "Piano Staircase" [10] which turned stair steps into a playable piano. This engaging installation attracted users by making stair climbing a more enjoyable experience, especially for younger users. Highlighting the importance of using interactive installations to influence behavior change. Similarly, Swenson and Siegel's study [27] placed storyboards and maps within a stairwell to increase stair use in a workplace setting. This intervention creates a more visually engaging, interactive experience in a social setting, suggesting that elements that introduce participation can be an effective strategy for creating long-term behavior change.

To conclude, promoting stairs over using the elevator involves a wide range of physical, cognitive, and environmental benefits. However changing user behavior, especially habits can be a difficult task. Factors such as motivation, cognitive dissonance, and compensatory health beliefs are relevant to the design of the installation. While common nudging techniques related to increasing stair usage, like static signs, have shown limited success, an interactive installation more engaging for university students could result in better long-lasting behavior change.

Chapter 3: Methods and Techniques

Research on encouraging stair usage demonstrates multiple benefits, including physical, cognitive, and environmental, as well as the effectiveness of nudging and interactive interventions.

Building on the previous insights, the goal of this project is to design an engaging and interactive system that encourages university students and employees to choose the stairs instead of the elevator. To guide the development and evaluate the system, the primary research question is: *"What interactive design can effectively nudge university students and employees to choose the stairs over the elevator?"*

To create an effective intervention, the Creative Technology and HCD design methods are applied to the project. This will be combined with an online questionnaire to understand the habits and motivation of students, and employees and an interview to test the effectiveness of the prototype.

3.1 Design methods

Human-centered design (HCD) is an approach that prioritizes the needs, values, and experiences of the user in the design process [23, 24]. This approach will help guide the design and develop an understanding of people and their needs [24], essential for creating an effective solution for this project. Engaging stakeholders early in the design process ensures the development of a solution accepted and useful to a wider audience. For this project, this aspect is especially important as stated in the background research, all users should feel respected and dignified. A questionnaire and multiple rounds of interviews will be conducted to incorporate the needs of stakeholders, test the appropriateness of certain prompts, and value the effectiveness of the intervention.

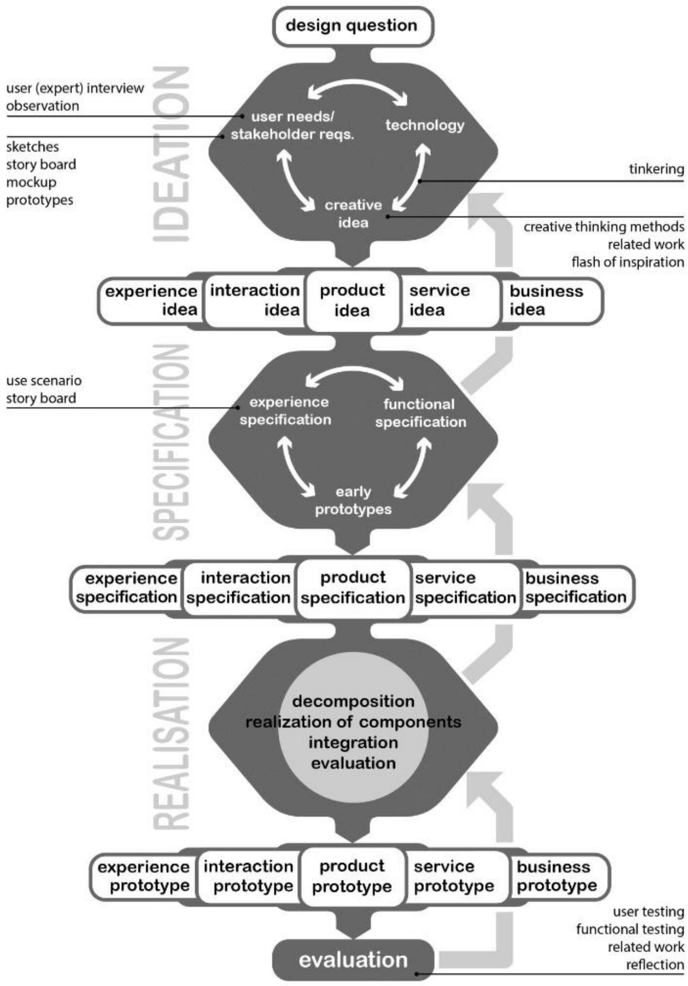


Fig. 1. The Creative Technology Design Process from Madar & Eggink [25]

The Creative Technology design process from Mader & Eggink [25], provides a structured method for designing solutions using technology which will structure the rest of this report. The process is divided into the following phases: Ideation, Specification, and realization, where each phase iteratively incorporates divergence and convergence models to broaden the design ideas and iteratively refine and support design decisions. Starting with a design question and eventually resulting in a product prototype ready for evaluation.

Design questions: To initiate the model a design question must be created, for this project this would entail: "*What design of an interactive can nudge university students and employees to choose the stairs instead of the elevator using humor while being respectful?*"

Ideation phase: This phase encourages exploring a wide range of potential design solutions that help encourage individuals to take the stairs instead of the elevator. An online questionnaire will be utilized to understand user needs aligning with the HCD model. Diverging by creating a lot of different ideas using sketches, storyboards, and more, helps develop a possible idea for the intervention that aligns with the users' needs and can be used for the specification phase.

Specification phase: In this phase, initial concepts are refined to concrete design requirements, which helps realize the product idea created in the ideation phase. Creating storyboards and lo-fi prototypes of the installation will help users test the effectiveness and appropriateness of the system. Defining technical and functional requirements helps create product specifications for an engaging interactive system.

Realization phase: Using these product specifications the idea can enter the realization phase to end up with a prototype to be evaluated. Technical components will be integrated and tested to ensure that the installation is effective and aligns with user needs. The outcome should be a fully operational prototype that can be tested in a real-world setting.

Evaluation: In this phase, the prototype will be evaluated with the use of user testing and reflecting on the work done. User interviews can be utilized to qualitatively evaluate the prototype and gain feedback from users, particularly on the appropriateness of the system and other areas for improvement, eventually validating the effectiveness of the system in promoting a healthier option.

Following the Creative Technology Design Process while integrating principles from Human-Centered Design helps the intervention be user-focused and effective. Every phase supports the development of an interactive system that follows user needs respectfully encouraging stair usage. To gather more information on user motivations and habits, the design process starts with an online questionnaire. Introducing the needs of stakeholders early allows for a better understanding of the current elevator habits of University of Twente employees and students.

3.2 Formative Method

As part of the ideation phase, an online questionnaire will be employed to gain initial insights into user motivation and requirements. This phase focuses on exploring a wide range of potential solutions by understanding the user needs and aligning with the HCD model. This survey will target the University of Twente students and employees, asking them to share their current preferences, habits, and motivations about their decision to take the stairs or the elevator. Gathering this information will be essential to support initial design decisions with user needs.

The questionnaire should cover topics like demographics, frequency of elevators and stairs use their reasoning for choosing one over the other. Asking respondents questions about their knowledge regarding the health and environmental benefits of taking the stairs could test the current need for education surrounding the subject of taking the stairs instead of the elevator. This will support the ideation phase and incorporate stakeholders in the design of the project, ensuring that the project's ideation follows an HCD approach from the beginning.

3.3 Summative Method

Interviews can help gain further user feedback and refine the design of the system. The interviews will be divided into two parts. The first section will test the tone and content of prompts on users to develop a set of prompts that can be used for the prototype. The second section will be conducted after the prototype is realized and participants have interacted with it to test the effectiveness of the system. This aligns with the evaluation phase, gathering feedback and validating the intervention.

Prompt Interviews: The initial interviews will focus on evaluating two things. First of all, the tone and feel of the prompts will help ensure all users remain dignified during the interaction with the installation. Second of all, the content of the prompts, the system should remain effective at nudging users to take the stairs instead of the elevator.

Prototype Interviews: After participants have had the opportunity to interact with the prototype, a series of semi-structured interviews can evaluate the overall effectiveness of the intervention. This qualitative feedback can validate the effectiveness of the system and identify further improvements that could benefit the impact of promoting a healthy habit.

Chapter 4: Ideation

4.1 User Context Analysis

An online questionnaire was developed to help understand elevator and stair usage habits among students and employees of the University of Twente. Specifically, the online questionnaire was aimed to understand user motivation and habits surrounding the elevator or the stairs. A short quiz was added to identify if individuals knew the physical and environmental benefits of taking the stairs. This information was gathered to help make an informed decision on the design of the system to encourage stair usage.

To gather this information and reach participants, flyers were designed, printed, and distributed to students and employees around campus. The flyers contained a QR code prompting the individual to scan it and go to the online questionnaire (see Fig. 2).

Fig. 2. Flyer containing a QR code linking to the online questionnaire.

Survey Structure

The online questionnaire was designed to understand user's behavioral habits and discover knowledge gaps related to taking the stairs versus the elevator. The questions followed a structured approach, gathering relevant data while trying to avoid biases or speculative responses. The questionnaire had the following question structure.

The first section of questions was in place to gather demographic information to understand the background of the respondents. Questions were asked about the individuals' age, gender, and role at the university (student or employee). These questions helped segment the data helping find patterns or allowing for other insights.

The second set of questions was in place to understand the habit and motivation for taking either the stairs or the elevator. Questions for this section aimed for results into participants' frequency of campus visits and how often they pick the stairs or the elevator. Afterward, participants were asked to describe the most recent instance of using the stairs or the elevator, adding their reasoning for why they did not pick the other option. Questions like, "How many times per week do you take the elevator when you are on campus?", "Which elevator was the last one you took on campus?" and, "What prevented you from taking the stairs?", helped understand the user's motivation.

The final section was designed as a quiz to assess an individual's knowledge of the health and environmental benefits of opting for the stairs instead of the elevator. Multiple-choice questions like "Climbing just 8 flights of stairs a day lowers early mortality by?" with the options "6%, 12%, 24%, 33%, and I don't know" prompted respondents to question their knowledge and gave valuable insights how accurately individuals know the benefits of taking the stairs instead of the elevator. The option "I don't know" was added to reduce speculative answers.

Results

The survey was completed by ten participants, consisting of nine students and one university employee. Respondents were primarily male (80%), with two female respondents (20%).

	Mean	SD	Min	Max
Age	23.2	1.32	22	25
Campus visits	3.9	0.74	3	5
Elevator per week	1.7	2.65	0	10
Stairs per week	14.7	10.27	4	30

Table 1. Numerical Summary, Age, Campus visits per week, Elevator visits per week, and flights of stair climbed per week

Participants visited the campus an average of 3.9 times per week (SD = 0.74), in those days the elevator was significantly visited less than the stairs, 1.7 times per week compared to 14.7 times per week indicating that individuals on campus already often choose the stairs instead of the elevator.

Participants were asked to reflect on their last instance of taking the elevator instead of the stairs, these qualitative responses were coded into meaningful themes. Results showed that the majority of participants had (physical) convenience (66,67%) as the primary reason to take the elevator, especially if respondents had to travel more than three floors. Social factors, like a group dynamic in which individuals followed the decision of someone else, accounted for 22,22% of the responses. Only 11,11% of participants mentioned environmental factors, like the placement of the elevator or the stairs, as their reason for picking the elevator instead of the stairs.

(Physical) convenience	66,67%
Social	22,22%
Environmental	11,11%

Table 2. The motivation for taking the elevator is coded and grouped into 3 sections. (Physical convenience, Social, Environmental.

The final section, the quiz, aimed to determine the participants' knowledge of the health and environmental benefits of taking the stairs instead of the elevator. Results showed a notable knowledge gap with only 15% of participants answering the question about the health benefits correctly and even less, 10% answering the environmental questions correctly. This showed that participants required more knowledge on the benefits of taking the stairs instead of the elevator.

Correct answers health benefits	15,00%
Correct answers environmental benefits	10,00%

Table 3. Amount of questions answered correctly in the quiz section, expressed in percentages.

Insights & Requirements

Results from the survey provided valuable insights into the motivation and knowledge gaps surrounding elevator and stair usage among students at the university. These findings revealed the need for an intervention to encourage stair use, especially when traveling a large number of floors or in social situations. The gap in knowledge about the benefits of taking the stairs can be used by the system as well. The background research also gave insights that helped create some of the user requirements.

UR01. Physical Convenience as Main Motivator: The survey results indicated that two-thirds of participants chose the elevator due to (physical) convenience, especially when individuals were required to travel more than three floors. These findings align with literature around habit formation, such as the work of Wood and Rünger [9], which suggests that individuals likely choose the most convenient option, especially when physical effort is involved. Although results indicated that the stairs are already more utilized than the elevator by students and employees, respondents acknowledged that the use of stairs was almost always in the context of a few steps or 1 to 2 floors. Respondents decide to take the elevator when a large number of floors are involved. Research showed us that especially stair climbing a large number of floors (≥55), leads to greater health benefits, like lowering the mortality rate by 25% [4]. The design of the system should use prompts that specifically address the health benefits of climbing a large number of flights of stairs.

UR02. Social Influence on Elevator Use: The survey also emphasized the role of social factors in elevator usage. Participants mentioned instances where they opted for the elevator instead of the stairs because one individual in a group setting decided to take the elevator, causing others to follow. Indicating that social situations can often discourage users from taking the stairs. As proposed by earlier findings, climate shame is a tool that is especially useful in social situations, like choosing a more environmentally friendly option like the stairs (climate shame). The design should incorporate prompts that highlight the environmental impact of using the elevator and induce this shame in the group resulting in them reflecting on their decision.

