PERCEPTION OF INFORMATION: ENRICHING LOCATION SPECIFIC INFORMATION THROUGH THE USE OF CALM COMPUTING

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PERCEPTION OF INFORMATION: ENRICHING LOCATION SPECIFIC INFORMATION THROUGH THE USE OF CALM COMPUTING

by

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DECLARATION

I, Daryn Molenaar, declare that the contents of this thesis represent my own unaided work, and that the thesis has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

25-03-2012

Signed **Date**

ABSTRACT

Many studies have been conducted on the interaction between environments and relevant information in the field of interaction design. Most of these studies are focused on increasing the awareness of technology, information and the interaction between them. This awareness could negatively lead to an increase in information overload where each bit of information is competing to be the centre of a person's attention.

This information overload gets compounded even more when a person is in a public place because of the amount of available commercial information like billboards, digital displays and printed media which are constantly pushing information into the space. Cognitive studies have shown that human beings have a limit to the amount of information they can consciously focus on and process. When a person reaches information saturation, the quality of their decision-making ability deteriorates drastically (Bray, 2008). Information overload can lead to a situation called decision paralysis.

The research proposed an investigation into the possibility of decreasing information overload through the use of calm computing. Relevant information could be pushed to the periphery where it could be accessed or attended to when it was needed. It was argued that when the intake of peripheral information could become an unconscious activity, mainly through the use of ubiquitous computing, more attention could be given to other important activities like increasing social interaction in public spaces.

KEYWORDS

- Ambient Display
- Calm Technology
- Cape Town
- Civic Centre
- Industrial Design (ID)
- Information Overload
- Interaction Design (IxD)
- MyCiti bus service
- Participation
- Quasi-experiments
- Ubiquitous Computing

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TABLE OF CONTENT

CHAPTER 1

CHAPTER 2

CHAPTER 3

CHAPTER 4

CHAPTER 5

CHAPTER 6

CHAPTER 7

CHAPTER 8

CHAPTER 9

APPENDICES

TABLE OF FIGURES

LIST OF TABLES

CLARIFICATION OF TERMS

Affordance:	An affordance is an action that an individual can potentially perform in their environment
Ambient Display:	Is a new genre of consumer electronics characterized by its ability to be perceived at-a-glance
Calm computing:	Is technology that enables a user to attend to information in his/her periphery when it is needed
Centre of attention:	Is information that is currently focused upon. Information, which is not currently focused upon, is placed in the periphery
HCI:	See Human-computer Interaction
Human-computer interaction:	Human-computer Interaction (HCI) is a discipline concerned with the study, design, construction and implementation of human-centric interactive computer systems
Information:	Is data that has been logically grouped together
Interaction Design:	Interaction Design is "the practice of designing interactive digital products, environments, systems and services." (Cooper, 2007)

Knowledge:	Is appropriate information that has been grouped together with the intent to be useful
Microelectromechanical systems (MEMS):	Is a new form of technology that consists of very small mechanical devices driven by electricity
Non-Pixel based display:	This is the term used to describe displays that do not use one or more digital screens to display information
Perception:	Perception is a process that involves understanding one's environment through the organisation and interpretation of sensory information
Peripheral Information:	Peripheral information is information that is not central to a person's current task
Persona:	A virtual personality generated from studying a number of individuals with common goals Personas help share understanding of real users in terms of their goals, capabilities and contexts without revealing their identities.
RFID:	Radio Frequency Identification is technology that uses radio waves to transfer data, which helps with identifying and object or tracking an object

Sensory overload (SO):	A situation when senses are strained to a point where it has become increasingly difficult to focus on what one is busy with
Ubiquitous computing:	Ubiquitous computing (UbiComp) is a post-desktop model of human-computer interaction (HCI) in which information processing has been thoroughly integrated into everyday objects and activities
Ubicomp:	See Ubiquitous computing

Chapter 1

INTRODUCTION

1.1. BACKGROUND TO THE RESEARCH PROBLEM

In our contemporary society information is everywhere. We get bombarded with this information that is being pushed upon us on a near constant basis. Information can either be relevant or irrelevant. The relevance of information may depend on the situation, an individual and/or a specific location. The drastic increase in the amount of information can be attributed to the introduction of new portable devices, which can access the Internet. With the creation of social media sites on the Internet like Facebook, MXit, Twitter and YouTube, the amount of online information available is confounding.

Statistics from Facebook demonstrate that more digital content is created every second than ever before (Facebook, 2011). With the increase in wireless networks and portable devices that are able to connect to them, access to information can thus be seen as instantaneous whereas in the past, printed media and subsequently television used to be the fastest means of accessing information.

With all this information that is created and then pushed upon us, it has become ever more difficult to filter information. An individual will filter information to create meaningful knowledge to help with decision-making. All of the pushed information then competes to be at the centre of our attention and this creates a condition called *information overload*.

Information overload is compounded even more with irrelevant, unsolicited, redundant and low-value information currently available online and in physical spaces. This type of information creates *information pollution* (Orman, 1984). When a person is in a public space, this information pollution becomes even more of a problem due to the increase of commercial information, which is competing for attention. The increase in useless and undesirable information can have a serious detrimental effect on human activities.

Cognitive studies have shown that human beings have a specific limit to the amount of information they can process. If more information is added then it starts deteriorating the ability to make sensible decisions (Bray, 2008). Information overload can lead to condition called *decision paralysis*, where a person is unable to make a decision, as the relevance of that decision cannot be seen.

If there is a decrease in the amount of information competing to be at the centre of your attention it could lead to an increase in the ability to process information. This can be accomplished by pushing more relevant information to a person's periphery where information can be accessed at will.

Information first needs to be perceived in order for it to be translated and interpreted into knowledge. We perceive information though our sensory organs by responding to certain sensory cues. An example of a sensory cue is the fuel-indicator flashing to alert a driver to the amount of fuel that is left in his vehicle. We then use expectations and past experiences to categorise the information we perceive. These categories are known as perceptual sets.

A perceptual set can be seen as specific expectations that shape an experience by making people more sensitive to a particular kind of information. A perceptual set is a predisposition to the way things are perceived (Weiten, 2008).

Cape Town has been selected as the location for this research. World events like the FIFA World Cup in 2010, World Design Capital 2014 and Table Mountain, which was selected as one of the 7 natural wonders of the world, creates an influx of tourists. Each tourist will have his or her own perceptual set. Calm computing could potentially bridge some info-related issues that arise because of the different perceptual sets.

The purpose of this research was to investigate the possibilities of decreasing information overload through the use of calm computing in the public transportation sector of Cape Town. The MyCiti bus service was selected as the focus area of this research as the service is new and very popular among commuters. The Civic Centre bus terminus was selected as the specific location as this is the most used station as it connects Cape Town's feeder routes and the trunk route from Tableview. Relevant information was pushed to people's periphery where it could be accessed or attended to when it was needed. If the information intake could ultimately become an unconscious activity through the use of calm computing then more attention could be given to social interaction in public spaces.

1.2 STATEMENT OF RESEARCH PROBLEM

The lack of real-time scheduling in the public transport sector creates stress for commuters and conductors. The current display technologies used push information instead of providing peripheral information that could help to decrease information and sensory overload in the location. This problem will be investigated.

1.3 RESEARCH QUESTION

How can calm computing be used to enhance important information in the public transportation sector of Cape Town?

Research sub-questions

- What is the current state of information overload at the MyCiti's Civic Centre bus terminus in Cape Town?

- What information is currently important to the people occupying the selected space?

- How can display technology be used for peripheral information?

- How can calm computing in display technology be used to increase the important information without adding to the information overload?

Research Problem	The lack of real-time scheduling in the public transport sector creates stress for commuters and conductors. The current display technologies used push information instead of providing peripheral information that could help to decrease information and sensory overload in the location.	
Research Question	How can calm computing be used to enhance important information in the public transportation sector of Cape Town?	
Research sub-questions	**Research method(s)**	**Objectives**
What is the current state of information overload at the MyCiti's Civic Centre bus terminus in Cape Town?	Participant observer Unscheduled semi-structured interviews Video analysis	Determine the level of information overload in a specific location.
What information is currently important to the people occupying the selected space?	Unscheduled semi-structured interview	Identify the most important information to an occupant in the location.
How can display technology be used for peripheral information?	Literature analysis Quasi-experiment	Developing prototypes to determine how peripheral information can be displayed on display technology.
How can calm computing in display technology be used to increase the important information without adding to the information overload?	Participant observer Participatory action research Unscheduled semi-structured interview Quasi-experiment Video analysis	Developing prototypes to determine if the information is enhanced and if it is decreasing information overload.

Table 1.1: Research Questions

1.4 CURRENT STATUS OF THE RESEARCH AREA

This section contains an overview of the current projects and theories behind public displays, public spaces, pushing of information, calm computing and sensory systems. This will provide a better understanding of the theories and methodologies, which will be adopted in this thesis.

1.4.1 DISPLAY-TECHNOLOGY IN THE PUBLIC DOMAIN

The vision of a post-desktop era where the capability of processing information is integrated into every day objects is fast becoming a reality. This means that information is always available, anywhere and at any time. This is called ubiquitous computing or UbiComp (Weiser, 1998). As new technology becomes more advanced, the price of current technology decreases (Eriksson, 2007). This can be seen in the drop in price of large digital displays.

The low cost of these displays has caused an increase in the amount of the displays being used in public spaces (Eriksson, 2007). Interactions between the user and these large digital displays are changing constantly with the development of new technology such as proximity sensors, range cameras and multi-touch gesture technology. Privacy is one of the biggest problems facing the interactivity on such large digital displays in a public area (Vogel and Balakrishnan, 2004).

An example of a large digital display is the project called *"hello.wall"* (Streitz et al, 2003). This interaction design prototype uses a hand-held device, which can calculate its proximity to the display and then allows appropriate information to be displayed on the screen. The information depends on the distance a user is away from the display, the closer you are to the display the more personal information would be displayed.

The *"hello.wall"* can be seen as an example of inobtrusive display technology because general information would be displayed on the screen. An inobtrusive display can be seen as a form of calm computing where the way information is displayed reduces the overall excitement of the information (Weiser, 1999). This information could be glanced at to understand it. As soon as one moves closer to the display, the level of interaction increases. The display exploits our ability to perceive peripheral information without competing to be the centre of a person's attention until a person starts interacting with it (Streitz et al, 2003).

BlueBoard is a large interactive display designed and built by IBM Research. It uses Radio Frequency Identification (RFID) tags to identify users to allow private and public information to be displayed differently (Russel, 2002). This helped to address privacy issues, which was determined to be a major problem when using a large interactive display in a public space according to the BlueBoard research project. This prototype increased the users ability to collaborate and interact more while using the prototype. Ambient displays have the ability to provide information in such a way that a user can ignore it when necessary.

Mankoff created ten heuristics to help evaluate the effectiveness of an ambient display with special focus on displays that are non-pixel based (Mankoff et al, 2003). Pixel based displays traditionally focuses on being at the centre of a person's attention and can be seen as displaying digital information digitally. Non-Pixel based displays can be seen as a physical link between a digital world and a physical world. This creates an enriched experience when interacting with the display. Information Percolator (Heiner et al, 1999) and Ambient Room (Ishii et al, 1998) can be seen as good examples of non-pixel based ambient displays.

The Information Percolator uses compressed air to represent physical pixels. Text and basic images can be created by the manipulation of air that is pumped into cylinders filled with a liquid (Heiner et al, 1999). These non-pixel displays can be seen as the link between a digital world and a physical world. The manipulation of physical objects through the use of a digital medium is changing the way information is perceived.

1.4.2 RECLAIMING PUBLIC SPACES

Public spaces are changing drastically from what they used to be. This change can be accredited to the increase of portable devices, which can connect to the Internet. Most of these devices have been designed for a single-user. These single-user devices can create an individual private space or private bubble in the public domain. People listening to MP3 players and reading emails on their mobile devices are not interacting with the physical world like the public space, but rather interacting with the digital world (Eriksson et al, 2007). This private space or private bubble that is created in a public domain is one of the reasons why information is being heavily pushed through digital displays in public areas. This has increased dramatically due to the overwhelming adoption of new technology in our daily lives. The technology that is currently available in the public areas has either been designed to push information to a person or to help a person create a private bubble. This can be seen as the complete opposite to why public spaces were developed in the first place.

Public spaces can be seen as areas that are open to anybody and are usually free of charge. A public place is determined by the use qualities and context, which was created by people who utilise that space (Harrison & Dourish, 1996). These spaces can be designed to increase social interaction between different classes in society or be designed to segregate people to minimise the risk of a confrontation with strangers.

There seems to be an increase in the centralisation of public spaces to increase the amount of control over what happens in such a space. This has lead to an increase in the number of projects that have focussed on reclaiming public spaces to increase social and democratic interaction. The project *Urban Screens* is a good example of designing to reclaiming public space. *Urban Screens* was an exhibition that exhibited contemporary visual art on digital screens in public areas (Struppek, 2006).

Another project with the topic of reclaiming a public space was the *Blinkenlights* installation called *Stereoscope* in 2008. This installation manipulated lights in a building to create a visual art exhibition. The public were invited to participate in the exhibition by downloading an iPhone application to help create low-resolution videos that would then be uploaded to the installation and projected on the building (Blinkenlights, 2011).

Reclaiming public areas is becoming increasingly important in contemporary society. This is because the need for physical interaction and digital interaction is increasing on a daily basis. This is why installations like Stereoscope and Urban Screens are so important as they marry the physical world and the digital world.

1.4.3 PUSHING OF INFORMATION

With the increase in large malls and large public spaces, commercial interest in controlling the information available in these places is increasing constantly. Each of these interests is competing for the maximum amount of exposure and ultimately to become the centre of a person's attention. We can look at Time Square in New York City as a place, which constantly pushes information from large companies (Eriksson et al, 2007).

Figure 1.1: Public Information overload

(Source: Scott Beale / Laughing Squid, Time Square at Night, 2007)

In summary, some of the issues in current research that are relevant for this research are the study of privacy issues, degree of pervasiveness, location, delivery of information and general issues surrounding interaction with calm computing and ambient displays.

1.5 RESEARCH DESIGN

The two main research approaches adopted in this thesis consist of a qualitative study and research through design, as an in-depth look is needed to understand the interaction between important information and users in a selected public space. This is important to determine why and how people make decisions on what information will be focussed on at that moment and what information can be placed in a person's periphery.

A thematic analysis approach was used to reduce the gathered information to concepts, categories or themes that would then be interpreted. Information was organised chronologically and categorically and was reviewed constantly and recoded. Appropriate software namely *Atlas.ti* and *Statistical Package for Social Sciences* (SPSS) was used to aid in the process of data analysis.

Interviews were used to establish the amount of information that is currently available in the selected public space. Interviews were recorded, transcribed and coded using common goals and concepts (Durrheim, 1999.) Participant observer research strategy was used where the author was first an "outsider observer" to gain knowledge and understanding into the workings of the MyCiti bus terminus. This was achieved by video analysis and field notes focusing on the commuters and the conductors (DeWalt, 1998). Participation in the daily routine of commuting on the bus created an opportunity to conduct interviews with the passengers and conductors, observation on how commuters and conductors acted at the bus terminus and self-analysis were used. Afterwards collective discussions where held with a focus group on the findings from the participant observer research (ibid).

Participatory action research was used to help develop the prototype through planning, taking action and evaluating what was done (O'Brien, 2001). A focus group was created to help develop and test design iterations and quasi-experiments (Dick, 2002). To decrease the amount of bias, the gathered information was triangulated through using participant observer, participatory action research and the video analysis. The triangulation will help verify the information gathered and help identify any bias from the research as different methods were used to gather the information.

The main criteria for selecting the participants for interviews and quasi-experiments were the level of engagement, interaction and the frequency of occupation in the location. The sample size for the interviews and quasi-experiments was 59 people. This increased the reliability of the information as well as provided a large cross section of relevant information pertaining to different individuals.

A large cross section of information and the video analysis helped with the validation of all the gathered information. This improved the credibility and reliability of the information that was gathered through fieldwork.

Timeline of research activities		
Methodology	Detail	Outcome
Observer	General discussion with stakeholders and video analysis of stakeholder's (commuters and conductors) behaviour.	List of issues and concerns around the MyCiti bus service and video data, which was used as a control test.
Participant Observer	34 Stakeholders were interviewed on three consecutive weekdays, which consisted of 2 sessions each per day. Interviews were semi-structured and unscheduled as this could help tailor each interview to the specific stakeholder although focused concepts remained consistent.	Information overload and the lack of bus timetables and scheduling were the main issues according to the majority of the interviews stakeholders.
Quasi-experiments	Focus group was created to aid the development and evaluation of different design iterations.	A comprehensive prototype was created that satisfied the focus group and addressed the main issues according to the stakeholders.
Participatory Action Design	The prototype was placed in-situ for testing and evaluation through video analysis and unscheduled semi-structured interviews. The prototype was tested from the 14th to 20th November 2011. A total for 59 stakeholders were interviewed.	Data was gathered to aid in the design and development of a larger more integrated system, which was based on the finding of the methodology.

Table 1.2: Timeline of Research Activities

1.6 ETHICAL ISSUES REGARDING THIS RESEARCH

Any research that is undertaken must be ethical especially when dealing with public spaces and information overload. The participants were not compelled into participating in the research and any participant could withdraw from the research at anytime if they felt so.

The information that was collected through the interviews and quasi-experiments is confidential and names have been altered to protect the informant's reputation. No participant was seduced into participating in this research. The researcher tried to be as ethical as possible in all the dealings with the research from the collection of data to the interpretation of it. The research was communicated without any bias from the research assistants and the author.

1.7 DELINEATION OF THE STUDY

This study explores the possibilities of using calm computing as a form of communication in the public transportation sector of Cape Town. The MyCiti bus service was the primary focus area as the service is new and extremely popular among a large diverse group of commuters. The use of unscheduled semi-structured interviews borrowed from the Participant Observer methodology creates a basis for local knowledge.

The Civic Centre bus terminus was focused on as it is currently the busiest station in the MyCiti service. The station connects the Tableview Trunk route (T1) with the feeder routes in Cape Town. This station was selected as the specific location for conducting Quasi Experiments as part of the Research Through Design methodology and Participatory Action Research methodology to test ideas and concepts (Frayling, 1993).

A focus group was created based on their unique skill sets, willingness to participate and diversity. The focus group tested quasi experiments in a controlled lab environment where planning, taking action, observing, evaluation, reflection and redesigning quasi experiments according to the findings, could happen constantly (O'Brian 2001: McNiff 2002).

The final concept, which was developed and tested by the focus group, was then placed at the Civic Centre bus terminus to conduct in-situ testing. Unscheduled semi-structured interviews, video analysis and observations were used to help evaluate the effectiveness of the concept in-situ.

The research seeks to improve the way information is presented in public transportation through introducing calm computing as the main vehicle of information delivery.

1.8 CONTRIBUTION OF THE RESEARCH

The main emphasis of this research is to study and improve the way information is presented and used in a public space with a specific focus on the public transportation sector of Cape Town. Using Mark Weiser's vision of the computing future, calm computing is used as the main conduit for delivering such information, predominantly focusing on the ambient display subdivision of calm computing and how such a display can be designed to improve information use and delivery.

This study centres on the situation where a person is waiting for public transport, more specifically the MyCiti bus service. The study focuses on the information, which is made available regarding how much time a person has left before the bus arrives. A particular station was selected for this study, which was the Civic Centre bus terminus as it is the most used station in the system.

Chapter 2

LITERATURE REVIEW

In this chapter, literature will be reviewed to provide background knowledge to help with the understanding of information overload and calm technology. An overview will be given of the principles of ubiquitous computing, information to knowledge and ambient displays.

2.1 PERCEPTION OF INFORMATION

Perception is a process that involves a person's understanding of his environment through the organisation and interpretation of information gathered by his sensory organs. This understanding creates an increased awareness of the environment that surrounds him (Pomerantz, 2003). According to Bruce Goldstein, the author of *Sensation and perception*, perception involves signals in the nervous system that are created through the physical stimulation of a person's sensory organs (Goldstein, 2009). An example of a signal that is created through physical stimulation is light waves hitting the rods and cones at the back of the retina or pressure waves moving through the ear canal to the inner ear and then vibrating the eardrum.

Because sensory processing happens outside of our conscious awareness it might seem that it is a very simple and straightforward process, but perception depends on very complex functions that happen in our nervous system almost instantaneously (ibid). There is also a concept of perception called *selective perception* which is the ability only to focus on a specific thing and filter out any other information. An example of this could be seen in the ability to hear your name in a conversation although you are not following the conversation (Bronkhorst, 2000).

2.1.1 ACTIVE OR PASSIVE PROCESS

Traditionally, sensory organs were viewed as being passive receptors of stimuli but new research into illusions and ambiguous images shows that the brain is actively attempting to make sense of all the sensory input it receives (Gregory, 1987). This means that the brain will always attempt to make sense of any sensory information it receives as seen in Figure 2.1 where the centre squares are the same colour although your brain is constantly attempting to compare the two. Even when a person knows the colour is the same the mind will still try to compare them. This shows that your sensory organs are active receptors more than passive receptors.

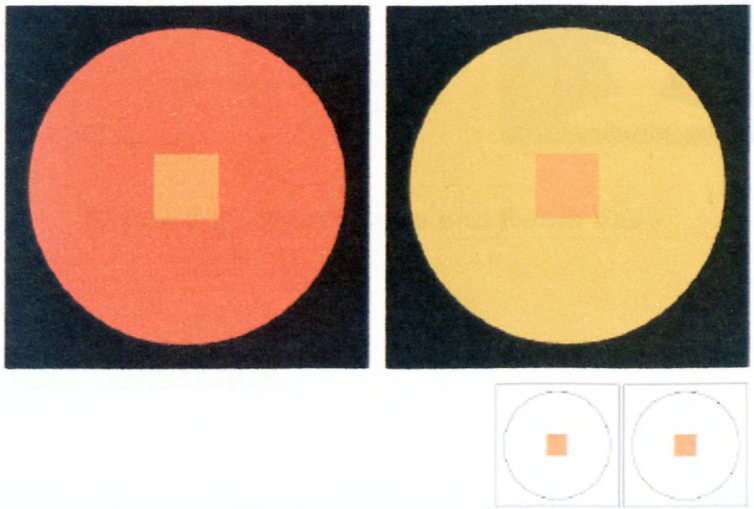


Figure 2.1: Simultaneous Colour Contrast

(Source: Purves, Lotto and Nundy, 2003)

2.1.2 HOW DOES PERCEPTION BEGIN?

Perception starts with a physical phenomenon. Through light, vibration etc. a physical object stimulates one or more sensory organs. The input is then transformed into neural activity through a process that is called transduction (Pomerantz, 2003). These neural activities are then transmitted as a neural signal to the brain for processing.

It is also noted that a single stimulus will rarely be used to create a perception. Ambiguous objects could have multiple perceptions and this is called *multistable perceptions* (Kruse and Stalder, 1995). The Necker cube is only one stimulus but the cube could be seen from the front three-quarter view or the bottom three-quarter view. The same can be said about the Rubin vase, which is only one stimulus with different perceptions. It can be a vase or it can be a silhouette of two faces looking at one another.

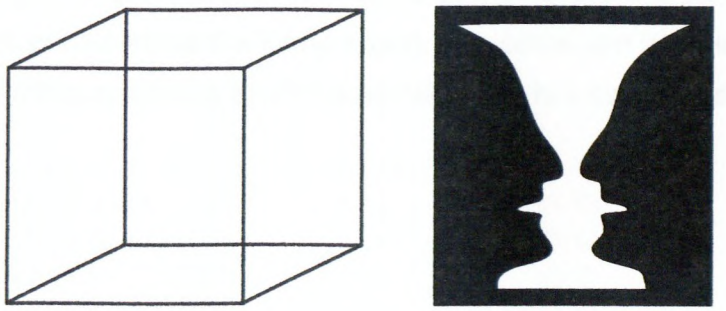


Figure 2.2: Necker Cube and Rubin Vase

2.1.3 PERCEPTUAL CONSTANCY

Perceptual constancy is the ability to recognise the same object from different sensory inputs (Atkinson et al, 1990). We can recognise a person from either the front or from the side profile, although the shape of the object differs on our retina. We recognise the shape as a single three-dimensional object. If we did not possess perceptual constancy an object moving towards us from a far away distance will look like it is growing in size as it comes closer.

There are other constancies like the colour, texture, odour, melody, words and brightness. We recognise a piece of white paper although the lighting conditions in a room might change. Our mind will compensate when our hands move quickly over a rough surface to affect our perception of the texture that we are experiencing (Goldstein, 2009).

2.1.4 GESTALT LAW OF GROUPING

Psychologists developed a set of principles to help explain how we perceive different objects. These sets of principles are called Gestalt law of grouping (Banerjee, 1994). The law states that we perceive objects as organised patterns. There are six categories that can help define a perception.

The *Proximity* principle states that if all other inputs are the same then an object can be perceived as the same object. The same can be said when two objects are further apart they might be perceived as two separate entities.

Figure 2.3: Proximity principle

(Source: http://en.wikipedia.org/wiki/File:Gestalt_proximity.svg)

Similarity principle states that when all else is equal an object that resembles another object can be seen as part of one object and if an object looks different it can then be seen as a different object. This helps with distinguishing between overlapping objects and adjacent objects based on their physical appearance.

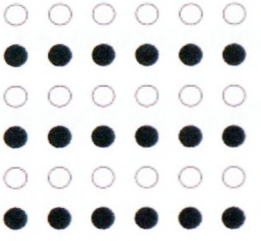


Figure 2.4: Law of Similarity

(Source: http://en.wikipedia.org/wiki/File:Gestalt_similarity.svg)

The *Closure* principle states that the mind wants to see a complete figure. The figure might be obstructed or a section of the object might be completely missing. Your mind will fill in the missing detail (Wolfe et al, 2008).

