THE DESIGN AND APPLICATION OF WAYFINDING IN PHYSICALLY AND VIRTUAL IMMERSIVE ENVIRONMENTS.

By

Chané Haarhoff

[1287609]

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INTRODUCTION

This research paper is focused on the wayfinding potential offered by interactive, virtual immersive environments. Through this paper, I propose that merging wayfinding with interactivity and virtual reality could not only present potential improvements to the world of wayfinding, but further provide solutions to the challenges with which traditional wayfinding is faced today. Wayfinding is a term emanating from the world of design, to describe systems designed to enable people in motion to find their way. Wayfinding systems typically include elements such as maps and signage. These systems were developed to meet the requirements of people in need of knowing where to go and how to get to a desired destination effectively. From the perspective of this focus, the paper questions wayfinding systems and analyses the effectiveness and applications of wayfinding in various immersive environments. As introduced by the research focus: "The Design and Application of Wayfinding in Physically and Virtual Immersive Environments," this research paper is mainly concerned with the application and adaptation of design elements and principles, to wayfinding systems. How these design applications may change to suit various immersive environments, as well as how design influences the use of wayfinding systems will also be addressed.

In order to present a sufficient analysis of wayfinding in immersive environments, it is necessary for this research paper to address a variety of these environments. The three main types of chosen immersive environments are: physically immersive environments, digital physically immersive environments and virtual immersive environments. Throughout this paper, the term "physically immersive environments" is intended to convey an environment in which the user is physically surrounded with visuals and/or audio that create an immersive environment which the user can physically manipulate or interact with. In contrast a "virtual immersive environment", for the purpose of this paper, can be construed to be a highly immersive environment in which a user is able to virtually navigate around a computer-generated space. In addition to this, it is an experience and an environment that is fully dependent on the use of virtually immersive and interactive technology such as the *Oculus Rift* or *GoogleCardboard*.

Commencing with a brief introduction to virtual reality, interactivity and wayfinding, the paper will thereafter flow into Chapter Two. Chapter Two will present a thorough discussion of the design of wayfinding techniques and systems, looking at the applications of design in order to create an efficient wayfinding system. The research paper will be supported by four comparative case studies, to be analysed from an information design perspective. This analysis will have a clear focus on the role of informational wayfinding and the manners in which wayfinding information is applied, presented and designed within the selected virtual environments.

The first case study will focus on Menlyn Park Shopping Centre's newly updated wayfinding system. This system is an example of a physically immersive environment that combines traditional and digital, interactive wayfinding techniques. Case Study Two will deal with *Find Your Way Essex,* a virtual wayfinding mobile application which was chosen to represent a digital physically immersive environment. This application was selected specifically for the fact that it relies on virtual wayfinding to aid user navigation in the physical world. *StreetMuseum: Museum of London* will be the focus of Case Study Three. *StreetMuseum: Museum of London* is a purely digital mobile application, however, unlike *Find Your Way Essex*, this application is predominantly concerned with navigating users through virtually represented historical events. Finally, the example chosen to represent a virtually immersive environment in the final case study is *Honeywell - Virtual Museum Tour,* a virtual wayfinding experience that relies fully on the *GoogleCardboard* device. An analysis of these case studies will result in a better understanding of the relationship between physically and virtual immersive environments and different applications and the effectiveness of informational wayfinding within such environments.

Chapter One is set in place to briefly introduce the terms most significant to the research focus; "The Design of Informational Wayfinding in Physically and Virtual Immersive Environments." The very purpose of this paper is to analyse and discuss the role and effect of wayfinding within different immersive environments. It is therefore necessary to commence this research paper with an introduction to wayfinding practices and systems, in order to effectively discuss wayfinding. Together with wayfinding, a summarised, in-depth overview of immersive environments will also be looked at within Chapter One, as immersive environments make up an important component of the case studies to follow in Chapter Three.

CHAPTER 1:

AN INTRODUCTION TO VIRTUAL IMMERSIVE ENVIRONMENTS AND WAYFINDING

1.1 VIRTUAL REALITY AND IMMERSIVE ENVIRONMENTS

1.1.1 VIRTUAL REALITY AND INTERACTIVITY

"Virtual reality (VR) is an event or entity that is real in effect but not in fact." The words of renowned virtual reality theorist, Michael Heim, superlatively sum up and explain the essence of the virtual world and its virtual reality (109). Different virtual environments exist within the realms of virtual reality and virtual worlds. These virtual environments (VE) are merely computer-generated spaces able to respond in real time to user behaviours and actions.

