ASHESI UNIVERSITY COLLEGE

REFLECTION: A KINECT-BASED INTERACTIVE ARTWORK IN ASHESI BETA SPACE

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Applied Project

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REFLECTION: A KINECT-BASED INTERACTIVE ARTWORK IN ASHESI BETA SPACE

By

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Applied Project submitted to the Department of Computer Science, Ashesi University College In partial fulfillment of the requirements for the award of Bachelor of Science degree in Computer Science.

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Applied Project

Declaration

I hereby declare that this dissertation is the result of my own original work and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature:…….

Candidate's Name:……

Date:……..

I hereby declare that the preparation and presentation of the dissertation were supervised in accordance with the guidelines on supervision of dissertation laid down by Ashesi University College.

Supervisor's Signature:……..

Supervisor's Name:…….

Date:……..

Acknowledgement

Thanks to my family and friends without whom this project wouldn’t have been a success. Their support has been an essential motivation from the beginning to the end.

Special thank to my supervisors; Dr. Astrid T. Larssen and Dr. Ayorkor G. Korsah for their feedback, guidance and support during the implementation of this project.

Abstract

The campus of Ashesi University Collage has a unique architecture which creates a relaxing feeling for the people who work there or visit it. Even though this is true for most spaces on campus, there are some spaces on campus which have a few design issues like the confined spaces and the lack of natural light. This has caused a dull effect on the people using these spaces as they use them. The location being examined in this project is a staircase which has a low ceiling and little natural light.

This problem has been addressed in this project by the implementation of interactive art which has proven useful in bringing excitement to the people using the staircase. This document describes the process of design, implementation and testing this artwork to evaluate its effectiveness.

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Chapter 1

1.1 Introduction

Unlike science, the definition of art has never been clear or definite. However, it could be described by its properties, contents, or effects on human beings. This report explains the making of the interactive art installation I created for a staircase at the Ashesi University College's campus. The purpose of the installation was to entertain (and relax) students, faculty and staff who use the passage. I will discuss the procedures and technologies I used in the implementation of this project. This also includes testing of separate components of the installation and experiments undertaken. The report could also serve as a guideline to the use of the Kinect gaming sensor for similar future projects.

Art can be classified into many classes. One category of art is interactive art. Unlike traditional forms of art, interactive art does not only allow the viewers to enjoy staring at the installation, but they could also participate in its creation. This caused a continuous fascination with the artwork; not only at the beginning of its life, but at any point in time as long as it continues to be displayed. New forms of interactive art have evolved with time and with the development of the techniques used in making art. With the beginning of the electronic age, more techniques were open to the artist's creativity for

creating art as well as development of computer games. Computer games have become one of the most popular use of computers since the early 1970s with the wide spread of the first gaming systems by manufactures like Nintendo and Atari. Today, interactive art can be seen in many forms in public spaces, on the internet and on personal computer and gaming systems. Electronic games can be classified as a form of interactive art because of the ability of audience to participate in producing the images and music to create an entertaining user experience.

Often a separated from computer games, interactive art is considered to be a form of engagement of people with their surroundings. An interactive art piece on display can be categorized according the content being exhibited and the form of interaction involved. The art content on display depends on the two main categories of art; visual or auditory. Interactive art differs mainly from computer games by the form of interaction. While video games use universal controllers designed specifically for a particular form of interaction like in joysticks and keyboard, interactive art are mostly controlled by simple body movement. The body movement often being used to interact does not require a special skill that is difficult to learn nor needs intense thinking. This allows anyone to participate in the installation without necessarily learning new skill. One example of a simple form of motion detection is in *Boundary Functions,* in artwork by Scott Snibbe which dynamically draws lines on the floor between people (Snibbe). The

participants are required to simply walk in an area in the floor for their action to be detected.

Figure 1 A Sony game controller with buttons used for playing video games on a gaming system (Cnet)

Figure 2 Boundary Functions, an interactive artwork being controlled by a motion sensor which captures participants' movement (Snibbe)

Like all forms of art, there may be psychological benefits of viewing and, moreover, interacting with interactive art. Artists can use principle techniques like color combination, for example, to create a positive experience such as a calming effect on the viewers (Lindell & Mueller, 2011). Other principles techniques used include texture, motion, and shapes. Just like vision components, auditory components are also used in interactive art. Variation in the tempo of music and mode may have positive effects on people's feelings (Hunter). In most modern computer games, for example, we find music being used in the background to induce feelings that affect the excitement level of the players which affects the flow of the game (Pichlmair).

1.2 Background

The new Ashesi university campus was constructed in 2011 outside Accra as a permanent location for the university. The campus has a unique architecture and design to serve its functionality and portray its beauty. The green lawns and gardens as well as the stone walls and high ceilings trigger a feeling of relaxation and induce creativity. A design principle, the Cathedral effect, states that high ceilings promote creativity and thinking. Another principle is the Biophilia effect which claims that natural scenery reduces stress and enhances focus and concentration (Lidwell, Holden, & Butler, 2010). Such elements can commonly be seen on campus, however, there are some locations on campus which could be seen to have a negative effect of dullness on people as they move through these spaces. This negative effect could be attributed to absence of these principles. One of those spaces is the staircase on which the project is centered.

Figure 3 The Founders Court forms the center of the University's main building and is characterized by its green lawns and flowers.

Figure 4 The first fold of the staircase in question; Located beneath the Adjunct faculty office.

Figure 5 The second fold of the staircase; Continued from Figure 4.

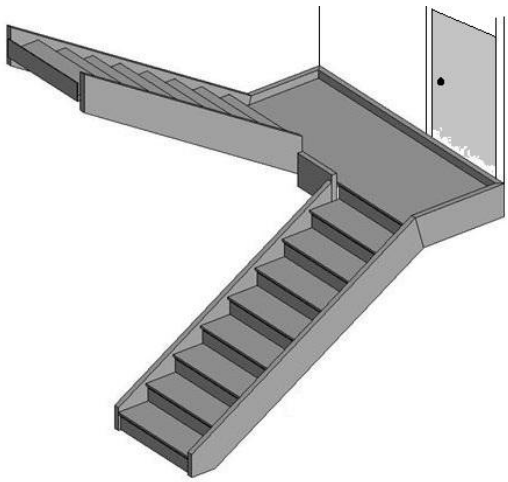

Figure 6 A computer-generated model of the staircase. Combining Figure 4 and 5

The two fold staircase (see Fig. 6 above) is characterized by the shortage of light from natural sources and by a low ceiling at its center. These characteristics may cause a feeling of isolation from the rest of the campus and a may trigger negative emotions such as dullness as shown in section 2.3 of this report which describes the data gathering process.