UR03. Knowledge Gap: The quiz component of the survey revealed that a knowledge gap exists among participants regarding the health and environmental benefits of taking the stairs instead of the elevator. The system should incorporate prompts that make users aware of the health benefits. Literature supports the idea that when individuals are made aware of the positive health impact, they may feel a sense of cognitive dissonance [13], allowing the system to nudge the users towards a healthier decision.

UR04. Interactivity: as mentioned before, especially for university students a more interactive intervention can create a more long-lasting impression and have a bigger impact in improving the amount the stairs get taken. The system should create an interactive experience where using sensors, it responds accordingly to the users' inputs.

UR05. Engagement: The system should try to ensure active user engagement, to create an effective experience. To promote the intended goal of promoting stair usage, and have an effective interaction, the user must first notice the installation and want to interact with it. Failing to achieve this will result in an ineffective installation.

UR06. Tone: The system should use an appropriate tone to create a positive user experience and reduce the possibility of users not wanting to interact with it, making the installation ineffective. Ensuring that the interaction remains respectful, friendly, and well-calibrated to all users is essential. Humor can act as a tool to make the interaction more enjoyable, it can also increase the likelihood of creating a positive perception towards the intervention.

These insights and requirements provide support for the ideation phase and help select a final concept.

4.2 Constraints

The design of this project is constricted by several technical and environmental constraints, particularly related to the limited space and limited connectivity within an elevator. Elevators are used in a public space and safety is a main priority.

CO01. Physical constraints elevator: The elevators in the University of Twente have limited interior space, which restricts the size and placement of the installation when placed inside the elevator. Due to safety concerns, the installation should be placed away from the door and not tamper with any of the functionality of the elevator.

CO02. Connectivity and Power: Elevators of the University of Twente are made of metal, which causes them to act like Faraday cages, not letting any connectivity through. Wireless connectivity to the system, like Wi-Fi, will not be possible. If placed inside the elevator the installation must be self-contained and be functional offline. If applicable, all data should be stored on local storage. Because there are no outlets in the elevators of the University of Twente, the installation must work on a battery if located inside the elevator. While this solution is feasible for initial implementation, it is not ideal as a long-term solution due to the frequency of battery replacement and the associated maintenance costs. Powering the installation directly through a power source near the elevator could be a more sustainable solution.

CO03. Safety: As mentioned before, the installation must adhere to safety regulations and cannot tamper with the functionality of the elevator. This includes positioning the installation to not block the elevator buttons or other sensors, and in case of an emergency, the installation cannot block any exits. In addition, all hardware components, such as wires, sensors, and devices must be securely encased. This will prevent tripping hazards which could cause accidental damage and safety problems while also ensuring no pathways or exits are obstructed.

CO04. Ethical and privacy: The system is intended to interact with the general public, in which case careful considerations must be taken to address ethical or privacy concerns. If sensors are used, all data that is gathered must remain anonymous. Data should be deleted after it is no longer needed for the functionality of the installation. Additionally, the design must consider the ethical implications. Because the installation is placed in a public space, the prompts should remain respectful to all types of users. Especially those with a physical disability can feel disrespected if they are told to take the stairs and should be taken into consideration during the design.

CO05. University Constraints: The design of the intervention must adhere to constraints in place by the University of Twente. The system should not modify or tamper with the functionality, safety, and aesthetics of the elevators. Not obstructing emergency pathways, sensors, or other safety-related equipment. The overall design should be professional and respectful of the visual standards expected of the university.

These constraints will help create the design and implement an effective intervention while maintaining safety, ethical, and privacy expectations.

4.3 Concept Generation

For the concept generation phase, a structured ideation process was used to explore and ideate as many innovative and novel solutions for discouraging the elevator. Guided by techniques like mind mapping and conceptual thumbnailing, ideating as many concepts as possible to come to an effective final concept.

Ideation

Mind Mapping: The ideation process started with mind-mapping, a tool to help structure initial ideas by creating an overview of elements like placement, interaction type, communication method, sensors, and more. This overview helped form ideas for the thumbnail sketches. Configuring different options of elements like sensors, moods, placement, interaction types, and more made ideation of a wide array of different ideas possible.

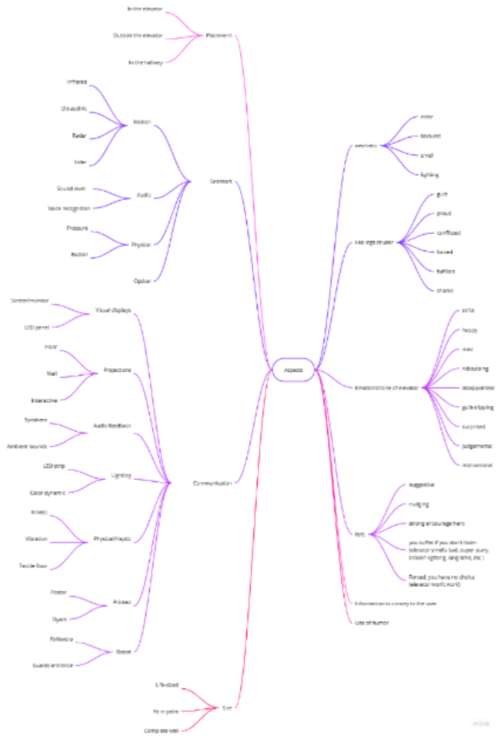


Fig. 3. Mind map of design elements during concept generation

Thumbnail Sketching: This method helped conceptualize different configurations of elements into visual ideas. To create a wide array of ideas and not focus on the detail too much, a timer was set for three minutes per sketch. The approach delivered a lot of creative ideas, for example. Automatic door detection, a system that recognized users who were not reliant on the elevator and automatically closed the door. Another example is making the environment less appealing by placing artificial flies or a bad odor to make the space less attractive.

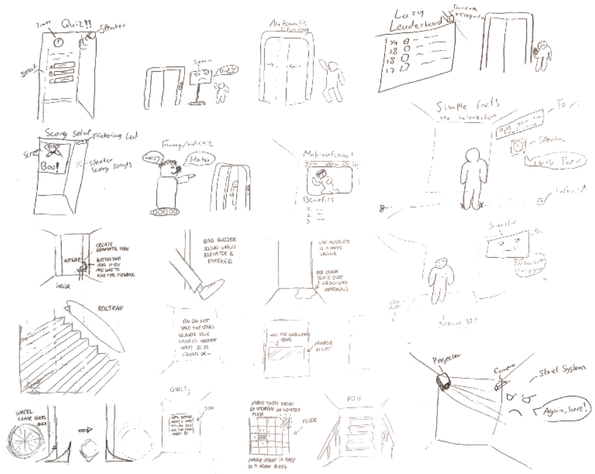


Fig. 4. Scanned physical thumbnails created during the ideation phase.

While these concepts were inventive, almost all of these methods were not feasible due to the constraints in place. University regulations discourage lowering the safety, cleanliness, or workings of the elevator. This helped select a top three list of ideas that would align with the literature, followed constraints, and could effectively nudge the user toward taking the stairs more often.

The best ideas of the previous section were further conceptualized using digital drawing tools to create higher-resolution ideas. The ideas were as follows:

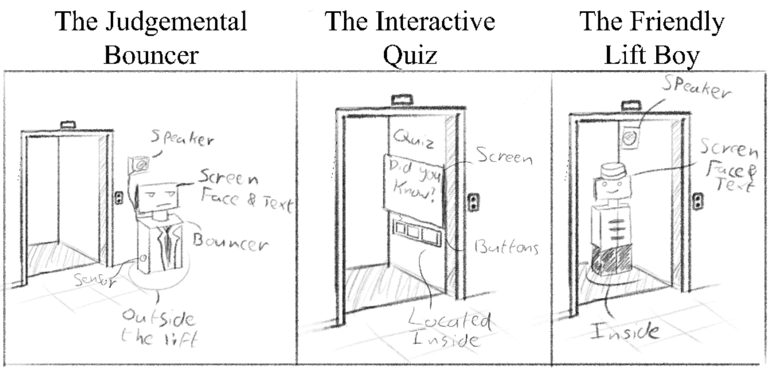


Fig. 5. Digital sketches of the top three design concepts.

The Judgmental Bouncer: This installation has a screen displaying a face when idle and showing text prompts when the user interacts with the installation, combined with the speaker it would ensure it would grab the user's attention before entering the elevator. The screen would be placed on a box containing all the electronics, this box will be designed to look like a bouncer, making it easy for the user to understand the function of the 'robot' before having interacted with the installation.

The Interactive Quiz: Located inside the elevator is a screen with three buttons and a speaker. It would educate users during the elevator ride about the benefits of taking the stairs, allowing the users to compete against each other using the buttons and answering questions.

The Friendly Lift Boy: Similar to the bouncer idea, this 'robot' would be a screen on a box containing all the electronics but it would be designed like an old school lift boy and would be placed inside the elevator, welcoming the users in the elevator while and making the ride a pleasant experience. Explaining to users the physical, cognitive, and environmental benefits during the ride, will educate users on why they should take the stairs next time around.

These ideas helped further develop the design of the installation to be as effective as possible and follow the constraints and university guidelines, setting a final concept.

4.5 Final concept

After thorough concept generation and evaluation, the Judgmental Bouncer was selected as the final concept and design. Several factors, including feasibility, alignment with literature, and constraint deemed the Judgmental Bouncer the best contender. Using convincing prompts to nudge users towards taking the stairs instead of the elevator

Rationale

Placing this installation outside the elevator removes several practical and safety constraints that would be in place if the intervention was located inside the elevator. Deciding to place it outside minimizes obstruction and would not take away space from the elevator, allowing users who rely on the elevator to use it without compromises. It would not block buttons or obstruct exits in case of an emergency aligning with the safety goals of the university. It would also remove physical constraints that are associated with placing the installation inside the elevator, the Judgmental Bouncer can be plugged into an outlet and communicate data wirelessly if needed.

On top of that, from a nudging perspective, placing the installation outside the elevator could be more effective according to the literature. As stated in the background research, Fogg's Behavior Model highlights that three things need to happen to create long-lasting behavior change, ability, motivation, and trigger. Placing the installation inside the elevator could trigger and motivate users but without the ability to act on these feelings, long-lasting behavior change will not occur. Nudges from the installation will be more effective if these occur outside the elevator, solidifying the design behind the Judgmental Bouncer.

The visual design of the Judgmental Bouncer will be a simple stair sign until a user gets close, after which the installation will show an interactive face. Here, eyes follow the user around to give them a feeling of climate shame [21], creating a sense of social accountability. Combined with the user of speakers communicating the occasional prompts will make sure the installation grabs the attention of users who might otherwise distracted. An example of how this would look can be found in Fig. 6.

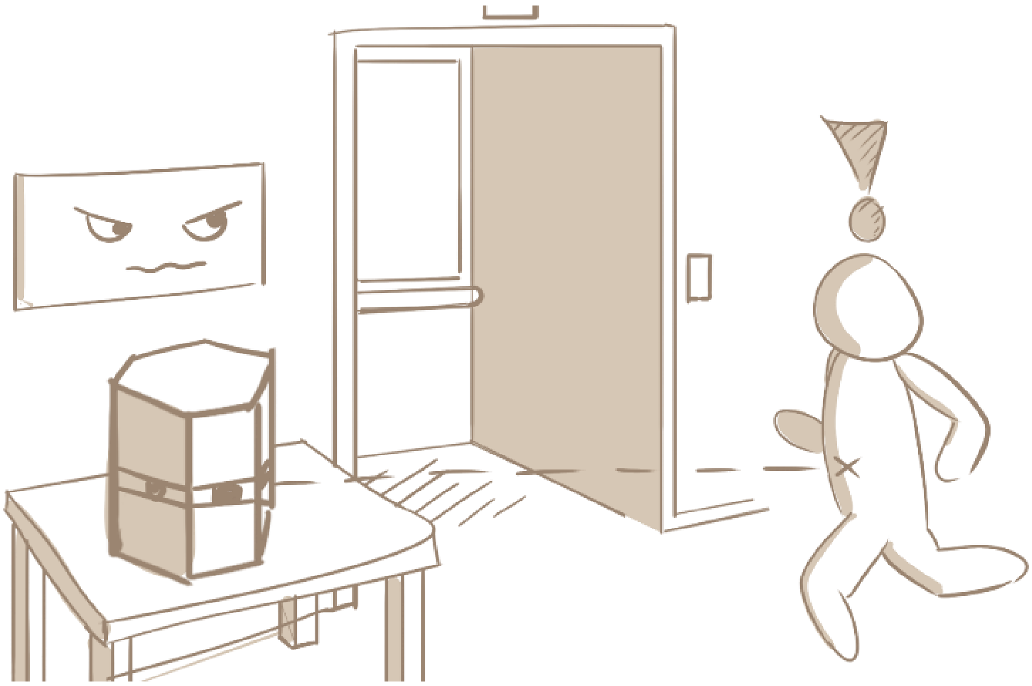


Fig. 6. Sketch of the final ideation

Chapter 5: Specification

This chapter outlines the specifications of the prototype to be evaluated, including its functional and non-functional requirements, technical specifications, and interaction flow. These parts define the functional goals of the system and make sure that the system effectively achieves its intended purpose of encouraging individuals to take the stairs rather than the elevator. Establishing these specifications, also helps the prototype align with the human-centered-design principles

5.1 Functional Requirements

The functional requirements of the system are most important to its success, as they establish that the prototype meets its primary objective of nudging users towards a healthier and more environmentally conscious decision.