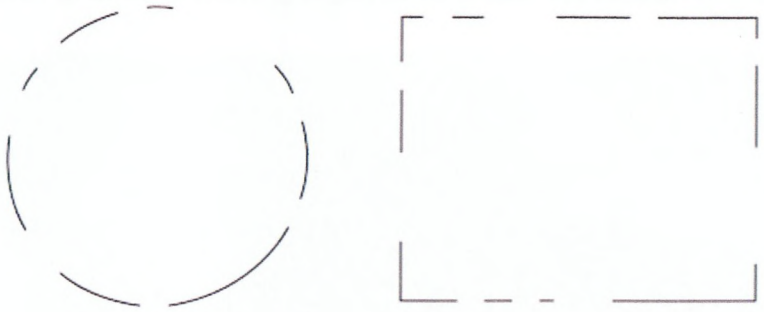


Figure 2.5: Law of Closure

(Source: http://en.wikipedia.org/wiki/File:Gestalt_closure.svg)

Good Continuation is the ability to make sense of objects, which are either touching each other or overlapping each other. Each object that is overlapping another object will be perceived as a different object.

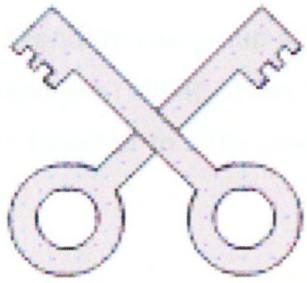


Figure 2.6: Good Continuation

(Source: http://en.wikipedia.org/wiki/File:CrossKeys.png)

Common fate groups stimuli together, which are moving at the same rate and direction. This helps to identify singular objects even when they are moving together and their colours and outlines are blurred. This can be seen when a large flock of birds is moving together to create the illusion of a singular entity.

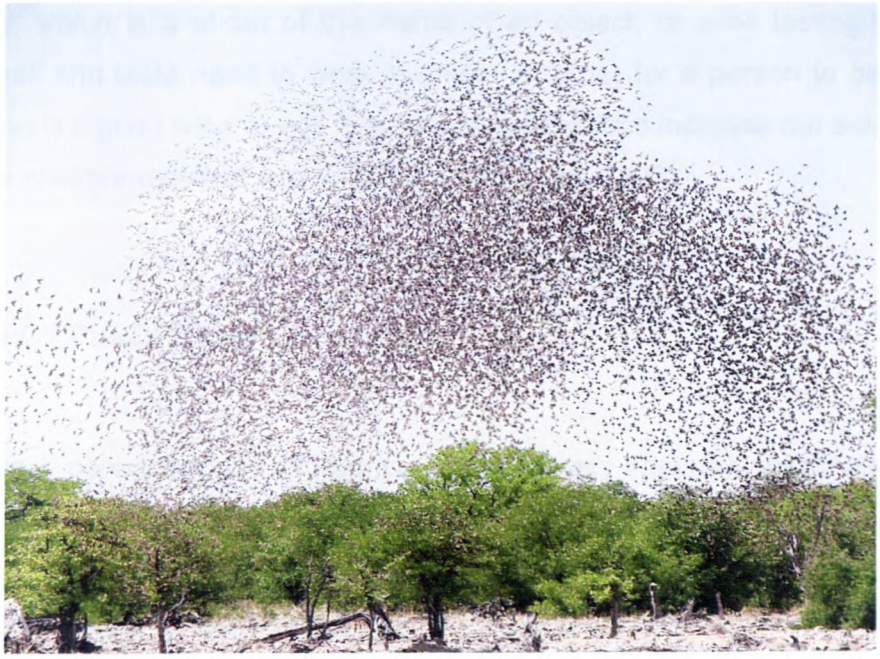


Figure 2.7: Common Fate

(Source: Alastair Rea, nd)

Good Form is the mind's tendency to group stimuli together of similar shapes, colour and patterns (Banerjee, 1994). Even when these forms overlap the brain tries to group them together to differentiate different patterns or shapes as seen in Figure 2.8.

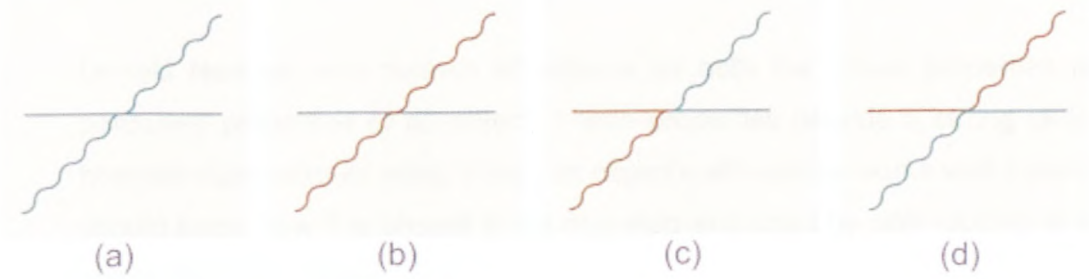


Figure 2.8: Good Form principle

(Source: www.scholarpedia.org/article/File:Todorovic-Gestalt_principles-Figure_7.jpg)

2.1.5 PERCEPTUAL LEARNING

A human being has the ability to fine-tune his/her perceptions. An example of perceptual learning is our ability to read and understand an image of an X-ray, which is a photo of the inside of an object, or wine tasting where the smell and taste need to work in unison in order for a person to gauge if the wine is a good wine or not. These new perceptions increase our awareness of the environment that surrounds us (Kellerman, 2002).

2.1.6 DIRECT PERCEPTION

Direct perception or affordance is the theory that the information in our sensory receptors is enough to perceive anything. This means that we perceive directly because there is no need for higher-level cognitive processes to bridge between perception and sensory experience (Sternberg, 1996).

2.1.7 AFFORDANCE

There are currently two very distinct understandings around the theory of affordance namely:

Donald Norman who defines affordance as both the actual properties and perceived properties of an object. These properties provide a strong clue to how the object should work. When an object's affordance works well a person should know how it is should to be operated and used by only looking at the object (Norman, 1999).

James Gibson defines affordance, as the actual properties of an object should reveal its use without the user's experience, culture knowledge and/or ability to perceive (Gibson, 1977).

In summary, perception is the ability to be aware and understand the environment around you through the interpretations and the organization of information gathered through your sensory organs. If the methods by which the information is displayed and delivered are redesigned, then the ability to perceive information will be changed, possibly enhanced. The introduction of computers as information portal subsequently changed the way people perceive information.

2.2 FROM HCI TO AMBIENT DISPLAYS

In the 1970s the only humans who had any interaction with computers were information technology (IT) professionals and maybe some dedicated hobbyists like Steve Jobs and Steve Wozniak. This changed drastically with the introduction of the personal computer (PC) in the 1980s. Personal software was made available to enable the users to manipulate text, spread sheets and play interactive games. This made everyone in the technologically developed world a potential computer user. It quickly became apparent that the use of these computer tools was not user-friendly and huge deficiencies were identified in the usability of the PC (Carroll, 1997).

These tools or programmes were created with unmanageable complex software and code, which was far too difficult for the average PC user to understand, manipulate or comprehend. Computer graphics and the retrieval of information became important to the interactivity of the computer system. It became evident that the future of computing necessitated a better understanding of the users in order to empower them to do more (ibid).

In the early 1980s a synergy developed between Cognitive Sciences, Human Computer Interaction (HCI) and Cognitive Engineering. Early HCI theories were based on simple science. Perception, memory and motor behaviour were combined to create a model of human processing (ibid, 2011).

This gave rise to HCI as a discipline in the computer sciences. One of the main focuses of HCI was increasing the usability of a system. Although HCI was originally created to focus on productivity programs like spread sheets and text editing software, it quickly expanded to include systems development, user interface, visualisation and collaborative systems (Myers, 1998).

HCI focused on the task-orientated goal, typically from an individual user's perspective. It was discovered that if HCI practitioners and researchers engaged with the design process rather than merely pointing out the problems relating to the usability of an application, it would be of greater significance to the end user.

In the 1990s digital products changed completely from task orientated or work-orientated duties towards a more fun, pleasurable and recreational experience. This was attributed to the expansion of the Internet, mobile connectivity and digital games. Traditional instrumental qualities such as *usability* and *usefulness* lost some significance and were overshadowed by non-instrumental qualities such as aesthetics, playful and social qualities.

With an increased focus on user experience and design, a better description of the field was required. The name Interaction Design (IxD) was adopted to better describe the inter-disciplinary design approach. One of the key features of IxD is the ability to imagine things as they could be as opposed to focusing on how things currently are (Lowgren, 2011).

Bill Moggridge and Bill Verplank first coined the term *Interaction Design* in the 1980s. Verplank's *Interaction Design Sketchbook* described IxD as a combination between *user interface design* and Industrial Design (ID). Moggridge described IxD as the application of ID to a product containing software. This was an improvement to the term *soft-face*, which Moggridge coined in 1984 (Moggridge, 2006).

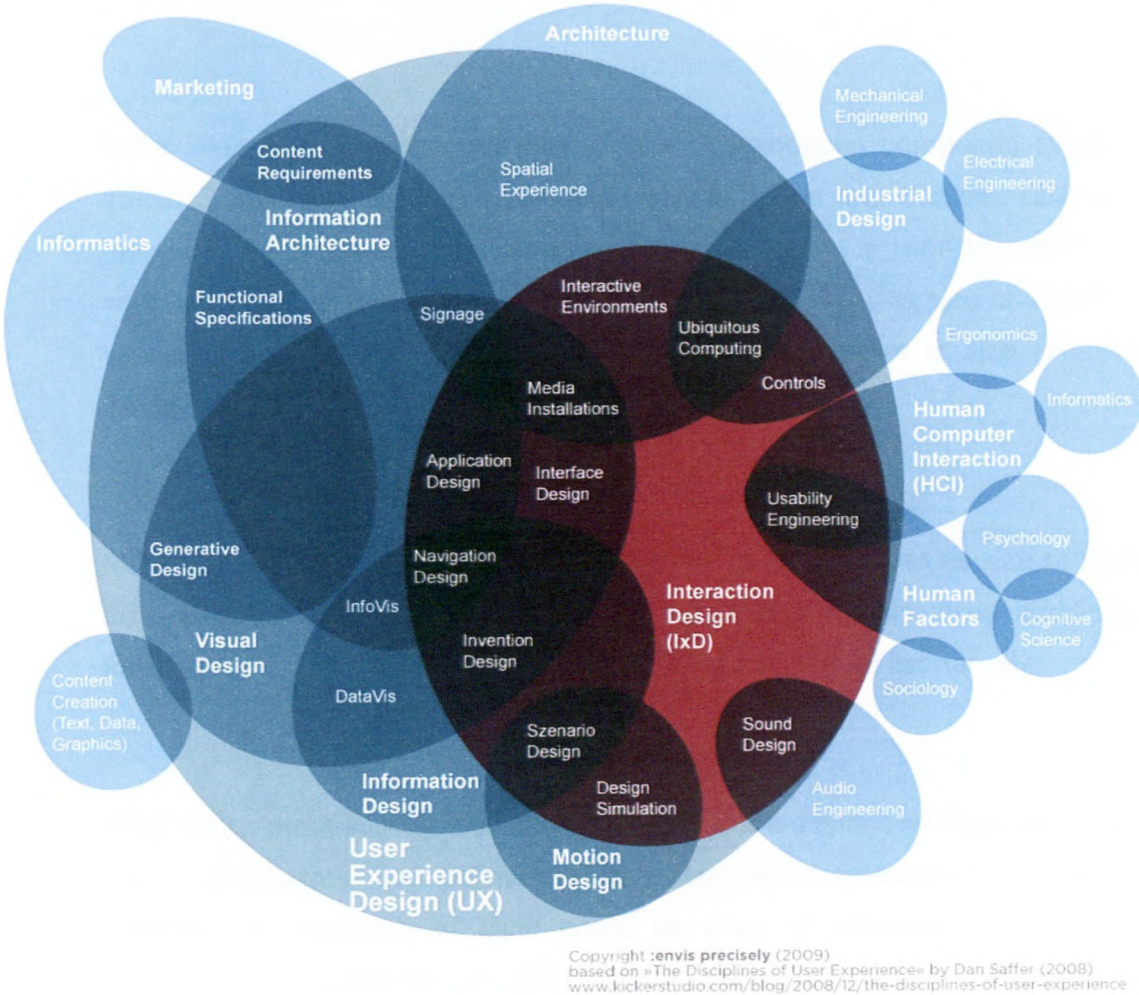


Figure 2.9: Disciplines of the user experience

(Source: www.kickerstudio.com/blog/2008/12/the-disciplenes-of-user-experience)

This overlapping area created between IxD and ID creates an interesting inter-disciplinary research area called *Ubiquitous computing* (Ubicomp) (Saffer, 2009). The late Mark Weiser coined the term Ubicomp in 1988 while working for Xerox.

Ubicomp can be described as technology which has been embedded into everyday life. At the centre of this research field is the vision that small inexpensive devices are interconnected through a wireless network. Refrigerators will be able to detect the amount of milk that is left as well as the freshness of it. It will then decide, based upon how much milk one uses on a daily basis, if it needs to order more online and send an email notifying that milk has been ordered.

Mark Weiser proposed three basic forms of ubiquitous computing systems called *Smart Devices*, which consisted of tabs, pads and boards. *Tabs* was described as technology that was wearable and about a $1cm^2$ in size, *Pads* was described as hand-held devices approximately $10cm^2$ is size and *Boards* which was described as display objects that are a meter in size (Weiser, 1998).

Mark Weiser characterised these Smart Devices according to its size ranging from a centimetre to a meter. Current research suggests three additional forms of Smart Devices that could be added to the original list namely:

Dust, which are miniature devices with or without a display, which could range from nanometres to millimetres like Microelectromechanical Systems (MEMS). An example of *Dust* could be seen in research done at the University of California in 2001 called *SmartDust* which conceives a hypothetical system consisting of many tiny MEMSs, which are connected through a wireless network. These devices detect light, temperature, vibration, magnetism and or chemicals and will relay the data through the network.

Skin, which is based on conductive polymers, light emitting fabrics and organic computer devices that are flexible enough to be incorporated into clothing, fabrics and or curtains. An organic light-emitting diode is an example. Organic molecules start emitting luminosity when exposed to electricity. Sony recently created a flexible display prototype in 2010 using OLED.

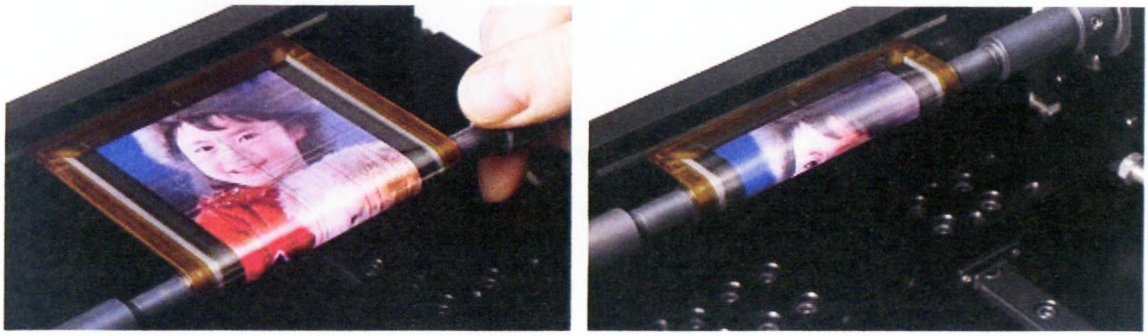


Figure 2.10: Flexible Screen developed by Sony

(Source: nDevilTV, 2010)

Lastly we can mention *Clay,* which is a malleable material consisting of millions of MEMS that can be formed to any shape a person desires. The *Clay* would stay in that position until a user or computer commands it to change into a different form.

Mark Weiser and John Seely Brown published a research paper about computing in the next fifty years. They predicted that computing would split into more defined eras. Calm computing can be seen as the next evolution or revolution in the computer age.

Currently there are six trends or eras in the world of computing namely (Weiser and Brown, 1996):

- Mainframe era could be described as the era where experts mostly controlled computers. One mainframe or computer is shared between many users.

- The Personal Computer (PC) era, which started in 1984 when the number of people owning a PC, surpassed the number of people sharing a computer.

- The Internet and distributing computing era can be seen as the introduction of the Internet where your PC was connected to a larger community of other PCs and where information becomes readily available at a touch of a button.

- Mobile era signifies that your personal computer has become portable and access to information is not bound to a specific location.

- Ubiquitous Computing (UbiComp) era can be seen as the era where loads of computers are shared between each of us. Computers will be embedded in everything from walls, clothing and even people.

- Calm computing era, which is the current era where information is so easy to attend to that it does not worry the user. This means that a person's focus will not be on computing or information but becoming more *"fully-human"* through the increase of free time.

Calm technology can be described as technology that allows information to be freely available in a person's periphery. The individual will have the option to switch focus from the centre of attention to the periphery.

An example of this switch can be seen when a person is driving a motor vehicle. His focus is on the road, people in the vehicle and music on the radio. A person does not notice the sound that a vehicle's engine is making. This is called *auditory discrimination*. As soon as the engine's sound changes, all other sounds can be blocked out to increase the focus on the peculiar sound the engine is making (ibid).

The sound of the motor vehicle's engine was unconsciously being monitored and the information was placed at the periphery. This allows more information to be processed at one time.

Calm technology enables information to be available at a person's periphery and can be monitored unconsciously. Because it is monitored unconsciously it does not add to information overload.

Calm computing created a new genre in consumer electronics called *Ambient Devices*. These devices deliver information without increasing the load on a person's cognitive ability to attend to information. One such a device is called the *Ambient Orb*. The *Ambient Orb* won the Idea of the Year Award in 2002 and is still commercially available. *Ambient Orb* is a frosted glass ball lamp that is connected to the Internet, which can display any information in the form of different colour values.

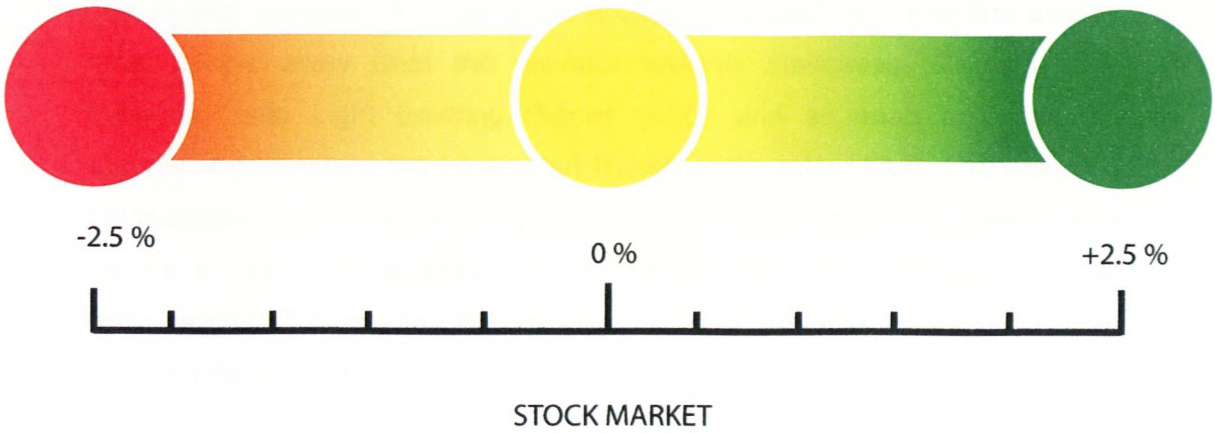


Figure 2.11: Ambient Orb Illustration

(Source: www.ambientdevices.com/cat/orb/orborder.html)

Ambient devices work on the principle that information can be obtained by only glancing at an object for a fraction of a second. Two streams of ambient devices are currently emerging, an ambient device for personal use and an ambient device for public use. Most ambient devices utilise some sort of display technology to provide different types of information.

Clouds and Lights were physical installations, which investigated how ambient display technologies could be used to encourage a better ecological behaviour. The researchers described traditional signage as "too in your face" and set out to design a display that could trigger an emotional response but also be ignored when wanted to (Hazlewood, et al. 2011). The project was intended to be playful but play on peoples' weaknesses and guilt. This was achieved by designing the installation in such a way that the display could lure and nudge people towards specific decisions. These decisions were then displayed in a communal space where a person can reflect on their own decisions they have made (Rogers, 2010).

The project consists of three ambient display installations. The first display lures people away from the elevator towards staircases. Carpets were imbedded with Light Emitting Diodes (LED) and as soon as a person approached the stairs the LEDs start flickering the colour blue. The flickering will increase in speed to help support the decision a person has made to use the stairs. The closer a person moves to an elevator, the more the blue LED lights would change into the colour red as to attempt to influence that person's decision (ibid).

Figure 2.12: Clouds and Lights photo

(Source: Hazlewood, et al. 2011)

The second ambient display consists of grey and orange spheres hanging as an installation in the communal space. Each of these spheres could move independently up or down according to the data it receives. The grey spheres in the installation represent the stairs and the elevators are represented with orange spheres.

Pressure plates were installed in front of the stairs and elevators which counted how many people used each of them. The height of the spheres represents the amount of people using the stair or elevator for example the more people would use the stairs, the higher the grey spheres will hang and vice versa (Rogers, et al. 2010).

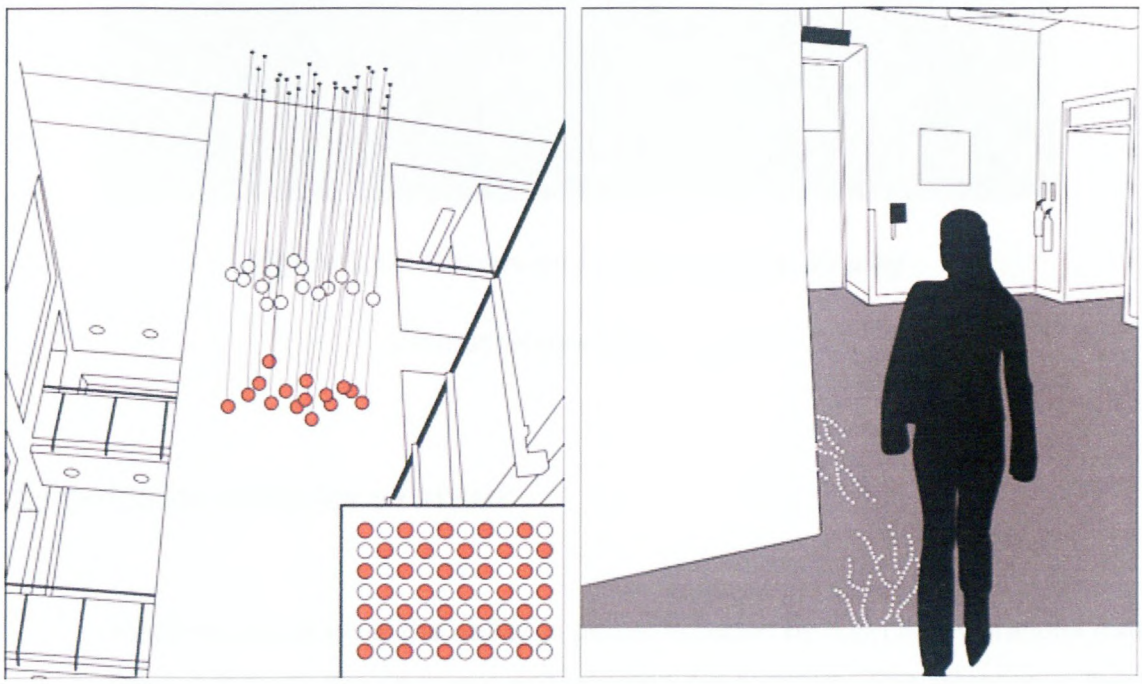


Figure 2.13: Clouds and Lights illustration

(Source: Hazlewood, et al. 2011)

The third display, which completed the installation, was a display that presented a weekly history of the experiment. The information is represented in the form of a pie chart and each pie chart represents a day of the week. This method was deliberately more literal than the other two displays. The colours of the pie charts matched the colours of the clouds to make it easier for observers to understand the connection between the installations (Rogers, et al. 2010).

Figure 2.14: Clouds and Lights history display

(Source: Rogers, et al. 2010)

2.3 TYPES OF SENSORY SYSTEMS

Hearing or audition is the ability to perceive sound by detecting vibrations that passed through the inner ear and vibrated the eardrum. This vibration is then changed into neurological signals that are transported to the primary auditory cortex. We have the ability to hear frequencies from 20Hz to 20,000Hz (Watkins et al, 2010).

Touch or haptic perception is the ability to recognise an object only through touching it. The perception of an object depends on a combination of information of somatosensory (something is missing here but I don't know what), which is the pattern felt on the skin like the edges and texture etc. and proprioception of the position on your hand (Klatzky et al, 1985). Haptic perception relies on the information gathered during touch (Robles-de-la-torre and Hayward, 2001).

Taste or gustation is the ability to perceive flavours. We receive flavour information from our taste buds or gustatory calyculi on our tongue. We can perceive five different primary tastes (Siegel & Albers, 2008). Sweetness like in sugars, bitterness like in coffee, sourness like lime juice, saltiness like salt and umami (what's that, never heard of) in soya sauce. Other factors like smell, texture and temperature may influence our perception of taste (Andrew, 1999).

In summary the literature review provided background knowledge to help with the understanding of information overload, perception and calm technology. The principles of ubiquitous computing, information to knowledge and ambient displays were presented. These principles form the basis for investigating and evaluating the amount of information overload and ambient displays at the MyCiti Civic Centre bus terminus.

Chapter 3

EVALUATION

In this chapter the evaluation process will be determined for both information overload and ambient display. This is necessary to understand the problems and constrains when evaluating proposed in-situ experiments.

3.1 INFORMATION OVERLOAD

Information overload is an increasing problem in a contemporary society that thrives on mobile devices and digital interconnectivity. Driving while speaking on a mobile phone has been banned in South Africa, because studies have shown that while a driver is speaking or texting on a mobile device his attention is distracted and this creates a lack of concentration on the road according to the Arrive Alive website (www.arrivealive.co.za) accessed on 14th December 2011. This problem is compounded even more with pressure from society to be connected at all times.

There are very few things that can be truly multi tasked, while you are in a conversation with someone and you receive a SMS, you can read it quickly and listen to the conversation at the same time. Speaking while reading a SMS does not mean that a person is truly multi tasking, it merely means that you have developed the ability to rapidly switch between reading words, listening to words and speaking words. This means that both activities demand higher cognitive attention and by switching rapidly between these activities your train of thought is constantly disrupted. These disruptions merely mean that you have to take a fraction of time to refocus on your central activity.