In an effort to add more beauty to the campus and to promote art and creativity, the administration of the university often host artwork from famous Ghanaian artists to be installed temporarily or permanently in the halls and corridors of the campus. Some examples include paintings by Gabriel Eklou displayed in the university library in a in 2012-2013 and two tall wooden sculptures, 'Progress' and 'Certainty', by the Ghanaian sculptor Fred Oko-Marley which were placed at the doors of the library. The artist said the sculptures were his impression about Ashesi University (see Figure 7 and 8). There are other paintings in other places on campus, such as the reception and in a conference room. The art hosted at Ashesi falls in the

category of traditional paintings, sculptures and or abstract modern art by contemporary Ghanaian artists.

Figure 7: Progress, one of two sculptures in front of the Library. Artist: Fred Oko-Marley

Figure 8: Certainty, the second of two sculptures in front of the Library. Fred Oko-Marley

1.3 Observation

From observation, people who pass through the staircase often move quickly. A survey conducted at the location indicates mostly negativity or mixed emotions associated with the place. Even though the time spent in the staircase is brief and the purpose is to pass through on the way to a lecture, lunch, or meeting etc, setting up an art installation in this location could make the place more attractive and would reduce the unhappy feelings of people using the facility by adding excitement to the space. The absence of natural lighting and space in the staircase in question makes it challenges to install traditional art pieces in the stair case. However, an art installation in

the space could have a positive effect on the feelings or emotion of the passersby.

A genre which could use the characteristics of the location to its advantage is Interactive Art. The dark nature of the place makes it possible to use light to its advantage and the low ceiling may emphasize the presence of any art installation. Also interacting with the installation, passively or actively, will make the space more attractive to pass though and therefore attract more people to use it. This will also open the door for similar projects to be implemented on the university campus.

1.4 Objectives

After the complete implementation of this solution, the staircase will contain an art piece with visual and auditory components which when combined will create a positive effect on the emotions of people who use the facility and will transform the location from being used only for its functionality to also act as a place for entertainment and enjoyment. The objectives of the project will include the following aspects.

1.4.1 Trigger positive emotions

The artwork should create a desirable feeling of happiness and excitement. This will be done using the visual and sound elements.

The visual elements will be displayed on a projector screen and sound will be emitted by speakers.

1.4.2 Make an art statement

The artwork will therefore send a message of creativity and will promote recycling and reusing waste materials. Symbolism of light as energy will add excitement to the art piece. Moreover, the chance for anyone to participate directly in the artwork shows the importance of every person on campus.

1.4.3 Promote interactive art on Ashesi campus

This project will be the first of its kind on Ashesi university campus. This project could serve as an introduction to the use of motion capture sensors such as Kinect (the key motion sensor used in this project) to produce Interactive Art and games. It will also encourage other students to create art-based projects or use art as part of their solutions in their final year project.

In addition to the core objectives, I intended to make my work environmentally friendly by reusing waste materials. Some parts of the installations will be made primarily out of materials which would otherwise

have been considered waste. A projector screen was created using used cardboard and used A4 sheets. A stand for the motion sensor was created using an old lamp stand and other waste material.

1.5 Implications

The successful execution of this project will result in several outcomes. First, the artwork will hopefully have a positive psychological effect on the users of the stairs whether people interact with it passively or actively. The effects created will carried away with the people and therefore increase feelings of happiness on campus. Secondly, it will send the message of recycling/reuse of waste material to produce useful things. Thirdly, beginners who read this report will be introduced to how to use the right tools to implement a similar project.

1.6 Motivation

I was motivated to take this project for two main reasons; First of all, I appreciate art in its different forms as a way of expressing beauty or as to send a message. I am a photography hobbyist and also a member of the photography club at the university. Secondly, I want explore the capabilities of the Kinect sensor to create solutions for everyday problems; like the unfriendly nature of some architecture, in this case the specific staircase in question.

1.7 Approach

For this project, I have created an interactive art installation in the staircase in question to change the general mood of the people who pass through it. First, a series of data gathering procedures was undertaken to understand the experience of the users of the facility at the time and how they had liked any change to be made to the place. This included surveys and observations. Second, the entire location was measured and analyzed for a better understanding of its architecture and design. This was very important when making design choices for the final setup and for the electronic interface hence, I was able to draw out the requirements for the design.

Secondly, I analyzed the capabilities of the motion sensor and its programming platform though its manuals to understand how it works and in order to produce a suitable user experience around it. This gave me an understanding about the type of objects the sensor is able to detect and the range within which the users had to be in order to be detected and properly participate. Understanding the programming platform determined the type of graphics to display on the screen and the type of audio which could be included.

Finally, I used the data to produce a final design which was based on the information I have been able to gather from the first two stages of the project. The final Interactive Artwork was similar to some of the examples which I shall discuss later in this paper. During every stage of designing the

artwork, tests were conducted to ensure that the project met its intended purpose and to make possible improvements.

1.8 Literature review

Interactive Art could be divided in various categories depending on the nature of the art presented and on the technology used to make it. The area of interactive art could best be described as a combination art in its various forms and interaction design. However, the rules of interaction design may be twisted by the artist as a part of the artwork or to make an art statement. The technology used may also vary depending on the kind of interaction. One new form of input to interactive systems is motion sensors while more traditional forms of electronic input include the use of buttons, switches or touch screens for interaction. The interaction which occurs between the audience and the artwork could be either passive or active (Khut, 2007). Some examples of the various forms of interactive art will be discussed in this section.

1.8.1 Interactive Art

The components of interactive art can be divided mainly into; the content, the transmission medium, the technology, the audience. The content presented is what can be sensed by the audience which could include visual content, sound, texture and others. The transmission medium is the channel

which allows the content to reach the audience. The technology used could be divided into two; one to present the content and another to sense input from the audience. An intermediate module, often a computer, is sometimes used to process user input and use it to manipulate the content depending on the logic created by the artist. Finally, the audience plays an important role by performing actions, willingly or unwillingly, which will be used to manipulate the content.

1.8.2 Audience

The other important component is the audience of the art piece. Their role is to basically participate by performing actions which serve as input to the system to be used. Audience interaction could be classified into four modes; *physically active* or *physically passive*, *immersive* or *reflective* (Khut, 2007). Active forms of interaction require the participant to intentionally perform an action to get a reaction from the installation while passive form of interaction may occur when the human participant unintentionally performs an action which may trigger a reaction from the artwork.

1.8.3 Technology

Given the type of interaction which the artist has decided to implement in the artwork, the choice of technology used also varies in form and complexity. The mode of feeding data into the system could be a common one (e.g. a

computer keyboard) or a less common one (e.g. a motion sensor). The mode of presentation also depends of the type of artwork. Some artwork requires a large image projection on a screen while others make use of any screen available. Although less common, there are some works that do not require the use of any screens. Such works which feature non-visual content and trigger senses such as touch or audition. In computer gaming, the content is often compatible with a variety of screen sizes unless it was designed for a platform which does not accept a variety of sizes.