ID	Requirement	Rationale	User Req. Ref
FR01	The system shall detect user input through sensors	Ensure the system can identify and respond to user presence and actions, enabling interactivity	UR04
FR02	The system shall emit auditory cues	Ensures users notice the system, increasing engagement and effectiveness of the intervention.	UR05
FR03	The system shall emit visual cues	Ensures users notice the system through visual elements, drawing attention and improving engagement.	UR05
FR04	All hardware components shall be securely encased	Prevent tripping hazards, and accidental damage and ensure safety in a public setting.	CO03
FR05	The placement of the intervention shall align with university safety regulations.	Ensures that the intervention complies with the safety standards and prevention of obstruction	CO03
FR06	The system shall create an engaging user experience	Ensures a positive experience that makes sure the installation reaches its goal of nudging users to take the stairs	UR05

Table 4. Functional requirements

These requirements are the key elements for the prototype, critical to the technical success of the system and the ability to influence user behavior meaningfully and ethically.

As shown in the research, interactive interventions can be particularly effective for university students and employees, especially regarding promoting stair usage. For this reason, the system must be interactive and capture individuals' attention, being able to react in real-time to users, employing sensors to detect this input, and using this to create engagement.

The prototype's ability to nudge users towards taking the stairs is its central purpose. Behavioral change should be encouraged without restricting the freedom of choice for the user, aligning with ethical standards. Through a combination of audio and visual cues, using humor and social pressure, the action to take the stairs can be promoted.

Finally, the installation should attract attention and sustain interest by being inherently engaging. Using visually appealing elements and well-used audio prompts, the system can create an experience the user remembers to create a more long-lasting behavioral change.

5.2 Non-Functional Requirements

The non-functional requirements of the prototype are important to create quality in the interaction with the system. While the aspects do not directly help achieve the primary goal of encouraging stair usage, it ensures that the prototype operates smoothly reliably, and respectfully aligning with the expectations of all stakeholders.

ID	Requirement	Rationale	Constraint Ref
NFR01	The system shall operate autonomously with minimal human intervention.	Reduces maintenance and oversight needs.	CO02
NFR02	The system shall consistently detect users despite varying environmental conditions.	Ensures reliable performance.	CO03
NFR03	The system shall adhere to university safety regulations, avoiding obstructions or hazards.	Guarantees public safety.	CO03
NFR04	The system shall anonymize all user data and ensure secure storage.	Protects user privacy and complies with ethical standards.	CO04
NFR05	The system shall use intuitive audio and visual cues for guidance.	Enhances usability and user experience.	UR02
NFR06	The system shall avoid language or prompts that could be interpreted as offensive or alienating.	Maintains respect and inclusivity.	UR05
NFR07	The system shall withstand daily wear and tear in a public environment.	Ensures durability and long-term functionality.	CO06

Table 5. Non-functional requirements

The system must demonstrate good performance and reliability to function effectively in a real-world environment like a university building. This means the prototype should work without assistance and operate autonomously without frequent intervention. It should consistently detect users despite varying environmental conditions. Any performance gaps can undermine the effectiveness of the installation, reducing its impact.

Usability is another important consideration, as the system must be usable by a broad audience, including students, staff, and visitors, without needing prior knowledge or training. The installation must be intuitive and simple visual and audio cues should guide users to using the system making the system as effective as possible.

As mentioned before safety is an important aspect of the installation because is it situated in a public location. The system must adhere to university safety standards and avoid any obstruction of emergency exits, the operation of the elevator, or other essentials. Hardware parts, such as the casing, sensors, or other wires must be securely installed and put away avoiding trip hazards or other obstructions. Ethics and privacy are equally as important requirements for the prototype. This means respecting the privacy of users, not storing data unnecessarily or retaining it longer than required for the functionality of the system. All collected data must be anonymized and stored securely, following the ethical standards of the university.

The tone of the installation's prompts must also be carefully tested and calibrated to ensure the intervention does not use language that could be interpreted as offensive or alienating to some users. Promoting a positive user experience that integrates humor and light-hearted nudging to create motivation instead of resentment. Finally, the installation could create a sense of shame in users, to help create the behavioral nudge. This can be done by the installation or indirectly caused through a social situation, allowing users to reflect on their choices.

Although these requirements are not vital to the success of the intervention, they help create a better user experience and help the system align with human-centered design principles.

5.3 Technical Specifications

The technical specifications of the prototype detail the hardware components and software necessary to implement the intervention. These specifications help realize the functional and non-functional requirements outlined before. Integrating hardware and software to create a reliable prototype that creates the intended user experience.

A major component of the prototype is the ability to sense user presence and position relative to the installation. Distance sensors are employed to achieve this functionality. By detecting a change in proximity, the sensors can identify a user approaching without using more privacy-sensitive sensors like cameras. This allows the installation to be interactive and create actions determined by user input.

As mentioned before, the user should be able to communicate both through visual and audio channels. A screen or other visual interface will be deployed paired with a speaker to provide both audio and visual prompts. This combination of visual and audio outputs ensures that users notice the installation and interact with the installation. To manage these different components, the system will use both a controller to handle input data, such as the signals from the distance sensors, and a computational unit, to manage more complex logic and execute the script, showing the results on the visual interface.

Finally, a casing will be used to contain all the hardware while maintaining a visually appealing appearance. This casing helps ensure the installation does not have loose wires, complying with safety and aesthetic considerations.

Together, these components form the basis of the system, aligning with the project's functional and non-functional requirements. Using sensing techniques, engaging outputs and sleek casing can help create an impactful experience that nudges users towards the right option. These specifications help guide the prototype during the realization phase of the project.

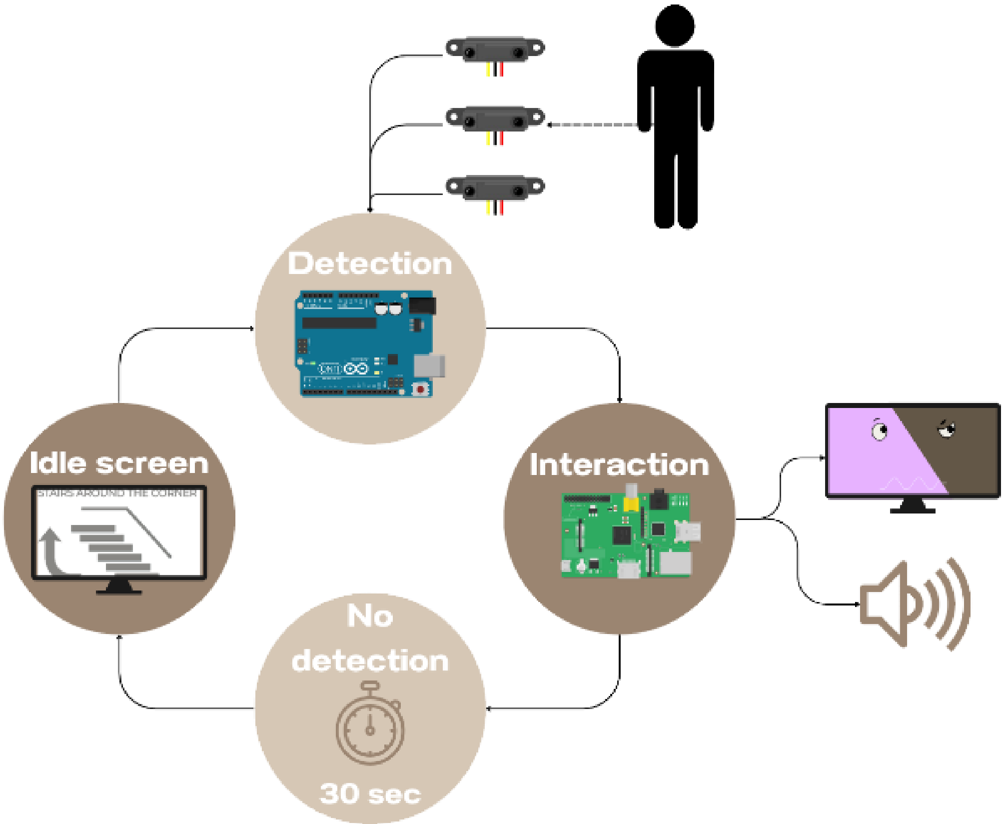


Fig. 7. Interaction flowchart of the installation

Chapter 6: Realization

This chapter will detail the development process of the prototype, outlining how the creation from an initial lo-fi prototype evolved into a functional system that could be used for testing and evaluation. The realization phase focuses on transferring the design specification and frameworks established in previous chapters into a tangible, interactive installation.

The development of the prototype followed an iterative design approach, evolving from a low-fidelity prototype and moving towards a fully functional interactive system. Each iteration was used to address problems that align with the functional and non-functional requirements outlined in Chapter 5.

6.1 Initial Prototype

The initial prototype was used as a miniature proof of concept. This helped check the core functionality of detecting user presence and triggering a system response. This phase focused on demonstrating the basic functionality without prioritizing robustness or presentation.

The hardware layout consisted of an ultrasonic sensor connected to an Arduino Uno microcontroller, with a laptop running a Python script to handle incoming commands and create an auditory output. This output consisted of prompts, and welcome and goodbye messages. However, the ultrasonic sensor had a very limited detection range, restricting the interaction to only proximity. The Arduino script consisted of a filter removing the "0" readings from the ultrasonic sensor and sending a "Human detected" via serial communication after having received five consecutive valid readings from the sensor. This command would then be sent to a laptop running a Python script. Which would emit simple audio prompts to encourage the user to take the stairs instead of the elevator. While this communication loop between hardware and software proved functional, the output was limited in professionalism and did not have the visual clarity required for proper testing.

Although the prototype fulfilled its objective of being able to detect users and communicate, the prototype showed several important limitations. The ultrasonic sensor had a limited range and due to there only being one sensor, the system was only able to look straight in front of it. Additionally, the output only consisted of audio prompts. This could easily be overlooked by any user and did not align with functional requirement FR03, failing to engage users effectively. The hardware components were left exposed with wires and devices unsecured without casing which did not align with FR04, introducing problems with durability and safety. Furthermore, the appearance was, rudimentary to say the least, failing to have a professional presentation.

Although this prototype was not suitable for any testing, it did bring valuable insights into the requirements for the system. Highlighting the importance of sensor accuracy, and the potential of the core functionality of the system. It also highlighted the importance of a professional presentation. This first step, despite the limitations, helped create the groundwork for the next prototype for a more refined interaction.

6.2 High-Fidelity Prototype

Following the insights gained from the initial prototype, a second iteration was developed to address all the shortcomings present in the proof of concept and to create a prototype that could be user-tested. The main focus of this stage was to improve the sensor coverage, system integration, and presentation, creating a prototype that was closer to the final version that was envisioned. This prototype has also created significant progress in hardware and software design and professionalism.

The ultrasonic sensor used in the proof of concept was replaced with three infrared sensors. This choice was made to increase the range of the distance sensor and be able to monitor users in a bigger area. These IR sensors allowed for the creation of a cone-shaped detection area, allowing the system to identify user presence better, and also improving detection reliability.

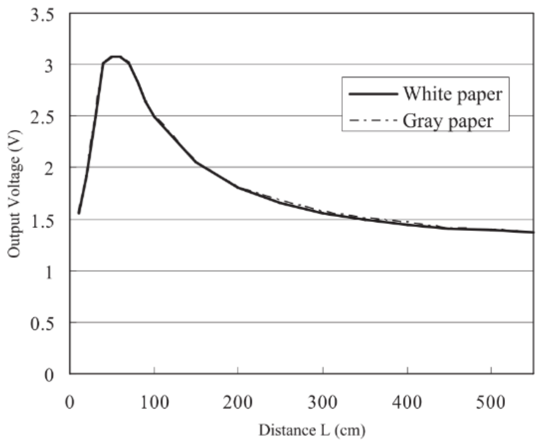


Fig. 8. Relationship between Output Voltage (V) and Distance (L) for White Paper (Reflectance: 90%) and Gray Paper (Reflectance: 18%) [28]

However, these IR sensors had their unique limitations. Unlike digital sensors, IR sensors provide analog output that varies non-linearly with distance. This relationship resulted in inconsistencies, especially within certain ranges. For instance, the IR sensor calibrated for a 5-meter range could only accurately give readings beyond a distance of 1 meter, shorter ranges resulted in data points overlapping and giving unreliable measurements.