Billinghurst, Kato and Poupyrev explain in "The MagicBook - Moving Seamlessly between Reality and Virtuality" that for at least two to three decades, researchers have tried to create intuitive computer interfaces by blending physical reality with virtual reality. The ultimate goal of virtual reality is to enable people to interact with digital, virtual domains with the same ease as they would interact with the real, physical world (6).

Interactivity, in terms of immersive or interactive virtual environments is described by Mel Slater and Sylvia Wilbur in their article "A framework for immersive virtual environments (FIVE): Speculations on the role of presence in virtual environments" to refer to the extent to which a user can create and modify the form and content of objects in virtual environments (12). In a truly interactive system, the virtual world should respond almost instantaneously to a user's actions (Ryan 117). By this classification of interactivity, Case Study Four would be the most interactive in the sense that the virtual museum environment, experienced through the *GoogleCardboard,* responds in real time to the user. In *Honeywell - Virtual Museum Tour,* the user is able to walk through the museum and as the walking motion occurs, walls and artworks move past the user, while distant points grow bigger; as would naturally occur in the physical world due to the phenomena known as perspective. As a user turns his/her head, the view of the room changes accordingly and when a user shifts and enters a new space the room and environment too will change. Looking at Case Study One, the most interactive and responsive wayfinding device in this system would be the digital YAH maps as they are able to change with user interaction. These maps, however, do not react naturally to user movement. Users have to purposefully initiate a response from the map by pressing buttons or icons, whereas a truly interactive system; by above mentioned definition; should react without the user even trying to activate a response. *Find Your Way Essex* of Case Study Two would not be described to be highly interactive as it is purely user controlled. By this I mean no change would occur if the user does not intentionally change the environment or activate certain buttons. Therefore, similarly to Menlyn's wayfinding system, *Find Your Way Essex* is not highly interactive in the sense that the virtual map is not as responsive as the virtual museum experienced through the *GoogleCardboard. Find Your Way Essex* is, however, still interactive in its own right, for without user input nothing would occur or change within the application. Case Study Three presents an experience in which the user looks at the physical world through his/her phone and then without needing to imitate anything, a historical photo will appear and be superimposed over the view of the physical world. This experience allows this application to be classified as interactive, for the virtual world of historical photos reacts 'naturally' and instantaneously to the user's view.

Case Studies One and Two may not be classified as highly interactive when looking at the manner in which the environment naturally reacts to the user, however these systems both rely rather heavily on the act of reading to interpret signage. It is therefore necessary to understand that reading in itself is not a purely passive experience. As said by Linda Hutcheon "The reader of fiction is always an actively mediating presence, the text's reality is established by his response and reconstituted by his active participation" (141).

Marie-Laure Ryan explains that if a user is not a 'co-creator' of a virtual environment; that is if he/she is not able to change the environment, the user may feel entrapped (122). This feeling could be expected in Case Studies One and Two, as these environments do not really inspire a feeling of co-creation, however, Marie-Laure goes on to explain that this entrapment may be lessened by making the results of choices more predictable. By doing so users are able to learn the laws of the environment, enabling them to easily navigate around this new territory (Ryan 122). This is effectively achieved in Menlyn's wayfinding system as well as in *Find Your Way Essex,* as these systems use universally understood icons and buttons. This means that users do not need to learn a new wayfinding language but simply have to apply their understanding of familiar icons without too much effort or thought.

These case studies are based on three types of immersive environments, each of which is interactive in their own right. It is therefore necessary to understand the fundamentals of interactivity in order to later formulate a valid discussion and argument around interactivity and these interactive environments alike. A clear emphasis is placed on interactivity in terms of virtual reality, as I propose that merging a traditional understanding of wayfinding as explored in print-based wayfinding with interactivity and virtual reality presents potential solutions to the numerous challenges with which traditional wayfinding is faced today. Interactivity is a term prevalent to interactive digital media and as can be gathered from the name; interactive media cannot exist without human input. Interactivity becomes an important term within this discussion, as the degree of interactivity will have an influence on the manner in which wayfinding information is presented, understood and engaged with. In summary, if explained simply, the concern of virtual reality is to facilitate sensory immersion within virtual, computer generated environments (Heim 112).