The end product of the combination of the components mentioned earlier may or may not always be predictable by the artist and therefore, it would be necessary to evaluate the user experience trough testing prototypes and observing the audience through several techniques. Although HCI techniques can be used in art production, we should not force HCI principles on art (Höök, Sengers, & Andersson, 2003). The evaluation techniques of interactive art share common features with the ones used in testing interaction design of computer systems. One of those techniques may include measurement of time spent interacting. This could be used to test the level of engagement but not the quality. Other techniques include observing the participants' body movements, face expression, mimics and gestures in detail and analyzing their level of engagement through the data. Other ways may include through conducting interviews (Bilda, 2006).

The table below summarizes significant artworks that exemplify different categories of interactive artworks created between 1998 and 2011. The table also shows the technology that was used to create the artworks.

Table 1: A comparison between some Interactive Art dy different artists

#	Title	Year	Artist	Art content	Interaction category	Technology	Source
1	Falling Girl	2008	Scott Snibbe	Graphics- human figure shadows	Active	Motion detection	(Snibbe)
2	Blow up	2005	Scott Snibbe	Amplified Wind	Active	Wind amplification	(Snibbe)
3	Boundary Functions	1998	Scott Snibbe	Graphics	Active	Motion detection	(Snibbe)
4	Transit	2009	Scott Snibbe	Graphics	Passive	Motion detection	(Snibbe)
5	La Machine à Turlute	2011	Daily Tous les Jours	Music segments	Active	Moving wheels	(Dikini)
6	Oribotics	2010	Matthew Gardiner	Origami robots and colored light	Active	Motion sensing	(Gardiner)

1.9 Conclusion of literature review

Interactive artwork components can be divided mainly into technology, content and audience. Those components could be brought together by the artist to create a positive impact on its viewers or to pass a message through the artwork. The interactivity of the artwork causes the audience to effectively participate in producing the output presented in front of them by the installation. Depending on the nature of the artwork, the technology varies. Table 1 compares the differences between a few examples of interactive art between the year 1998 and 2011.

1.10 Outline of Dissertation

In this paper, I will describe my approach of identifying the problem, designing a solution, implementing and testing it. The next chapters will be in the following order:

2. Design
3. Implementation
4. Testing and Results
5. Conclusion and Recommendations
6. Appendix

Chapter 2 Design

For this project, an interactive artwork which addressed some design issues in the staircase which causes feelings such as dullness to people who use it will be implemented. The design of the staircase prevents the entrance of enough natural light and the intersection between the two folds of the staircase has a low ceiling which causes a sense of confinement in the space. The solution implemented is aimed at creating a positive user experience when people interact with it. The installation is designed to display graphics and play sounds while participants manipulate this content using the movement of their bodies.

The main functionality of the system is to display a projection on a screen and allow user input to manipulate it using the movement of their hands as they pass in front of the sensor. The system consists of several components which will be outlined and discussed separately in this chapter. The diagram below shows a plan describing connections between the components.

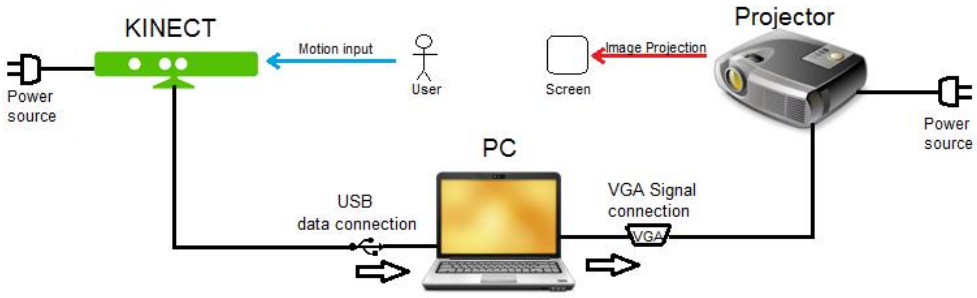

Figure 9 A plan for the connected hardware and data flow

2.1 The Users (Audience)

Given that the location of the artwork is a university campus, the audience of the artwork consist of any person who uses the staircase include mainly; students, faculty, visitors to campus, staff, and other workers.

2.2 The Location

The staircase where the artwork will be setup is located to the right of the Founders' Court which is surrounded by the main buildings of the university. The staircase is a direct link between the part of the ground floor which holds two lecture halls and first floor which holds two computer laboratories. It is a two-fold passage which passes underneath an office room and lacks any windows or light inlets apart from its two ends. The middle part of the stairs is where the main the interaction occurs.

2.3 Requirements/data Gathering

To be able to understand the work space and the users of the system, a series of surveys, experiments and observations were conducted. The exercises were carried out mostly in the staircase and around it to capture data from users of the facility. Two experiments were aimed at testing the equipment while one was conducted to test user experience when exposed to specific audio content.

2.3.1 Survey

In order to understand the experience of the people using the passage, I conducted a short survey in the staircase between class periods when students and faculty normally move from one location to the other. The survey had two sections each requiring a description of the feeling of passing through the staircase. The participants had to select from a list of positive and negative words to describe the passage by selecting three positive and three negative (see Figure 22 in the Appendix). The first section asked for their current feeling of the staircase when they pass through the staircase and the other section asked for their opinion for how they would like the place to change. The results were taken and the words selected the most on either section were used a guide.

The results from the survey showed that the most selected word to describe the current state of the staircase was that it was '*dull, creepy and boring'* and the desired change was to make it '*beautiful, fun and inviting'*. Those words in the first section are negative while the suggested change is described using positive words. Thirteen female students, fourteen make students, one male faculty member and two members of staff participated in the survey.

2.3.2 Observation

About ten minutes were spent every day over a period of one week observing people as they used the staircase to determine some elements which characterize their behavior. Some of those elements included the whether people are walking alone or with others and how fast do people pass through the stair case. Some significant observations were that the number of people walking alone exceeded the number of people walking in pairs or in threes. Also, those who choose to pass through this particular staircase spend a short time in the middle part. The reason may be attributed to the dull nature of the place as the results of the survey suggested. (See Figure 21 in the Appendix)

In terms of the architecture and design of the staircase, it was observed that, unlike other stairs on campus, it had little natural light and part of it had a ceiling that is significantly lower than that of any other space in the surrounding buildings. This makes it look even more confined when the artificial lights were turned off; which is the case most of the time.

2.3.3 Experiments

Three experiments were conducted at the start of the project to collect data. The first two involved testing equipment to determine where to place the artwork while a third one was to test samples of music for its impact on the feelings of people.