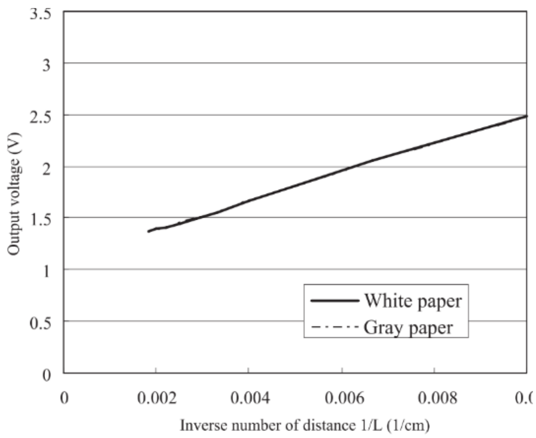


Fig. 9. Relationship between Output Voltage (V) and the Inverse Distance (1/L) for White Paper and Gray Paper. [28]

Linearization techniques were used in the code of the Arduino to interpret the analog readings correctly, the transformation of this can be found in Fig. 8 and Fig. 9. Additionally, the 3 IR sensors calibrated at the start of the code found the distance to the nearest wall. Whenever a reading was done that did not match this reading the sensor would know an object entered the detection area. To counteract random noise influencing the detection reliability, the Arduino would only send the “Human detected” serial command after multiple non-calibrated readings in a row.

Combined with the sensor improvements, a Raspberry Pi was introduced to the system to eliminate the reliance on a laptop to run the Python script. This upgrade made it possible to process everything in a single casing combined with the Arduino and IR sensors, improving safety and reducing the risk of damage following FR04. The Raspberry Pi acted as the central processing hub, receiving sensor data from the Arduino, running the Python script, and sending the audio and visual cues.

During the development of this stage, the components were still duct taped to a protein jar, which allowed for quick iteration of sensor alignment but did not secure the sensors enough to reliably calibrate at the start. To house to components securely, a custom casing was designed and 3D-printed, creating slots for the sensors and the HDMI and power cable. This personal first attempt to create a functional 3D print resulted in several problems. The casing was too slim and tall, leading to inefficient use of the internal space available. Although the Raspberry Pi and Arduino were accounted for and would fit in the housing, there was not enough room for the wiring and cables to plug into the USB ports. Furthermore, because of the slim design, the IR sensors would overlap when placed in the slots, which resulted in the sensors not being able to be secured to the casing. As a temporary adjustment, the middle sensor slot was carefully shaved down to lower the position of the sensor and make the prototype functional for initial user testing.

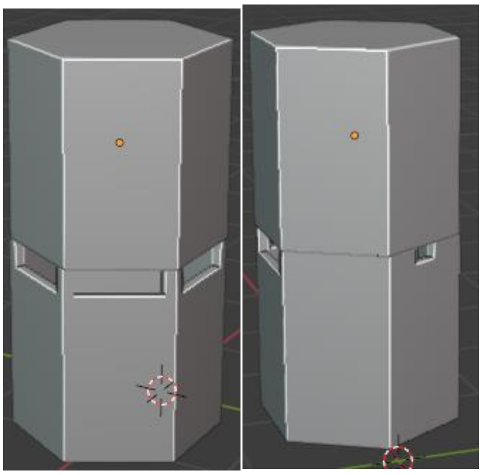


Fig. 10. 3D render of the second prototype's casing.

Fig. 11. Collection of pictures taken from the 3d printed casing

During this prototype stage, the development of the Python script also played a significant role in fulfilling the functional requirements and creating an engaging user interaction. The python script was used to display the different system states including an idle screen it would default to, displaying a static stair-promotion sign. This screen would remain active until the Arduino detects a user and sends the "Human detected" serial command. Upon receiving this signal the script transitioned using a smooth animation to a screen showing a virtual face, creating the impression of an interactive character that gives them the impression of being observed.

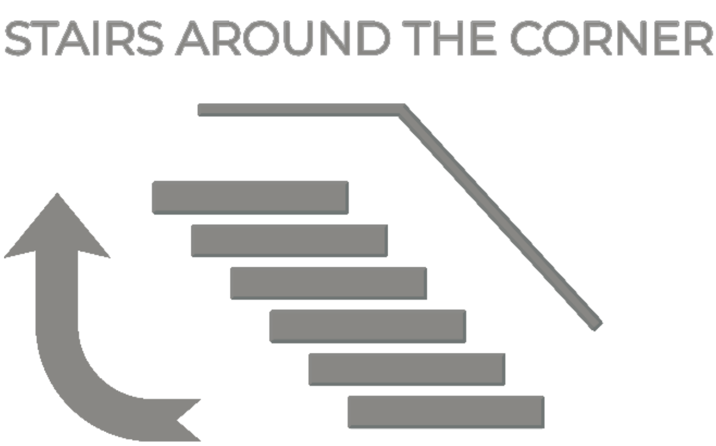


Fig. 12. Idle screen display.

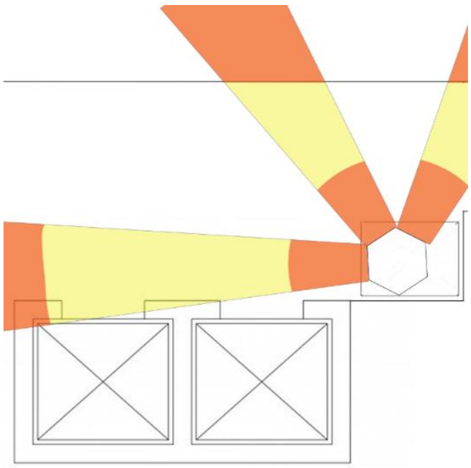


Fig. 13. Illustration showing the detection area of the installation

In addition to improving the detection area by adding more sensors, this also allowed for the installation to know the relative location of the user. This feature was useful to add simulated eye movement to the virtual face. Analyzing which of the three users detected an obstruction, the script would adjust the location of the irises of the eyes making the eyes "follow" the user. This detail significantly enhanced interactivity, amplifying the sense of observation to subtly apply social pressure against elevator use.

The prompts used by the system were prerecorded AI-generated, with each prompt having a unique filename stored in a designated folder. While a session was active the python script would randomly pick a mp3 file to play creating variability. To make sure the user would notice the prompts despite the environment, subtitles were created using the file name of the picked mp3 which could then be linked to a reference text file. Including subtitles ensured accessibility for users in noisy environments making the system more effective. Combined with this at the start of an interaction it would play a bootup sound to notify users and make them aware of the installation. This logic was applied to the end of the interaction, when the system did not recognize a user for a certain period, it would go back to the idle screen playing a shutdown sound, further polishing the presentation and user interaction.

When the system played audio prompts, the simple line it had for a mouth would transform into a sine wave consistently changing its starting phase creating a smooth animation. Combined with a random change in amplitude while the system was talking resulted in the effect of a robotic mouth "talking" to the user. Visually reinforcing the interaction, aligning with functional requirement FR06, making the installation even more engaging and understandable. A picture of this early version of the face screen can be seen in Fig. 14.

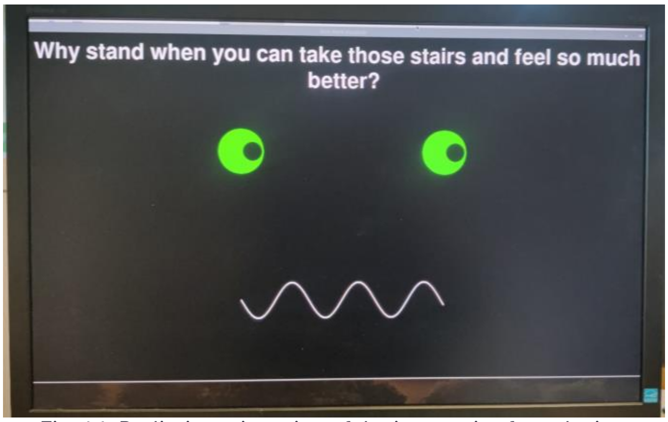


Fig. 14. Preliminary iteration of the interactive face design

6.3 Final Prototype

The final prototype focused on the shortcomings of the earlier iteration and was mainly designed to create a fully functional, professional installation. The improvements focused on hardware design, visual presentation, and functionalities resulting in a prototype that was ready for user evaluation and that aligned with the functional and non-functional requirements.

A new casing (Fig. 16) was designed to house all components securely while better using the internal space. This final prototype removed inefficient space distribution of the high-fidelity prototype by providing more room for the Arduino, and Raspberry Pi, room to plug wire into ports, and the wires itself. Each sensor slot had more space between them, ensuring the three IR sensors could be positioned without overlapping, securing them properly. This resulted in all internal wires being safely put away, with the only cables exiting the casing being the HDMI cable connecting to the external display, the power cable for the Raspberry Pi, and the aux cable leading to the external speaker. This layout substantially improved the safety and durability of the system. The new casing features a smoother finish with rounded corners, giving it a more polished and professional appearance. The design choice created a less harsh aesthetic which was a concern during the user evaluation.

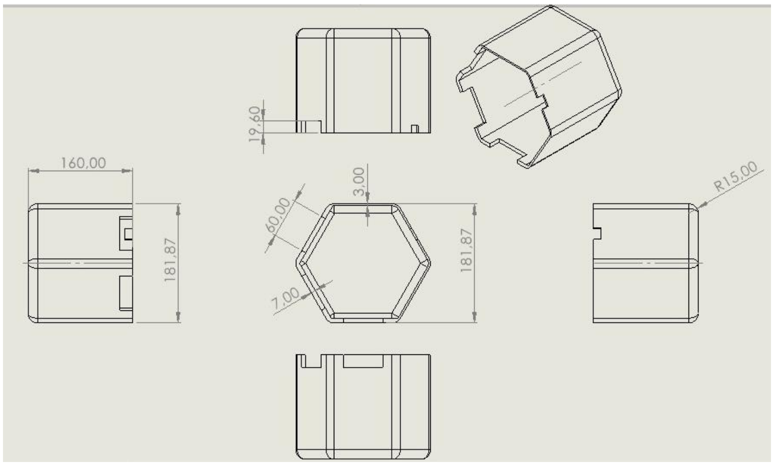


Fig. 15. Schematic illustration of the final casing design.

With the final evaluation in mind, two face modes were created to be later tested against each other, a motivational mode and a judgmental mode. Where each design was further reinforced with the content of the audio prompts adding to the user experience. The motivational mode (Fig. 16) features inviting eyes and background and friendlier prompts and voice, while the judgmental face (Fig. 17) has more concerned eyes, a somber background, and kept strict intonation. Both modes got assigned a specific key on the keyboard to quickly switch between the modes during the evaluation, with the creative “H” for happy and “J” for judgmental.

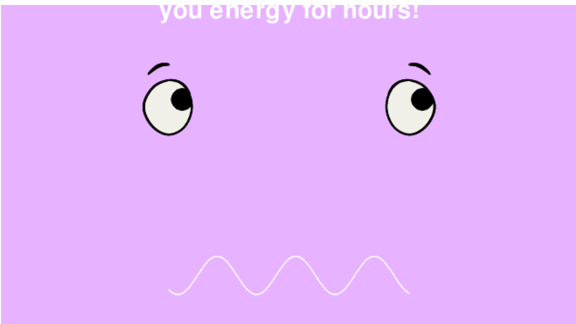


Fig. 16. Final design of the happy face

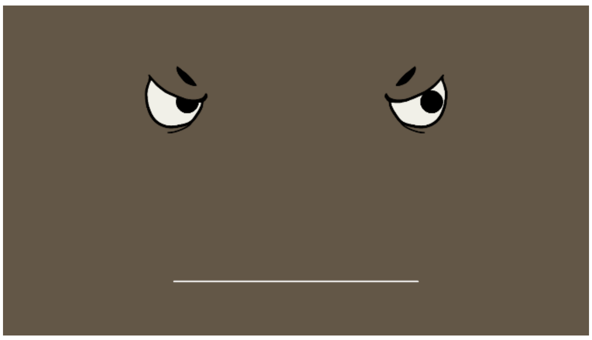


Fig. 17. Final design of the judgmental face

The final prototype was designed with the user evaluation in mind, through an within-subject design. Users interacted both with a motivational, happy voice and face and were compared to the more judgmental prompts and face, allowing them to directly compare the effectiveness of either system and tone. This setup allowed for both emotional tones to be tested under similar conditions, help giving insights into their impact. The final list of used prompts can be found in Table 6.

Category	ID	Prompt
System	**Bootup**	Hey you!
	Shutdown	Goodbye!
Judgmental	**C1**	Hi there, I've noticed you coming a bit close to the elevator. You're not thinking of taking it, are you?
	C2	This is awkward, you, me, and those neglected stairs...
	C3	Why are we still standing here? The stairs are right there!
	C4	Standing here won't make it any faster. But you know what's fast? Walking up one flight...
	C5	Time check, you could've burned 20 calories by now...
	D1	You're waiting on a closed door, don't you think it is time to take the stairs?
	D2	Oh, I see you there, thinking about skipping leg day?
	D3	Hey you! Those stairs aren't going to climb themselves.
	D4	Oh look, a fitness opportunity, it's called stairs.
	D5	I can hear those footsteps, don't even think about it.
Friendly	**E1**	Small steps lead to big victories, how about the stairs today?
	E2	Why wait for the elevator? Just a few steps on the stairs and you will feel awesome!
	E3	I mean sure, the elevator is fine... But the stairs are so much better!
	E4	Skip the wait, grab the victory, let's take the stairs!
	E5	The elevator saves you seconds, but the stairs will give you energy for hours!
	E6	Your health will thank you if you choose to take the stairs, give it a shot!
	E7	Why stand when you can take those stairs and feel so much better?

Table 6. Collection of all the prompts and their corresponding ID and category

Chapter 7: Evaluation

This chapter evaluates the effectiveness of the interactive installation in influencing behavioral choices between stair and elevator usage, focusing on comparing the impact of a judgmental versus a motivational tone. The study aims to determine how sarcasm as a motivator compares to a more supportive approach in nudging users.