Figure 3.1: Inattentional Blindness

(Source: http://interfacematters.com/2008/01/our-hairy-friend-and-inattentional.html)

Research that has been conducted at the University of Illinois had participants study a video of students playing a basketball game in a lobby. The participants were specifically asked to focus on the amount of passes between the players. Most participants in this study concluded that 15 passes had been completed.

After the video the participants were asked if they have noticed something peculiar while the video was playing. Most of the participants failed to notice a student wearing a Gorilla suit. The student in the gorilla suit walked calmly between the players as they were passing the basketball, briefly pausing in the middle of the screen and pounding his chest.

This research concluded with the theory that when you intentionally focus on something you might not notice valuable information right in front of you. This theory is called *Inattentional Blindness* (Simons and Chabris, 1999).

Research into *Inattentional Blindness* has shown that people do not fair extremely well when confronted with true multi tasking assignments and that people usually overestimate their ability to focus on more than one stream of information simultaneously. *Inattentional Blindness* is compounded even more when a person is occupying a public space because personal information is usually prioritized over information available in a public area.

This can then lead to severe stress and health related problems. Missing the bus, because a person is focused on playing a video game on his PlayStation Portable (PSP) can heighten stress and anxiety levels severely. Safety issues can occur as well when focussing on something like typing a SMS while walking as you are crossing a street and accidentally walk in front of a police car because you did not see him or hear its siren.

Evaluating the level of information overload in MyCiti's Civic Centre bus station consisted of doing a multitude of observations and unscheduled semi-structured interviews in and around the bus station. These observations and interviews were conducted in three consecutive weekdays. Chapter 4 will describe the interviews in more detail. This methodology helped with ascertaining what is the amount of information overload at the Civic Centre bus station and the amount of distractions in the space. This includes personal items that created distractions like mobile phones and MP3 players.

3.2 AMBIENT DISPLAYS

The nature of UbiComp as described by Mark Weiser in 1998 stated that technology should blend seamlessly into our everyday environment. Recent research projects and collaboration in the field of Interaction Design and UbiComp have identified that ambient displays are one of the front-runners of the world Mark Weiser envisaged.

Ambient displays are different to informative displays, as they have been designed to be perceived outside of a person's direct focus of attention and without unnecessarily distracting you. This is in complete opposite to that of informative displays as they were designed to attract a person's attention through flashing lights and object moving across the screen, and then demand focus in order to understand the information it is displaying (Vogel and Balakrishnan, 2004).

The nature of ambient display technologies creates a situation where information streams are displays in such a manner that they are embedded in our everyday environments. Information streams from these displays should be broadcasted in such a way that the information is easily accessed through a glance and can also be easily ignored when a person wishes to "tune out" of all the information. This ability to either glance or ignore the information when a person wishes to do so can be seen as a possible solution to the current threat of information overload.

The presence of unavoidable information, like in Mark Weiser's vision of the future where information and accessibility are everywhere and embedded into everything, could lead to massive information overload as an unintentional side effect.

Two of the biggest challenges facing the evaluation of an ambient display are the need for the display to be seamlessly embedded into its surroundings and the fact that a person should be able to tune out of the display as well as the information if he/she wishes to do so (Hazlewood et al, 2011).

There has been a lack in research regarding the evaluation process of ambient display technologies. This lack has been contributed to the difficulty in creating these displays and the difficulty of implementing and user testing this type of technology. Ambient displays are created to deliver a very subtle stream of information that uses an indirect method as apposed to a more traditional interface design methodology, which is task-oriented. The traditional Human Centred Interaction methodologies do not provide enough support for the evaluation of how ambient displays are experienced and used.

Ambient displays do not function as intended to if they are not completely blended into their surrounding environments. This is extremely difficult to simulate accurately outside of a controlled environment such as a studio or laboratory. This creates a paradox where the nature of UbiComp complicates the evaluation process even further. When intrusively observing the technology in the space, one hinders the intended function of these displays (ibid).

The user's attention will be unfairly directed if a researcher uses direct observation because the subject will be reminded constantly that there is something out of the norm happening. It can be seen that the more intrusively the researcher observes, the less accurate the results will be.

The methodology that was adopted to help evaluate the success of the ambient was based on unscheduled semi-structured interviews. This is the same methodology, which was used in the *LumiTouch* project (Chang, 2001) and *Clouds and Lights* project (Roger, 2010).

Chapter 4

DATA ANALYSIS

4.1 INTRODUCTION

This chapter introduces a thematic analysis of the data gathered from the observations and unscheduled semi-structured interviews conducted at the Civic Centre bus station between the 10th August 2011 until the 7th October 2011. Field notes were taken while observing commuters and conductors at the Civic Centre bus terminus. The findings were then cross referenced with video recording done in situ. The interviews were recorded on a digital voice recording function on a smartphone and transcribed into sentences, which was considered as open code. Sentences with a common theme were then grouped together to construct concepts. Common concepts were then grouped together into the occurring categories (Weber, 1990). Out of these categories two central hypotheses were created to help identify the main problem to address when designing a possible intervention or prototype.

4.2 INITIAL OBSERVATIONS

Observations were conducted from the 10th August 2011 until the 4th October 2011. Observations consisted of spending 3 hours in situ, taking field notes and video recording on the behaviour of the stakeholders. It was determined that the commuters and the conductors were most active while waiting for the bus to arrive as this can be seen as a shared activity between the stakeholders.

Findings indicated an increase in the level of irritation, agitation and stress of the stakeholders as the bus arrival time fluctuates, as much a 5 minutes. Stakeholders would start asking other commuters and conductors when the bus would arrive and why it was taking so long. It was also noted that the scheduling that is provided at the bus terminus is insufficient, as the bus never follows the schedule to the minute. Stress levels increased, as the information provided by the conductors was insufficient or wrong.

It was also noted that commuters who were reading, listening to music on a mobile device and/or browsing the Internet appeared to become agitated more quickly as they seemed to be focusing on their own personal information more than the information from the conductors or the printed schedules. It appears that they filter out the information which is not central to what they are currently doing like reading or browsing the Internet. The video recordings support this theory, but more investigation is needed in the form of interviews with the stakeholders.

4.3 UNSCHEDULED SEMI-STRUCTURED INTERVIEW

Interviews were used as the major method adopted to gain insight into the theories and concepts behind information overload in a public space. A total of 38 stakeholders were interviewed. These interviews were unscheduled to increase the amount of data and the accuracy of the data collected. The increase of the accuracy can be contributed to the relaxing nature of an unscheduled interview.

The interview style was informal although the interviewee was informed of the intent to use the collected data for research purposes. All the interviewees were made well aware of the fact that the interview was completely optional and if they wanted to stop the interview at any point in time they were more than welcome to do so.

Semi-structured method was used to ensure flexibility in conducting the interviews. Central themes were initially identified through observations. Questions were based on the observed themes, but new questions, directions and arguments were welcomed throughout the interviewing process. Semi-structured interviews allow for different themes and categories to be explored in a multitude of ways as the questions and directions are tailored according to the interviewee (Lindlof & Taylor, 2002).

Interviews allow assessment of verbal and non-verbal behaviour of each interviewee. Verbal information can either confirm or contradict central themes and non-verbal behavioural information may express consciously or unconsciously feelings about certain topics, questions and themes (Foxcroft & Roodt, 2005).

Composition of Interviewees	
Male	22
Female	16
Black	11
White	17
Coloured	10
16-24	13
25-44	11
45-65	9
65+	3

Figure 4.1: Composition of Interviewees

The data collected from this method gave a holistic view of the general feeling of commuters and conductors at the Civic Centre bus station with specific focus on information overload. These interviews were important to gain access to the factors that seem to precipitate and perpetuate information overload at the station.

4.4 CONVENIENCE SAMPLING

The adopted sampling technique for the research thesis was based upon the availability and the willingness of each of the participants. A sample is obtained through conversation or meeting with a person at the Civic Centre bus station. The interviewees were informed of the intention to use the gathered data in research focusing on calm computing in a public space to decrease information overload and at the same time increase important information.

It is understood that this sampling technique cannot be used to create a scientific theory, as the sample group does not guarantee a sufficient representation of the population. Convenience sampling is most frequently used to determine specific themes and directions. These themes and direction help conceptualise hypotheses and construct quasi experiments.

To increase the amount of information gathered and to aid to cross validation, interviews were conducted on three consecutive weekdays: Wednesday (5th October 2011), Thursday (6th October 2011) and Friday (7th October 2001). Each day was divided into two sessions: a morning session that started at 07:00 to 09:00 and an afternoon session that started 15:30 and ended at 17:30.

Commuters in each session were asked if they would mind to answer a few questions regarding information overload and what information they needed and used at the bus station. The availability of commuters and the willingness to participate in the research ensured that a large and very diverse sample group was interviewed.

4.5 CROSS VALIDATION

Because of the nature of semi-structured interviews, each interview was conducted slightly different. The questions and concepts were explained differently to each specific interviewee although the core themes were still the same. The large and diverse sample group generated rich data well suited for cross-validation. Each theme was scrutinised and restructured to create more encompassing concepts.

Categories of questions were formulated around these themes.

- The stakeholder's level of interaction with the Civic Centre Bus terminus e.g. how many times does the person use the MyCiti bus service? The more a person occupies the bus terminus the higher the level of interaction with that space.
- The level of a stakeholder's connectivity with regards to demand and overload of information e.g. how much information a stakeholder consumes and how is the information delivered?
- The creation of a personal bubble to support increased focus on personal information e.g. does a stakeholder create a personal space in a public area? Do the stakeholders create the personal bubble to increase personal information focus?
- The pressure that results from constantly being informed e.g. how much pressure does the personal information and the public information create? How does a stakeholder handle the amount of information?

General questions were then developed around these categories.

- How do you connect to information when commuting? Do you read newspapers, magazine and/or browse the Internet on a mobile device?
- Do you own devices that can connect to the Internet and how many of these devices do you use while commuting?
- Does the connectivity ever become too much to take in?
- Do you sometimes create a personal "bubble" (PB) to help you focus?
- Have you ever missed important information because of this PB?
- What information do you attend to first when you are commuting?

Appendix A contains all the coded field notes. Answers were recorded on a Dictaphone application on a smartphone. These answers were transcribed and grouped into common concepts. The common concepts were categorised, which created a central theme to help create hypotheses as table 4.1 indicates.

These hypotheses provided direction and clarity towards the development work with the focus group. This is described in the following chapter. It was important to understand how commuters perceive information and how they cope with the amount of information.

Unscheduled – semi-structured - interview			
Questions	**Concepts**	**Categories**	**Hypothesis**
How do you connect to personal information while commuting?	Books, Newspapers, Conversations, SMS, BBM, Email, Facebook, MXit, Tabloids, Music, Browsing	Information from external factors	Extra information in the form of external factors and mobile devices are increasing information that is already saturated.
Which devices, if any, do you use to connect with while commuting?	Cellphone, Smartphone, iPhone, Blackberry, Samsung, MP3 Player, Books, E-reader, iPad, Tablet, Laptop	Electronic Mobile Devices	
Do you sometimes feel like you are overwhelmed with the amount of information and why do you feel that way?	Too much information, Overflow, Cannot accept anymore, Cannot process anymore, Intense amount information.	Information Saturation	
When you are commuting, what information do you attend to first?	My information is more important, If I had a choice I would only focus on my own information, People get angry if I do not attend to all of the information, I miss out.	Personal Priority	
What information is most important to you while commuting?	Information central to your task, Context, Safety, Scheduling of activities, Value adding information, Information central to my well-being.	Important Information	Information overload leads to important information being disregarded because of personal priority.
Do you ever miss information because you were focusing on something else and what happens to the missed information?	Unattended information even if it is important information will be disregarded after a while.	Disregarded	

Table 4.1: Coding for Unscheduled Semi-structured interview

Chapter 5

FOCUS GROUP AND DESIGN INTERVENTION PLANNING

5.1 INTRODUCTION

The following chapter focuses on the different design interventions developed for the MyCiti Civic Centre bus terminus/station to address the two hypotheses created in Chapter 4. A focus group of five people was used.

The focus group was selected based on the persons' willingness to participate in the study and based on his/her unique set of skills and consisted of two engineers, an architect, a designer and a psychologist. All members of the focus group are frequent users of the MyCiti bus service and all travel to and from the Civic Centre bus station. (I forgot to switch on track-changes in the above two paragraphs an did make some changes. Please check with the original)

5.2 WHAT INFORMATION SHOULD BE DISPLAYED?

The interviews in Chapter 4 helped to determine what information would be most suited and helpful to the people occupying the bus station. Both conductors and commuters were interviewed. After coding all the answers, there was a clear indication that scheduling and arrival times were the most important information pertaining to the stakeholders.

It was discovered that the current scheduling system and estimated arrival times were calculated on the system that would rely on the perception that the time it takes to travel from point A to B is consistent. After traveling more than ten times between the Woodstock station and the Civic Centre station, it was discovered that the travel time would range from 2 minutes 30 seconds to 5 minutes and 40 seconds. This time discrepancies are contributed to two traffic signals on route between the stations and the inconsistency in the speed of the bus.

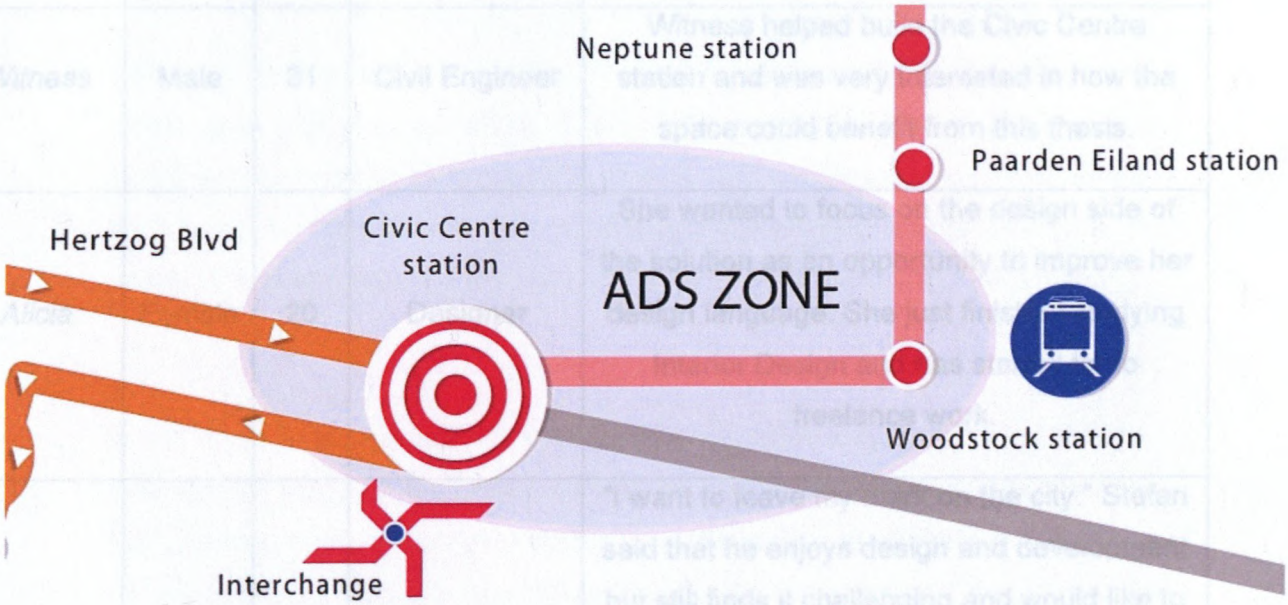


Figure 5.1: Ambient display system activation zone

Name*	Sex	Age	Occupation	Reason for participating
Sebastian	Male	44	Engineer	"I use the service everyday and I would like to help improve if for everybody including myself."
Sara	Female	36	Psychologist	She indicated that her expertise lies in the field of understanding people. She was busy conducting research for a book on the possibilities of interacting with a public space.
Witness	Male	31	Civil Engineer	Witness helped build the Civic Centre station and was very interested in how the space could benefit from this thesis.
Alicia	Female	20	Designer	She wanted to focus on the design side of the solution as an opportunity to improve her design language. She just finished studying Interior Design and has started to do freelance work.
Stefan	Male	25	Architect	"I want to leave my mark on the city." Stefan said that he enjoys design and development but still finds it challenging and would like to be part of a group tasked to focus on something more abstract. He indicated that he was very interested in the field of Interaction design.

Table 5.1: Focus Group Composition

*Names have been changed to protect the identity of the focus group members.

5.3 DISCUSSION ON TRAVEL TIMES BETWEEN STATIONS

The time discrepancy in travelling between the Woodstock station and the Civic Centre station was observed by the majority of the focus group. It was argued that the reason the previous up-to-the-minute schedule was removed was because of the unreliable arrival times. This created a great deal of tension between commuters and conductors. Conductors working at the Civic Centre station confirmed this and added that the arrival times were too inconsistent and were a source of constant frustration.

Sebastian suggested that instead of focusing on the unreliable travel time, which does not stay constant, it would be more effective to focus on a variable, which would stay constant. It was then decided that distance would be a better variable to use. This means that the possible design intervention needs to indicate distance the next bus is away from the Civic Centre station.

It was also discussed that if a specific time would be indicated on the design intervention, that it would create even more stress because "if you had a bad day, 2 minutes may move very slowly" and "if you say goodbye to a loved one on the station, 2 minutes may move really fast". It was argued that time is a constant in science, but the perception of time is not as it relies on a person's current disposition.

5.4 INITIAL FOCUS GROUP MEETINGS

A total of 6 meetings were held between 17 October 2011 and 26 October 2011. These meetings consisted of discussing possible technologies, which could be used as methods to calmly indicate the bus schedule. The meetings were held in a laboratory type environment where factors like the arrival time of the bus could be controlled and repeated.

A make shift station was created to simulate commuters waiting for the bus. Each design intervention started with a discussion around a possible design direction. A testable prototype was then developed. A prototype was placed in the make shift station and a series of tests were conducted. Through discussions during and after the tests, iterations were developed to accommodate results of the discussions.

5.4 POSSIBLE DISTANCE INDICATION METHODS

What methods will be the most suited to calmly indicate distance? The following methods were explored and tested during meetings with the focus group.

- Numbers
- Lights
- Haptic feedback
- Sound
- Taste/Smell
- Colour

5.4.1 NUMBERS

The first meeting with the focus group was to discuss the possibility of using numbers to indicate when the next bus would arrive. After the discussion, quasi experiments were developed where the distance of the next arriving bus was displayed on two large LCD displays mounted at eye level. Each LCD screen was mounted at opposite ends of the make shift station.

These LCD displays mirrored information from a laptop screen. The laptop was then disguised to help improve the simulation. The distance was displayed in white text on a black background, as this was more visible in the daytime. The distance would start counting from 5km in 10-meter intervals. *Sara* and *Stefan* stated that they expected to get overly excited and/or anxious as the distances decreased.

Then *Sara*, *Witness* and *Alicia* said that it was not a calming experience because the display would constantly update itself. This was causing a distraction because it was observed that when the displays updated it, the text would seem to flash as to allude to the fact that there is new data that needs to be attended to.

Sebastian and *Stefan* suggested the display should update itself every kilometre until it reached two kilometres away from the Civic Centre bus station. The display would then count down in increments of 10 meters until the bus arrived at the station.

The program was rewritten and recalibrated to accommodate the iteration suggested by *Sebastian* and *Stefan*. The experiment was conducted another two times. Alicia felt that the updates in the first 3 kilometres were too slow and that the anxiety level would rise very rapidly when the final 2 kilometres were counted down in increments of 10 meters. Sara and Alicia then suggested that the first 3 kilometres should be counted down in increments of 250 meters. This would still update the commuters at a reasonable pace without being overwhelming.

This was confirmed by the all the focus group after running the quasi-experiment with the new iteration for another three times. However, it was noted that the first experiment was more accurate and all the information was updated in real time, which helped the commuters to feel more knowledgeable about the precise location and distance of the next arriving bus. Sebastian, Sara and Alicia commented that they would want to be constantly updated about the location and distance of the next arriving bus without being constantly reminded of the update. They wanted the information to fade into each other.

5.4.2 LIGHTS

The next quasi-experiment was based on the system that was developed for the Chengdu Metro Company where a LED would light up on a map of the route indicating that they have just passed a station. The quasi-experiment consisted of a $2m^2$ map, which indicated the route between the Woodstock Station and the Civic Centre station. There were LEDs incorporated into the map along the route, which would light up to indicate the current location of the bus.

The LEDs were controlled by a micro controller, which was connected to a laptop. This allowed for controlling the LEDs and to manipulate the time it takes for each of these LEDs to light up. As the simulated bus moves along the route it lights up a LED to indicate its location.

It was observed that this experiment was better received than the previous quasi-experiments, which used numbers to indicate distance. *Sara*, *Alicia* and *Stefan* felt that indicating the current location of the bus on a map by lighting up a LED created confusion at first. According to them the display did not provide enough real-time information, as the lights were spaced to far apart.

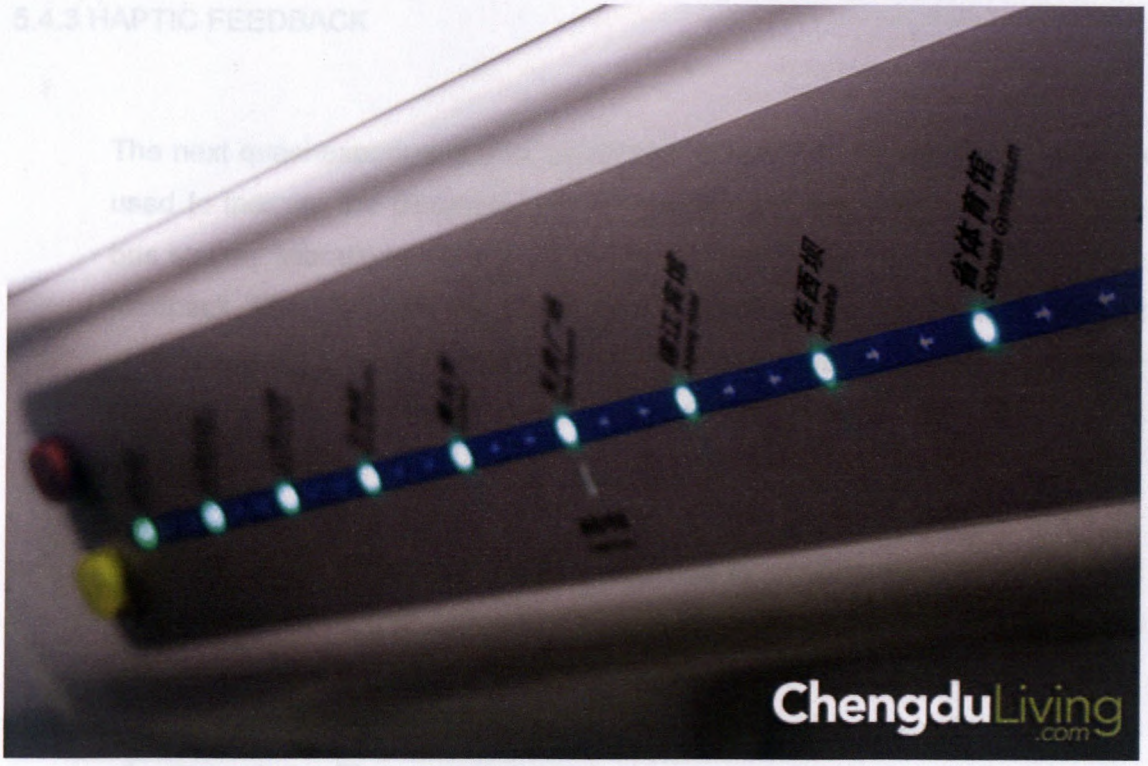


Figure 5.2: Chengdu LED station indicators

(Source: Suscha Matuszak, 2010)

The second iteration of the quasi-experiment included a LED at every 250 meters along the route. The distance between Woodstock Station and the Civic Centre bus station was calculated to be 2,52 km. A total of ten LEDs were then incorporated into the display. The experiment ran for another three times. The group felt that the display provided a sufficient amount of information, although *Sebastian* did mention that he would rather want the information to be updated constantly and through a means where information could seamlessly flow into one another as not to distract him.

It was observed that when a LED would light up that this created a slight visual cue for the focus group that new information was available on the display that need to be attended to. This new information created a small but noticeable distraction in all the focus group members. Alicia and Stefan said that the light should fade-in which will create a subtler visual cue.

5.4.3 HAPTIC FEEDBACK

The next quasi-experiment was developed to test if haptic feedback could be used to indicate the distance between the arriving bus and the Civic Centre bus station. Vibrations were used as the primary method of creating a haptic feedback. The vibrations tried to mimic the vibration feedback you would feel at a train station as a train passed by. A vibration plate was constructed by mounting unbalanced motors to a $1m^2$ wooden platform.

The unbalanced motors were then connected to a microcontroller, which was connected to a laptop. This allowed precise control of each motor and the amount revolutions each motor completed in a minute. The revolutions created the vibration that a commuter would experience when standing on the vibration plate. These unbalanced motors would start spinning at low revolutions as soon as the bus left the Woodstock Station and incrementally increased as the bus moved along the route towards the Civic Centre bus station.

The closer the bus got to the Civic Centre bus station, the faster the unbalanced motors would complete a revolution. The severity of the vibration feedback indicated the distance that the bus was away from the station. This experiment was however not received well and ended up quite unsuccessful, as all the members in the focus group did not like the feeling of the vibrations. *Witness* and *Sara* said that although the distance was "felt", it was creating too much distraction and anxiety as the plate started to vibrate more severely. It was also mentioned by *Sebastian* that it could be a health risk to older commuters and commuters suffering from osteoporosis[§]. It was noted that the focus group felt that it was impossible to ignore the vibrations, as it is impossible "tune out" a person's haptic sense.

[§] *Current research into the field of low bone density discovered that vibration actually increased muscle mass and improved bone density. The procedure is commonly referred to as whole body vibration or WBV (Rittweger, 2004).*

5.4.4 SOUND

The next quasi experiment consisted of a series of speakers, which was used to determine whether or not sound waves could be used to indicate distance. These speakers were connected to a laptop and iTunes. The speakers were mounted on opposite sides of the make shift station. This created an even sound throughout the make sift station and enabled the possibility of using stereo sound. The first experiment used a high power sub woofer to create a low base note.