2.3.3.1 Testing image projection

The projector that was to be used in the completed product was placed in different locations and at several angles in the staircase to determine the best location to produce a large and bright image. Possible sources of electricity and places to hang the projector were taken into consideration. (See Figure 10 below)

2.3.3.2 Testing sensor range

Like the projector, the motion sensor was also tested for the range in which it can possibly capture the users' motion. The motion of a user can only be captured when they are within the range of the sensor.

Given that the space is limited in the staircase, conducting these two experiments was difficult because the projector had to be as far as possible from its image to produce a large image and the sensor also had to be far enough to function properly. (See Figure 10 below)

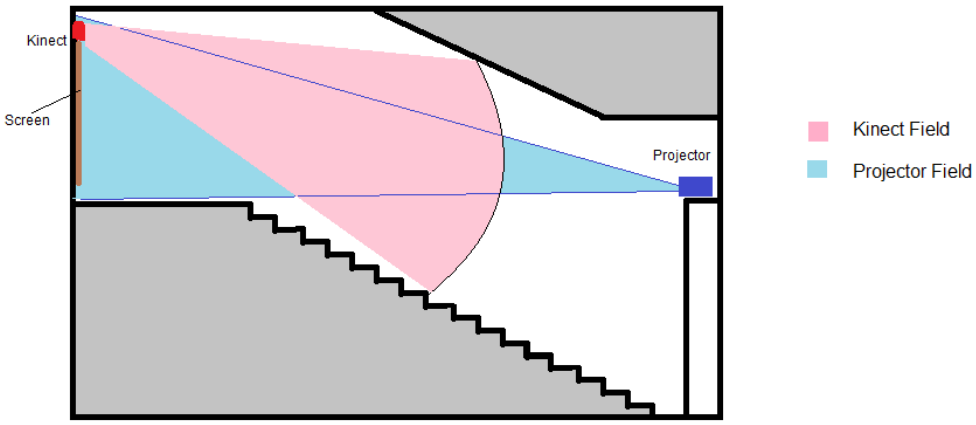

Figure 10 The position of the projector (right) and the motion sensor (left) in the stairs and their fields of coverage

2.3.3.3 Testing music samples

In this experiment, a pre-selected set of small sections of music tracks of instrumentals were placed in a playlist for evaluation by the subjects. The music was not labeled in any way and had equal length of about 20 seconds. The subjects had to listen carefully to every track and determine if it felt boring, calming, exciting or noisy. Since the music tracks contained no words, the goal was to determine the type of musical instruments which were calming and those which were exciting, the results were intended to be used to produce part of the content of the artwork. Figure 11, below, shows a summary of responds in for this experiment. A tabular form can be seen in the appendix.

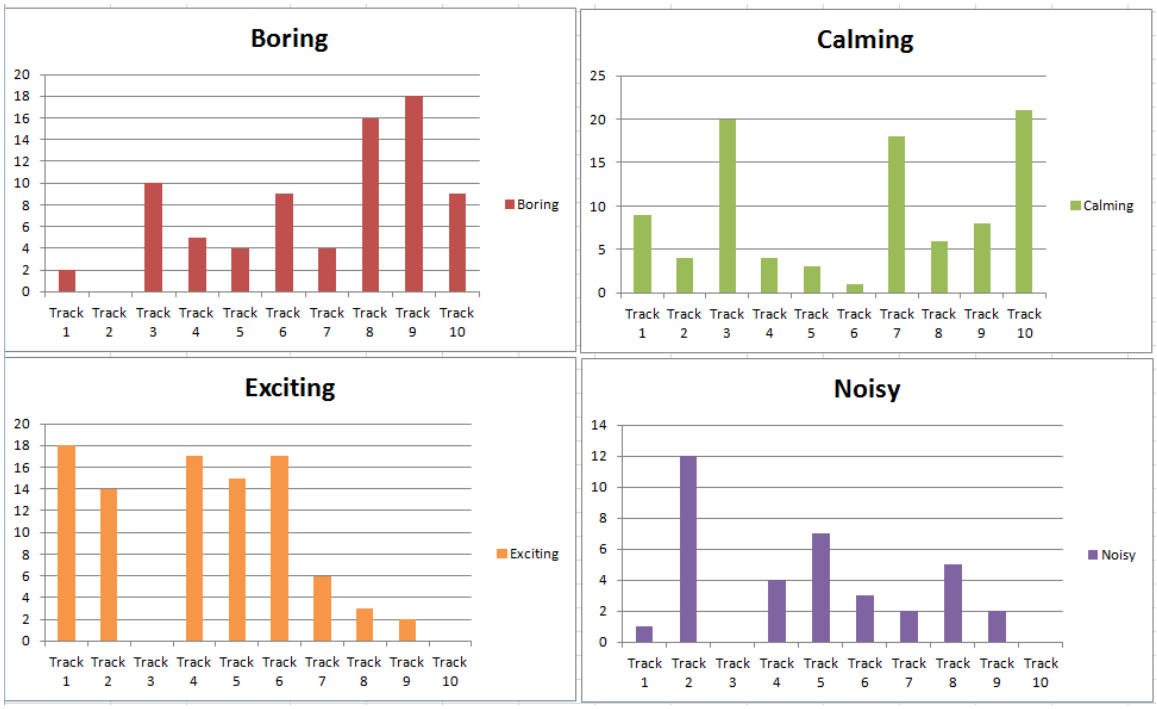

Figure 11 Results tables for different reactions to sound tracks. Each graph shows the number of people against item being evaluated.

2.4 Design requirements

The final artwork should fulfill the following requirements

- **Positive feeling**

  The users should experience a positive feeling during and/or after their interaction with the system. The positive experience should be confirmed in the testing stage.

- **Content**

  The artwork should contain both graphic and sound components which together form the content aspect of the setup.

- **Interactivity**

  Any user who enters the interaction zone of the artwork should be able to participate passively or actively. Even though passive interaction cannot be avoided by people who do not want to participate, they can still opt-out by choosing to ignore the content.

- **Ambiguity**

  The ambiguity of the technology behind the artwork should be hidden as much as possible from the users. Any visible details should serve a purpose and should not distract the user from the main point of interaction. This means that only the components necessary for interaction should be visible while unnecessary cable and hardware should be hidden.

- **Motion sensing**

  The system should make use of motion sensor capable of detecting particular parts of the user's body; e.g. right hand, or head

2.5 Design Components

The design of the system is divided into three main components which are combined to fulfill the design requirements of the system; the art content, the system design, and the interaction design.

2.5.1 The art content

The content of the artwork is mainly made of the graphics and sound. The combination of those two components creates the bulk of the visible end-user interface. The displayed projection on the screen consists of a two-dimensional image made of multiple circle outlines arranged in a grid (see Figure 12 below). The fill color of the circles changes when the users move their arms. Sound consists of very short segments of music which are played on interaction. The sound segments played is closely linked to the circles displayed and are manipulated simultaneously. In other words, when the user performs an action which will trigger the color of a circle, the sound associated with that circle is played. This would cause a different combination of sounds to be played every time an interaction is made. The sound segments are an extract of a music track selected through an experiment which was conducted to determine which type of music had the most positive effect on the users.