The evaluation used a combination of quantitative and qualitative feedback: We observed participants' decision between the stairs and the elevator under controlled conditions and collected their perception through a survey providing data to understand the impact of the system. Additionally, three participants who interacted with the intervention were interviewed, giving deeper insights into the experience of the participants with the prototype.

The research was approved by the Ethics Committee of the University of Twente under application number 240801, ensuring that ethical standards are followed throughout the study.

7.1 Methodology

7.1.1 Experiment setup

The evaluation was conducted in a real-world setting at the Ravelijn at the University of Twente (Fig. 18). Participants on university grounds, including students and employees, were randomly recruited by directly approaching individuals and inviting them to participate if they had a few minutes to spare. After receiving instructions and signing an informed consent form, they were guided through the experiment.

Fig. 18. The installation setup used during the evaluation, located at the Ravelijn building at the University of Twente.

The evaluation used a within-subject design, where each participant interacted with both the judgmental and motivational modes of the installation. This design allowed us to analyze and compare the two modes while minimizing variability from individuals. To minimize the carryover effect, the order in which the participants interacted with either system was randomized.

Participants were instructed to complete a task that required them to move between two adjacent floors in the Ravelijn, where both the stairs and the elevator were visible and accessible. The installation was placed near the elevators on one of these floors. Some participants started on the floor where the installation was located, while others began on the floor without the installation. In both cases, they had the freedom to choose between taking the stairs or the elevator to reach the other floor. During this process, they had the opportunity to interact with the installation but were not explicitly instructed to do so.

After finishing this task one time, they were asked to scan a QR code leading to an online survey, in which they were asked to fill out which decision they made and multiple questions regarding their experience using a Likert scale, see Appendix B. After submitting the survey, participants repeated the task with the other mode and completed a second survey. Each survey was linked to either of two modes, this process allowed for the collection of data on behavior and perception for both modes.

7.1.2 Interview

In addition to quantitative data collection, qualitative insights were gathered using semi-structured interviews. These interviews aimed to gain further context on user interaction and potential improvements. The primary purpose was to uncover the reasoning behind participants' decisions and behaviors, offering insights that could not be fully captured through the quantitative method.

Participants for the interviews were selected from the pool of individuals who participated in the experiment and interacted with the installation. A total of three participants were chosen randomly from this group, ensuring a diverse demographic representative of a university environment, primarily students. The interviews lasted approximately 10-15 minutes and were conducted in person, either on university grounds or at an agreed-upon location for the participant's convenience.

All interviews were automatically transcribed using Microsoft Word and manually verified to ensure accuracy. The transcriptions were then coded and analyzed to identify recurring themes and patterns in user responses. This process enabled a comparison of qualitative insights with the quantitative data, highlighting aspects of the interaction that may not have been apparent in the survey responses.

The semi-structured interview format allowed for a balance between structured questions and the flexibility to explore specific topics in greater depth. This ensured consistency across interviews while allowing participants to elaborate on their experiences. Participants were asked about their perception of the interaction, the installation in general, and how it influenced their decision-making. The themes derived from these interviews were later analyzed alongside survey responses to provide a more comprehensive understanding of user behavior. For a detailed overview of the interview guidelines and questions used, see Appendix B.

7.1.3 Participants

Because the focus of this study was university students and employees, for the experiment and interview the participants were selected to be representative of this focus group. Because the study was held on university grounds all individuals present were representative of this group. A total of 26 participants took part in the experiment, of which 23 were students and three employees. For the semi-structured interview, only students were selected, with a total of three individuals interviewed.

Participants were recruited on-site through random selection, with the researcher approaching individuals and inviting them to participate. Those willing to participate were asked to sign an informed consent form before engaging with the installation. The participants included a mix of different genders and age groups representative of a university population.

Participants received a small incentive for their time, 24 participants in the form of a complementary snack, while two students who requested a cup of coffee received that as compensation. This recruitment strategy made it easy to ensure the sample was diverse enough to align with the objective of evaluation the installation in a read-world setting.

7.2 Results

This section represents the outcomes of the evaluation, outlining the behavioral impact and the participant's perception of the system under a judgmental and motivational tone. The primary aim is to asses which tone was more effective in encouraging stair usage and how it influences factors such as motivation, engagement, and social accountability.

7.2.1 Behavior

Before interacting with the installation, participants showed a stronger preference for the elevator, with most participants choosing the elevator over the stairs under both conditions. After the interaction, stair usage increased significantly for both tones, with judgmental shifting from 40% to 56% and motivational shifting from 36% to 56%. Interestingly, the shift was almost identical across both conditions, as seen in Fig. 19 and Fig. 20.

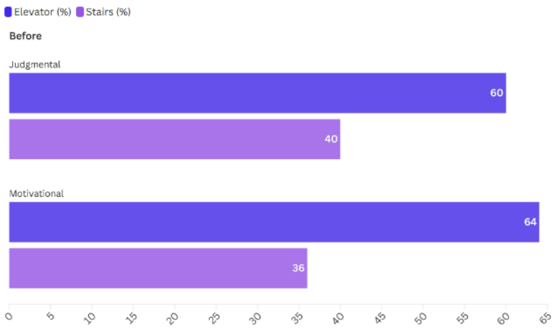


Fig. 19. Behavioral preference before interaction with the system.

A Chi-Square test was conducted (Appendix A) to examine the relationship between tone and user behavior. The test showed no significant association, $\chi^2(1, N=50) = 0.333$, $p = 0.564$, indicating that tone does not significantly influence behavioral choice.

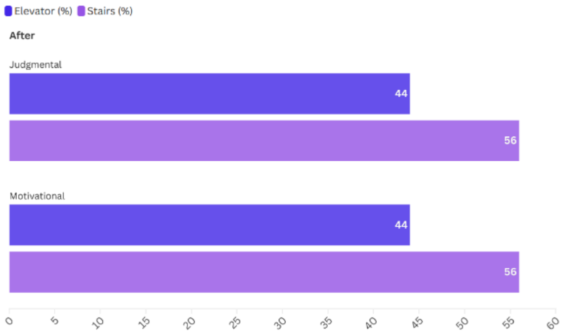


Fig. 20. Behavioral preference after interaction with the system.

These results indicate that while the system is effective ad nudging participants towards stair usage, tone alone did not create a significant behavioral difference.

7.2.2 Statistical Comparison

The data provided insights into how participants experienced and perceived the system. Across six total factors, considerations of stairs/elevator, noticeability, tone engagement, motivation, reflection, and social accountability.

The assumption of normality was tested for each factor using the Shapiro-Wilk Test and the Kolmogorov-Smirnov Test. As shown in Appendix A, all dimensions failed to meet the assumption of normality, with all p-values less than 0.005 across both tones. Consideration, design, and tone engagement were all significantly deviated from normality. Because of these results, the Wilcoxon Signed-Rank Test is selected to analyze the differences between the two tones. The results of the Wilcoxon Signed-Rank Test can be seen in Fig. 21, which visually represents the proportion of negative, tied, and positive ranks across the six factors when comparing motivational vs judgmental.

Participants showed a preference for the motivational tone in the factor of noticeability compared to that of the judgmental tone, which will be further explored in the interview section. Although the motivational tone appeared to show higher noticeability, as shown in Table 7, the difference was not significant (Z = -1.184, p= 0.236)

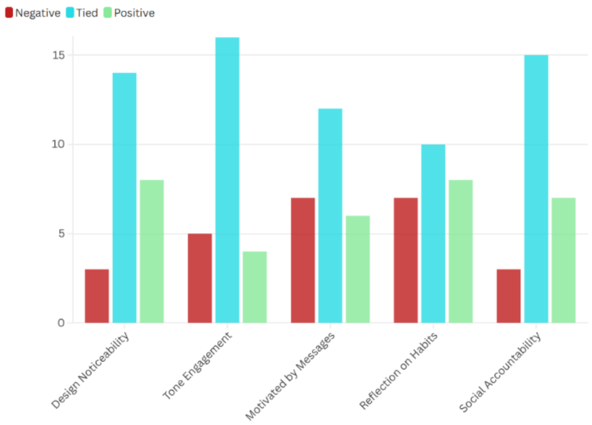


Fig. 21. Proportion of negative, tied, and positive ranks for the six factors comparing motivational and judgmental tones.

Dimension	Z Value	Significance (2-tailed)
Design Noticeability	-1.184	0.236
Tone Engagement	-0.312	0.755
Motivated by Messages	-0.263	0.793
Reflected on Habits	-0.119	0.905
Social Accountability	-1.308	0.191

Table 7. Results of the Wilcoxon Signed-Rank Test comparing motivational and judgmental tones.

Both tones showed similar results in terms of tone engagement, motivation from the messages, and reflection on their habits. These findings indicate that the tones had comparable effects on these aspects with no statistically significant differences observed. Contrary to expected, social accountability also showed a stronger trend towards the motivational tone. (Z = -1.308, p = 0.191).

These findings show that we did not find a significant effect of tone on user behavior and perception of the installation.

7.2.3 Interviews

The semi-structured interviews provided valuable insights into the participants' experiences with the installation and how this influenced their behavior. This process helps uncover aspects that were not fully captured by the survey responses, giving deeper explanations for the observed data.

The opinions of the participants about the design of the system aligned with the trends shown in section 7.2.2, where the motivational tone of the installation was perceived as more noticeable and visually appealing. As one participant noted, "*I liked the color of the motivational one and the eyes made it easier to interact with*". In contrast, the judgmental tone had mixed reactions. While one participant did mention that the judgmental tone made them reflect more on their choices, it was perceived as too harsh, making the participant less likely to follow the intended message of the installation. In conclusion, the next iteration should more carefully tune the tone to induce shame while not being perceived as ignorant and creating a backfire effect.

When users were asked to give their opinion on the system's ability to influence their behavior, two interviewees noted that the system might be effective when deciding to take the elevator or stairs for one or two floors, but more than that will most likely cause the user to ignore the messages of the installation and resort to convenience. Where one participant noted, "*If it's just a few floors. I'd consider it, but for like the upper floor of the Horst tower it would not change my mind"*. This aligns with the observed data for the reflection on their habits, as participants did not find the system changing their behavior. Concluding that the next iteration should try and challenge users' habits even more.

In terms of interaction experience, participants generally appreciated the interactive elements. Where one participant mentioned that animations and the eyes following you added an aspect that made it more appealing to engage with than an average stair sign. However, one participant reported initial confusion about the purpose of the system, giving the following response. "*When I started using the installation it was not doing anything for a moment and did not understand what I was supposed to do"*. Highlighting the importance of clearer messaging for the next iteration.

In conclusion, the qualitative data gave valuable insights and ideas for future improvements of the installation. Where the next system should further tune the tone to prevent the installation from being rejected, clearer messaging, and further challenge the user's habits.

Chapter 8: Discussion and Future Work

The analysis combines the quantitative and qualitative data insights to evaluate the system's overall impact on user behavior. Deciding if the installation effectively nudged users to take the stairs instead of the elevator and the impact tone has on the user experience.

Survey data revealed that stair usage increased for both tones after interacting with the installation, where participants' stair usage shifted on average from 48% to 56%, suggesting that the installation itself was the primary factor in the success of nudging users to take the stairs instead of the tone of the installation. This supports the idea of Engelen et al. [26] that a more interactive approach to the static stair sign could be more effective in environments like a University. Further supported by the qualitative findings where participants expressed liking the interactivity of the installation.

Overall the judgmental tone did not achieve the reaction it was intended to give. Participants described the motivational tone as “friendly” and “encouraging” while missing the social accountability the judgmental tone should have given, often being perceived as “harsh”. This resulted in rejection for some participants undermining the engagement and reducing the effectiveness of the installation. However, we did not evaluate shame, but this would be an interesting factor to look at for the next evaluation of the system, Although E. Aaltola [21] found that shame can be used as a form of nudging users through moral cultivation which can be a trigger for behavior change.

The study also showed several challenges in creating an interactive installation. One example of such a challenge was achieving clarity on the system's purpose. Multiple participants mentioned initial confusion about the purpose of the installation and a few even walked past it before an interaction could have occurred, suggesting that future work should be more robust for quick interactions where users do not notice the installation itself initially. Additionally, the deliberate exclusion of cameras ensured higher user privacy but limited the system's ability to create a more dynamic interaction. While the current setup proved functional, integrating alternative sensors could enhance the installation's engagement and effectiveness.

The methodology, which included real-world testing in a university setting, allowed for valuable insights into the system's performance in practice. While the sample size was limited due to timing constraints and unfortunate test dates, the evaluation captures a diverse pool of participants who are representative of the target demographic. Real-world context allowed for feedback on the robustness of the system and the effectiveness to grab the attention of users. However, there is a need for clearer messaging and more dynamic interactions to prevent the initial struggle to understand the installation, as some participants have noted.

The results show that while the installation effectively nudged participants toward taking the stairs, the difference between the motivational and judgmental tones was minimal. Stair usage increased significantly after interaction with the installation for both tones, but no significant behavioral difference was detected. This suggests the presence of an interactive installation is more influential in shaping user behavior than the tone it uses, further implying the importance of designing for human behavior with factors like, visual appeal, and ease of use.