The focus group only felt the low base note as the low frequency was close to be inaudible. *Witness*, *Sara* and *Alicia* did feel that the low base sound was a good solution at first, but as this experiment progressed *Sara* and *Alicia* started feeling nauseous.

The second quasi-experiment played a series of notes. The quicker the notes are repeated the closer the bus would be to the station. According to *Sebastian* and *Witness*, the notes started to become an annoyance after it was repeated once. The conductors at the station would constantly have to listen to the notes. This will become annoying after a while and would start adding to the stress level they experience while working. It was also discovered that sound only added to the white noise already experienced in the Civic Centre bus station.

Sara, *Alicia* and *Stefan* pointed out that people sometimes wear headphones and will not be able to hear the notes. This was backed up with the initial interviews and observations conducted at the station. *Sara* expressed her concern that if series of notes were to be used for the final design, it would exclude a large part of the population suffering hearing loss.

5.4.5 TASTE/SMELL

Taste and smell were senses that were particularly difficult to create quasi experiments around. Vanilla essence was used as it creates a pleasant smell. A 12v computer fan connected to a microcontroller, which was connected to a laptop that controlled the speed of the fan. The fan was used to help spread the smell of vanilla evenly throughout the station. The closer the simulated bus got to the make shift station, the more intense the fan would disperse the smell. In this quasi-experiment the biggest obstacle was extracting the smell of vanilla out of the station after the bus had left. The smell would linger in the air for too long.

Although the smell of vanilla was not unpleasant, *Alicia* and *Sebastian* said that they would not like to be over exposed to the smell, as it was quite intense. As in the sound quasi experiments, conductors working at the station would be over exposed to the smell and thus would not be as effective. *Sara* mentioned that she did not like the smell as it reminded her of somebody she dislikes. One of the key elements of calm computing is the ability to ignore the information stream if you wish to do so. This was impossible with this experiment.

5.4.6 COLOUR

Three quasi-experiments were created to test the theory that colour could be used to indicate distance. The first experiment utilized a large LCD screen mounted at eye level against a wall. This display was connected to a laptop running a Flash program. The program would subtly change colour according to the simulated distance between the bus and the station. This was then displayed on the LCD screen, which was placed in front of the focus group as they pretended to wait. This was a successful test as all the members in the group said that they were able to glance at the display and understand the information instantly.

This experiment used a LCD screen. This was problematic as it was seen as a distraction purely because of its shape and familiarity. Stefan said, "You could even run adds on them or put the cricket score on".

Sebastian, *Alicia* and *Sara* argued that the prototype should be an object developed and created to fulfil the specific need of calmly indicating distance in a public space. The group felt that a large LCD screen was designed with too many extra and expensive features, which would not be used and that this will hinder the implementation of the display, as it would be very expensive.

The second quasi-experiment was using physical photo filters connected to a motor. This motor could select different colour filters and position them in front of a light source. The motor was connected to a microcontroller, which was controlled by a laptop. A high power LED spotlight light was situated inside an enclosure with the photo filters in front on an opening in the enclosure. The light shone through the opening, through the selected colour filter and onto an adjacent wall. This system did not fade-in colours as smoothly as the LCD display, but it would be cheaper to implement. However, the system was complex as the filters had to physically move in front of the opening. This movement was visible against the wall. It was observed that the light became the focal point rather than the information it was trying to provide.

The last quasi-experiment was created using Red, Blue and Green (RGB) strip LEDs. The strip LEDs was placed against a wall with an opaque plastic diffuser covering the LEDs. The LEDs were connected to a microcontroller that was operated from a laptop. The LEDs created an opportunity to allow colours to fade into one another as they did on the LCD display and it was cheaper and quicker to implement in a space than the previous experiments.

This experiment also provided the best combination of creating an unfamiliar shape because of the flexibility of the LED strip and the subtle colour changes achieved on the LCD screen. It was also noted that LEDs consumed less energy and would last longer than a LCD display. The focus group clearly stated that the RGB LEDs would be the best option to indicate distance through the use of colour.

5.5 WHAT COLOUR?

The focus group had decided that distance would be indicated through the use of different colours. A number of programmes were created to test different colour combinations and what connotation the focus group attached to them.

Test 1

As the bus left the Woodstock Station, the light starts shining red as this indicates that the bus is on its way. The colour cycles through to yellow and ends in green as to show that the commuters will be boarding now.

RED-YELLOW-GREEN

Figure 5.3: First colour combination

All the members in the focus group did not like the combination as it begins with the colour red and this means stop or danger and ends in the colour green that means go or you still have time left before the bus arrives. This is seen as a result of the group's perceptual set of the meaning of colour.

Test 2

GREEN-YELLOW-RED

Figure 5.4: Second colour combination

This colour combination was preferred to test one as the colour red would indicate that the commuter should not go anywhere at that time as red indicates that the arrival of the bus is imminent. *Sebastian* and *Sara* said that the colour combination is the same combination of colours used in the traffic signals in South Africa and that this would aid in the quick adoption of the display as it represents a well-know perceptual set.

The focus group felt that the colour combination should not end on the colour red as this could represent danger and this was not a colour associated with a calm experience. It was observed that the colour red was creating an environment that is more stressful and elevated the level of anxiety of the focus group even more. It was then decided to end the combination on a colour that was a better representation of calmness than the colour red.

Test 3

GREEN-YELLOW-RED-BLUE

Figure 5.5: Final colour combination

Ending the colour combination on the colour blue created a more calming effect according to *Stefan*, *Sebastian* and *Sara*. The display would still turn into the colour red to indicate that the bus will be arriving very shortly and that commuters should get ready and not leave the station or the queue. The colour blue would indicate that the bus has arrived and boarding would start shortly.

Sara and *Alicia* indicated that the colour red should be displayed for a shorter time than that of the other colours. They believed that the shorter display time would not significantly increase stress levels but rather just inform commuters.

It was decided that the Green-Yellow-Red-Blue colour combination was the best suited to indicate distance though the use of a LED strip light display. The display would be seamlessly integrated into the environment as specified by Mark Weiser's vision of calm computing.

5.6 CALCULATING THE DISTANCE BETWEEN STATIONS

Four possible technologies were investigated to relay distance information from the arriving bus to the display at the Civic Centre bus station. These technologies were tested in a controlled environment. The results were used to evaluate possible communication methods between the bus and the station according to the ease of use and manipulation, the cost and the infrastructure needed. Results of these tests are in table 5.1.

Global Positioning System (GPS), Radio Frequency Identification RFID, proximity sensors and cellular triangulation system were investigated. The information obtained would be used to change the colour of the display.

Technologies	Advantages	Disadvantages
GPS	Currently used by MyCiti. Implementation would be quicker and less expensive. Real time accurate feedback.	Very complex system to use.
RFID	Inexpensive equipment. Easy to manipulate and less complex system than GPS.	New system needs to be created. More expensive and the RFID tag will need to be scanned as the bus passes the scanner. This means that the scanner needs to be in close proximity to the bus traveling on the route.
Proximity Sensors	Could be used as a security system. Fairly uncomplicated system to use.	A complete new system needs to be created. Expensive equipment. Difficult to implement into current MyCiti system.
Cellular Triangulation	Easy to implement and cost effective. Good reception all along the route.	Accuracy issues. SIM cards can be stolen and sold, which means system would be down until new card is activated and incorporated into the system. Cellular downtime could affect display.

Table 5.2: Distance indicating technologies

5.6.1 GPS

After meeting with the Civic Centre bus station manager on 10 Augustus 2011, it was discovered that all of the MyCiti buses are equipped with a GPS module. All of the information is then relayed to the MyCiti Headquarters (HQ) in Goodwood, South Africa, for processing and distribution to the different stations and departments.

He demonstrated that he could connect to the MyCiti monitoring system through the Internet on his desktop computer in his office. The information that was displayed on his screen was in real time. He selected a bus and all the relevant information of that bus was displayed. The information included speed, direction and GPS co-ordinate of the specific bus together with all the current positions of the different buses currently active.

The MyCiti bus service is currently using GPS service as a fleet management system. The GPS service has already been integrated into the bus service, which will mean that the design intervention and system would be able to be implemented quicker and cheaper as the backbone of the system is already in place. However the current GPS system is very complex and difficult to use. This is seen as problematic.

5.6.2 RFID

This system would be less expensive to setup than the GPS system as the components are cheaper and the system is easier to manipulate. Currently the bus needs to stop at a specific location at each station in-order for an Infra-Red (IR) sensor to activate the opening of the doors of the bus and the station. The IR sensor is situated above each door of the bus and doors at the station. There are lines drawn on the bus driver's window, which he lines up with corresponding lines at the station. This ensures that the IR sensors can easily be positioned directly across each other in order to communicate.

Each bus could have a Wavetrend WLAN reader Rx1000 RFID tag reader situated on the left side on the front bumper and a wireless powered Wavetrend Personnel TG501 RFID tag situated on the right hand side of the front bumper. The right side RFID tag will communicate with a RFID tag reader connected to the station.

As soon as the bus has arrived at a station, information would be sent to the Civic Centre to indicate that the bus has stopped at a station. When the communication between the reader and the tag breaks, information is sent to the Civic Centre station indicating that the bus is moving again.

There would have to be physical beacons placed along the bus route housing self-powered RFID tags (Active RFID tags). As the bus passes a beacon the RFID tag reader would read the active RDIF tag and send the beacon's location, using 3G cellular technology to the Civic Centre bus station. This ADS (what's that?) system will then update the value according to the information received.

A completely new system would need to be implemented which could be prone to vandalism and even theft. RFID tags would need to be placed along each route to ensure that real time information would be displayed at the Civic Centre bus station. 3G technology could become a costly communication method.

5.6.3 PROXIMITY SENSORS

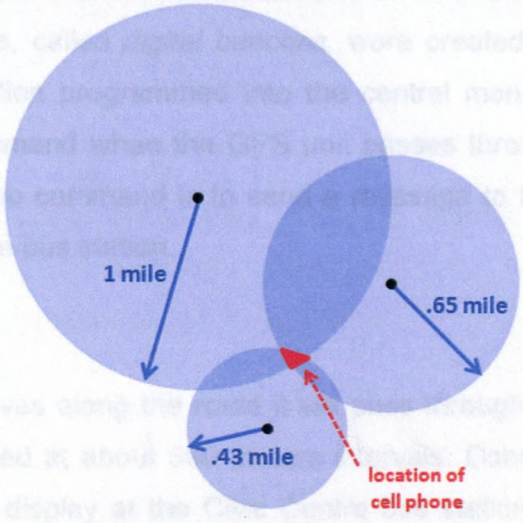
This system would be similar to the RFID tag beacon system. There would be beacons placed along the MyCiti route. Each beacon would house a photoelectric proximity sensor. Photoelectric sensors have the ability to detect plastic and metal objects. If a large object approaches the beacon, the proximity sensor detects it and when the object is at a specific distance away from the beacon, it will send a message using 3G cellular technology. This means that each beacon will have a cellular module.

As an added advantage the beacon would be able to pick up an unauthorised vehicle on the dedicated bus lane. The system could then alert the appropriate authorities about the vehicle and its location.

This proximity sensor system would need to be developed and integrated into the MyCiti bus service. It would also carry the risk of being vandalised or stolen.

5.6.4 CELLULAR TRIANGULATION

According to Vodacom, a local cellular service provider, the coverage along the current MyCiti routes is excellent and could be used to triangulate a cellular module's location within a 10 meter radius. Triangulation depends on a cellular module connecting to minimum three different cellular towers. The accuracy of the system increases with the number of connections.



Triangulation - cell phone detected within a certain radius of each of 3 cell towers – the area where each cell tower overlaps the phone is where it is pinpointed.

Figure 5.6 : Triangulation

(Sourse :http://searchengineland.com/cell-phone-triangulation-accuracy-is-all-over-the-map-14790)

The bus's location could be sent to the Civic Centre bus station as a message using a 3G cellular network. Each bus would have an on-board cellular module powered by the bus itself.

After the testing and developing of the different communication methods i.e. GPS, RDIF, Proximity Sensors or Cellular Triangulation it was decided that the GPS system, currently being used by the MyCiti bus service, would be the preferred system to communicate real time location information to the design intervention at the Civic Centre. The GPS system was selected because it is very accurate, affordable and because the system is the most integrated system and already in place.

5.7 DESCRIPTION OF THE PROPOSED SYSTEM

The system will monitor the GPS co-ordinates from the buses traveling between the Civic Centre bus station and the Woodstock bus station. Points along the route, called *digital beacons,* were created. A digital beacon is a Boolean condition programmed into the central monitoring system that will execute a command when the GPS unit passes through a specific point. In this instance the command is to send a message to the design prototype at the Civic Centre bus station.

As the bus moves along the route it will pass through these digital beacons, which are placed at about 360 meters intervals. Consecutive messages will be sent to the display at the Civic Centre bus station. The display will then change its colour according to the messages received.

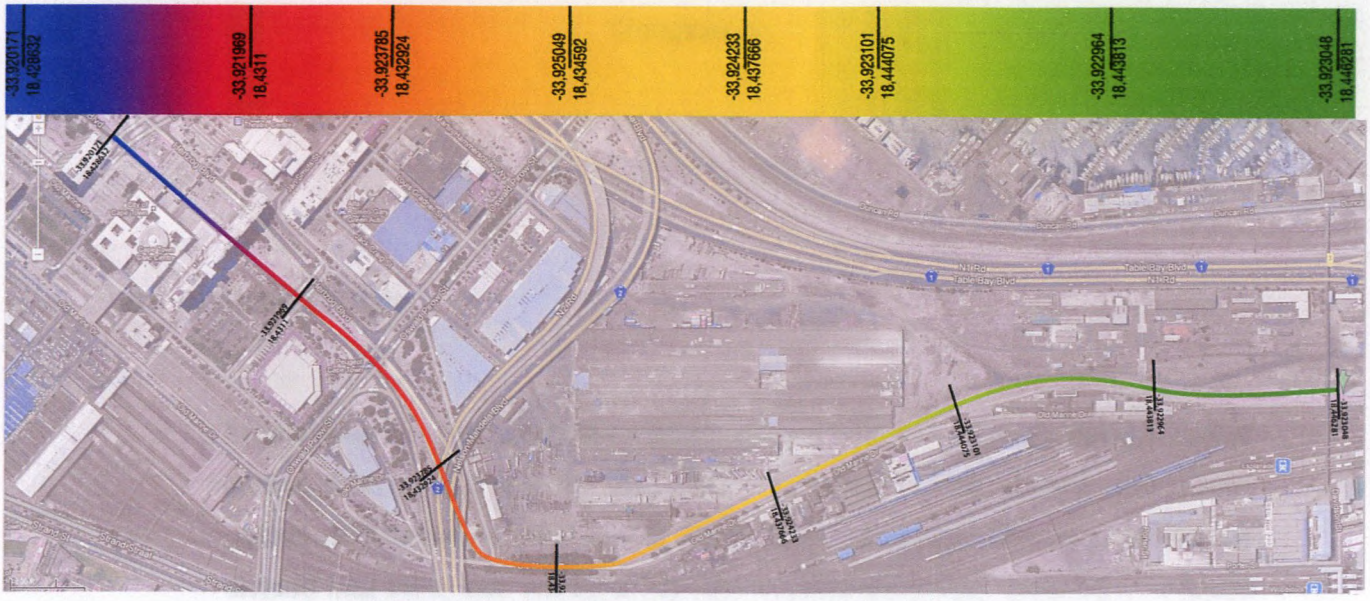


Figure 5.7: Digital beacon placement

Each digital beacon is linked to a specific colour code. With each message received a micro controller will operate the RGB strip LEDs to start changing colour. The colour displayed by the LEDs will indicate the distance between the next bus and the Civic Centre station.

Each colour change should take about 15 seconds. This was calculated according to the maximum traveling speed of the bus between the digital beacons. This provided the maximum amount of time for the display to fade to a different a colour.

Chapter 6

PROTOTYPE DESIGN

6.1 INTRODUCTION

In this chapter, the designing, development and prototyping process of the design intervention will be discussed. Included in this chapter are some design and developmental inputs from the focus group. This chapter will be divided into three sub sections namely: conceptualisation, building and focus group testing.

6.2 CONCEPTUALISATION

The Civic Centre bus station is divided into different sections. These sections are called pods. There are four pods at the station namely: Gardens pod, Tableview pod, Airport pod and the Waterfront pod. The design intervention will happen at the Tableview pod. This pod was selected because it is the most frequently used part of the Civic Centre bus station.

After a meeting with Mr Ronald Kingma, chief operational manager of the MyCiti bus services, it was decided that the testing and evaluating of a prototype would be allowed in the Tableview pod section of the Civic Centre bus station form 14 to 20 November 2011. However, Mr Kingma highlighted that there were a few design constraints in the selected space.

Batteries are the only form of electricity usable. The Tableview pod at the Civic Centre bus station does not have any electrical wall sockets. Using an extension lead/cord is not allowed in the station, as it is a safety risk and extra permission from the city council.

The prototype could not be fixed against a wall or the ceiling as no drilling or glueing is allowed. It was then agreed upon that the display would be a freestanding prototype. The prototype was not allowed to impede the flow of the commuter traffic, as this was a safety risk. The display should form part of the environment as much as possible and try to blend into the station seamlessly.

The last restriction, which was highlighted in the meeting, was that the prototype was not allowed to utilize the buses GPS network for testing. According to Mr Kingma, the system is highly specialised, and only after council has approved the display would the restriction be lifted. However, the prototype could use a virtual simulation of the messages it would have received from the central monitoring system.

6.2.1 SHAPE

The previous quasi-experiments determined that the shape of the prototype should not remind any commuters of a familiar object that provides information as this will trigger a different perceptual set. Shapes like rectangles, which could remind commuters of a television set, could be a source of complaints, as commuters would ask conductors to change the channel. This was a unanimous discussion by the focus group.

The focus group said that the shape was a very important aspect of the prototype as this was the first interaction between the display, the user and the proposed calm display system. The shape should be inconspicuous enough to be easily ignored until it is utilized through a persons glance then it needs to be easy to read and understand.

The space in the station's pods is quite compact and any designed intervention should have a small footprint. The display would be placed against a wall as not to impede the flow of commuters departing or boarding the stationary bus. The display needed to be taller than the average South African, which is about 1,7 meters[§], to ensure maximum exposure to the presented information. The display prototype should not include any sharp angles or corners as this can be perceived as aggressive and in contrast to the effect calm computing should have.

A protective housing around the prototype was designed to house the micro controller, battery and all other electronics that were used to control the RGB LED strip lights. Because the pods are subject to a heavy traffic flow in the mornings and afternoons, the electronics will need to be protected against accidental bumps and kicks. Any damage sustained by the prototype would hamper the planned continuous testing and evaluation within the limited time. This would cause less reliable test results.

[§] This is according to the South African Demographic and Health Survey (SADHS), which was, initiated in 2003. The average heights of the people were calculated from a large sample group. (http://www.info.gov.za/view/DownloadFileAction?id=90143) Accessed on 25 August 2011

6.2.2 ARDUINO MICRO CONTROLLER

A micro controller was used to enable digital changes to the colour of the RGB LEDs. The selected micro controller used was the Arduino Uno board.

Figure 6.1 Arduino Uno board

(Source: www.Sparkfun.com)

Arduino is an open source electronic micro controller that enables easy and flexible coding and construction of electronic prototypes. The micro controller has input and output pins which allow it to communicate with the physical world through the use of sensors, motors and actuators. The micro controller can also communicate with digital information that is available online, or through programmes like Flash or Processing.

6.2.3 BREADBOARDS

A breadboard, also called a *protoboard*, is a solderless electronic circuit board that is used to create quick and uncomplicated electronic prototypes.

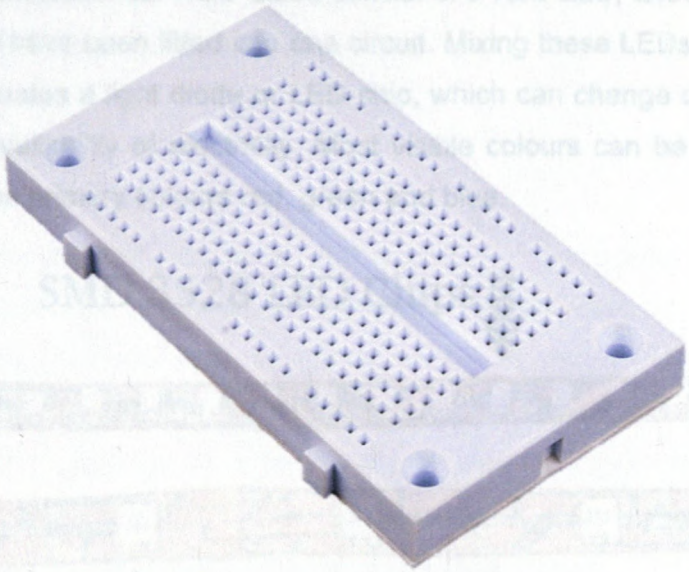


Figure 6.2: Breadboard

(Source: www.Sparkfun.com)

These boards do not require any soldering to connect components allowing the effective testing of proposed circuits which can easily and quickly be changed if need be. The board can be re-used as no permanent fixtures are connected to the board.

A breadboard typically consists of a perforated plastic block, as shown in figure 6.2, with nickel-silver spring clips underneath the perforations. The distance between the perforations is typically 2.54mm apart. This is the standard lead pitch of common integrated circuits (ICs). This means ICs can easily be inserted onto the board without soldering or bending of the ICs leads.

6.2.4 RGB LED STRIP

LED is a semiconductor light source that releases energy in the form of photons. This energy from photons creates the light and this is called electroluminescence. RGB LEDs consist of a Red LED, Green LED and Blue LED that have been fitted into one circuit. Mixing these LEDs together on one circuit creates a light diode or LED chip, which can change colour depending on the availability of electricity. Most visible colours can be created through mixing the primary colours red, green and blue.

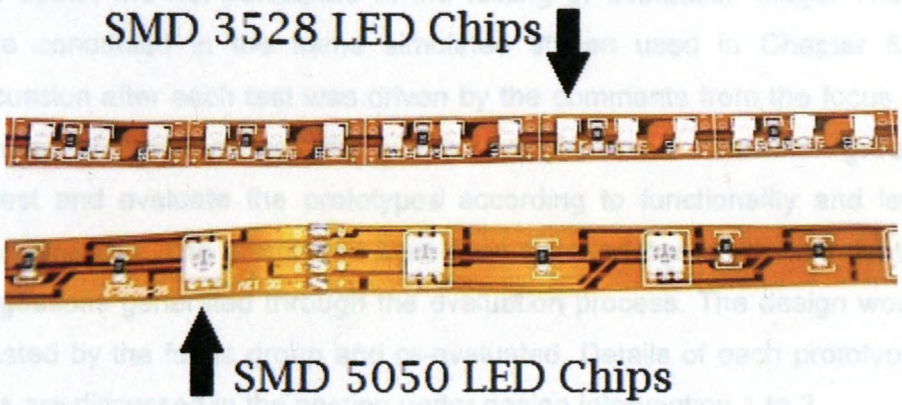


Figure 6.3: REB LED strip lights

(Source: Bmauriello, 2011)

At the time of prototyping there were two types of RGB surface mount (SMD) strip LEDs light specifications available, the SMD 3528 LED strip which carries a single chip per colour and ranges between 300 and 600 LEDs/5m and the SMD 5050 LED strip which consists of a Tri-Chip (Red, Green and Blue LEDs on a single circuit) and ranges between 150 to 300 LEDs/5m.

The 5050 SMD RGB LED strips were selected as the light source for the display. The higher luminosity offered ensured higher visibility in bright daytime conditions.

6.3 FOCUS GROUP TESTING

Three design interventions were set up, each with a prototype. These prototypes were tested by the focus group in a controlled environment. The controlled environment was designed to simulate the Tableview pod at the Civic Centre bus station. The same focus group used in Chapter 5 was used again.

The author did not participate in the testing or evaluation stage. The tests were conducted in the same simulated station used in Chapter 5. The discussion after each test was driven by the comments from the focus group although observations from the author were discussed. The focus group had to test and evaluate the prototypes according to functionality and level of pervasiveness. The prototypes were then tweaked based on comments and suggestions generated through the evaluation process. The design would be retested by the focus group and re-evaluated. Details of each prototype and tests are discussed in the section under design intervention 1 to 3.

Each test took about five minutes and a series of 10 tests were conducted per prototype. Between tests open discussions were held with the focus group to comment on and evaluate the prototypes. Observations made were noticed by the author. Issues with the prototypes, according to the focus group, were addressed through on-site alterations where possible. Subsequent retesting was done with the new parameters.

Different scenarios were created where the "bus" would drive either slowly, drive really fast, stop at one of the traffic signals or stop at both traffic signals on route to the Civic Centre bus station. The arrival times differed from 2 minutes 30 seconds to about 5 minutes in the scenarios. This was the maximum discrepancy experienced while commuting between the two stations. The focus group was informed that there would be different scenarios for some tests although they were not informed of what the scenarios were and when they will be adopted in a test.

Scenario 1

The first scenario consisted of a bus leaving the Woodstock bus station at exactly 10:00:00 am. The bus then proceeded to travel at the speed limit, which is 60 km/hour. Both of the traffic signals along the route were green which meant that the bus arrived at the Tableview pod at the Civic Centre bus station at 10:02:50 am. The complete traveling time was two minutes and fifty seconds (2 minutes 50 seconds).

Scenario 2

In the second scenario a bus leaving the Woodstock station at 10:00:00 am proceeded to travel faster than the recommend speed limit (60km/h). Along the route the bus passed both traffic signals, which were green. This meant that the bus arrived at the Tableview pod of the Civic Centre bus station at 10:02:30 am. The overall traveling time was two minutes and thirty seconds (2 minutes 30 seconds). This is 20 seconds faster than in scenario 1.

Scenario 3

In scenario three a bus would leave the Woodstock bus station at exactly 10:00:00 am. The bus traveled slower than the maximum speed limit. The bus passed both traffic signals without having to stop. The bus would arrive at the Tableview pod at the Civic Centre bus station at 10:03:05 am. The total travel time was three minutes and five seconds (3 minutes 5 seconds). Scenario three was 15 seconds slower than scenario one.