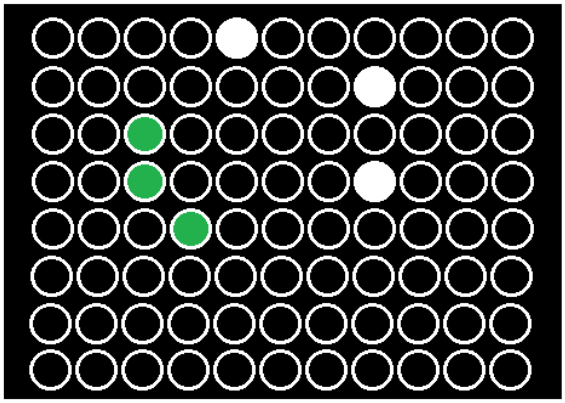

Figure 12 An example of the graphics being displayed on the screen while the player is interacting with it

2.5.2 Technology

The key technology component in the system is a computer program which takes input from a motion sensor and outputs graphics and sound though an image projector and speakers as output devices. The program runs from a laptop computer of regular specifications. The motion sensor is a multiple sensor system that consists of several devices including cameras and sensors infrared. The system uses the data captured by the individual sensors to construct a depth map of the scene in front of it. The raw data retrieved from the system is processed in the computer which makes it possible to interpret the presence of one or more human bodies. The program uses this data to detect the position of particular points on a human body to output a manipulated combination of sound and graphics.

Figure 13 Kinect; a motion sensor created by Microsoft for XBOX 360 Gaming System

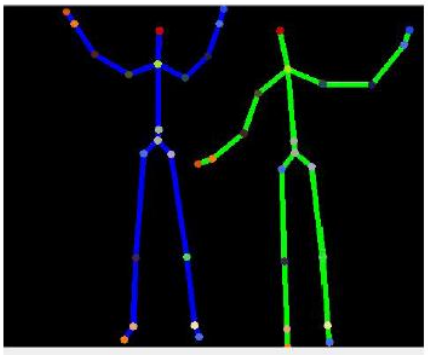

Figure 14 The representation of the human skeleton as a series of points and edges as recognized by Kinect (Figure 13) (Anderson)

2.5.3 Interaction Design

Interaction with the system forms the basis of generating the content of the artwork. Interaction between computers and humans is a two-way process. The user performs actions which are read by an input device as data and sent to the computer that interprets it and sends back signals to the user through an output device in a form he/she understands. The input provided by the user and the feedback gotten from the computer thus creates a dialogue between the two (Pérez-Quiñones & Sibert, 1996).

In this system, the user's form of input to the computer is the motion sensor that is connected to the computer. The sensor senses the position of the right and left hands and sends the map to the computer which in turn feeds it into the program. The program interprets the position of the hands and uses it in its 'game logic' which uses the positions to control a two-

dimensional image and sound which form the output that gets sent to the imaging and sound devices.

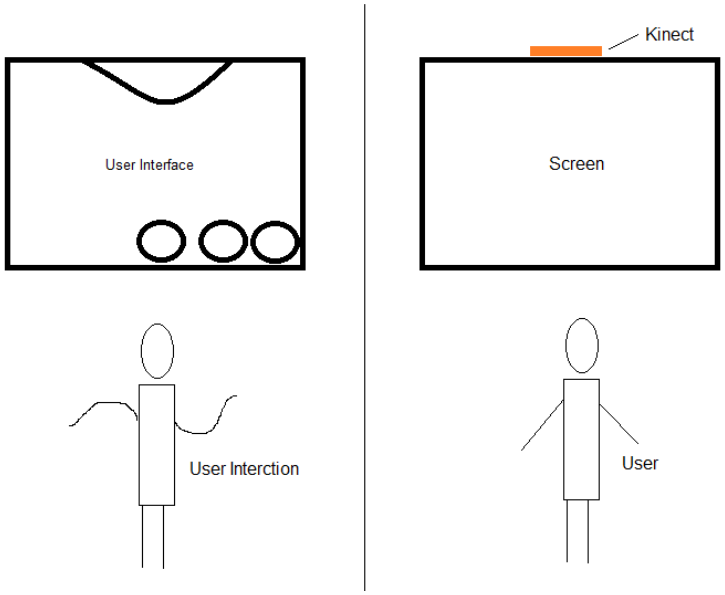

Figure 15 An illustration of a user interacting with the installation.

The user can participate in the artwork while they are in the *interaction zone* (i.e. about 0.8 meters in front of the motion sensor and within 4 meters away from it). The artwork will be displayed immediately it detects any person moving within that zone and continues until no people are around.

2.5.4 The Game Logic

As the user comes close enough to the motion sensor, he/she can now be detected by the sensor and hence enters the interaction zone. The program displays the circles on the screen and detects the skeleton points the user. The position of the right and left hands can be detected and mapped to the individual circles on the screen. When a hand 'touches' a circle, it changes its

color and a unique sound is played. The users continue to move their hands as they wish to manipulate the content output to their pleasure until they leave the interaction zone.

Chapter 3 Implementation

3.1 Technology and tools

I made use of software and special hardware tools to implement the solution to meet the design requirements. The software tools and platforms include both Microsoft products and open source solutions.

3.1.1 Software

The program behind the artwork was created to run on a Microsoft operating system installed on a small laptop computer and can run on a my computer with a Windows operating system. Microsoft Visual C++ was used with Visual Studio as a development environment. The reason for the use of Microsoft products is that the motion sensor, Kinect, is also a product is Microsoft and has released Software Development Kit (SDK) for program creation. Even though there are several open-source SDKs released online for development with Kinect, the reason to choose the Microsoft SDK over open-source is to avoid cross-platform complications. The only open-source software tool used was FL Studio which is an audio workstation used mainly to edit and produce sound files. In this project FL Studio was used to produce short sound clips which formed part of the content in the artwork. The clips were added manually to the program files during the development process to be called upon request.

3.1.2 Sample programs

The Windows Developer Toolkit released by Microsoft for Kinect provides complete code examples and documentation for a few programs and games. The content is posted publicly on the official Microsoft development website, Microsoft Developer Network (MSDN) in an attempt to help developers learn and understand the SDK. This project makes use of the developer kit and components of its sample programs. MSDN was also used as a guide to understand Visual C++.

3.1.3 Hardware

The main hardware used in association with the final program are: a personal computer (PC), an image projector, and a motion sensor (Kinect). The projector and the motion sensor are connected to the computer though USB and VGA data connections respectively. Both devices also require separate electricity (AC) connections while the computer used an in-built battery.