Looking forward, the study would suggest several areas of improvement for future research. Enhancing the system functionality with better sensors and computational devices to create a more impactful experience. Larger-scale evaluations could give results with higher statistical significance and more insights through a larger amount of interviews.

Chapter 9: Conclusion

This study explored the effectiveness of an interactive installation designed to nudge users towards choosing stairs over elevators at the University of Twente. The primary research question aligned with the broader design research goal of exploring what interactive design can effectively nudge university students and employees to choose the stairs over the elevator. Specifically, this study examined whether a judgmental tone, aimed at creating a sense of social accountability, would be more effective than a friendlier tone in influencing user behavior.

The system consisted of an interactive display positioned near an elevator, featuring a dynamic face and convincing prompts, engaging users with either a friendly or judgmental tone. The goal was to assess whether a judgmental tone, designed to create a sense of social accountability, would be more effective than a friendlier tone at encouraging stair use. The evaluation showed that stair usage increased after participants interacted with the installation regardless of the tone used. Suggesting that the presence of the interactive installation what the primary driver of behavioral change rather than the specific tone of the prompts and interactive face. The sarcastic tone, intended to create a sense of "climate shame" did not create this intended feeling. In contrast, the friendlier tone was more appealing to users. Qualitative interviews highlighted that the installation was a nice addition and would be more engaging than a regular stair sign, it would most likely not change behavior when deciding for longer distances. This indicates that while the installation can influence behavior in certain contexts, like lower buildings, it may not be sufficient to overcome every convenience-driven decision.

The study underscores the importance of designing interactive systems that are engaging and user-friendly. From a public health perspective, the study demonstrates the potential of interactive installations to promote physical activity and healthier public spaces. By encouraging stair use, systems like this can contribute to reducing sedentary behavior, improving cardiovascular health, and lowering energy consumption.

In conclusion, the study provided valuable insights into the effectiveness of an interactive installation aimed to nudge users towards a healthier choice. While the installation showed promising results in increasing stair usage, the limited impact of the tone suggests that the design of such installations should prioritize engagement. By refining these interactive interventions, systems like the judgmental bouncer have the potential to become scalable solutions for promoting healthier behaviors and reducing energy consumption in public spaces.

References

[1] L. D. DELFINO *et al.*, “Association between sedentary behavior, obesity and hypertension in public school teachers,” *Industrial Health*, vol. 58, no. 4, pp. 345–353, 2020, doi: https://doi.org/10.2486/indhealth.2019-0170

[2] Y. You *et al.*, “The association between sedentary behavior, exercise, and sleep disturbance: A mediation analysis of inflammatory biomarkers,” vol. 13, Jan. 2023, doi: https://doi.org/10.3389/fimmu.2022.1080782

[3] C. A. Jennings, L. Yun, C. C. Loitz, E.-Y. Lee, and W. K. Mummery, “A Systematic Review of Interventions to Increase Stair Use,” *American Journal of Preventive Medicine*, vol. 52, no. 1, pp. 106–114, Jan. 2017, doi: https://doi.org/10.1016/j.amepre.2016.08.014

[4] P. Meyer *et al.*, “Stairs instead of elevators at workplace: cardioprotective effects of a pragmatic intervention,” *European Journal of Cardiovascular Prevention & Rehabilitation*, vol. 17, no. 5, pp. 569–575, Oct. 2010, doi: https://doi.org/10.1097/hjr.0b013e328338a4dd

[5] F. C. Bull *et al.*, “World health organization 2020 guidelines on physical activity and sedentary behaviour,” *British Journal of Sports Medicine*, vol. 54, no. 24, pp. 1451–1462, Nov. 2020, Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7719906/

[6] A. Stenling, A. Moylan, E. Fulton, and L. Machado, “Effects of a Brief Stair-Climbing Intervention on Cognitive Performance and Mood States in Healthy Young Adults,” *Frontiers in Psychology*, vol. 10, Oct. 2019, doi: https://doi.org/10.3389/fpsyg.2019.02300

[7] M. F. Adak, N. Duru, and H. T. Duru, “Elevator simulator design and estimating energy consumption of an elevator system,” *Energy and Buildings*, vol. 65, pp. 272–280, Oct. 2013, doi: https://doi.org/10.1016/j.enbuild.2013.06.003

[8] T. Radtke and P. Rackow, “Autonomous Motivation Is Not Enough: The Role of Compensatory Health Beliefs for the Readiness to Change Stair and Elevator Use,” *International Journal of Environmental Research and Public Health*, vol. 11, no. 12, pp. 12412–12428, Nov. 2014, doi: https://doi.org/10.3390/ijerph111212412

[9] W. Wood and D. Rünger, “Psychology of Habit,” *Annual Review of Psychology*, vol. 67, no. 1, pp. 289–314, Jan. 2016, doi: https://doi.org/10.1146/annurev-psych-122414-033417

[10] M. Peters, C. Megens, E. van den Hoven, C. Hummels, and A. Brombacher, “Social Stairs: Taking the Piano Staircase towards Long-Term Behavioral Change,” *Persuasive Technology*, pp. 174–179, 2013, doi: https://doi.org/10.1007/978-3-642-37157-8_21

[11] B. Fogg, “A Behavior Model for Persuasive Design,” *Proceedings of the 4th International Conference on Persuasive Technology - Persuasive ’09*, vol. 40, no. 40, pp. 1–7, 2009, doi: https://doi.org/10.1145/1541948.1541999

[12] T. Radtke and P. Rackow, “Autonomous Motivation Is Not Enough: The Role of Compensatory Health Beliefs for the Readiness to Change Stair and Elevator Use,” *International Journal of Environmental Research and Public Health*, vol. 11, no. 12, pp. 12412–12428, Nov. 2014, doi: https://doi.org/10.3390/ijerph111212412

[13] L. Festinger, “A theory of cognitive dissonance.,” *psycnet.apa.org*, 1957. Available: https://psycnet.apa.org/record/1993-97948-000

[14] M. Rabia, B. Knäuper, and P. Miquelon, “The eternal quest for optimal balance between maximizing pleasure and minimizing harm: The compensatory health beliefs model,” *British Journal of Health Psychology*, vol. 11, no. 1, pp. 139–153, Feb. 2006, doi: https://doi.org/10.1348/135910705x52237

[15] T. M. Marteau, D. Ogilvie, M. Roland, M. Suhrcke, and M. P. Kelly, “Judging nudging: can nudging improve population health?,” *BMJ*, vol. 342, no. jan25 3, pp. d228–d228, Jan. 2011, doi: https://doi.org/10.1136/bmj.d228

[16] L. Ledderer, M. Kjær, E. K. Madsen, J. Busch, and A. Fage-Butler, "Nudging in Public Health Lifestyle Interventions: A Systematic Literature Review and Metasynthesis," *Health Education & Behavior*, vol. 47, no. 5, pp. 749–764, Jun. 2020, doi: https://doi.org/10.1177/1090198120931788
[17] M. Nocon, F. Müller-Riemenschneider, K. Nitzschke, and S. N. Willich, "Review Article: Increasing physical activity with point-of-choice prompts - a systematic review," *Scandinavian Journal of Public Health*, vol. 38, no. 6, pp. 633–638, Jul. 2010, doi: https://doi.org/10.1177/1403494810375865
[18] R. E. Andersen, "Can Inexpensive Signs Encourage the Use of Stairs? Results from a Community Intervention," *Annals of Internal Medicine*, vol. 129, no. 5, p. 363, Sep. 1998, doi: https://doi.org/10.7326/0003-4819-129-5-199809010-00003
[19] T. Nomura, Y. Yoshimoto, Y. Akezaki, and A. Sato, "Changing behavioral patterns to promote physical activity with motivational signs," *Environmental Health and Preventive Medicine*, vol. 14, no. 1, pp. 20–25, Oct. 2008, doi: https://doi.org/10.1007/s12199-008-0053-x
[20] P. Bachert *et al.*, "Students on stairs: a participatory approach using decisional cues in the form of motivational signs to promote stair use," *Journal of American College Health*, pp. 1–11, Jan. 2021, doi: https://doi.org/10.1080/07448481.2020.1845704
[21] E. Aaltola, "Defensive over Climate Change? Climate Shame as a Method of Moral Cultivation," *Journal of Agricultural and Environmental Ethics*, vol. 34, no. 1, Feb. 2021, doi: https://doi.org/10.1007/s10806-021-09844-5
[22] P. G. Hansen, L. R. Skov, and K. L. Skov, "Making Healthy Choices Easier: Regulation versus Nudging," *Annual Review of Public Health*, vol. 37, no. 1, pp. 237–251, Mar. 2016, doi: https://doi.org/10.1146/annurev-publhealth-032315-021537
[23] R. Pea, "User Centred System Design-New Perspectives on Human/Computer Interaction," 1987.
[24] I. Holeman and D. Kane, "Information Technology for Development ISSN: (Print) (Human-centered design for global health equity Human-centered design for global health equity," 2019, doi: https://doi.org/10.1080/02681102.2019.1667289
[25] A. Mader and W. Eggink, "A DESIGN PROCESS FOR CREATIVE TECHNOLOGY A DESIGN PROCESS FOR CREATIVE TECHNOLOGY," 2014.
[26] L. Engelen, J. Gale, J. Y. Chau, and A. Bauman, "Are motivational signs to increase stair use a thing of the past? A multi-building study," *Health Promotion Journal of Australia*, vol. 28, no. 3, pp. 178–184, Mar. 2017, doi: https://doi.org/10.1071/he16107
[27] T. Swenson and M. Siegel, "Increasing Stair Use in an Office Worksite through an Interactive Environmental Intervention," *American Journal of Health Promotion*, vol. 27, no. 5, pp. 323–329, May 2013, doi: https://doi.org/10.4278/ajhp.120221-quan-104
[28] Sharp Corporation, "GP2Y0A710K0F Distance Measuring Sensor Unit," Technical Datasheet, 2013. https://global.sharp/products/device/lineup/data/pdf/datasheet/gp2y0a710k_e.pdf

Appendices:

During the preparation of this work the author used:

Grammarly: Used to identify and correct grammatical mistakes, spelling errors, and inconsistencies throughout the report.

Murf.ai: Used to generate the voice prompts implemented in the interactive installation.

ChatGPT: Used for improving sentence structure and refining the overall flow of the report

After using this tool/service, the author reviewed and edited the content as needed and takes full responsibility for the content of the work.

Appendix A. Statistical tests

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Tone * Before_interaction	50	100.0%	0	0.0%	50	100.0%

Tone * Before_interaction Crosstabulation

			Before_interaction		
			Elevator	Stairs	Total
Tone	1	Count	15	10	25
		% within Tone	60.0%	40.0%	100.0%
		% within Before_interaction	48.4%	52.6%	50.0%
		% of Total	30.0%	20.0%	50.0%
	2	Count	16	9	25
		% within Tone	64.0%	36.0%	100.0%
		% within Before_interaction	51.6%	47.4%	50.0%
		% of Total	32.0%	18.0%	50.0%
Total		Count	31	19	50
		% within Tone	62.0%	38.0%	100.0%
		% within Before_interaction	100.0%	100.0%	100.0%
		% of Total	62.0%	38.0%	100.0%

Tone * After_interaction Crosstabulation

			After_interaction		
			Elevator	Stairs	Total
Tone	1	Count	11	14	25
		% within Tone	44.0%	56.0%	100.0%
		% within After_interaction	50.0%	50.0%	50.0%
		% of Total	22.0%	28.0%	50.0%
	2	Count	11	14	25
		% within Tone	44.0%	56.0%	100.0%
		% within After_interaction	50.0%	50.0%	50.0%
		% of Total	22.0%	28.0%	50.0%
Total		Count	22	28	50
		% within Tone	44.0%	56.0%	100.0%
		% within After_interaction	100.0%	100.0%	100.0%
		% of Total	44.0%	56.0%	100.0%

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Tone * After_interaction	50	100.0%	0	0.0%	50	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.333[a]	1	.564		
Continuity Correction[b]	.083	1	.773		
Likelihood Ratio	.334	1	.563		
Fisher's Exact Test				.773	.387
N of Valid Cases	50				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 10.00.