Scenario 4

The bus leaves the Woodstock bus station at exactly 10:00:00 am. It travels at the correct speed limit. The bus has to stop at one of the traffic signals on its way to the Civic Centre bus station. The bus arrives at the Tableview pod at the Civic Centre bus station at 10:03:20 am. Traveling time was three minutes and twenty seconds (3 min 20s). This scenario was a total of 30 seconds slower than the first scenario.

Scenario 5

In the last scenario the bus left the Woodstock bus station at exactly 10:00:00 am. The bus proceeded to travel at a slower speed than the recommended speed limit. The bus had to stop at both of the traffic signals. The bus arrived at the Tableview pod at the Civic Centre bus station at 10:03:50 am. Time spent was three minutes and fifty seconds (3 minutes 50 seconds). The travel time is 60 seconds slower than in the first scenario and the slowest scenario tested.

The feedback received from the focus group consisted of an analysis of the design intervention through focusing on the following: what perceived value was given to the displayed information; was the displayed information ever used by the focus group? How was this information used and was the display ambient enough or was it too intrusive? The information gathered after each test created an opportunity to alter the design.

Scenarios	SPEED	1ST TRAFFIC LIGHT	2ND TRAFFIC LIGHT	TOTAL TIME
SCENARIO 1	Speed limit	No	No	2 min 50 sec
SCENARIO 2	Faster than speed limit	No	No	2 min 30 sec
SCENARIO 3	Slower than speed limit	No	No	3 min 05 sec
SCENARIO 4	Speed limit	Yes	No	3 min 20 sec
SCENARIO 5	Slower than speed limit	Yes	Yes	3 min 50 sec

Table 6.1: Scenarios

Design Prototype 1

The first prototype consists of an acrylic matte white base with a cylindrical diffuser, 180mm in diameter. The complete display measured 1,9m from the ground. The internal components of the display were housed inside the cylindrical diffuser. The internal components consisted of one strip of RGB SMD LED 5050 30 LED/m 1,5m long, a 12-volt battery and a micro controller.

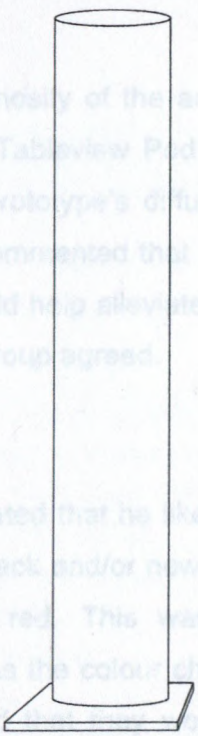


Figure 6.4 :First design prototype

According to discussions held between the focus group members, the information that was displayed on the ambient display, in the form of different colours was considered very valuable. *Sara*, the psychologist said that the information was displayed in such a manner that you did not have to worry if you have missed any information. *Alicia*, the designer, commented that the shape of the prototype was "ugly and utilitarian".

The comments were positive when it came to the functionality of the prototype. It was commented by *Sara* that the information was valuable because the different colour hues were only an indication of information rather than a well-defined quantity like time or weight. *Sebastian*, the engineer, wanted more precise information as he felt that only using a representation of information was not accurate enough and that he would like it to be more informative although he understood that precise information could increase stress and anxiety.

It was noted that the luminosity of the ambient display was not enough for daytime conditions in the Tableview Pod at the Civic Centre bus station. It was also noted that the prototype's diffuser created small hotspots on the surface. Sara and Alicia commented that the diffuser had to be further away from the LEDs as this would help alleviate the visual hotspots on the surface of the diffuser. The focus group agreed.

Stefan, the architect, indicated that he liked starting to gather his belongings like, shopping bags, backpack and/or newspaper as soon as the light started changing from yellow to red. This was confirmed by the observations conducted by the author. As the colour changed from a red to a blue colour, *Alicia* and *Sebastian* found that they would stop communicating with their cellular phones, tablets or other people because of the imminent arrival of the bus. Both indicated that this was a positive thing. This was confirmed by the observations done by the author on the testing of the first prototype.

However, it was noted that the focus group did not like the abrupt colour changes and said that the colours needed to fade into each other more evenly. *Sara* said that the large incremental changes from yellow to red felt like it elevated her stress levels and she would feel more anxious as she waited for the simulated bus. The focus group agreed that the abrupt colour change decreased the ability of the display to be ignored.

The information displayed on the ambient display was very valuable according to the focus group. Unexpected small changes in behaviour of the focus group were observed as the colours changed e.g. gathering belongings and stopping to communicate with other people or on their mobile devices. *Joe*, the Civil Engineer, commented that the visual cue from the ambient display was better than the visual cue of the bus suddenly arriving at the station. It gave him a better indication of when he has to get his belongings ready. Everybody, except *Alicia,* said that the shape was inobtrusive although the abrupt changes in colour created a display that was hard to ignore.

Name	What was liked?	What should change?
Sebastian	He liked the shape of the prototype.	Sebastian wanted more precise information as he felt that only alluding to the information was not informative enough.
Sara	That you don't have to worry about missing any important information. Sara liked that the colour indicated information rather than displaying precise information.	She did not like that the colour changed abruptly and also disliked the long time yellow would take to turn into red as this increased her stress and anxiety level.
Joe	He liked that the display used visual cues for indicating when the bus would arrive.	
Alicia	The shape was "ugly and utilitarian". She also indicated that she would stop to communicate either on her mobile or while in conversation to get ready for the bus.	Would like to change the shape into something more "pleasant".
Stefan	He liked to that he could get ready for the bus just before the bus would arrive.	He wanted the colour to fade into each other instead of abrupt colour changes.

Table 6.2: Comments Prototype 1

Design Prototype 2

The second prototype used two RGB SMD strip LED 5050 30 LED/m, each 1,5m long. A new diffuser has been designed in the form of a bow or sail shape that will vary the light intensity from the LEDs to help eliminate the hotspots.

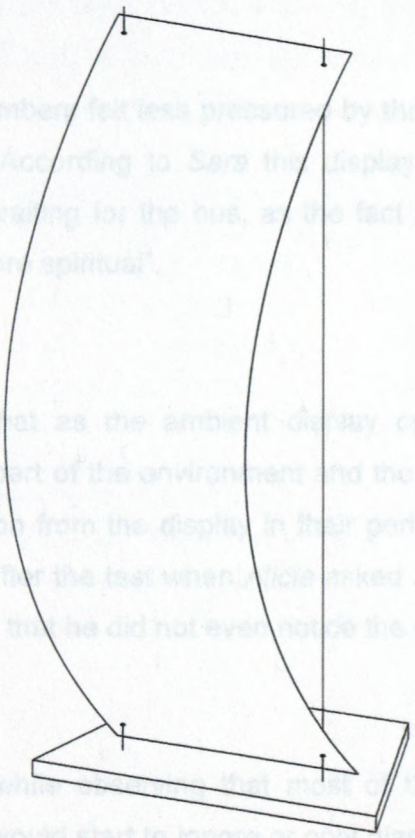


Figure 6.5: Second design prototype

The micro controller had to be reprogrammed to accommodate the fading between colours as suggested by *Stefan* and *Sara*. According to *Alicia* and *Joe*, the fading created a calmer experience without hindering or diluting the information that the ambient display presented.

It was observed that the colour fading still resulted in the same unexpected behavioural changes, but they were more subtle than with the first ambient display, which incorporated a more abrupt colour change. As the ambient display changed from the colour yellow to the colour red, it was noticed that *Sara*, *Alicia* and *Sebastian* would stand up or gather their belongings gradually and not all at once as in the first design prototype. *Stefan* waited to the last colour change to get his belongings together although he had made sure that all his belongings were ready earlier.

All focus group members felt less pressured by the second prototype than by the previous one. According to *Sara* this display would decrease her own stress level while waiting for the bus, as the fact that the colours faded into each other was "more spiritual".

It was observed that as the ambient display cycled through the various colours it became part of the environment and the group members started to place the information from the display in their periphery. This was confirmed by the discussion after the test when *Alicia* asked *Joe* what he thought of the display and he said that he did not even notice the display.

This was noticed while observing that most of the focus group members, except *Sebastian,* would start to ignore or only glance at the display, however they still changed their behaviour as observed during the test. *Sebastian* commented that the shape of the design created a small focal point in the environment, which he felt was not the case in the first design prototype.

The sail diffuser was unsuccessful as most of the light dispersed through the sides of the display. *Joe* and *Stefan* both felt that the variation in the light intensity on the diffuser, which was created by the bow shape, detracted from the overall experience of the ambient display. *Alicia* and *Sebastian* suggested that the cylindrical shape would work better if the hotspots from the LEDs could be revisited or decreased.

With the addition of the second LED strip, the group felt that the light would be sufficient in the Civic Centre station although it was suggested to add one more strip as this will increase the luminosity even more.

Name	What was liked?	What should change?
Sebastian	The colour fading works better as this indicated more precisely the location of the bus. "Almost red means a specific location which was not achieved, according to me, in the first prototype.	He did not like the shape as he indicated that the shape created a focal point in the environment. "The previous shape (prototype 1) works better."
Sara	Colour fading was more of a spiritual experience than the abrupt colour change of the previous prototype (Prototype 1)	
Joe		Felt that the bow diffuser detracted from the overall experience as the uniformity was lost and that if you decreased the previous prototype (prototype 1) hotspots it would work better.
Alicia	The introduction of the crossfade created a calmer experience as the colour would "just fade into each other which was a relaxing experience."	
Stefan	I liked the fading colours, as this allowed me to plan better when I need to be ready.	"It starts looking like a lampshade and there is no uniformity in the light. Maybe you should have both, a lampshade and the first prototype in one."

Table 6.3: Comment on Prototype 2

Design Prototype 3

The third prototype consisted of two RGB SMD LED 5050 30 LED/m of 1,5m each and one RGB SMD LED 5050 30 LED/m of 1m in length. The diffuser for the ambient display has been redesigned to include the cylindrical shape of the first design prototype and the two larger diameter diffusers to create more visual appeal and to help decrease the amount of hotspots which was commented on in the first design prototype.

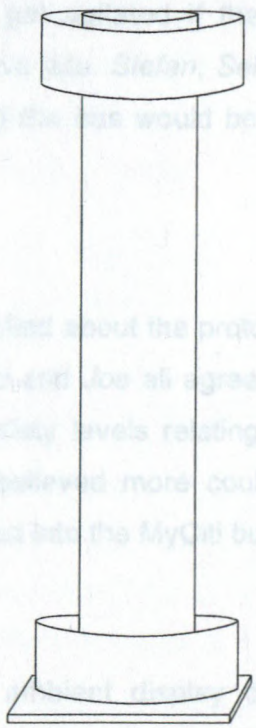


Figure 6.6: Third design intervention

The major differences between the second prototype and the third prototype are the diffusers and the inclusion of the extra one-meter LED strip. The larger diffuser band at the top of the display helps to diffuse light even more, which was more visually pleasing according to *Alicia*, *Stefan* and *Sara*. The height of the band was calculated to be at eye level for the average South African as this will help when glancing at the display as the band is illuminated even more.

Everybody in the focus group said that they noticed the ambient display immediately but it was never the focal point for their attention. *Sebastian* commented that the design was easy to ignore but also easy to read. It was an object that was pleasant to glance at and the information displayed was clear to understand and interpret.

Observations revealed that the more these test were administered the less the focus group would get agitated if the test ran a scenario where the simulated bus would arrive late. *Stefan*, *Sebastian* and *Alicia* noted that they could mentally prepare if the bus would be late through a quick glancing at the ambient display.

The focus group was excited about the prototype as they felt they had helped to develop it. *Sara*, *Alicia* and *Joe* all agreed that the ambient display would decrease stress and anxiety levels relating to bus travel. *Sebastian* said it was a solution but he believed more could be done and that the design should be better integrated into the MyCiti bus service.

It was added that the ambient display calmly increased the amount of important information in the Civic Centre bus station. The focus group argued that the display did not increase the information overload, which was experienced at the station, as the ambient display was very easy to ignore when wanted to.

Name	What was liked?	What should change?
Sebastian	"The shape makes it easy to quickly look at it, read it and understand the colours quickly and it is not so "in your face" design".	"Better communication about the specific location should be investigated further, but as it stands it would be useful, It should be better integrated and maybe form part of a bigger system."
Sara	Said that the intensity of the light created a better visual cue and "It was much more informative because the light was brighter"	
Joe	"Using this display will help me not to get so angry when the bus is late."	
Alicia	"The brighter light creates more intense colours and helps illuminate the make shift station better." Alicia said that the display helped her to get mentally ready for the commute.	
Stefan	"Brighter is better." "You don't have to focus on the display, it works just as well when you glance at it."	

Table 6.4: Comments on Prototype 3

It was clear that the best prototype among the three tested was prototype number three. This combined most of the positive features, according to the focus group, and addressed most of the issues except the issue of having more precise reading on the display. The controlled environment and focus group helped develop the prototype, in situ testing is needed to test real world application, and this will follow in the next chapter.

Chapter 7

FIELD-TESTING

7.1 INTRODUCTION

This chapter will discuss the in situ field-testing and the conclusions ascertained from the investigation. The testing was administered at the Civic Centre bus station from 14 November 2011 to 20 November 2011. The ambient display prototype was placed at the Tableview pod in the Civic Centre bus station. The methodology used for the examination and verification of the data were video analysis in conjunction with unscheduled semi-structured interviews.

Three assistants were used to help with the data collection, Miss Nehanda Magan, Mr Nico Hendricksz and Mr Jonty Erne. Miss Magan and Mr Erne operated the prototype and Mr Hendricksz operated the cameras. The author interviewed stakeholders keeping consistency with the earlier interviews.

7.2 IN SITU FIELD-TEST

Interviews were conducted from 7:00am to 9:00 am and between 3:30 pm to 7:00 pm. These times were selected based on the expected commuter traffic. The prototype was placed in a corner of the Tableview pod on the 14th and 15th of November 2011. Later it was placed next to the main entrance where it was more visible to the commuters and conductors. The lighting conditions next to the main entrance were also better suited for the prototype.

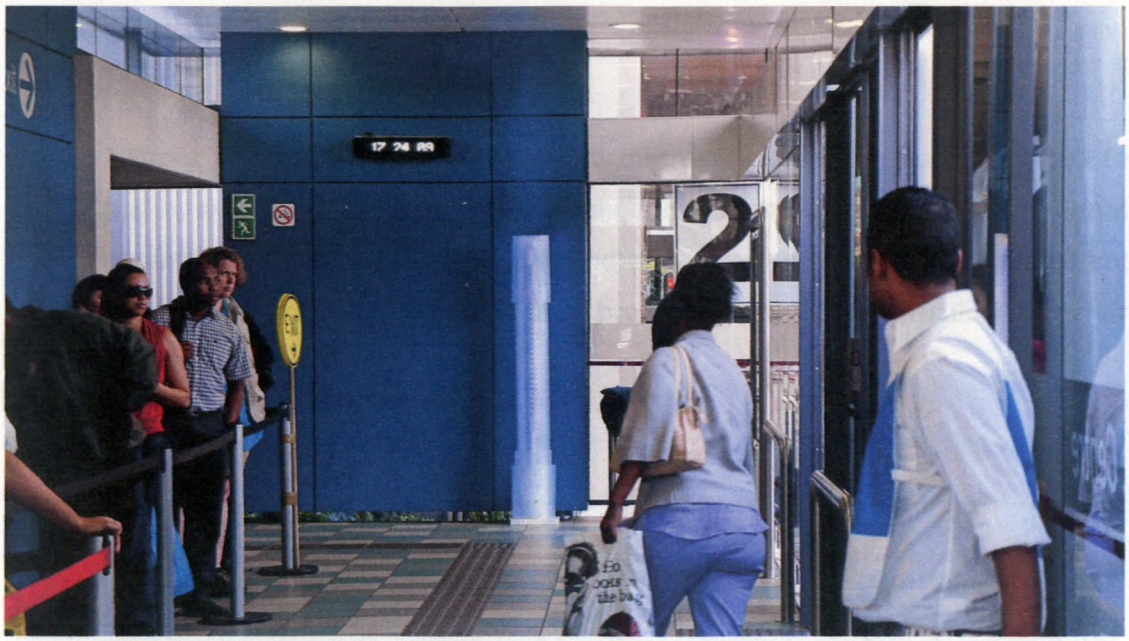


Figure 7.1 :In Situ Testing

The video was taken from the other end of the Tableview pod as not to attract unnecessary attention to the ambient display prototype. The indicator on the video camera was camouflaged. Miss Magan noted that commuters did not react to the camera and carried on doing what they were busy with as normal.

Mr Hendricksz controlled the ambient display prototype by resetting the micro controller. The simulation used time rather than GPS co-ordinates, because it was impossible to connect to the bus's GPS modules at the time.

Although the simulation worked sufficiently it was felt that a richer experience for both the commuters and conductors would have been provided if the display was connected to the GPS units on the bus. However the information gathered was sufficient to establish proof of concept.

7.3 INTERVIEWS

Twenty unscheduled semi-structured interviews were conducted in situ to gather sufficient feedback on how stakeholders perceived the prototype, what connotations they connected to it and what their experience of the ambient display was like. The interview style provided better insight resulting in richer and more in-depth data.

In Situ Interviews while filed testing								
		14 Nov	15 Nov	16 Nov	17 Nov	18 Nov	19 Nov	20 Nov
RACE	Asian				1			
	Black	1	2	1	1	1	2	
	Coloured	2	1	1	1	1	1	2
	White	1	1	2	1	1	1	2
AGE	16-25	3	1	2	1	1	1	1
	25-45	1	1	1	2	1	1	2
	45-65		2		1	1	2	
	65+			1		1		1
SEX	M	1	2	2	3	2	2	1
	F	3	2	2	1	2	2	3

Table 7.1: Composition of In Situ interviewees

Interviewees were selected based on the criteria used for earlier interviews; the same ethical procedure was applied (see chapter 5). Each interview took about 3 minutes. Transcriptions are available in Appendix B. The name of each interviewee was altered to protect his/her identity.

7.4 FINDINGS

Day 1

It was determined that most commuters did not notice the display although the majority of them felt that they were more relaxed about the arriving bus. This was evident when one of the buses was more that 3 minutes late. A total of four commuters were interviewed. *James*, a 44-year-old man, said that he did notice the ambient display and quickly understood that the changing of the light was connected to the arrival of the bus. All of the interviewees connected the changing of the colour to the time it would take for the next bus to arrive.

It was noted that the conductors at the Tableview pod would constantly glance at the ambient display to determine the location of the bus. They became so confident in the system that they did not use their printed time schedules. They determined that the green light means that the bus just left the Woodstock station and that red indicated the opportune moment to call the commuters outside as the bus will be arriving shortly.

Figure 7.2: Conductor glance day 1

One of the conductors mentioned that she would rather use the ambient display system because it was quicker to read and easier to understand. She then proceeded to announce to the commuters that the next bus had left the Woodstock station as soon as the ambient display turned green.

Day 2

It was discovered that *Clara,* an 18-year-old woman, and *Johan,* a 50-year-old man noticed the ambient display and made connotations to it. *Jessica,* a 45-year-old woman said that she would rather stand outside and as soon as the ambient display would turn red, she would join the queue.

Stakeholder connotations varied from displaying the arrival time to the temperature inside the Tableview pod as it filled up with commuters. There was considerable variation but the context remained a constant factor.

Figure 7.3: In situ testing day 2

Being the second day of testing the conductors at the Tableview pod were familiar with the ambient display and understood what information it presented. It was noted that they stopped announcing the specific arrival time of the next bus. They would rather indicate that the bus has either just left the Woodstock station, as the ambient display turned green, or that the bus is waiting at the traffic signals when the ambient display turned red.

Commuters said that the new information, which was location based rather than a specific time created a calmer experience. It was noted that fewer commuters became agitated when the bus was late, because the conductor never specified at what time the bus would arrive.

Day 3

Most of the interviewed commuters understood how to use the ambient display and comprehended the information it displayed. They attached time or the specific location of the bus to the ambient display.

Terrance, a 28-year-old conductor, connected the colour red to the two traffic signals along the route and *Peter,* a 20-year-old man, connected the colour to the speed the bus was traveling towards the station. All of interviewed stakeholders indicated that they would like a map to reference the data the ambient display presented. It was however determined that they understood the system without any extra information.

Figure 7.4: In situ testing day 3

Commuters said that they would like to see more of these displays at other stations as they felt it was beneficial to both the conductors and commuters. Some commuters raised concerns around the luminosity of the display. They wanted the display to be brighter and some would like the display to be integrated into the station more efficiently.

Commuters were informed that the purpose of the current testing was only to proof the concept. A more integrated system would be designed based on the results.

Day 4

It was decided that the remainder of the in situ tests would only take place in the afternoon, as the number of commuters was on average 10 times more that in the morning. When the afternoon session started, the conductors asked whether they could use the ambient display after the tests were completed.

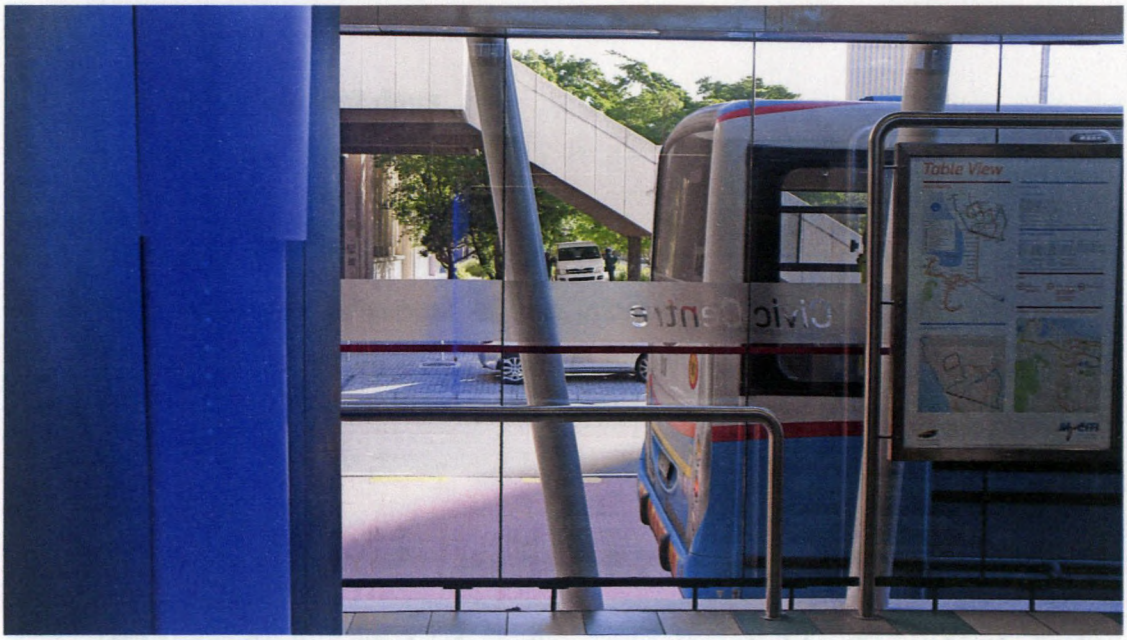


Figure 7.5: In situ testing day 4

All of the interviewed stakeholders, except *Dennis* a 48-year-old man, stated that the ambient display improved the experience traveling from the Civic Centre bus station, as they were well informed about the arrival of the bus. It was observed in the video footage that commuters who travel often started to inform other commuters about the ambient display and what information it displayed according to them.

It was noted that conductors stopped announcing the arrival time all-together and that *Peter,* a 31-year-old man, and *Sam,* a 25-year-old woman, indicated that they would rather use the ambient display to gauge information instead of relying on the announcements of the conductors. The conductors discovered that they spent more time on managing the pod rather than announcing hypothetical information.

The rest of the test days

Interviews with commuters and conductors continued, but the gathered information was a repeat of the information from the first 4 days. The transcribed interviews are available in Appendix B.

7.5 CONCLUSION

Without indicating what information was presented by the ambient display, commuters and conductors quickly figured out that it pertained to the arrival of the next bus.

After the second day of in situ testing most conductors had a clear understanding of how to use the ambient display. Because the commuters interacted far less with the display than the conductors, it took them longer to figure out what the ambient display presented. This was determined after commuters were exposed to the ambient display more than twice. It was thus concluded that the information the ambient display presents is relatively easy to understand.

When the ambient display was understood, both the conductors and commuters used the display to determine when the next bus would arrive. Because commuters and conductors were informed by the display, slight behavioural changes were noted. According to the interviews, these changes improved the overall experience of waiting at the bus station. It was then concluded that the ambient display was useful to the people occupying the bus station on a regular basis.

The system however could have been better incorporated into the environment. The prototype had drawn unnecessary attention to it. This undoubtedly aided the quick understanding of the information and decreased the amount of ambiguity around the message.

It was however observed that after the novelty wore off, conductors and commuters used to glance quickly at the display and then carry on with what they were busy with. It was determined through the interviews that the glance was to obtain the information quickly, which was displayed.

One commuter described the process as similar to glancing at a watch. When somebody asks one directly what the time is after glancing at a watch, one would usually have to look again to answer the question. According to the commuters one might understand the information by glancing at it quickly but one will not be able to recall it afterwards.

Figure 7.6: Quick adoption

It was surprising how quickly commuters and conductors adopted the system in the Tableview pod. This is believed to be the direct result of the lack of proper signage and schedules at the Civic Centre bus station.

It was, noticed when analysing the video recordings that the more commuters and conductors saw the ambient display the more they would change their behaviour. This was discovered when observing the same three commuters and conductors on different days. The behavioural change was more prevalent in the conductors as they saw the system operating more often.

Video recordings and observations took place before the in situ test started. This served as a control instrument. The recordings revealed that commuters became agitated and stressed when the conductor announced the *estimated* arrival time. People would stand in a queue and show signs of frustration. Most commuters would constantly look at their watches or cellular phones.

This changed when the ambient display was introduced into the Tableview pod. Once the information was understood, it was no longer necessary to check watches constantly in order to be updated on when the bus would arrive. The display would provide that information at a glance. It was found that this calmed commuters down and decreased the level of stress and anxiety associated with waiting for the bus.