1.1.2 Virtual Immersive Environments

Sensory immersion, within the context of virtual environments, describes the "extent to which computer displays are capable of delivering an inclusive, extensive, surrounding and vivid illusion of reality to the senses of a human participant" explain Mel Slater and Sylvia Wilbur (3). With reference to this quote: 'inclusive' describes the extent to which physical surroundings are hidden or unnoticed by the user. 'Extensive' indicates the range of sensory modalities that are accommodated within an immersive system. Similarly to 'inclusive,' 'surrounding' deals with the extent of immersion within virtual environments. The term 'surrounding' is used by Slater and Wilbur to discuss the extent to which a virtual reality is panoramic rather than limited to a narrow field. Lastly, 'vivid' indicates the resolution quality of virtual environments; that is how realistic and clear the visual rendering is. Together, these aspects of immersion are largely concerned with the display of information within virtual environments.

Bowman and Hodges explain that the existence of immersive virtual environments has led to the introduction of a new human-computer interaction paradigm, in which users no longer simply play the role of external observers of images on a computer screen. Instead, users are now becoming active participants within computer-generated, three-dimensional virtual worlds ("Formalising the Design" 37). In support of this, and as explained in "Human Factors of Wayfinding in Navigation" by Montello and Sas, immersive virtual environments are computer-generated environments that are capable of responding in real time to user actions and behaviours (12). Unlike a 'real' physical environment, virtual environments range in degrees of immersion from being partially immersive to being fully immersive. In support of the introduced notion of sensory immersion, and as is written in "Persuasive Effects of Presence in Immersive Virtual Environments" by Dan Grigorovici, low-immersive virtual environments are commonly referred to as "over-the-Internet" or computer-monitor-based applications of virtual environments (194). High-immersive virtual environments, on the other hand are described to be "high-end, high-resolution, specialised displays." These environments rely on highly immersive technology such as CAVE-style systems (Figure 1), Immersadesk (Figure 2), Head-Mounted Displays (HMD) (Figure 3) and Augmented Reality" (Montello and Sas 12). 'Degree of immersion' is a necessary quality to address, for the extent of immersion, together with the type of virtual environment, has an impact on both wayfinding design and performance. For example, a physically immersive environment may restrict a user's actual physical movements; by placing the user on a treadmill for example, this would mean that the user is physically unable to turn and walk from side to side, which could cause confusion when moving around and navigating in the virtual world. This is of some importance when addressing the case studies in Chapter Three of this research paper, which are specifically referred to, in order to address the types of immersive environments and wayfinding applications and usage with within them.

Fig. 1. Immersive CAVE-system.

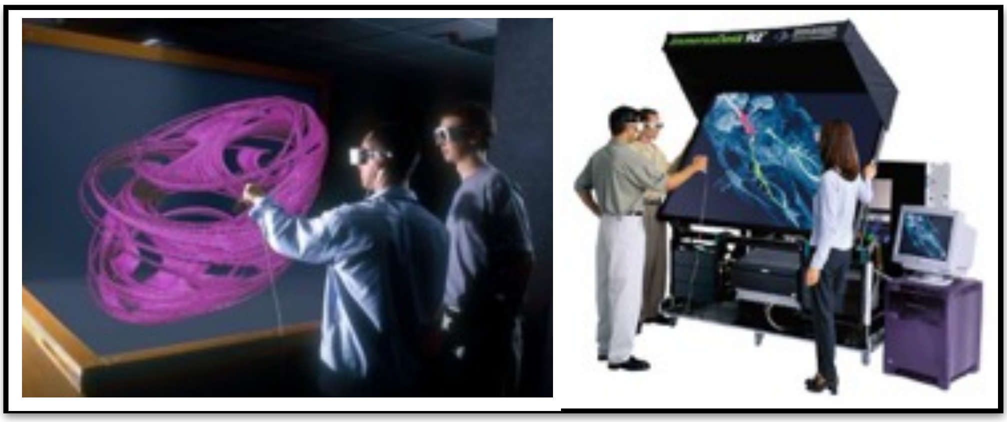

Fig. 2. Immersadesk.

Fig. 3. Head Mounted Display (HMD).