3.1.3.1 Kinect

The motion sensor, Kinect, is a device created by Microsoft and was designed to be used as game controller for its gaming system, XBOX 360. Microsoft later released its SDK to permit game developers to use it to experiment and to create games. The most-used feature in the development library is the ability of the sensor to sense the presence of people in front of it. This allows players to control the games using their body movement. From the developer's point of view, the human body is represented by a skeleton made

of points representing the twenty joints on the human body and nineteen edges linking the joints together to form a full image (see Figure 14). Every single joint can be used in the game logic to control the game. In this project, the position of the right and left hands were used separately to interact with the game. The system is capable of detecting multiple players at the same time. While the sensor is capable detect up to six players at the same time, a programmer can program for any number of players within the range.

3.1.4 Non-electronic components

In addition to the software and hardware tools, the only additional equipment required to complete the setup are: a projector screen and a stand to carry the motion sensor. Since the workspace contains to electricity outlets, an electricity extension will also be needed.

Both the screen and the stand are made of reused materials which would have otherwise been considered waste. The screen was made from a large cardboard box which was cut to desired size (200 X 200cm) and covered with the waste office paper. The paper, which was obtained from the library, was turned over to the blank side and glued to cardboard to form a large white surface (see Figure 16). The stand was made using an old lamp stand, a PVC pipe and plastic beverage bottles (Figure 17). The components were fitted together to form a structure about two meters high which stood in-line with the screen to hold the sensor. The idea of re-using waste materials came

from the numerous programs at Ashesi University which encourage the recycling and being environmentally conscious.

Figure 16 The Kinect sensor on its stand (front) and the cardboard screen (back)

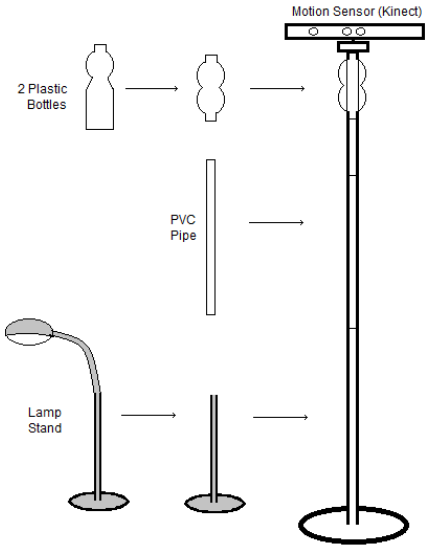

Figure 17 An illustration on the creation of the Kinect stand

Because of the limited room in the exhibition space, both electronic and non-electronic equipment, needed to be placed in their optimal positions without interfering with the original function of the staircase. In other words, the equipment had to occupy the least space possible in order to allow people to continue to use the stairs normally. The diagram below illustrates the placement of the equipments from two different angles.

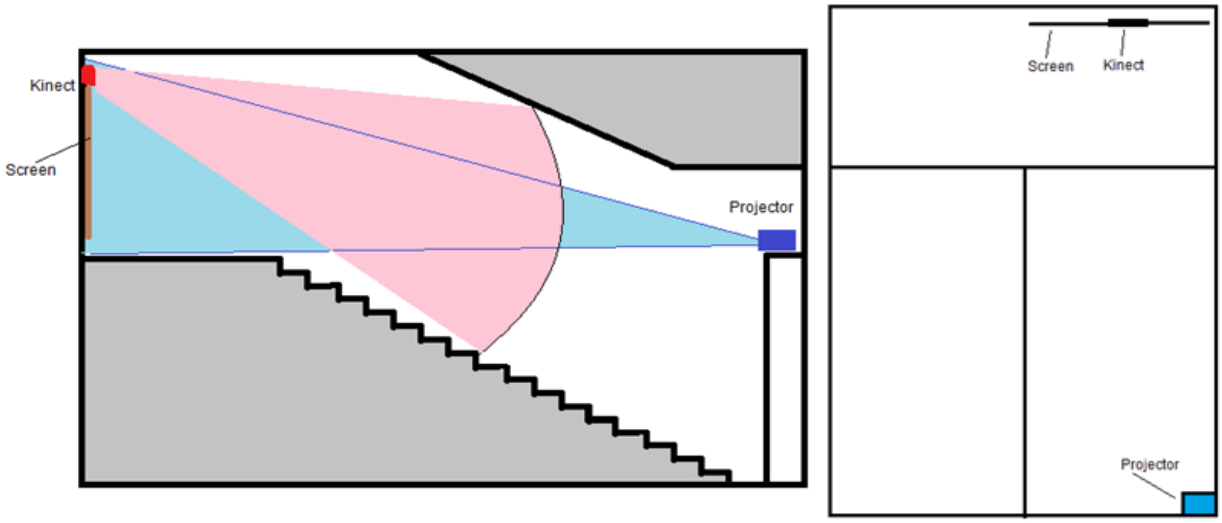

Figure 18 An illustration of the placement of the equipments from two different angles; side(left) and top (right)

3.2 Prototypes

The implementation process was divided into segments according to the type of output produced by the system. During the development process, one main prototype was produced. The first part the implementation was to display graphics and manipulating it. The second part involved adding audio to the output and adding it to the interaction process. Although the main prototypes were produced were produced at each stage, smaller components had to be tested separately. A final prototype which tests the setup in the staircase was also created and tested.

The first main prototype is one which displays the graphic aspect on the screen and allows users to change the colors of the circles using the motion of their hands. The next main prototype is one which, in addition to the graphics, has sound included. The users are allowed to change the colors of

the circles on the screen as well as play music tracks associated with the circles. However, in the final implementation, only the graphics were working without the sound. The process of testing the prototypes and its results will be mentioned in the next chapter.

Chapter 4 Test and results

4.1 Testing prototypes

Testing the first prototype and the second prototype were done in the laboratory and only the final (third) prototype was tested in the staircase. The first prototype includes only graphics showing on a computer screen while the latter two were intended to have both sound and graphics on display but the sound did not work. A total of two out of three experiments were conducted.

Ten participants took part in the first two experiments while twenty took part in the final one. Two tests were conducted, one for time spent by the participants interacting and the other test was for the qualitative benefit attained by the participants. The latter test involved asking the participants to classify their experience in front of the artwork as either being dull, creepy, boring, impersonal, interesting, beautiful, fun or inviting. Testing the time spent was done by estimating how long every participant spent passing through the staircase. Both tests were conducted at the same time for every user before the next interaction.