Figure 7.7: Bus left Woodstock bus station

Figure 7.8: Bus at train yard

Figure 7.9: Bus at traffic signal

Figure 7.10: Bus just arrived at Civic Centre bus station

The ambient display prototype was successful in testing the proposed concept. This was determined by the amount of positive feedback received from the stakeholders. This argument was confirmed and strengthened by the information provided by the video analysis.

Chapter 8

INTERGRATED SYSTEM

8.1 INTRODUCTION

The following chapter will discuss the possibilities of designing and developing an ambient display system that could be integrated with the current MyCiti management system. It is based on the findings and discussions in Chapter 6 and 7. The current MyCiti system will be interrogated and some possible design interventions will be mentioned. A system will then be conceptualised incorporating the ambient display technology. This is intended to increase information at each bus stop without increasing information overload as discovered in Chapter 5 and 6.

8.2 THE CURRENT MYCITI SYSTEM

The current MyCiti system consists of four nodes or stations. These nodes work together catering successfully for commuters, conductors and bus drivers.

The four nodes are as follow:

- Feeder route stops
    - Each route provides feeder route stops (FRS) that have been constructed at 500m to 1km intervals. These stops currently consist of a vertical metal pole that has a cement footing.
    - New FRS have been designed and implemented as the research was completed. These new stops provide some shelter and information regarding the bus services. There are currently five new variations depending on the popularity of the stop and the availability of space at the specific location.

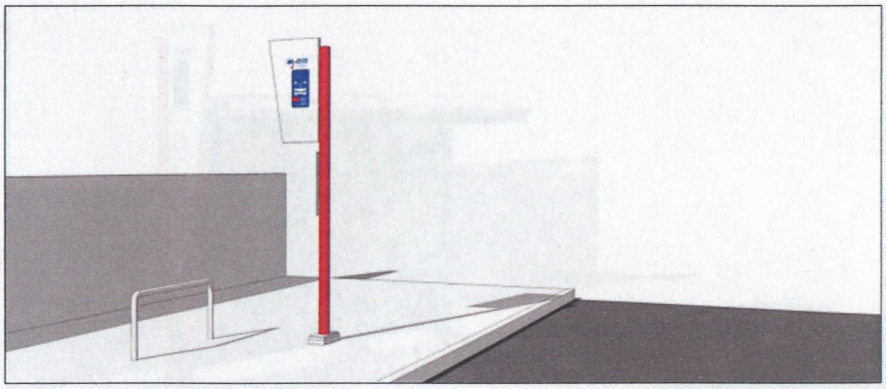


Figure 8.1: Smallest FRS

(Source: www.Skyscrapercity.com)

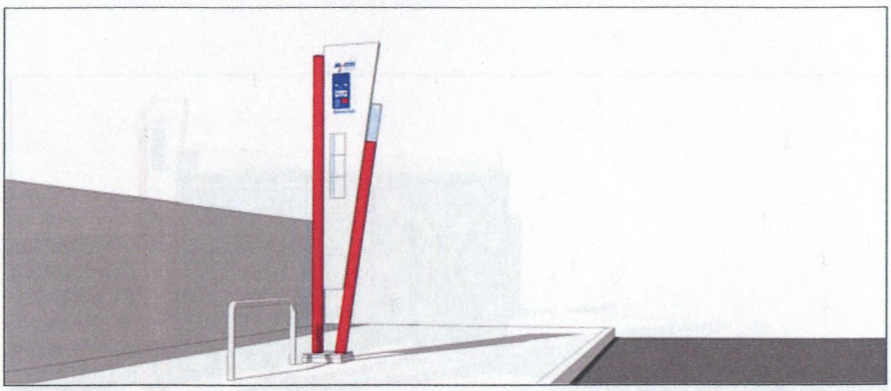


Figure 8.2: Medium FRS

(Source: www.Skyscrapercity.com)

Figure 8.3: Large FRS closed side

(Source: www.Skyscrapercity.com)

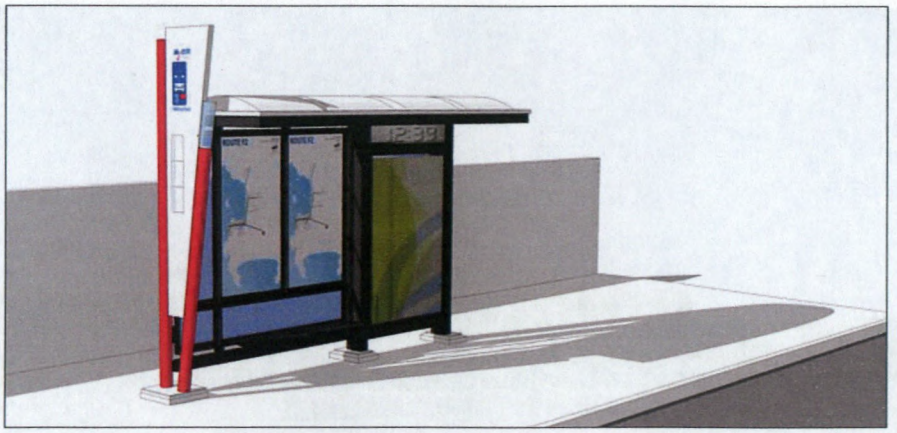


Figure 8.4: Large FRS open side

(Source: www.Skyscrapercity.com)

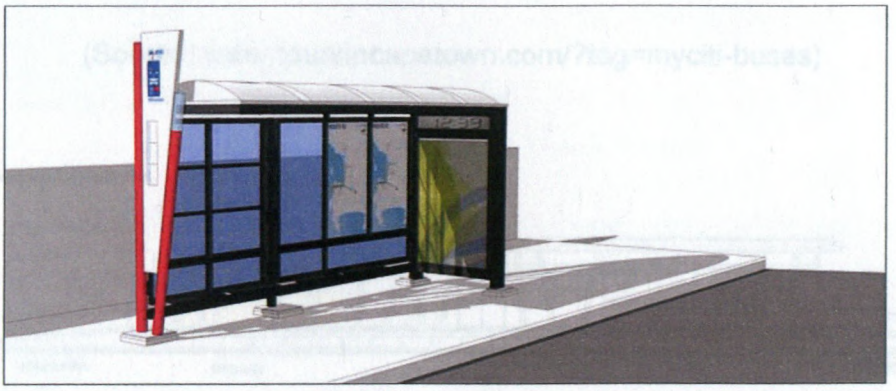


Figure 8.5: Maxi FRS

(Source: www.Skyscrapercity.com)

- Connection Stations
    - The connection stations (CS) are located in the heart of a suburb where the MyCiti bus service operates. These stations connect all the feeder routes. The CS also connects to trunk routes, which connect to the city centre. An example of this type of station can be seen at Tableview.

Figure 8.6: Tableview connection station

(Source: www.toursincapetown.com/?tag=myciti-buses)

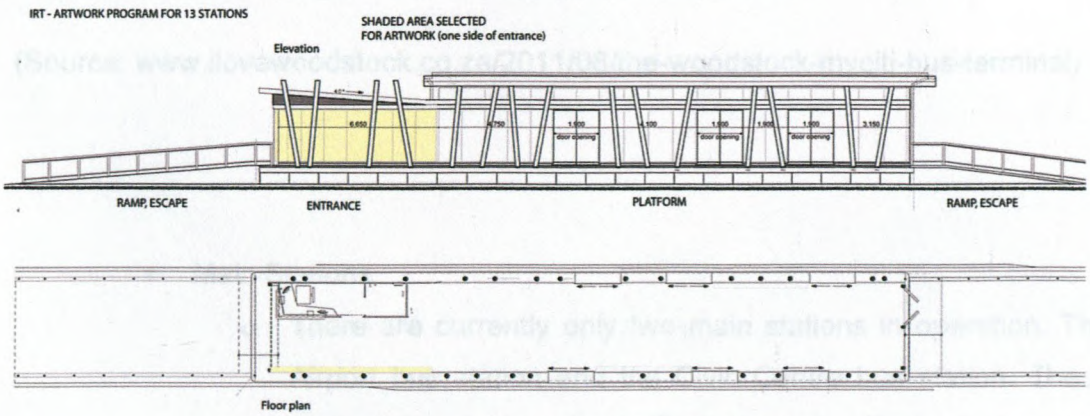


Figure 8.7: Connection station schematic

(Source: www.myciti-art.blogspot.com)

- Trunk Stations
  - These stations are situated along a trunk route. These stations are not connected to feeder routes, but are often seen as a connection hub with other modes of transport like trains or minibus taxis.

Figure 8.8: Woodstock Trunk Station

(Source: www.ilovewoodstock.co.za/2011/08/the-woodstock-myciti-bus-terminal)

- Main Stations
  - There are currently only two main stations in operation. The Airport bus station and the Civic Centre bus station. These stations are designed specifically to a site. Each site has very strict design guidelines and the size differs tremendously.

Figure 8.9: Main station at Airport

(Source: www.toursincapetown.com/?tag=myciti-buses)

Figure 8.10: Main station at the Civic Centre

(Source: www.flickr.com/photos/richardatuct/5797061881/sizes/z/in/photostream/)

Each type of node has been investigated as a system on its own and as part of the larger MyCiti system. The aim of the proposed ambient display system is to introduce the proven benefits of the tested prototype to each kind of bus stop in an optimised way.

MyCiti is using both Worldwide Interoperability for Microwave Access networks (WiMAX) and cellular technology to communicate between the different nodes and HQ. These types of communication will be used in the development of the proposed ambient display system.

Backbone of the ambient display system

This *Backbone* concept refers to both the technology that will make the system feasible and the methods of implementing this technology into the current system of the MyCiti bus service. The technology can be seen as the components needed to deliver the correct real-time information to each ambient display.

The headquarter (HQ) of MyCiti is able to track each active bus through its built-in GPS unit. The HQ is able to receive real-time GPS co-ordinates from these units and to redistribute the information to the correct nodes in the network.

The preferred method of communication for MyCiti bus service is currently WiMAX. WiMAX is a wide area wireless network with a range of about 50km. Alternatively MyCiti sends data by means of cellular technology.

According to a representative from Neotel (second national telecommunications network – contacted on 15 August 2011) up to 1 Gigabit of data can be sent via WiMAX per second to a fixed station like the nodes in the current MyCiti system. Each node has the capability to connect to the network and receive data from HQ.

Although there have been many discussions around the topic of using solar panels to power each node (including the FRSs), this issue was not finalised by the time this study was completed. All stations run on electricity from the grid, supplied by Eskom (national power supplier). Each station, including FRS, is supplied with 220v-240v AC.

FRS design

The new FRSs have been designed to shelter commuters, improve brand visibility, increase display space for information and provide reasonable safety. A light has been incorporated into one of the signage poles. This light fitting will be re-equipped with a 12V transformer, a micro controller connected to a RGB LED light with the capacity to provide enough luminosity.

Figure 8.11: Proposed FRS

The micro controller will be connected to the network through WiMAX or a cellular module and use information received from HQ to steer the RGB LED through its colour pattern. Digital beacons along the routes will be programmed into the central system. A bus passing through a beacon area will trigger a message to be sent to the relevant node.

Connection Stations

The same principle as described for the FRS applies to the connection stations. The ambient display will change colour according to the distance between the bus and the station.

The red line in figure 50 indicates the proposed location to incorporate RGB LED strip lights into the current connection stations. A U-shaped channel runs around the ceiling perimeter. The dimensions of the channel will perfectly accommodate the ambient display system. It was also established that the space inside the channels would remain unused as they are purely structural elements. All existing stations have been built along the same structural design specifications.

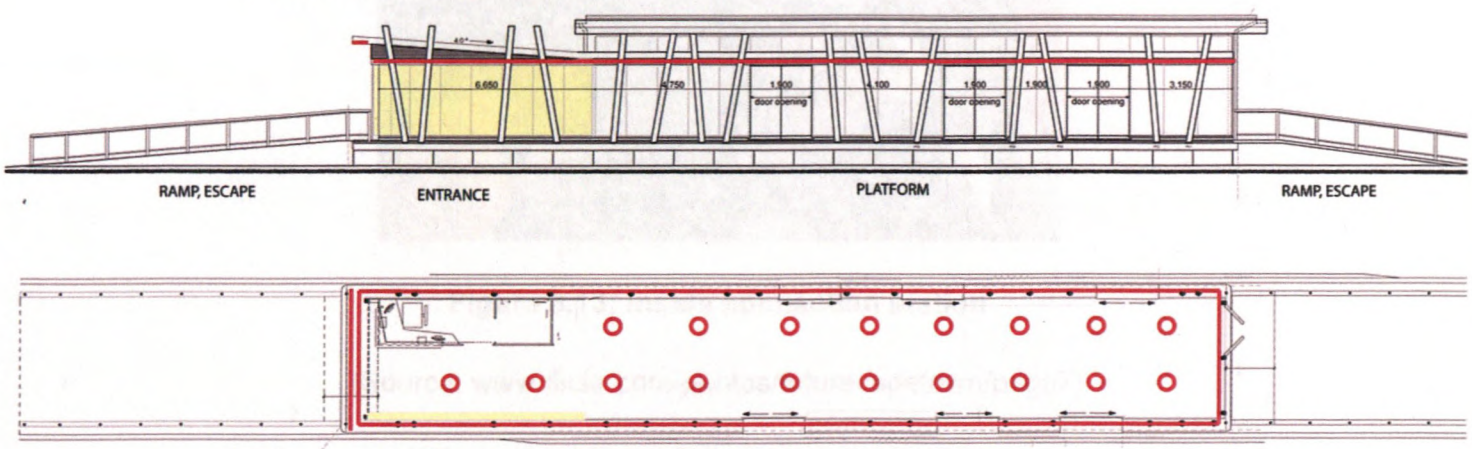


Figure 8.12: Proposed Connector Station

The ambient display system would shine light up to the ceiling of the stations creating a kind of halo effect against it. This effect will be noticed by the commuters and conductors but could be easily ignored if they wished to do so. The expected halo effect is illustrated in figure 8.13. This image was taken from futurecapetown.com. The colour on the ceiling in the photograph is a reflection of the designated red surface that the buses travel on. This image could be seen as a representation of what the ambient display system would look like once it is incorporated into the U-shaped channel. The luminosity of the RGB LEDs would ensure that the reflection would not interfere with the information being displayed.

Figure 8.13: Inside connection station

(Source: www.flickr.com/photos/futurecapetown/page7)

Because of the availability of the channel and the expected ease of installation, the display system could be implemented in a short period of time and with minimal inconvenience to the commuters and the conductors.

Main Station

The same proposed system applies to the main stations, although the size and the footprint of each station differ. The Civic Centre bus station uses high power spotlights in the central area where all the pods connect. Those could be replaced by high power RGB LEDs. Although these high power RGB LEDs are very expensive, they provide the best colour fade ability. The pods at the Civic Centre bus station are designed in the same manner as the connection stations which means that they have the same U-shaped channel, which would be utilised to house the ambient display system.

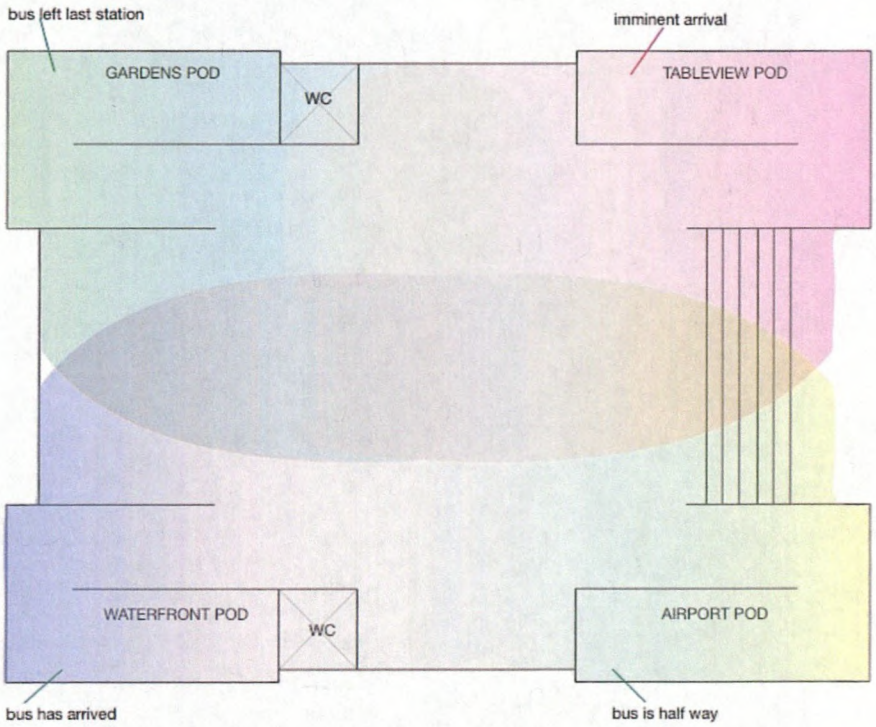


Figure 8.14: Proposed Civic Centre main station

The colour of the light would be visible from outside the station which means that regular commuters outside will have a clear and early understanding of the arrival of the next bus which is currently not available. This would mean that a commuter could walk to the station and by judging the colour that is being emitted from the station, adjust his or her speed accordingly.

Chapter 9

CONCLUSION

The ambient display system was developed to utilise location specific information and display in a manner that would not increase information overload and the negative effects connected to it like decision paralysis. It is of the author's opinion that the reason for the overload of information is not necessarily the amount of information, but can often be attributed to the vehicle and format used for the delivery.

It was clear that the ability of people to attend to the large amount of information presented to them was increasing although the amount of information available was increasing more rapidly. This creates a situation where a person wants to attend to all the available information but it becomes physically impossible. This was highlighted as a major frustration for most people who participated in the interviews.

Calm computing principles were used to develop prototypes for testing in a controlled environment with a focus group. A final prototype was created from the finding of the focus group. The prototype was tested in situ as suggested by the findings of Hazlewood (Hazlewood et al, 2011). The quasi-experiments and in situ testing created situations where information was enriched without contributing to information overload. This can be attributed to the ability of human beings to perceive information without having to focus on it cognitively and their ability to understand and interpret a visual representation of information at a glance.

The ambient display system prototype created a situation where the environment was the primary vehicle to deliver information. This resulted in a calming effect on the commuters. Their behaviour also became part of the information that was displayed to others as discovered in the video analysis. Together this created less of a distraction than previously displayed digital information and allowed less stressful circumstances.

The working of the ambient display and the system behind it was never explained to stakeholders and it was found that most of them would attach their own connotations to it. The connotations varied from time to speed. This depended on a person's own perceptual set and current disposition towards commuting and the MyCiti bus service.

It was found that if a commuter had a bad day, the ambient display system would relax the person as it removed one thing that was previously worried about. It was also established that if a commuter had a good day, the colours would cause an increased level of excitement.

The system would use very accurate data from the bus and HQ itself. The resulting very small margin of error and perceived reliability of the system would create a calming effect on people. It was found that the focus on information regarding time increased the stress levels of commuters when the estimated time of arrival did not coincide with actual arrival of the bus. Even a 30 seconds difference increased the level of stress notably.

As the colours of the display would fade into each other, commuters felt that the rate of change was sufficient to be noticed, yet slow enough not to become pushed information that needed immediate attention. This was in contrast to a digital clock where it was found that people would constantly focus on it and count down the seconds.

The information most sought after by commuters in the station was if the bus was on its way. People liked to know if they should start forming a queue and wait or could they do something else in the mean time. The ambient display system provided a service not only for the commuters, but for the conductors as well. It was established that the display made it easier to get commuters prepared for the next bus, as the colour change was a reliable indication of the situation.

This thesis has provided findings to suggest that information overload may not only be caused by the amount of information, but also by saturation of the method used to deliver the information. Findings suggest that it could be more beneficial if information could be delivered in a less saturated form like colour, smell or haptic sensation. It could provide a much richer environment where society could absorb more information calmly.

Although the prototype used in the in situ test was not fully integrated into the environment as envisaged by Mark Weiser (Weiser, 1998), according to the interviews it blended sufficiently into the surroundings. The blending of the colour alleviated some of the agitation commonly associated with information overload. It created a calming effect according to the interviews and video analysis. The proposed ambient display system would be fully integrated into the MyCiti station's environment. This will help create a situation where the information, displayed by the system, would be perceived in a person's periphery rather than being the forced focus of his/her attention.

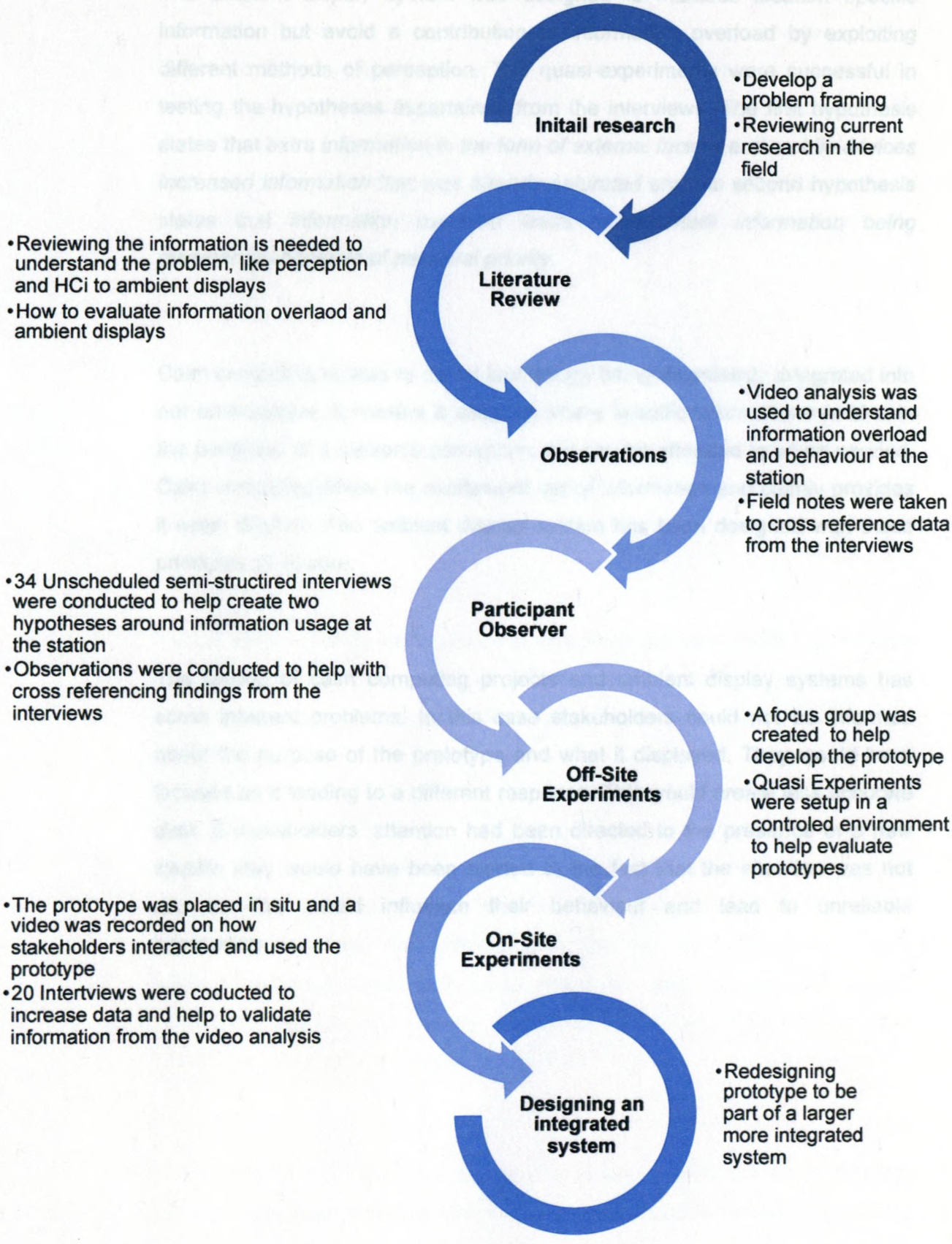


Table 9.1: Process Overview

The ambient display system was designed to increase location specific information but avoid a contribution to information overload by exploiting different methods of perception. The quasi-experiments were successful in testing the hypotheses ascertained from the interviews. The first hypothesis states that *extra information in the form of external factors and mobile devices increased information that was already saturated* and the second hypothesis states that *information overload leads to important information being disregarded because of personal priority.*

Calm computing relates to digital technology being seamlessly integrated into our environment. It creates a situation where specific information remains in the periphery of a person's perception, but can be attended to when needed. Calm computing takes the excitement out of information and calmly provides it when desired. The ambient display system has been designed with these principles at its core.

The testing of calm computing projects and ambient display systems has some inherent problems. In this case stakeholders could not be informed about the purpose of the prototype and what it displayed. They would have focused on it leading to a different response. This would create less accurate data. If stakeholders' attention had been directed to the presence of a new system they would have been alerted to the fact that the situation was not normal. This would influence their behaviour and lead to unreliable information.

Organisational issues in the MyCiti bus service created restrictions and complications for the development and design of the ambient display prototype. As a result only battery power could be used and the data that are readily available in the MyCiti information management systems had to be simulated. This raised questions about the accuracy and validity of the testing that had to be overcome through the development of alternative solutions. The testing situation had to rely on simulated information as close as possible to real-time events.

The conductors and commuters of the Civic Centre bus station easily accepted the ambient display system. This was established through the interviews and the video analysis. However, people who are blind and people with colour blindness have been excluded from the testing of the proposed design interventions.

Future design developments will try to include people with visual impairments like blindness and colour blindness. A suggestion would be to change the intensity of the colour to accommodate people who suffer from colour blindness.

The purpose of the study was to investigate the possibilities of using calm computing to enhance location specific information through the use of an ambient display. It was discovered that the lack of real-time scheduling in the public transportation sector created stress for both the commuters and conductors. An ambient display was used to provide information without increasing information and sensory overload.

The testing of the proposed intervention clearly proved the point that the concept increased real-time scheduling information calmly without increasing information overload.

If the system is to be implemented, the integration with the existing MyCiti infrastructure is expected to create more stringent requirements and opportunities to refine the design of the ambient display system and its physical components. At this point further experiments should be undertaken to increase its inclusivity towards individuals with visual impairments.