b. Computed only for a 2x2 table

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Considered_Stairs_Elevator_Judgmental	.278	25	<,001	.880	25	.007
Design_Noticed_Judgmental	.265	25	<,001	.808	25	<,001
Tone_Engaging_Judgmental	.376	25	<,001	.759	25	<,001
Motivated_By_Messages_Judgmental	.222	25	.003	.900	25	.019
Reflected_Habits_Judgmental	.218	25	.004	.897	25	.016
Social_Accountability_Judgmental	.192	25	.019	.885	25	.009
Considered_Stairs_Elevator_Motivational	.259	25	<,001	.868	25	.004
Design_Noticed_Motivational	.249	25	<,001	.812	25	<,001
Tone_Engaging_Motivational	.346	25	<,001	.809	25	<,001
Motivated_By_Messages_Motivational	.228	25	.002	.872	25	.005
Reflected_Habits_Motivational	.210	25	.006	.910	25	.031
Social_Accountability_Motivational	.194	25	.016	.919	25	.049

a. Lilliefors Significance Correction

Ranks

		N	Mean Rank	Sum of Ranks
Design_Noticed_Motivational - Design_Noticed_Judgmental	Negative Ranks	3[a]	6.83	20.50
	Positive Ranks	8[b]	5.69	45.50
	Ties	14[c]		
	Total	25		
Tone_Engaging_Motivational - Tone_Engaging_Judgmental	Negative Ranks	5[d]	4.00	20.00
	Positive Ranks	4[e]	6.25	25.00
	Ties	16[f]		
	Total	25		
Motivated_By_Messages_Motivational - Motivated_By_Messages_Judgmental	Negative Ranks	7[g]	7.00	49.00
	Positive Ranks	6[h]	7.00	42.00
	Ties	12[i]		
	Total	25		
Reflected_Habits_Motivational - Reflected_Habits_Judgmental	Negative Ranks	7[j]	8.29	58.00
	Positive Ranks	8[k]	7.75	62.00
	Ties	10[l]		
	Total	25		
Social_Accountability_Motivational - Social_Accountability_Judgmental	Negative Ranks	3[m]	5.00	15.00
	Positive Ranks	7[n]	5.71	40.00
	Ties	15[o]		
	Total	25		

a. Design_Noticed_Motivational < Design_Noticed_Judgmental

b. Design_Noticed_Motivational > Design_Noticed_Judgmental

c. Design_Noticed_Motivational = Design_Noticed_Judgmental

d. Tone_Engaging_Motivational < Tone_Engaging_Judgmental

e. Tone_Engaging_Motivational > Tone_Engaging_Judgmental

f. Tone_Engaging_Motivational = Tone_Engaging_Judgmental

g. Motivated_By_Messages_Motivational < Motivated_By_Messages_Judgmental

h. Motivated_By_Messages_Motivational > Motivated_By_Messages_Judgmental

i. Motivated_By_Messages_Motivational = Motivated_By_Messages_Judgmental

j. Reflected_Habits_Motivational < Reflected_Habits_Judgmental

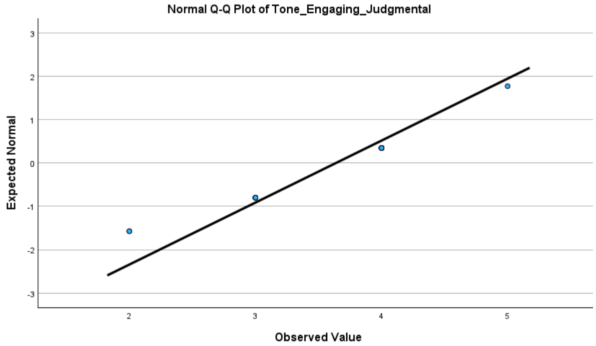
k. Reflected_Habits_Motivational > Reflected_Habits_Judgmental

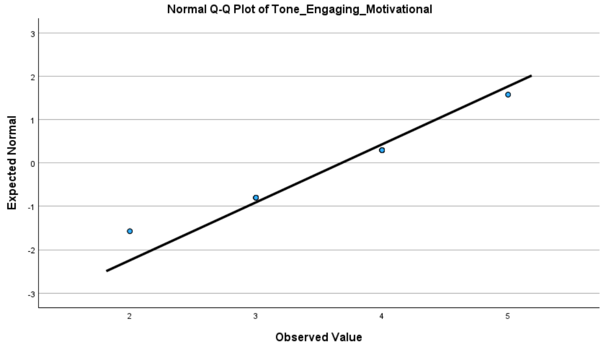
l. Reflected_Habits_Motivational = Reflected_Habits_Judgmental

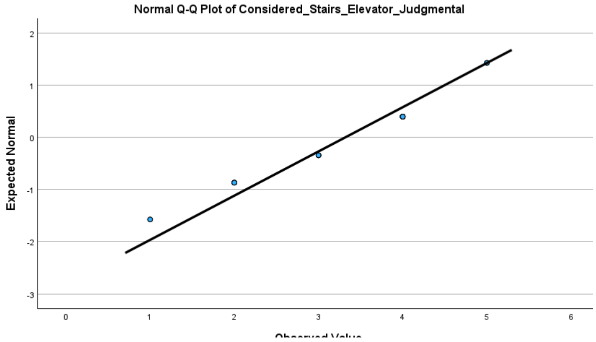
m. Social_Accountability_Motivational < Social_Accountability_Judgmental

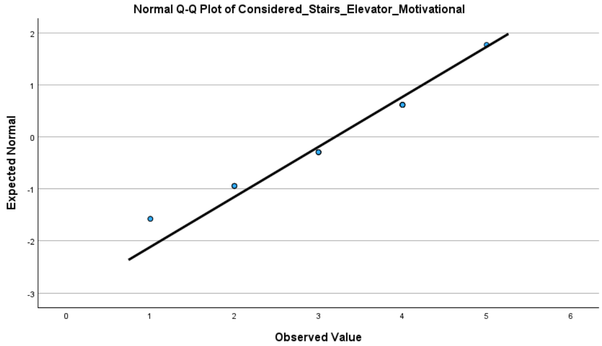
n. Social_Accountability_Motivational > Social_Accountability_Judgmental

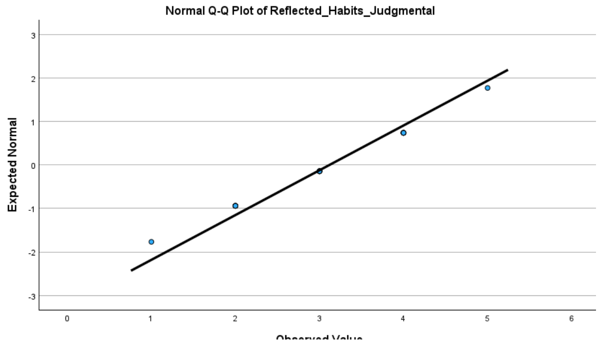
o. Social_Accountability_Motivational = Social_Accountability_Judgmental

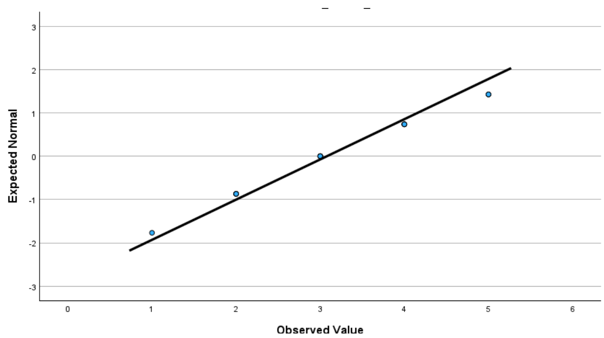

Normal Q-Q Plot of Tone_Engaging_Judgmental
Expected Normal
Observed Value

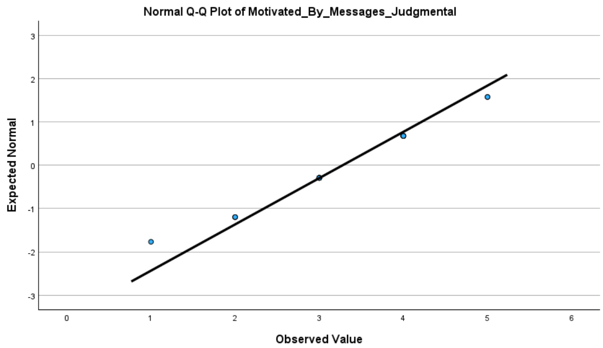

Normal Q-Q Plot of Tone_Engaging_Motivational
Expected Normal
Observed Value

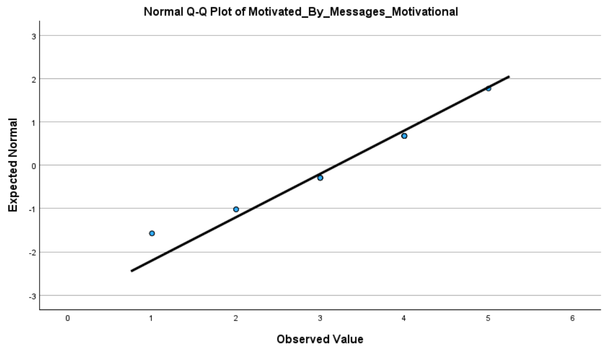

Normal Q-Q Plot of Considered_Stairs_Elevator_Judgmental
Expected Normal

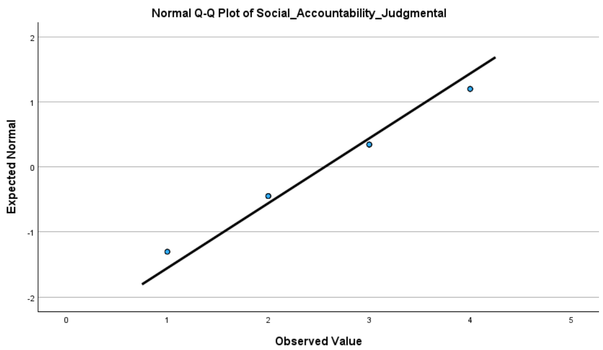

Normal Q-Q Plot of Considered_Stairs_Elevator_Motivational
Expected Normal
Observed Value


Normal Q-Q Plot of Reflected_Habits_Judgmental
Expected Normal

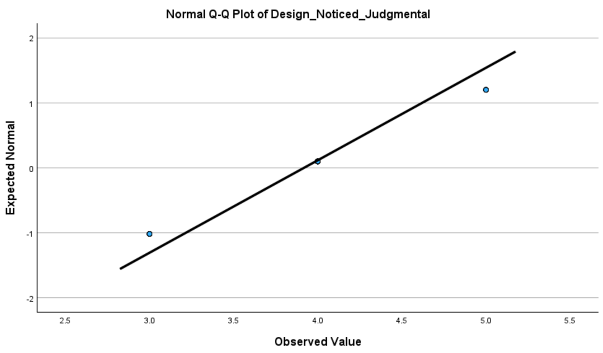

Expected Normal
Observed Value

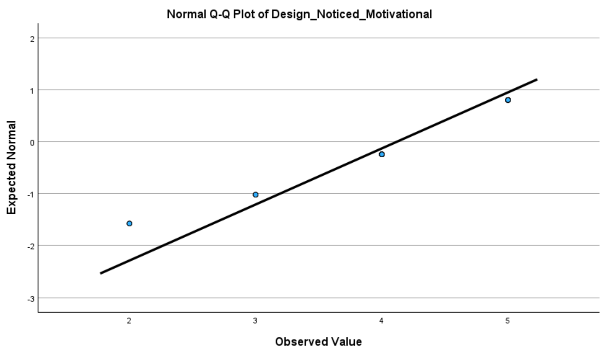

Normal Q-Q Plot of Motivated_By_Messages_Judgmental
Expected Normal
Observed Value


Normal Q-Q Plot of Motivated_By_Messages_Motivational
Expected Normal
Observed Value


Normal Q-Q Plot of Social_Accountability_Judgmental
Expected Normal
Observed Value


Normal Q-Q Plot of Social_Accountability_Motivational
Expected Normal
Observed Value


Normal Q-Q Plot of Design_Noticed_Judgmental
Expected Normal
Observed Value
2
1
0
-1
-2
2.5
3.0
3.5
4.0
4.5
5.0
5.5


Normal Q-Q Plot of Design_Noticed_Motivational
Expected Normal
Observed Value
2
1
0
-1
-2
-3
2
3
4
5

T-test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Considered_Stairs_Elevator_Judgmental	3.32	25	1.180	.236
	Considered_Stairs_Elevator_Motivational	3.20	25	1.041	.208
Pair 2	Design_Noticed_Judgmental	3.92	25	.702	.140
	Design_Noticed_Motivational	4.12	25	.927	.185
Pair 3	Tone_Engaging_Judgmental	3.64	25	.700	.140
	Tone_Engaging_Motivational	3.68	25	.748	.150
Pair 4	Motivated_By_Messages_Judgmental	3.28	25	.936	.187
	Motivated_By_Messages_Motivational	3.20	25	1.000	.200
Pair 5	Reflected_Habits_Judgmental	3.12	25	.971	.194
	Reflected_Habits_Motivational	3.08	25	1.077	.215
Pair 6	Social_Accountability_Judgmental	2.56	25	1.003	.201
	Social_Accountability_Motivational	2.84	25	1.179	.236

Paired Samples Correlations

		N	Correlation	Significance One-Sided p	Significance Two-Sided p
Pair 1	Considered_Stairs_Elevator_Judgmental & Motivational	25	.828	<,001	<,001
Pair 2	Design_Noticed_Judgmental & Motivational	25	.527	.003	.007
Pair 3	Tone_Engaging_Judgmental & Motivational	25	.407	.022	.043
Pair 4	Motivated_By_Messages_Judgmental & Motivational	25	.472	.009	.017
Pair 5	Reflected_Habits_Judgmental & Motivational	25	.229	.135	.270
Pair 6	Social_Accountability_Judgmental & Motivational	25	.572	.001	.003

Paired Samples Test

		Paired Differences					t	df	Significance	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			One-Sided p	Two-Sided p
Pair 1	Considered_Stairs_Elevator_Judgmental & Motivational	.120	.666	.133	-.155	.395	.901	24	.188	.376
Pair 2	Design_Noticed_Judgmental & Motivational	-.200	.816	.163	-.537	.137	-1.225	24	.116	.233
Pair 3	Tone_Engaging_Judgmental & Motivational	-.040	.790	.158	-.366	.286	-.253	24	.401	.802
Pair 4	Motivated_By_Messages_Judgmental & Motivational	.080	.997	.199	-.331	.491	.401	24	.346	.692
Pair 5	Reflected_Habits_Judgmental & Motivational	.040	1.274	.255	-.486	.566	.157	24	.438	.877
Pair 6	Social_Accountability_Judgmental & Motivational	-.280	1.021	.204	-.702	.142	-1.371	24	.092	.183

Paired Samples Effect Sizes

			Standardizer[a]	Point Estimate	95% Confidence Interval Lower	95% Confidence Interval Upper
Pair 1	Considered_Stairs_Elevator_Judgmental & Motivational	Cohen's d	.666	.180	-.217	.574
		Hedges' correction	.688	.175	-.210	.556
Pair 2	Design_Noticed_Judgmental & Motivational	Cohen's d	.816	-.245	-.640	.156
		Hedges' correction	.843	-.237	-.620	.151
Pair 3	Tone_Engaging_Judgmental & Motivational	Cohen's d	.790	-.051	-.442	.342
		Hedges' correction	.815	-.049	-.428	.331
Pair 4	Motivated_By_Messages_Judgmental & Motivational	Cohen's d	.997	.080	-.313	.472
		Hedges' correction	1.029	.078	-.303	.457
Pair 5	Reflected_Habits_Judgmental & Motivational	Cohen's d	1.274	.031	-.361	.423
		Hedges' correction	1.316	.030	-.350	.410
Pair 6	Social_Accountability_Judgmental & Motivational	Cohen's d	1.021	-.274	-.671	.128
		Hedges' correction	1.055	-.265	-.650	.124

a. The denominator used in estimating the effect sizes.