Sensory immersive systems, in the context of virtual environments may be easily identified by the technological devices used, such as head-mounted displays (HMD) (Figure 3) and data feedback gloves (Figure 4). In systems relying on head-mounted displays to portray virtual immersive environments, the head-mounted display device blocks out visual and audio sensations from the user's surrounding physical world and artificially replaces these sensations with ones that have been computer-generated. To create the illusion that the user's body is able to move around in such environments, the user might wear specialised technology such as feedback gloves — to track hand gestures — or use foot treadmills or joysticks to 'walk' around the virtual environment (Heim 112).

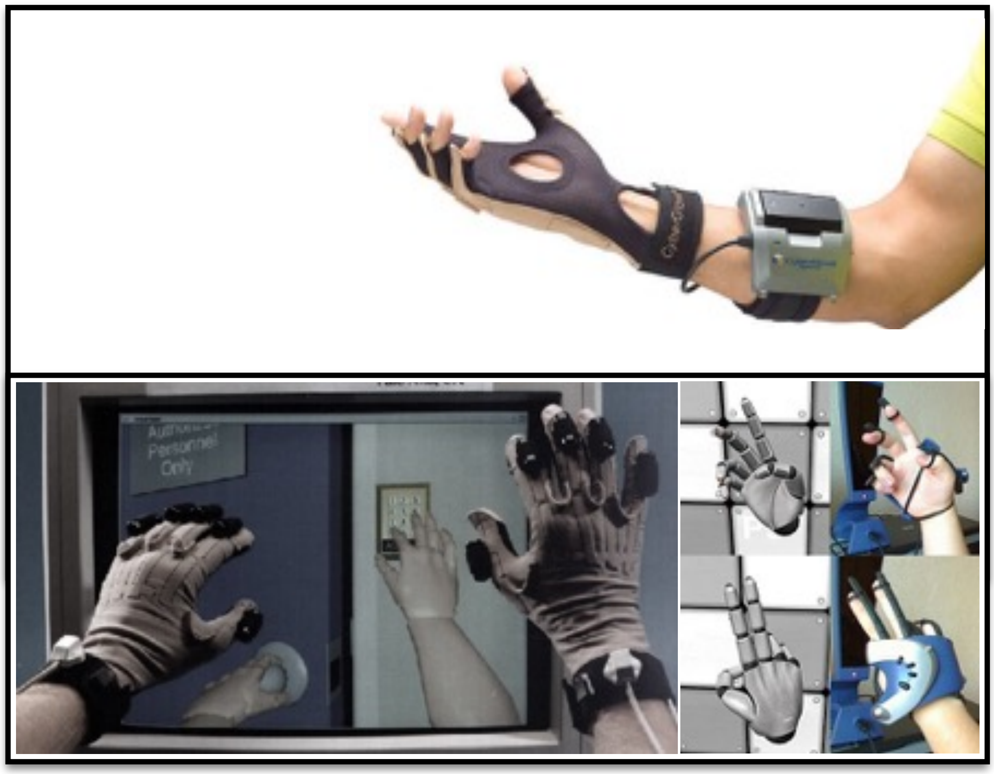

Fig. 4. Data Gloves In Action.

Thus far only the sensory side of immersion has been touched on. In order to fully understand immersion and to be able to present an adequate discussion on immersion — with regard to virtual environments and their effects and influences on wayfinding, the physical aspect of immersion should also be discussed. Physical immersion speaks of an experience in which the human body is within a physical world that is enhanced by digital, interactive technology. In physical immersive situations, the environment can be either partially enhanced by technology or may alternatively be fully enhanced — in which case the human body is within a room-like space made up of screens and other devices, as is the case with CAVE-style environments.

1.1.3 Physically Immersive Environments

In the late 1960s, as virtually immersive head-mounted displays (HMD) began to appear on the scene, Myron Krueger, father of virtual reality, introduced a radically alternative approach to engaging with virtual reality. Krueger created physically immersive environments in which people were able to move freely. These virtual environments, unlike their predecessors did not rely on encumbering gear, which meant that users could move and interact without the restrictions of being dressed in technology. An example of this 'free' interaction is represented in Figure 5, which depicts a user interacting with Krueger's *Videoplace*. Physically immersive environments such as the ones created in Krueger's work use cameras and monitors to project a user's body on to a display so that it can interact with projected graphic images on a screen. Since such computer-human interaction occurs without having to cover the body in gadgets, the burden of input rests with the computer, and the body's free movements become data for the computer to read. Cameras follow the user's body, and computers synthesise the user's movements with the artificial environment (Heim 114).