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APPENDICES

Appendix A: Initial Interview Coding

Appendix B: ADS Interview Coding

APPENDIX A

Initial Interview Coding

OPEN CODING

4 Semi-Structured Sections/Questions

		Wednesday 05 - 10 – 11 (Morning Session)		
		07:00- 09:00		
		C	W	B
	Age	16-25	25-45	29
	Sex	M	F	M
1. Level of spatial interaction	Level of interaction and the amount of time he/she occupied the public space (MyCiti Bus terminus, Civic Centre)	I use the bus every day and most weekends, I party in Cape Town and don't own a car. I work at the Waterfront.	I travel Mondays to Thursdays by bus, Friday I use my own car because I knock off from work at 3:00. I work in the Graphics department of SilverBanana	I use the bus in the mornings and the taxi in the afternoon. The taxi is quicker and cheaper but the bus is warmer in the mornings.
	What information is regarded as important to you in the space?	I think, gigs and parties posters are important. They don't advertise here and they should.	Well, for the bus station I would think the time schedule and delays are important.	When the bus is coming. How many people are in it?
	What makes you happy and what frustrates you the most regarding the space?	Paying for my ticket, to many people on the bus and the bus sometimes takes a long time to arrive.	It frustrates me that the bus is seldom on time and its usually so packed that I have to stand. What makes me happy is the ability to use public transport for real.	The queues I don't like. Waiting I don't like.

2. Level of informational connectivity regarding demand and overload	Connection to information while travelling from, print media to mobile wireless devices	I MXit a lot and I'm trying save money to buy a Blackberry. All my friends have one. It's cool.	I use my BlackBerry for everything from BBM to emails. It's a great device. Sitting on the bus and chatting to the world. I'm saving for a new Kindle. Can't wait.	I SMS. And I read the New Age Newspaper because it's for free.
	What devices (including print media) do you constantly connect with and why?	I use my cellphone because everybody has one. It is easy to tell them something by just SMSing.	I have my IPod and BlackBerry. Most of the time I would listen to music on the bus and read and send messages from my BlackBerry.	I SMS and I email at school.
	How much information can you attend to while in a public space and does it ever become overwhelming?	I just forget about things, but I usually just ignore things I can't focus on now. It works or me!	Because of my devices I do feel overloaded with information. I can only take so much it. That's why I have my earphones. It helps me focus on my things.	I attend to all the information that I can. If I miss information. Then it is not good.
3. Level of personal space "bubble" in public space to enhance information intake	Do you create a personal space "bubble" while in a public space?	I have earphones and I listen to music, this calms me down. I sometimes close my eyes so I can feel the music.	*That's why I have my earphone. It helps me focus on my things.*	No.
	Do you create this space to help focus on sometime important like a phone call?	I just walk away or talk softly. People don't want to listen to other people talk on their phones.	I don't take phone call on the bus station or on the bus; I just think it's rude. I do sometimes go sit in the bathroom just to take a breather from chaotic queues.	
	Have you missed important information before while creating the personal space "bubble" because you aren't paying attention to other information?	All the time. If I listen to music to don't here what people are saying, like if the bus is going to be late or that the bus is to full and you have to wait.	I have missed my bus because of miss information I got from the station's guide. I quickly went to the bathroom and I missed it.	

4. Level of pressure from information to be constantly informed	Do you feel pressured to be well informed all the time?	Yes, I can't chat on MXit to everybody. I sometimes forget about a SMS I got and forget to reply. Sometimes it is very important things	Yes, some friends demand your immediate response and some gets pissed off if you are busy with something else. Emails, I think it's the worst. Silly emails asking a question that they should know the answer to.	If I get a phone call I need to take it, because phoning back is going to cost me money. If I miss a call then I feel pressure that I missed important information.
	What information do you attend to first?	Personal things. The first thing I check is my Facebook page and then I MXit to see who is doing what.	*LEFT ALONE BECAUSE SHE WAS A AGETATED AFTER THE LAST QUESTION*	I don't know?
	What information is usually attended to last?	Like news and stuff. It just makes my day sad. Things that is not personal.		Unimportant information

OPEN CODING			Wednesday 05 – 10 – 11 (Afternoon Session)			
			15:30-17:30			
			B	B	W	W
4 Semi-Structured Sections/Questions		Age	16-25	45-65	65+	22
		Sex	F	F	M	F
1. Level of spatial interaction	Level of interaction and the amount of time he/she occupied the public space (MyCiti Bus terminus, Civic Centre)		I'm studying performance arts at Michaelis and the bus stops right outside. It works for me and I use it maybe 6 days of the week to travel around town.	I used to use the taxi. It was getting dangerous. Now I use the bus everyday to go to work and home.	I am a photographer, Love taking photos of the boat at the Harbor. The MyCiti bus has made it possible travel to and from V&A with easy. I travel about 2 times a week. Depending on the weather.	I work in Longstreet. I studied IT. I moved in June to a cheaper apartment, which overlooks a MyCiti bus stop. I've been using it ever since.
	What information is regarded as important to you in the space?		Scheduling is the most important thing. Missing a bus could mean a 20min wait.	How much people are on the bus and when I am coming.	Safety and scheduling is the most important information for me when using this public transport. I need to know is the bus safe? Is the station safe and when is the bus arriving?	Information about the area I'm in at the moment. Information about my friends and family and also information about my job.
	What makes you happy and what frustrates you the most regarding the space?		I love the idea of public transport and that it's cheap enough to be utilized by anybody. The frustrating part is probably waiting.	My children make me very happy and they go to a good school. I don't get angry much but I think it will probably be because I get paid to little.	It frustrates me if the bus is overcrowded. I have sensitive equipment with me. I will make me happy if the bus ran on time.	Frustrated that the station does not have Internet and also that the busses seem to be either 2 to 3 min early or late. That impacts heavily on my day. Happy that I moved to a new pozi. Closer to my friends, work and cheaper. Win Win.

2. Level of informational connectivity regarding demand and overload	Connection to information while travelling from, print media to mobile wireless devices	I am an apple freak. I have an IPod, IPhone 3GS and iPad I got for my birthday. I also read quite a lot of books.	I have my cellphone but it is difficult to use and expensive. I travel with Margret and we usually just talk on the bus.	I would either read a book or daydream out of the window.	I will always have my cellphone with me. It's my life. Everything and everybody is connected through it.
	What devices (including print media) do you constantly connect with and why?	I use my IPhone the most because it is so functional and easy to use. Most of my friends have IPhones and we love it.	We do not have a Telkom line so I use my cellphone to phone people.	I am a Tom Clancy fan; you will always find me with one of his books. Riveting read and paints a wonderful world of suspense with worlds.	My Samsung and my laptop. Convenience and mobility
	How much information can you attend to while in a public space and does it ever become overwhelming?	I don't know. I do sometimes feel that I'm getting to much information, especially in a public space because then I have the time to chat to people, but there are to many things to do like, Facebook, twitter MXit. Where do you get the time to do all that?	I struggle with too much information because you see; I don't want to know about what is happening everywhere else. I sometimes just tired of all the information.	At this old age, I can't process in all the information that I could when I was younger. I often find myself daydreaming to a point where I almost miss my bus.	I usually have about three windows open at a time on my laptop and usually two conversations running on my cellphone. This is just to be informed about things and people. I definitely become overwhelmed with everything. Just too much information.
3. Level of personal space "bubble" in public space to enhance information intake	Do you create a personal space "bubble" while in a public space?	I think you have to otherwise you'll go mad. Too many things are happing in a public space you have to zone out to see it in a different context.	No. I just close my eyes because all the noise and sounds give me headache.	*YES, he daydreams can be regarded as a personal space "bubble"*	I used to listen to music on my cellphone but it depletes the battery to quickly. So, now I just blackout most of the noise in the space.
	Do you create this space to help focus on sometime important like a phone call?	All the time. I crashed my boyfriend's car because I was talking on the phone and for the life of me I did not see the Stop Sign.		Daydreaming helps me plan future compositions.	This defiantly helps with focusing.

	Have you missed important information before while creating the personal space "bubble" because you aren't paying attention to other information?	The Stop Sign was pretty important. I do feel that creating a "bubble" around yourself you block information out. That information can be critical.	How do I know? If I missed it, I missed it.	I have missed a bus or two because I will be walking around the station looking at the architecture and daydreaming.	I miss a lot of information because I focus on a single task. This is fine. I just ask the person sitting next to me about the announcements.
4. Level of pressure from information to be constantly informed	Do you feel pressured to be well informed all the time?	Yes I do. All the time. As much as I love my iPhone, it can really tick me off. If you are always connected then you are always available to be interrupted.	I have go get the children dress and get then to the taxi to go to school. I then need to catch the bus to work. Sometimes I miss the bus because of the taxi that was full so I have to wait for the next one.	Not anymore. I know that I can't attend to all the information that is available and I don't even try.	There is constant pressure on a person to know everything and to do everything. It's not healthy. They should limit the amount of "*kak*" information that available.
	What information do you attend to first?	I usually check my emails first, then Facebook then information that is more general.		Information about my well-being, safety and my passion.	My friends and my work. If I don't people get very angry and agitated with me.
	What information is usually attended to last?	Class work.		Information about things that doesn't affect any part of my life.	I usually don't don't get there.

OPEN CODING		Thursday 06 – 09 -11 (Morning Session)						
		07:00- 09:00						
4 Semi-Structured Sections/Questions		W	B	C	C	W	B	W
	Age	25-45	24	45-65	62	25-45	45-65	16-25
	Sex	M	F	F	M	F	M	M
1. Level of spatial interaction	Level of interaction and the amount of time he/she occupied the public space (MyCiti Bus terminus, Civic Centre)	Before I use to go with the Golden Arrow Bus. The MyCiti is more convenient and a cleaner/better package.	The bus stops outside the office so it is very convenient. I use the bus everyday. It is nice and clean and very organized.	I started using the bus about one moth ago with my husband. We travel together to work. He works about 2 blocks away from me.	I started using the bus the first month it was working.	I work at the Civic Centre so the bus terminus is place very conveniently. I use the bus every day and sometimes over the weekend with the family.	I come from France and I have stayed in South Africa for 10 years. I love it here. Its good to have a public transportation that works. I have started to use the bus since Monday (03-10-2011) and I think it is very good.	I study at Granger Bay hotel school and the bus stops very close to it. It is very nice.
	What information is regarded as important to you in the space?	Signage is important. It was very strange the first few times on the bus because of the confusing information.	Any information regarding my friends and also about where the bathrooms are and whens the busses coming.	Bathrooms, safety, dustbins and how much it will cost. O, and the time the busses depart.	I like to know here things are and what time things are happening. I Worked as an engineer for many years.	Time. Time is very important to me. I need to know when the bus will arrive or leave. How long will it take and when will I be at home.	There is no tourist information and the bus schedule does not work so well. People say the bus will be late and then it's early and vice versa.	Information about Cape Town is important. Where to go for coffee and what time the busses leave.
	What makes you happy and what frustrates you the most regarding the space?	They have taken the time schedule way at the Civic Centre because people became angry when the bus was not on time. The still have a general idea when the bus will arrive but no real set time. At least that's the way it feels.	It makes me happy that the bus is always clean. Sometimes the bus is a bit late but it's fine.	It makes me happy to see so many people enjoying the bus. It frustrates me to wait for the next bus.	Happy that Cape Town is provided good service at a competitive price. It frustrates me that not more people are using it.	It makes me happy if I get to the bus terminus and climb on the bus and it leave immediately. It frustrates me if I just missed the bus and I know if I have ran I would have caught it.	Connecting with people from other countries on the bus makes me happy. I'm proud to promote Cape Town. It makes me angry when services are not working.	It makes me happy that I can sleep on the bus for 30 min. It frustrates me when I have to stand because no seat is available. And also when I am late for class because the bus was slow or late.

2. Level of informational connectivity regarding demand and overload	Connection to information while travelling from, print media to mobile wireless devices	I connect using my iPad. All my data I need while travelling is on it. From books, iTunes and email client. It's made my daily commute more comfortable and made it feel quicker.	I read newspaper in the morning and I use my phone.	I use a cellphone to connect to get all my emails and SMS's from my daughter.	I have a new BlackBerry. I use it for emails from work and SMS's from family.	I have the new iPhone and it is fantastic. I connect to Facebook, twitter and email all from the single device.	I use my laptop and cellphone to connect to the Internet.	I have two cellphones. One for family and one for friends. I use both on a daily basis.
	What devices (including print media) do you constantly connect with and why?	My iPad and my phone, I would say is my most important devices at the moment. It keeps me connect to the world wherever I am.	I would say that I constantly use my phone because I have everybody's number who is important to me.	I have a Nokia something. Very difficult to work and to much buttons.	My BlackBerry and my diary. (VERY THICK DIARY) Everything that I need is on one of these things.	I use my laptop and my iPhone for everything because it is so compact and user-friendly.	The laptop has a bigger screen and more storage space; the cellphone has a smaller size and is easier to carry around.	I connect to Facebook from my phone I also use MXit, because all my friends as there and its easy to chat to them.
	How much information can you attend to while in a public space and does it ever become overwhelming?	I have tried to submerge myself in information, both physical and digital. I know for a fact that I suffer from information overload. If I don't connect to the digital world, I'm uninformed.	Because I am so busy with my phone I sometimes struggle to listen to what the people on the station tells us about the bus. It's going to be late or what not.	I try to get enough information about where I am and what I'm doing there. It's like a bathtub. Sometimes information goes down the drain or overflows.	I struggle to attend to constant emails from work and friends. I am very bad at responding straight away.	*She got a phone call for the rest of the wait at the bus station. She is creating a personal bubble by turning her back towards the people and I had to tap her shoulder to indicate that the bus has arrived.*	I think that the information on the internet is too much and if you connect to your social media site and your twitter account, then you can't accept more information. You are full already.	I went to London last year and we went to Piccalilli Circus. There were so many adverts and screens that I got nauseas from feeling so overwhelmed.

3. Level of personal space "bubble" in public space to enhance information intake	Do you create a personal space "bubble" while in a public space?	It does happen from time to time. I have recently stated watch a series on the iPad. This demands constant attention because of the sound and images. I think this creates a "bubble".	I will sleep on the bus or at the station. I travel far so I need to rest.	Sometimes yes. I find myself switching off for a bit. My husband always laughs at me.	I know my wife fades away but I don't think I do.		I listen to music on my cellphone. It relaxes me and helps me to enjoy the commute.	I usually sleep on the bus. Does that count? I sometimes listen to music with my earphones.
	Do you create this space to help focus on sometime important like a phone call?	Sometimes I have to attend to work emails while still commuting. I then have to create a "bubble" because I need to focus.	*Does not enhance focus, Sleep is maybe more for recovery or starting the day.*	I think while I'm switched off thinking about dinner and money matters.			Yes, it relaxes you and you are not disturbed. So you can focus on other things.	No
	Have you missed important information before while creating the personal space "bubble" because you aren't paying attention to other information?	I know I have but I can't think of anything right now. I have boarded the wrong bus because I didn't hear what the conductor said.	People always wakes me up if I fell asleep. So they know if I'm asleep and they will tell me if I missed anything.	I think I have missed a couple of key bits of information. My husband sometimes stops in the middle of his sentence and asks me if I'm listening.			Yes I have missed information because on my earphones and because I was new to the MyCiti.	I have missed my stop a few times and I have missed the bus before.
4. Level of pressure from information to be constantly informed	Do you feel pressured to be well informed all the time?	Yes, I see myself as a well-informed person. The problem is to keep being well informed you have to constantly be connected.	If everybody at work is talking about something and I don't know what its about I feel stupid. There is a lot of pressure.	There is just too much information for one person to read.	Yes. When a person emails you they expect you to respond straight away. You can't always and then they get frustrated.		If you are not informed you are behind the world. You need to know things and if you don't you lose out on important information.	I feel a lot of pressure to attend to as much information as possible. From friends to my studies.
	What information do you attend to first?	Any information that's central to the task I'm busy with.	I don't know.	Anything that has to do with family or friends.	Important information like an email from the boss.		Information about my life and what I'm doing now.	I want to say my studies but its my friends then family the studies.
	What information is usually attended to last?	Redundant information, like the Stock exchange and Verimark Adds	I don't know.	I think its newspapers and books.	Information like celebrities and stuff. It does not interest me so I don't spend anytime on it		Non-essential information	Then studies.

OPEN CODING			Thursday 06 – 10 – 11 (Afternoon Session)							
			15:30-17:30							
			B	C	C	W	W	B	W	W
4 Semi-Structured Sections/Questions		Age	17	17	16	65+	45-65	25-45	32	45-65
		Sex	M	M	F	M	F	F	M	F
1. Level of spatial interaction	Level of interaction and the amount of time he/she occupied the public space (MyCiti Bus terminus, Civic Centre)		I use the MyCiti since it started to travel to school and to go out over weekends in town.	Some of my friends work on the station and I chat to them everyday. I travel from Rugby with Zola everyday to school. I want to be a rugby player.	I also stay in Rugby with my parents. They work in Paarden Island so I travel with them and then to school. Cape Town Commercial.	I will retire at the end of the year and with the MyCiti, it's created to opportunity to do so. I have sold my vehicle.	I used to use the Golden Arrow bus, but I think the MyCiti is faster. So that's why I switched about two months ago?	I stay in town and work in the Waterfront. It's very nice to pay R10 to go to work and to come back.	I studied architecture and I'm busy with the MyCiti stations in town. I travel everyday.	I only use the station for the bus.
	What information is regarded as important to you in the space?		Adverts about things I like and also about sporting events in town.	If my friends are working and the bus timetable.	I would think its information about the area. The station and how the busses work.	Scheduling and travel and the help from the young people working at the station.	I believe that the timetable is very important when using public transportation. MyCiti's timetable works better than Golden Arrows'.	There is no information available at the station except the map and a basic idea of travelling times.	I think that larger screens need to be installed to relay more information because the current boards don't work well.	Time, the bus schedule and the map.
	What makes you happy and what frustrates you the most regarding the space?		It makes me happy that the bus stops so close to school and it frustrates me to wait for the bus because classes could have started already.	There is no precise bus timetable and sometimes I'm late for school because I just missed the bus.	There is not a lot of information about the busses or Cape Town. The information that is here is usually wrong.	Happy that a working public transportation has finally been implemented. Nothing frustrates me more that having to than disrespectful people.	It is a central space and quite large. It frustrates me that busses are sometimes not on time and sometimes the station is a bit dirty.	It makes me happy when I don't miss the 5:00 bus at the Waterfront. It frustrates me if I do. But as far as the station goes, it could do with a bit of colour. Very bland.	Ii makes me happy to hear positive comments about the service that I'm helping to build. It frustrates me that not more people are using the service.	I don't know. Maybe waiting and the conductor who don't know anything.

2. Level of informational connectivity regarding demand and overload	Connection to information while travelling from, print media to mobile wireless devices	My phone was stolen so I'm using the "crap" thing. It does not have any internet of apps.	I read Soccer Life on the bus everyday. I also use MXit everyday.	I connect to the world from my cellphone. It has internet and MXit.	I read on the bus. I tried the newspaper a few times but there is just not enough space to do so. I read crime novels.	While I'm commuting I use my tablet computer to connect to work emails.	I have a MP3 player and a cheap cellphone. That's the way I connect to the world. At work we have internet but they have blocked Facebook.	I have my tablet computer with me at all times, then my cellphone. I connect to the internet with my tablet through my cellphone. I'll show you.	I read most of the time or chat to the people on the bus next to me.
	What devices (including print media) do you constantly connect with and why?	It uses to be my Samsung and maybe my MP3 player. I love music and it creates a good vibe in me.	My new android smartphone. It has all my music on it and its got apps like MXit on it. Helps me organize everything.	My cellphone it my precious possession. It has all my friends contact details.	I have a mobile phone but I do not use it except for making and receiving phone calls.	I have a smartphone, tablet and sometimes carry around a book.	I love my MP3 player and I travel with it everywhere. All my friends know it.	My phone and tablet computer, although I have a book diary, I don't use it that often.	I have a phone but it is usually off.
	How much information can you attend to while in a public space and does it ever become overwhelming?	I sometimes try to do some work for school on the station but its very difficult because it is so busy and noisy.	I think it's very easy to be overwhelmed with all the information because there is so much out there that you don't know.	A lot of information I think. Sometimes I get angry because friends are annoying and want your answer now.	When I was your age there was a lot less information that I had to worry about. These days information overwhelms be everyday.	I try not to process all the information because it frustrates me that I can't attend to all at once.	I do get overwhelmed sometimes because of all the information that's available in a public space.	Have you ever seen Time Square in New York? That's way too much information for even 10 people to take in at once. We are luckily not there yet.	I can multi task really well. I think people should relax because you will get stress out if you think about all of the information.

3. Level of personal space "bubble" in public space to enhance information intake	Do you create a personal space "bubble" while in a public space?	I put on my earphones and sit on the ground. It helps me with holding my book and it's a bit more quite down there.	When I read on the bus I put my earphones on because it is very noisy on the bus.	I don't think so. Sometimes I sleep on the bus.	My hearing is not so great sometimes, so I guess you could say that I create a barrier.	I believe everybody creates a "bubble" in a public space. I know I do.	I sometimes just zone out. It helps me think.	I usually walk away to a more quite place to talk over the phone. I sometimes get so focused on emails and stuff that I block out sounds.	No
	Do you create this space to help focus on sometime important like a phone call?	I think so. It is still difficult for me to focus on any thing.	It helps me to focus on reading and helps me focus on a match, if we have one.	No	It certainly helps me to focus on specific tasks.	It definitely helps with completing a task your busy with.	*It helps me think.*	Yes.	No

	Have you missed important information before while creating the personal space "bubble" because you aren't paying attention to other information?	I don't know. Possibly.	If you don't pay attention or if you can't hear, you loose out a lot of information.	No. Somebody afterwards will tell what is going on.	All the time. From phone calls to busses.	It does happen from time to time.	Yes. Sometimes. Can't recall one now but its happened before.	Well if I missed it then I won't know now will I. Sometimes people just inform me about information I lost while talking on my cell.	I sometime pay attention to a conversation and then I almost miss my stop, but its never happened.
4. Level of pressure from information to be constantly informed	Do you feel pressured to be well informed all the time?	MXit and Facebook are full of information and people committing on photos and statue updates. You need to be on top of it or you'll miss out so much of what's happening.	At school people also talks about things on MXit or on Facebook. If you want to speak with them you need to be connected.	*Participant wanted to stop the interview because I'm asking very difficult questions*	I have decided that there is too much information out there that I rather just focus on the information that is important to my well-being.	Yes. I think my work demands that I'm well informed about everything. If I'm not they'll let me know it for sure.	A little bit. Like, without Facebook I struggle to connect to friends from all over.	I believe everybody feels some sort of pressure. There is always some thing or someone trying to get your attention.	No
	What information do you attend to first?	Information about my friends.	Information about timetables and schoolwork.		Information about the environment I'm in at the moment.	Personal information gets priority.	Work things and maybe timetables of work and bus.	Emails, but if I receive a call I'll quickly answer it.	Information that's important for my current task.
	What information is usually attended to last?	I don't know. Sorry	Then my social group.		Information about politics.	I attend to Information that I don't really need last.	Facebook and email. Very bad at it.	What to eat and house cleaning. That's why I have a wife.	I don't know.

OPEN CODING

4 Semi-Structured Sections/Questions			Friday 07 – 10 – 11 (Morning Session)							
			07:00- 09:00							
			W	B	C	C	W	B	C	W
		Age	16-25	31	65+	25-45	21	25-45	16-25	45-65
		Sex	M	M	M	M	F	M	M	M
1. Level of spatial interaction	Level of interaction and the amount of time he/she occupied the public space (MyCiti Bus terminus, Civic Centre)		I travel to the closes bus station with my bike and then travel with the bus until town every morning. I cycle home if the weather is okay.	I used to travel by train. But the bus is less dangerous. I work in car workshop in town.	I am the operation manager and I'm here helping the busses work smoothly.	I travel throughout the week on the bus. It's better than sitting in traffic. I would like the space to be more interactive because currently you only occupy the space.	I use the station to catch the bus everyday.	I love the idea on the MyCiti. I work in town and party in town. It suits me perfectly. The Civic Station is nice and central.	I just wait here for the bus. I take it to work and then come back with it.	I try to use the bus twice a week. It's a healthy break from traffic.
	What information is regarded as important to you in the space?		The map is important and the bus schedules and also the time that's displayed on the screens.	Safety and price. There is not poster about price.	The conductor's schedules and the bus schedules are very important.	Currently, I feel it's the bus route and the timetable.	When will the busses arrive and leave again.	These posters (*map and bus schedule)* and the signs outside.	All the information about the roads and stuff.	Bus schedules and information about different locations.
	What makes you happy and what frustrates you the most regarding the space?		To be able to lock my bike here would make me happy. It frustrates me to wait for the next bus and hopefully they have space for my bike.	I don't know. But it's never good to miss a bus.	It makes me happy to work here because it feels that I'm making a difference to people. It makes me angry when bus driver drive to fast or to slow because we get the complaints.	It's a working public transportation. That makes me happy. It frustrates me that it took so long and that some of the drivers are incompetent because of the total disregard for scheduling and safety.	I don't know what makes me angry but it makes me happy when the bus arrives and I have not been waiting for long.	It makes me happy to see people interacting with each other on the station and also how people are different.	It makes me very happy when the bus is on time. It makes me very angry if I just missed it and now I have to wait for a long time.	It makes a huge difference in my da if I catch the early bus. Otherwise I have to wait for 15 min. That is not to bad. It does frustrat me when I miss the bus by mere seconds.