Cohen's d uses the sample standard deviation of the mean difference.

Hedges' correction uses the sample standard deviation of the mean difference, plus a correction factor.

Appendix B. Questions and surveys

User Insights Survey

1. **What is your age?**
2. **What is your role at the university?**
    - Student
    - Employee
    - Other
3. **How many days a week are you at the university on average?**
4. **How many times per week do you take the elevator when you are on campus?**
5. **How many times per week do you take the stairs when you are on campus?**
6. **How likely are you to take the stairs when both the stairs and elevator are available?**
    - Very likely
    - Somewhat likely
    - Neither likely nor unlikely
    - Somewhat unlikely
    - Very unlikely
7. **What is your group number?**
8. **Did you take the stairs or the elevator?**
    - Stairs
    - Elevator
9. **What influenced your decision to take the elevator/stairs in this instance?**
    - Convenience
    - Physical effort
    - Social influence
    - Routine
    - Other
10. **How easy was it to decide on using the elevator/stairs?**
    - Extremely easy
    - Somewhat easy
    - Neutral
    - Somewhat not easy
    - Extremely not easy
11. **Did you reflect on this decision?**
    - Yes
    - No
    - I don't know
12. **How noticeable was the installation as you approached the elevator?**
    - Very noticeable
    - Noticeable
    - Neutral
    - Barely noticeable
    - Not noticeable at all
13. **How much did the installation influence your decision to take the stairs instead of the elevator?**
    - Strong influence
    - Small influence
    - No influence
14. **How appropriate did you find the tone of the prompts?**
    - Very appropriate

- Appropriate
- Neutral
- Inappropriate
- Very inappropriate

15. **How did the installation make you feel? (multiple options possible)**
    - Encouraged
    - Motivated
    - Judged
    - Embarrassed
    - Other
16. **Do you have any suggestions or other comments?**

Final User Evaluation

1. **What did you choose to go up?**
    - Stairs
    - Elevator
2. **What did you choose to go down?**
    - Stairs
    - Elevator
3. **Likert Scale**
    - I considered both the stairs and the elevator
    - The installation's design and placement made it noticeable and easy to understand
    - The installation's tone was engaging
    - I felt motivated to take the stairs or elevator due to the installation's messages.
    - The installation made me reflect on my habits regarding taking the stairs or elevator.
    - I felt a sense of social accountability when making my choice.
        1. Strongly disagree
        2. Disagree
        3. Neutral
        4. Agree
        5. Strongly agree

Interview questions

General Experience

Can you describe your overall experience interacting with the installation?

What was your first impression when you saw the system? Did it immediately capture your attention?

Did you understand the purpose of the installation right away, or did it take some time to figure out?

Perception of Different Tones

Between the two modes—judgmental and motivational—did you prefer one over the other? Why?

How did each tone make you feel when interacting with the system?

Did the tone influence your decision to take the stairs or elevator? If so, how?

The judgmental tone was designed to create a sense of social accountability. Did you feel that it had this effect?

Engagement & Interaction

Did the interactive elements (such as the face, animations, or prompts) enhance your engagement with the installation?

Did you feel like the system was addressing you personally, or did it feel more like a general message?

Did you find the prompts engaging or repetitive?

Was there anything about the system's behavior that you found unclear or confusing?

Behavioral Impact

Did the installation make you reflect on your decision to take the stairs or elevator?

If you took the stairs after interacting with the system, do you think you would make the same choice in the future?

If you were in a hurry or had to climb multiple floors, would the system still influence your choice?

Would you be more likely to engage with similar installations in other public spaces?

Design & Usability

What did you think of the design of the installation? Did anything stand out to you?

Did the visual elements (such as colors, facial expressions, or layout) affect your interaction in any way?

Was the messaging clear, or do you think it could be improved?

Did you feel the installation fit naturally in the environment, or did it feel out of place?

Suggestions & Improvements

If you could change anything about the installation, what would it be?

Do you think adding more personalized or dynamic responses would improve engagement?

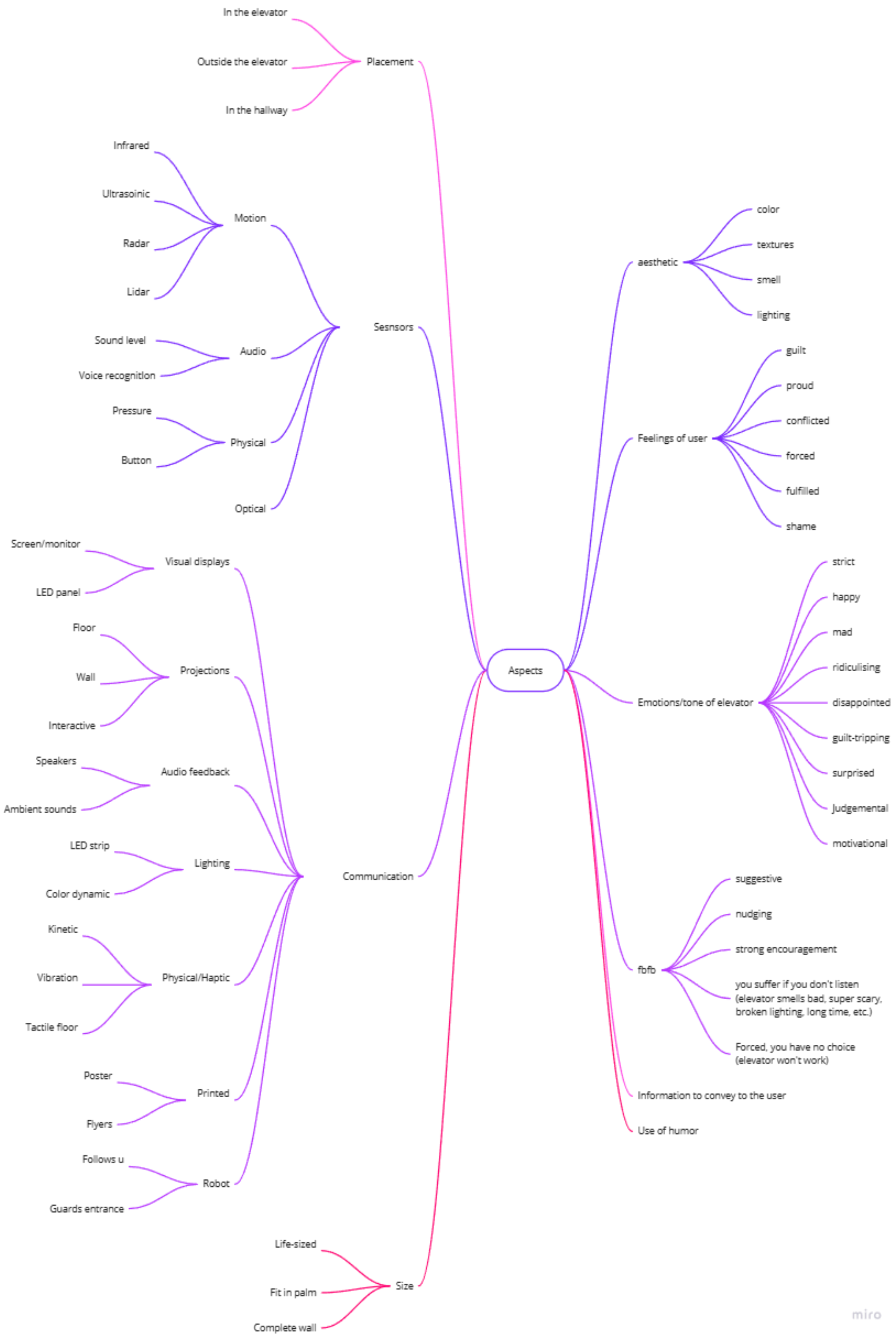
What kind of environments do you think this installation would be most effective in?

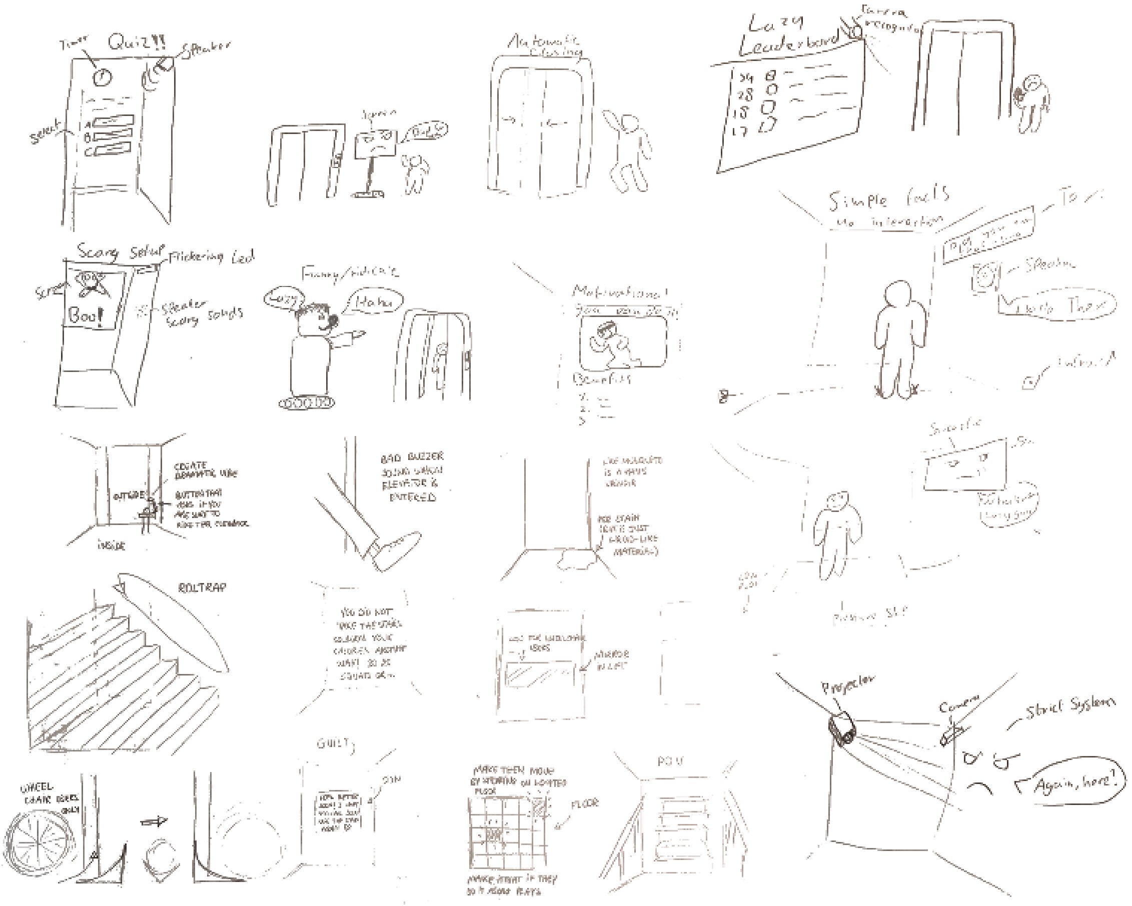
Would you suggest any alternative ways to encourage stair usage besides tone changes?

Final Thoughts

Is there anything else you would like to share about your experience with the installation?

Appendix C. Images





Quiz!!
Timer
Speaker
Select
A
B
C
Automatic Closing
Lazy Leaderboard
34
28
18
17
Scary Setup
Flickering Led
Screen
Boo!
Speaker Scary sounds
Lazy
Haha
Motivational
Benefits
Simple facts
No interaction
Speaker
Infrared
BAD BUZZER SOUND WHEN ELEVATOR IS ENTERED
ROLTRAP
MIRROR IN LIFT
WHEEL CHAIR USERS ONLY
GUILT
FLOOR
MAKE THEM MOVE BY STEPPING ON LIGHTED FLOOR
POV
Projector
Camera
Strict System
Again, here?