Figure 19 The image projection in the staircase during a user's interaction

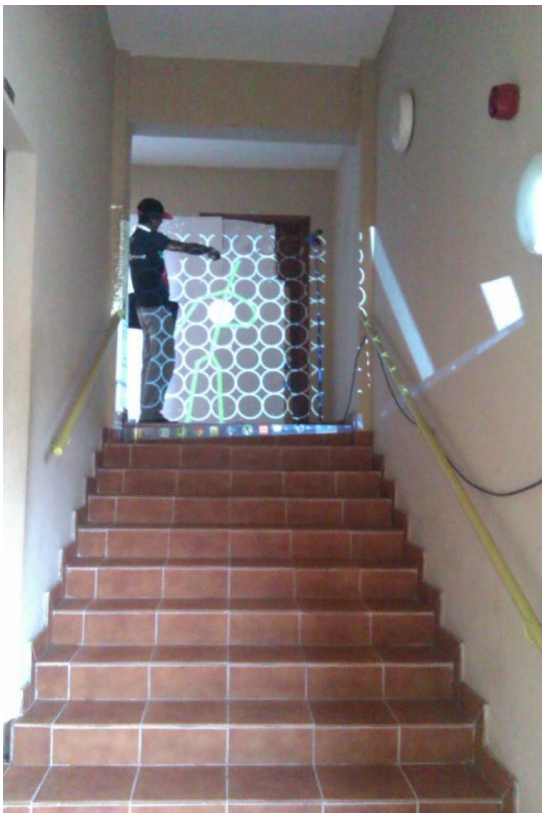

Figure 20 A user interacting with the installation in the staircase

4.2 Experiments and Results

The experiments were intended to be performed to test the effectiveness of the work done in this project. The experiments were intended to test; graphics only (in the lab), graphics and sound (in the lab), and the complete setup (in the staircase). Only two out of the three experiments were performed. This was due to some technical problems with implementing sound. While participants for the lab experiments could be selected to

participate, the final experiment, in the staircase, needed to have users randomly choosing to participate without being instructed.

4.2.1 Experiment-1: Graphics only

A computer screen was placed in front of the motion sensor for the participants who were recruited to view as they move their arms around. The participants were asked to freely perform the actions of their choice with the setup. Both the test for duration and the test for satisfaction were recorded as they were observed. About ten participants took part in this experiment.

4.2.2 Experiment-2: Graphics and Sound (in laboratory)

In addition to a screen, a set of speakers were to be used to amplify the sound as the participants interacted with the setup. Similarly, both the tests were to be performed on the participants' experience. However, the sound was omitted from this experiment because of a technical issue in the program.

4.2.3 Experiment-3: Graphics (in Staircase)

This experiment was aimed at testing the complete impact of the artwork on members of the public in its intended location. The participants were random people who were using the stairs and stopped to interact with the installation. All the equipment was setup in place and connected as planned. Both sound and graphics were intended to be used in this experiment but only graphics was used because of a technical issue with the sound.

As an observer, I waited at the bottom of the stairs for people who interacted with the installation and asked them to choose a word from a list to describe their experience. I also noted their first reaction as I glanced from the bottom. It was important to stay away from the setup to give the participants the liberty to interact freely without any interference from the observer. After they had passed though the staircase, they were asked to describe their experience. Within two hours of observation, reactions of about twenty participants were recorded.

4.3 Results

The results presented here are derived from experiments 1 and 3. Experiment-2 was not performed because of a fault in the program.

In experiment-1, the recruited participants were very excited to move their arms in front of the sensor and see a direct result. Most participants spent between thirty seconds and one minute interacting. In addition to moving

their arms, many participants attempted to move their entire body like they would if they were dancing. Since the location for the experiment was the laboratory, it was normal to see participants spending over thirty seconds, which is more than the normal time spent interacting in the third experiment, for participation.

In experiment-3, the participants who pass though the staircase during the experiment mostly spent more than fifteen seconds interacting before they moved away. When they were interviewed, most of the participants chose the words *'interesting'* or *'inviting'* among others to describe the installation. Some other observations included expressions of excitement and amusement.

Chapter 5 Conclusion and recommendations

5.1 Conclusion

By implementing interactive art as a solution for the problem of uncomfortable spaces, my suggestion was that interactive art, like more traditional forms of art, could be applied in poorly designed places to beautify them and make them appeal to people. The workspace, which was previously a dark, unattractive, confined space, was transformed to become an eye-catching place for people to pass through. Passersby could also interact with the artwork instead of being just another passage as derived from my findings. My results show that participants were excited to interact with interactive art especially when installed in a public place like the staircase.

I think that my experimental results satisfied the requirements outlined in the design. I believe that if the content of the artwork, i.e. sound and graphics, are improved, even more satisfactory results could be arrived at. There is no doubt that if different artistic elements were applied to the content, different results could be reached. By using the procedure of prototyping and continuous testing, the goals from the artwork will definitely be obtained.

After implementing this project, I noticed how involving it could be to execute an art project especially when deciding which type of content should

be used. The design process of an art project should involve more than procedural steps to attain a final result. It needs more imagination and contemplation over numerous ideas before finally deciding on a concept. Even with a chosen concept, if the technology does not support specific components, the concept has to be readjusted.

5.2 Recommendations

To improve upon this project in future work, some changes could be made to the content and technology. Changes could also be made to the mode of interaction.

Although the content in this project was sufficient to fulfill part of the requirements set, it would be interesting to work on more artistic content in future work. Using the same software tools, successive projects could implement artwork which has similar style to traditional paintings for example. Similarly, sounds could be added to enhance the functionality. Changing the content could also mean changing the entire experience since the content is what the users interact with.

An interesting future project could include more advanced art techniques and technology. The game logic could be changed to one which could recognize specific gestures made using the hands or the entire body. Since the developers' kit designed by Microsoft was made for advanced video

games, it would be interesting to explore the possibility of using three-dimensional graphics in a similar setup. However, this should not add any complexity to the interactivity in the design in order to ensure the ease of usage. Different development platforms could also be explored to make the implementation process easier. An example is the Microsoft XNA Game Studio which helps users with tools to develop games among other functions.

As well-designed as the university campus is, I think it would be beneficial for there to be more students taking up projects related to the fields of architecture and art. I think that the university should encourage more design projects related to its landscape and architecture. Projects like this one trigger the imagination of its creators as well as the audience who also participate in the final product.

I suggest that the university introduces a course which explores the relationship between art and technology closely and suggests ways to create more beautiful technology. Interaction Design and Interactive Art are two areas which involve a blend between technology and art. In interaction Design, as new forms of interaction are being developed using new technology, it creates a corresponding artistic reaction by developing new games and using it to create artwork. Similarly in Interactive Art, the artists use their imagination and the latest technology to implement their art and games which may also lead to new ideas in the field of technology.

Another way to trigger the imagination of the community is to have at least one Interactive Art project developed every year by a graduating student to be displayed on campus. This way, students will be involved and the campus will be beautified. There could also be collaborations between several students to create a better artwork.