2. Level of informational connectivity regarding demand and overload	Connection to information while travelling, from print media to mobile wireless devices	I have my laptop in my bag and also my Blackberry in my pocket.	I have a cellphone that I phone with.	I talk to all the bus drivers and conductors on different station using my short wave radio.	I love my new iPhone 4. It has everything built in from GPS to my daily calendar.	I connect to Blackberry for my emails and I get BBMs.	I read the newspaper on the bus and I have my Blackberry to connect to Facebook and twitter.	I MXit and SMS sometimes and I sometimes watch YouTube videos on my phone.	I like to read the newspaper on the bus and attend to emails while commuting.
	What devices (including print media) do you constantly connect with and why?	I use my Blackberry the most because it is so small and easy to use. I BBM my girlfriend and some friends who has BlackBerrys to.	My cellphone.	In my office I have a computer with email. I also use my cellphone it I cant get hold of somebody on the radio.	iPhone 4 and my laptop at home.	My Blackberry is always with me because it is so tiny.	The newspaper and my blackberry usually. Sometimes a computer.	My phone.	Newspapers and m smartphone.
	How much information can you attend to while in a public space and does it ever become overwhelming?	I sometimes get draw into a BBM frenzy where everybody BBM's me at the same time. Hectic to respond to everybody. And then it becomes overwhelming.	For me, I think that information is to busy. I want information to just say one thing.	When we are really busy I sometimes come and sit in my office because too much things are happening at once.	Overwhelmed is maybe to strong a word, frustrated, definitely. It's very easy to get frustrated. Especially in a public space.	If there is a lot of new information in the station then it becomes a bit too much.	You just get one of those days where you are thinking of too many things all at once and then you miss the announcement that you have to wait on another platform. It's happened before.	All the information. Only sometimes it becomes a bit much, hey.	I feel overwhelmec on a daily basis. Nc just here. You can' process all the information that is available to you.
3. Level of personal space "bubble" in public space to enhance information intake	Do you create a personal space "bubble" while in a public space?	I put on my earphone and close my eyes sometimes on the bus. Just to block out some of the white noise.	I sometimes fall asleep or just close my eyes.	*…I sometimes come and sit in my office…*	Yes, it helps me to keep my sanity.	I sometimes just block out load people on the station.	Yes, I think it's a survival thing.	I don't need to. I can do the things I need to do.	I do sometimes block white noise out on the station.

	Do you create this space to help focus on sometime important like a phone call?	Yes, I focus on work and maybe what's the plan for the weekend.	No because I am tired.	It helps me to focus on the tasks at hand.	Not just phone calls but emails and SMS too. If you don't block out things that's constantly interrupting you then you will never be able to do everything you have to do.	Yes.	Yes. Phone calls especially.	No, its fine.	It helps me focus o what I'm currently doing.
	Have you missed important information before while creating the personal space "bubble" because you aren't paying attention to other information?	Ja. With my eyes closed and my music on to escape, I think I miss out a lot.	No. I don't think so.	Because I'm not on the floor I lose out on some information but I get informed of some of the stuff through the conductors.	Not paying attention to the specific information makes it very easy to disregard information.	Yes. When the lady tells us when the next bus is arriving.	*A person arrived on the station and participant asked to be excused from further answering question.*	Never. I think	I am sure I have.
4. Level of pressure from information to be constantly informed	Do you feel pressured to be well informed all the time?	All the time. At work it is, Respond to the ASAP or answer this or meeting here. Too much.	I sometimes read the newspaper, but I don't know.	Yes. It is my job to be well informed.	It is necessary to be well informed this day and age.	No, not really.		Sometimes, you see, with MXit I can connect to everybody and it makes it easy to be connected.	Most definitely. If you are not connected in this day and age you ar disconnected from the world.
	What information do you attend to first?	The most import information I guess like work emails.	Work things.	Busses, drivers, conductors, complaints.	Personal information first.	*Her bus arrived and the interview could not be completed.*		My MXit and SMS	Whatever information is needed to complet the current task.
	What information is usually attended to last?	Personal emails.	Nothing.	Writing everything in my book. *(LOGBOOK)*	The public information			Work, always comes last.	Non essential information

OPEN CODING			Friday 07 – 10 – 11 (Afternoon Session)							
			15:30-17:30							
			W	W	C	B	W	B	W	C
4 Semi-Structured Sections/Questions		Age	16-25	23	25-45	25-45	45-65	25-45	45-65	45-65
		Sex	F	M	M	F	M	F	F	M
1. Level of spatial interaction	Level of interaction and the amount of time he/she occupied the public space (MyCiti Bus terminus, Civic Centre)		For me, interaction between the station and myself happen on a daily basis. I use the bus daily which means that I us the station everyday.	The level of interaction I would say is high. I use it everyday and sometimes-over weekends. Its very convenient for a city slicker like me.	This is now my third time this week (*travelling on the bus*). I love it.	I use the taxi in the morning. At night I use the bus because it is safer.	About a month ago I decided to start using the MyCiti bus and it been working great. Am at this station (*Civic Bus terminus*) twice a day. I would sit on the steps until I hear the conductor say that the bus would be arriving shortly.	I travel with the bus about three times a week. Depends on the amount of contract time I have to complete.	I travel everyday on the bus. I usually wait about 30min so I'll read on chat to somebody that I know.	I travel to and from town every day. I think that the space is not very interactive but very utilitarian.
	What information is regarded as important to you in the space?		Because this is a station for busses, I think any information regarding the bus as important.	Any information that would make my commute easier or faster.	I'm still trying to get my head around the timetable, but the map is pretty easy.	The bus times.	The detailed maps are important and the arrival schedules for the busses.	The timetable I believe it the most important piece on information in this space, although they could have made it clearer to understand.	Any Information, which is important to the busses and the city.	Cost of trip and map.
	What makes you happy and what frustrates you the most regarding the space?		It makes me happy to leave my car at work and interact with people I would usually not. It frustrates me that the bus sometimes arrives late.	That the system still works, makes me happy. It frustrates me to wait.	Happy because I don't have to pay R40 per day for parking in the street. Frustrating because the bus is sometime to full and late.	It makes me happy to get home safe. It makes me sad when I am late for home.	It makes me happy to travel among such a diverse crowd of people. It frustrates me that the scheduling and the queue system should have been more carefully planned.	Happy to find a seat on the bus and frustrated to be the first inline for the next bus.	Waiting is frustrating and maybe the amount of space on the station.	What makes me happy, that's personal. What frustrates me is the queue system at the station.

2. Level of informational connectivity regarding demand and overload	Connection to information while travelling, from print media to mobile wireless devices	I used to read newspapers on the bus but it's very difficult to read because of its size. Now I use my phone to connect to the digital world.	My Nokia and my Galaxy, I would say it the devices that I use while travelling.	The Daily Voice, The Sun and New Age newspapers (*tabloids*).	I have a cellphone. My children phone me on it so we can talk.	I have purchased a Blackberry a month ago and still trying to figure it out. I do receive emails and text messages on it. The browser is more difficult to figure out.	I have an iPhone that I connect with.	I have a cellphone but it can only phone and text.	I like being connected to the internet while travelling, Facebook and Emails are really important.
	What devices (including print media) do you constantly connect with and why?	My MP3 player and my cellphone. My PC and newspaper at home.	My Galaxy it the connection of choice. Larger screen.	I don't know.	I don't connect to any device.	While commuting I would say my Blackberry but I usually just read a book if I can.	My iPhone is my device most used for browsing and emails.	Newspaper and laptop.	My cellphone is the main device I use to connect.
	How much information can you attend to while in a public space and does it ever become overwhelming?	I do think that there is a limit to the amount of information I can process at once, more than that is overwhelming.	If there's too much information that you have to look at and take in, it can definitely become overwhelming.	I sometimes have to prepare for work on the bus or on the station. If that happens even the lady (*conductor*) becomes overwhelming.	Too much information is very hard.	I believe that information is already overwhelming even before adding more sources like the bus schedule.	I feel that the increase use of mobile phones and the connection power creates overload already. Not to mention information from the station.	I don't think information can become overwhelming, I just think that you won't be able to attend to all of it.	There is too much information that I wish I know. Extra text or images makes it very difficult to focus on what you are currently doing.

3. Level of personal space "bubble" in public space to enhance information intake	Do you create a personal space "bubble" while in a public space?	I do.	I have my earphones on the whole time while travelling and waiting on the station.	Not that I know of.	No.	I do try to block out white noise.	I do sometimes.	Sometime you have to, in order to read or focus	I sometimes use earphones to help me block out sounds.
	Do you create this space to help focus on sometime important like a phone call?	It does help me focus on what ever I'm busy with.	This helps me to focus and chill out for a while.		When I'm talking on the phone, I don't here what other people are talking about because I'm talking.	While reading a book it is easier to block out other sounds and sights because it helps you to focus.	It does help to focus and sometimes it stops me from feeling overwhelmed.	Yes. It helps with focus I think.	Yes, it does help.

	Have you missed important information before while creating the personal space "bubble" because you aren't paying attention to other information?	I have missed information and sometimes I daydream. I could be looking at the person speaking but I won't take in anything.	Yes. With my earphones on, I don't always here what other people are saying.	*He asked to be excluded, as he wanted to finish reading his paper. It was noted that he would immerse himself in the newspaper/ tabloid. It is believed that this is his personal bubble.*	No.	I believe so. When you block out streams of information you are blocking out information, which might be important.	Yes. Sometimes I have to ask people to repeat what was said because I did not listen.	I don't think so, it could have happened.	I have missed information before. If you are reading or listening to music then information sometimes just past you by.
4. Level of pressure from information to be constantly informed	Do you feel pressured to be well informed all the time?	All the time. I feel that it is vital to our existence to know as much as possible.	Yes I do.		No.	I have felt an increase for the past 10 year.	It is vital for my job to be constantly well informed. That creates extra pressure.	*Participant took a phone call and interview was ended.*	I believe everybody feel the pressure. Some people more than others.
	What information do you attend to first?	I would say, my information.	Information about what to do tonight.		I don't know.	Information regarding the context and safety of family, friends and myself.	My emails and my messages.		Phone calls, emails, BBM.
	What information is usually attended to last?	I would say, other people's information.	Work.		I don't know.	Prayer, before I go to bed.	Updates and Facebook notifications.		What's happening in the world?

APPENDIX B

Open Coding Ambient display system interview

OPEN CODING

3 Semi-Structured Sections/Questions

		14-Nov-11			
		Two sessions			
		W	C	C	B
	Age	16-25	16-25	44	22
	Sex	F	F	M	F
1. Level of possible ADS interaction	How many times do you travel on the MyCiti?	I use the bus service all the time. It's more convenient than travelling into town with my own car. Parking and all that jazz.	I have to use the bus everyday you see because the trains aren't safe anymore.	I used the golden arrow buses but it safer and more convenient to use the MyCiti.	I travel everyday with it.
	How do you feel about the scheduling and arrival times of the bus?	It only works sometimes. There is no schedule on the station and it frustrates me that they sometimes get it wrong.	Its okay. Sometime I wish that the buses could run on time for a change.	It's a difficult system to monitor and I think they struggle a bit because the buses are sometimes very late.	It is very good.
	If there were a system, which can improve on the scheduling and arrival times, would you use it?	Most definitely.	What like a timetable, I though they had a timetable.	I think I would use it but the people working at the station would use it the most.	I would think so.

2. Context of ADS according to interviewee	Did you notice something different at the Civic Centre bus station?	I saw an interesting light that changed colour.	This light thing on the station.	I saw a light type of thing against the blue board at the Civic Centre Station.	No.
	What do you think the object represented?	Don't know. It looked pretty though.	I think it changed colour the closer the bus comes.	Now that I think about it, probably something to do with the scheduling of the bus.	N/A
	Do you think the object represented the information sufficiently?	I don't even know what is was trying to display. Maybe when the bus is arriving I think. There was no explanation.	It's okay. A sign could help.	I don't know how to read the information but I think blue means the bus is at the station.	N/A
3. Level of calm computing	Do you feel that you would use the "display" to gain information again?	If I knew how it worked. I think I would. It's nice because you can see the light from the street. This could be very helpful.	Yes I think it's fine but a sign will help.	Yes. If I know how to read it.	N/A
	How did you gain this information the first time?	I looked at it and looked away. When I looked at the light again, it was a completely new colour. Then I focused on it but it changed to slow so I would look away for a minute or so and look at it again to see what colour the light turned.	I had to ask the guy filming the light what it means. Then I looked and waited.	I quickly looked at it and it went from red to blue.	N/A
	Do you think this display calmed commuters down?	I think people focused on the light and did not focus on the bus as much. I think it calmed people down.	I thinks so, you know mos people are angry when it bus is late, now people can see the bus coming.	If people knew when the next bus is arriving then it would calm me down.	N/A

OPEN CODING

		15-Nov-11			
		Two sessions			
		C	B	W	B
Semi-Structured Sections/Questions	Age	35	16-25	45-65	45-65
	Sex	M	F	M	F
1. Level of possible ADS interaction	How many times do you travel on the MyCiti?	I work for the city at the civic center so the bus stops right in front. I use the bus service everyday since it started.	I take this bus to school every morning but I take the taxi home.	I started using the MyCiti about a month ago. My car when into the shop and now I use the bus.	I use the bus most days.
	How do you feel about the scheduling and arrival times of the bus?	It only works some of the time. The other times it is a minute late or a minute early.	I am usually late because the buses are late.	It was difficult to get used to the lack of scheduling. Always approximately.	What scheduling, I think it does not work because there are so many variables to calculate.
	If there were a system that can improve on the scheduling and arrival times would you use it?	I know that I would use it but I do not know if others will.	If the system works, then I would use it.	If it were reliable, I would most certainly use it.	I would use it and so would the conductors.
2. Context of ADS according to interviewee	Did you notice something different at the Civic Centre bus station?	I saw an interesting light that changed colour.	I saw a light thing. The same one as yesterday.	I saw this light thing. Somebody was filming it. I asked about it and they said it was research indicating when the next bus would arrive.	There was the white light that changed colours.
	What do you think the object represented?	I think it got something to do with time.	I think it has something to do with when the bus comes.	Now I know that it represents the arrival time, I just do not know how it works.	I heard somebody say it was representing the arrival time; blue means its here and green means it just left the last station.
	Do you think the object represented the information sufficiently?	No because I do not understand it at all.	It was weird to use colour but I think if people saw it enough they will be fine.	I think the more people see it the more people would understand it.	Yes, I like the idea that it changes colours. Creates a nice mood.

3. Level of calm computing	Do you feel that you would use the "display" to gain information again?	If I knew what is was saying then yes.	I will, if I have to see it again and now I know that it is about the bus arriving.	It more accurate than the conductors so yes.	Yes, I hope that the light will be there tomorrow. I like to stand outside and now I can because I know when the bus will come.
	How did you gain this information the first time?	I watch it change from yellow to red and then to blue. The bus came so I could not see what colour it was changing to next.	Well, I saw the first bus arrive when it was blue. When our bus arrived it turned blue again. So, this morning I only looked quickly to see if it was blue.	It is easy just to look at it quickly to see the colour.	I looked at the light while it was changing.
	Do you think this display calmed commuters down?	I don't know	I people knew how long they have to wait for the bus it would stop people becoming angry.	Because you know where your bus it, you do not worry about it.	If people were educated about the meaning of the colour, it would definitely calm them down.

OPEN CODING

3 Semi-Structured Sections/Questions

		16-Nov-11			
		Afternoon sessions			
	Age	W 16-25	W 16-25	C 65+	B 25-45
	Sex	M	F	F	M
1. Level of possible ADS interaction	How many times do you travel on the MyCiti?	I use the bus everyday to go to work.	I also use the bus to go to work and sometimes over weekends.	This was my first time. I like the seats.	I use the bus everyday because I am a conductor at one of the stations.
	How do you feel about the scheduling and arrival times of the bus?	It works fine. The bus is sometimes late but it is still getting the time right. Just give it time.	The scheduling is okay but it could be better I think.	It works better than the trains and the Golden Arrow.	The scheduling is a problem because of the unreliability of the drivers and the traffic.
	If there were a system that can improve on the scheduling and arrival times would you use it?	I would use it.	Me too. I would use it.	If it worked even better, it would be good.	I would like to see a better system and I would then use it constantly.
2. Context of ADS according to interviewee	Did you notice something different at the Civic Centre bus station?	I saw an interesting light that changed colour. The light was not bright enough I think.	I saw this light thing at the station.	Not something different but a light. I do not know it is usually there.	I saw a new display being used at the Tableview pod.
	What do you think the object represented?	I think it was something to do with the time or speed of the bus.	I thought it had something to with the bus leaving the station or arriving at the station.	I think the time until the next bus has arrived.	I would think it has to do with how far the bus is from the station.
	Do you think the object represented the information sufficiently?	I think colour is a very interesting way to display time.	I like the colour and I would know what they mean tomorrow.	Number would work better but if people understood the colours, it would work.	Colour is a more relaxed way of representing information.

3. Level of calm computing	Do you feel that you would use the "display" to gain information again?	I would, it is cool.	It is much more interesting and informative than the conductors.	I can't see why not.	It helps me with telling commuters more specific information regarding the inbound bus.
	How did you gain this information the first time?	I just glanced at it as I was on the phone, but when I saw the lights turning different colours, I knew it had something to do with the bus.	I saw everybody looking at the light and speaking about it.	I just quickly looked at it and heard people talking about it.	I was every interested the first time, now I just glance at it.
	Do you think this display calmed commuters down?	Definitely.	If I knew where my bus was, I would relax more on the station. I would like to see this light be more integrated than what it is now.	I do not know. I would like to think so.	It does. People are starting to use it more often; I know from the chat at the other stations that they can't wait until they get one.

OPEN CODING

		17-Nov-11			
		Afternoon sessions			
		W	B	O	C
3 Semi-Structured Sections/Questions	Age	25-45	25-45	48	16
	Sex	M	M	M	F
1. Level of possible ADS interaction	How many times do you travel on the MyCiti?	I take the bus to bus every morning and afternoon.	It's more economical to use the bus in the week.	I travel around Cape Town often and MyCiti is the most reliable.	I use the bus to go to Gardens Commercial.
	How do you feel about the scheduling and arrival times of the bus?	I don't think that there is a scheduling system.	I wish they could sort it out.	I believe that it will improve.	I don't know if it works or not but the bus is sometimes very late.
	If there were a system that can improve on the scheduling and arrival times would you use it?	If there is one that works, I would like to use it.	I would use it everyday.	I think everybody would use it.	I think I would use it.
2. Context of ADS according to interviewee	Did you notice something different at the Civic Centre bus station?	There has been this light of the station for the passed two days.	I saw a new display light type thing that changed colour.	I heard everybody talking about this light thing, but I did not see it.	I saw a funky disco light at the station.
	What do you think the object represented?	The time the next bus will arrive.	I think the colour changes indicate how far the bus is away from the station or what time it would arrive.	NA	Green means I can still go to the bathroom, red means I must stay and blue means the bus is here.
	Do you think the object represented the information sufficiently?	Yes. You have to see it in action for two or three times, after that it's quite easy.	Yes, you have to figure it our but only once ore twice.	NA	Like a robot, it works well.

3. Level of calm computing	Do you feel that you would use the "display" to gain information again?	Yes, I used it just now.	I will you it as I did today.	NA	Ja, I would because it looks funky
	How did you gain this information the first time?	I had to look at it for a while until I got it.	I was looking at the light and then I asked the conductor about it. He explained that it works of GPS in the bus.	NA	I kept on looking at it.
	Do you think this display calmed commuters down?	Yes, it calmed me down. I would rather rely on the information from the light than listen to ill informed conductors.	I have seen a noticeable change in behavior from the commuters, more relaxed and less on the edge because the light provide better information than some of the conductors	NA	I don't think so.
				Photos suggested he did look at the light but did not notice it although he got ready as the light switched to blue without anybody indicating when the bus would arrive.	

OPEN CODING

		18-Nov-11			
		Afternoon sessions			
		W	W	C	B
3 Semi-Structured Sections/Questions	Age	26	16-25	65+	45-65
	Sex	F	F	M	M
1. Level of possible ADS interaction	How many times do you travel on the MyCiti?	I travel, like in every day I can.	I travel with Lize every day. We work together.	I work at the waterfront shipyard. The bus stops at the Waterfront. It takes longer but is more comfortable.	I use the bus every 2 days because I work at the Waterfront
	How do you feel about the scheduling and arrival times of the bus?	I tried to work it out but it was too irregular.	Sometimes the conductor would shout out that the bus is late, but they don't really know.	I travel with a gap of 20min. I arrive at work 20min either early or on time.	I like the schedule, it is flexible.
	If there were a system that can improve on the scheduling and arrival times would you use it?	If there is a system better than the one MyCiti is working with now, I will use it every day.	I would use it and they would use it.	I wish there was a system like that because the one they use now is not great.	I will use it if there was a better system.
2. Context of ADS according to interviewee	Did you notice something different at the Civic Centre bus station?	I saw people are video taping a light.	There was this light that changed colour.	There were these people taping a light-changing colour until the bus arrived.	There was a light being tested at the station.
	What do you think the object represented?	I think the light works with when the bus is coming.	It gave information about the bus and where it was.	The kept on changing colour until it changed blue. The bus arrived.	Green means that you don't have to rush. Red means it is coming.
	Do you think the object represented the information sufficiently?	No, it is very confusing and difficult to read.	I like that colour was used. It was useful.	Yes.	Yes, it reminds me of traffic signals.

3. Level of calm computing	Do you feel that you would use the "display" to gain information again?	Yes, but they need to make a sign or something.	I will use it next week.	I would use it again.	Yes, I use it every time it was there.
	How did you gain this information the first time?	The first time I looked for a long time but now I just quickly look at it to see if its blue or red.	Lize told me about it. So, I looked at it.	I just saw it at the corner of my eye.	I looked at it as it changed colour.
	Do you think this display calmed commuters down?	I don't know, I think so.	The like is like a big lava lamp and that calms me down.	Yes, I think it will because people get angry with the conductors when the bus is late.	Yes, the colours are relaxing and changes slowly.

OPEN CODING

		19-Nov-11			
		Afternoon sessions			
		B	B	W	C
3 Semi-Structured Sections/Questions	Age	45-65	45-65	32	16-25
	Sex	M	F	M	F
1. Level of possible ADS interaction	How many times do you travel on the MyCiti?	I use the bus everyday since they started operating in my area.	I work at the station for 3 months now. I'm at the station a lot.	At least 3 times a week. I don't have to be in the office everyday.	I take the taxi to school and the bus home in the afternoon.
	How do you feel about the scheduling and arrival times of the bus?	The signage is insufficient at best.	I wished that when I started we had on of those lights they are testing now because work a lot better than the printed things.	Scheduling is really important and I wish they can improve on what they offer at the moment.	It does not work, sometimes.
	If there were a system that can improve on the scheduling and arrival times would you use it?	I would most certainly use it.	Yes, it's my job.	Most definitely.	I would use it.
2. Context of ADS according to interviewee	Did you notice something different at the Civic Centre bus station?	There was this light at the station for the past week.	Other than the light. No.	This is now the third time I saw this light at the station.	I saw less conductors on the station and this light thing.
	What do you think the object represented?	I believe it's a pilot-testing prototype for improving the scheduling for the bus.	The light tells me where the bus is.	I heard the conductors say its got to do with the scheduling of the bus.	I tells me when the bus is coming.
	Do you think the object represented the information sufficiently?	I believe so. I know that when the light turns a blue tint, the bus is almost here.	Yes, I like the colours and that I can see them from far away.	I do think so. The colours make it universal.	No, I would like a time or something. Not just pretty colours.

3. Level of calm computing	Do you feel that you would use the "display" to gain information again?	Yes. I do believe the more I'm exposed to it the more it will make sense.	Yes. It works very well. Sometimes the bus is a bit slow but they are only testing for now I think.	I used it today.	Yes. It is there so why not. More information is better I think.
	How did you gain this information the first time?	I glanced at the light and saw it turn blue and then suddenly the conductors arrived and about 10 seconds the bus arrived.	I was waiting for the bus to arrive and I went to go and speak to *John* to ask him why is the bus late. He told me that the light turns blue when the bus is near.	It was something new, so I focused on it,	I was waiting for the bus and saw it change colour.
	Do you think this display calmed commuters down?	I do believe so. Colour does help and the improvement in the scheduling helps too.	Yes, and myself.	Yes. Knowing where the bus is make for a less stressful commute.	I don't know.

OPEN CODING

		20-Nov-11			
		Afternoon sessions			
		W	C	C	W
3 Semi-Structured Sections/Questions	Age	65+	28	25-45	18
	Sex	M	F	F	F
1. Level of possible ADS interaction	How many times do you travel on the MyCiti?	I use the bus to go to waterfront maybe once or twice a week.	I work at the Civic Centre so it is very convenient to use the MyCiti everyday.	I am a conductor on the bus and not on the station so I don't work on the station.	I work at the Gardens Centre which is a stop along the way. I use it everyday.
	How do you feel about the scheduling and arrival times of the bus?	Last time I had to wait for a long time because I just missed a bus and nobody told me.	I wish they were more accurate. I have waited more than 30 min the one time. Nobody knew what was going on.	They give me a print out everyday. It doesn't realy work because the bus is inconsistent.	It sux. They are never right.
	If there were a system that can improve on the scheduling and arrival times would you use it?	Not just me would use it, everybody else too.	Like the light thing. I would use it.	Yes I would	Yes.
2. Context of ADS according to interviewee	Did you notice something different at the Civic Centre bus station?	This it the second time I saw students testing this light.	Just the light thing.	Just the light that was here yesterday and the day before.	This week there were these people testing a light on the station. They were also filming it.
	What do you think the object represented?	I know it has something to do with the scheduling of the bus.	I think it tells me when the bus will arrive.	It tells me when my shift is starting.	I think the light is telling you the time of the next arriving bus.
	Do you think the object represented the information sufficiently?	I think I would need to see it more often and not just at this station to true understand it.	I think so. Don't know what other would think.	Yes. Blue means the bus is here and my shift starts.	I would need to use it more to really know.

3. Level of calm computing	Do you feel that you would use the "display" to gain information again?	Yes. I do think I would.	If it works I would use it everyday.	Yes because it is reliable.	Yes
	How did you gain this information the first time?	I was waiting in the cue when I saw the light turned red the purple and then the bus arrived.	I was late so I ran to the station. The conductor told me that the bus would be here when the light turn blue and he was right.	I waited for the bus and saw the light turned blue. People then told me it's the bus arriving.	I glanced at it but focused more on the guy filming me.
	Do you think this display calmed commuters down?	This time I did not worry if the bus left without me. So it informed me and that calmed me down.	Now I can see the light when I walk to the station so I don't have to run.	I don't know. Maybe if it looked better.	Without the cameras. Yes.