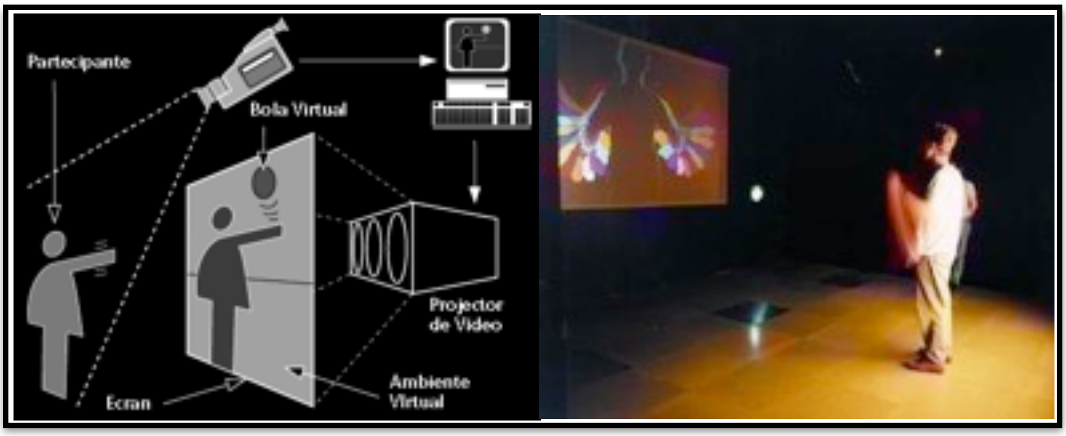

Fig. 5. The Workings of Myron Krueger's Videoplace.

Since the term 'immersion' presents degrees of immersion, it can be expected that physically immersive systems, too, range in levels of immersion. For the sake of the case studies to follow in Chapter Three of this research report, it is necessary to clarify that for the purpose of the discussions to follow, 'low immersion' will refer to physical environments enhanced by relatively simple interactive digital displays, such as a button and screen interaction. These low immersive systems typically work with basic human input to produce a limited digital output. Mid-level immersion, in terms of physically immersive environments will refer to environments similar to those created by Myron Krueger, in which there is a more complex human-computer relationship, with more human input. In these systems, users can really feel as if they are being allowed to see a glimpse of fully immersive virtual worlds. Lastly, highly immersive environments will describe CAVE-systems (Figure 6 and Figure 7); room-sized cubicles with up to six back-projection units, in which the user is physically surrounded by screens and technology. In these systems, the user's only physical restriction would be the room itself.

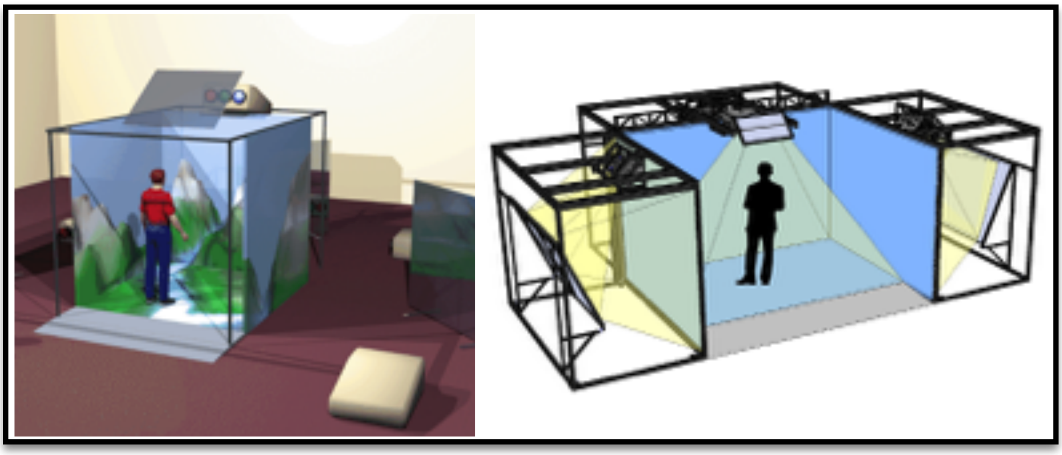

Fig. 6. Typical CAVE System Setup.