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Appendix

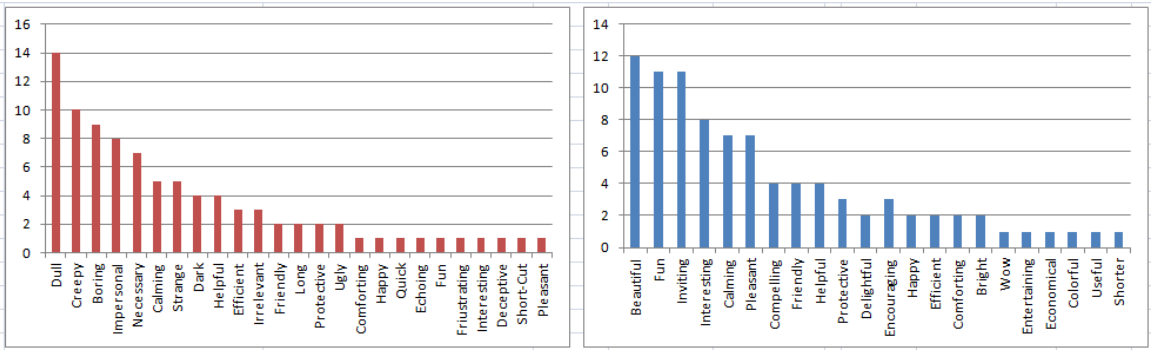

Figure 21 Results of a survey to find the feelings of the users of the staircase describing the current (left) and desired (right) states of the location

number	Date	Time	Gender	Category	Year Group	Current Description of Stairs	Desired Description of Stairs
1	26th Nov	2:00:00	Male	Staff	--	Dark, Quick, Deceptive	Useful, Shorter, Economical
2	26th Nov		Male	Staff	--	Boring, Creepy, Protective	Calming, Fun, Inviting
3	26th Nov		Male	Faculty	--	Dull, Echoing, Dark	Interesting, Inviting, Bright
4	30th Nov	5:00:00	Female	Student	2016	Creepy, Efficient, Impersonal	Delightful, Fun, Inviting
5	30th Nov	5:00:00	Female	Student	2015	Creepy, Fun, Strange	Beautiful, Fun, Protective
6	30th Nov	5:00:00	Female	Student	2016	Boring, Dull, Ugly	Beautiful, Fun, Protective
7	30th Nov	4:30:00	Female	Student	2013	Boring, Dull, Irrelevant	Beautiful, Compelling, Interesting
8	30th Nov	4:24:00	Female	Student	2013	Impersonal, Irrelevant, Necessary	Beautiful, Friendly, Inviting
9	30th Nov	4:25:00	Female	Student	2016	Comforting, Helpful, Necessary	Beautiful, Encouraging, Wow
10	30th Nov	1:30:00	Female	Student	2013	Dull, Helpful, Necessary	Beautiful, Fun, Pleasant
11	30th Nov	1:30:00	Female	Student	2012	Creepy, Impersonal, Strange	Fun, Happy, Bright
12	30th Nov		Female	Student	2015	Creepy, Impersonal, Boring	Fun, Inviting, Pleasant
13	26th Nov		Female	Student	2015	Boring, Dull, Dark	Beautiful, Interesting, Inviting
14	26th Nov		Female	Student	2015	Dull, Impersonal, Irrelevant	Encouraging, Interesting, Pleasant
15	30th Nov	3:00:00	Female	Student	2013	Creepy, Dull, Ugly	Compelling, Interesting, Inviting,
16	30th Nov	3:15:00	Female	Student	2016	Calming, Friendly, Short-Cut	Friendly, Helpful, Pleasant
17	30th Nov	4:58:00	Male	Student	2013	Boring, Dull, Impersonal	Beautiful, Calming, Entertaining
18	30th Nov	4:46:00	Male	Student	2016	Boring, Dull, Efficient	Beautiful, Efficient, Fun
19	30th Nov	4:32:00	Male	Student	2013	Dull, Frustrating, Long	Calming, Helpful, Pleasant
20	26th Nov		Male	Student	2014	Calming, Helpful, Necessary	Calming, Helpful, Interesting
21	26th Nov		Male	Student	2014	Calming, Dull, Necessary	Calming, Fun, Inviting
22	26th Nov		Male	Student	2014	Happy, Necessary, Protective	Delightful, Inviting, Protective
23	26th Nov		Male	Student	2014	Friendly, Helpful, Necessary	Beautiful, Compelling, Engouraging
24	30th Nov	1:45:00	Male	Student	2013	Boring, Creepy, Dull	Friendly, Fun, Interesting
25	26th Nov		Male	Student	2014	Boring, Dull, Impersonal	Beautiful, Fun, Helpful
26	30th Nov	1:30:00	Male	Student	2014	Creepy, Interesting, Strange	Compelling, Pleasant, Colorful
27	30th Nov	1:30:00	Male	Student	2014	Creepy, Impersonal, Strange	Beautiful, Comforting, Happy
28	30th Nov	5:00:00	Male	Student	2013	Calming, Long, Strange	Calming, Comforting, Inviting
29	30th Nov	5:30:00	Male	Student	2015	Creepy, Dull, Dark	Friendly, Interesting, Inviting
30	3rd Dec	9:50:00	Male	Student	2013	Calming, Efficient, Pleasant	Calming, Efficient, Pleasant

Figure 22 Results of survey: This table shows the combination of words used by each respondent to describe the current state of the staircase and how they wanted it to become

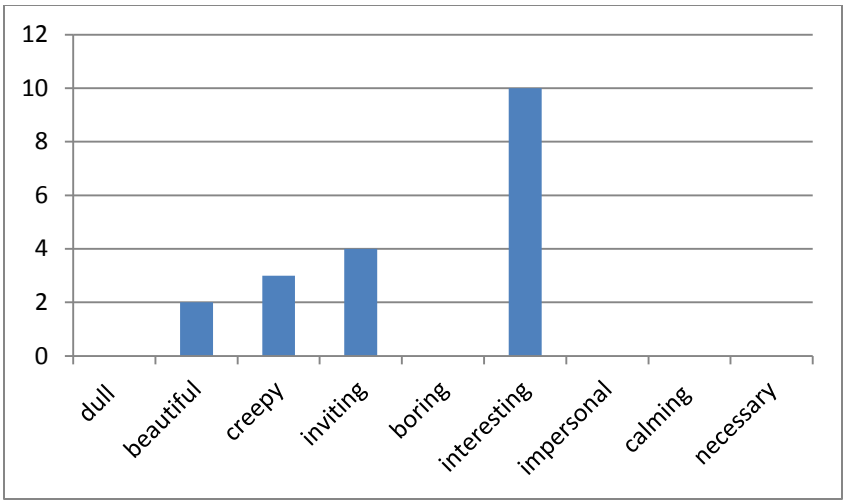

Figure 23 A graph of the responses of 21 people describing the installation after interacting with it in the staircase.