Fig. 7. User Interacting with Cave System

Staadt, Gross, Kunz, Meier explain that physically immersive environments, at times referred to as spatially-immersed displays (SID) in literature concerning immersive environments, enable users to interact in virtual spaces while being physically surrounded by a panorama of imagery. Probably the most common of these highly immersive systems today is the CAVE (201).

1.2 An Introduction to Wayfinding

Wayfinding can be classified both as a verb (process) and a noun (system). To initiate a successful in-depth discussion on wayfinding, both classifications of the term need to be looked at. Wayfinding as a process refers to the act of planning and travelling along a planned route to reach a goal destination. Alternatively, wayfinding as a system, refers to a designed set of instructional information put in place to aid users in the process of navigating through a space. The audience at which these systems are most often aimed are general, literate city inhabitants. It must be noted that literacy is not necessarily always a criterion, as well designed wayfinding systems try to facilitate both literate and illiterate audiences by employing pictorial symbols and colour, together with written instructions. The focus of this research report at large is on wayfinding as a system: the manner in which instructional wayfinding systems are applied to virtual immersive environments. Wayfinding as a process will additionally be referred to from time to time as a step towards analysing the manner in which instructional wayfinding systems are applied and used within virtual immersive environments.

People engage in various kinds of spatial behaviour in their daily lives. One of the most frequently encountered examples of this phenomenon, explain Toru Ishikawa, Fujiwara, Imai and Okabe, is planning a route and moving through space to a destination. This behaviour is called navigation and may for the reason that it is so common, be considered to be a straightforward and effortless task. However, there is a lot more to it than meets the eye, for in reality navigation involves multilevel cognitive processing. It is for its hidden complexity that the topic of navigation has attracted so much theoretical and practical interest from theorists and researchers alike (74).

Montello and Sas authors of "Human Factors of Wayfinding in Navigation" and Doug A Bowman, Davis, Hodges and Badre, authors of "Maintaining spatial orientation during travel in an immersive virtual environment." present similar definitions of navigation. According to them navigation consists of two parts: one part being 'wayfinding', which refers to the cognitive decision-making process by which a movement is planned; the other part being 'travel' or 'locomotion', which speaks of the actual motion from a current location to a new location. Naturally these two tasks are not separated so explicitly but often rather executed simultaneously in the physical world (Bowman et al. 619). Most acts of navigation involve both locomotion and wayfinding components, generally as part of an integrated system that can be separated only conceptually (Montello and Sas 3). Navigation is well summed up by Bowman et al. to be the complete process of moving through an environment ("Maintaining Spatial Orientation" 619).

Since travel and wayfinding are so closely related, the method of travel may have an effect on the ability to perform wayfinding tasks and thus on users' spatial orientation. This can be observed in the real world, as, in most people's experience, the driver of a car maintains better spatial orientation than the passenger. This is due to the fact that while steering the car, the driver is made alert of and is required to attend to spatial information (Bowman et al. 619). Wayfinding is the dominant concern of this paper, however, since travel is so closely related to navigation and in turn to wayfinding, the case studies will dedicate a quick glance at the methods of transport implemented in each of the examples to be studied.

The concept of wayfinding, explains seminal author Passini, was developed in the late 1970s and was preceded by the notion of spatial orientation. Spatial orientation refers to a person's ability to mentally represent the spatial characteristics of a setting and the added ability to situate himself/herself within that mental representation. This notion links to the concept of spatial cognitive mapping, a discussion that is to follow shortly ("Wayfinding Design" 321).

Wayfinding, a central term to this research paper, can be best defined through a collection of definitions. With reference to Montello and Sas, wayfinding is plainly explained to refer to a person's requirement to know where to go and how to get there. This definition effectively positions wayfinding as the efficient goal-directed and planning component of navigation, which supports previously discussed definitions of the term 'navigation' and its relationship to wayfinding. The definition of wayfinding can be expanded through the description of wayfinding; found in *Universal Design New York's* wayfinding article, to be the "organisation and communication of our dynamic relationship to space and the environment" ("Universal Design New York"). This quote of course only serves to introduce a more in-depth exploration of the term, through which one may begin to understand the importance of successful wayfinding design and how it may be implemented to enable people to orientate themselves within a space.

The process of wayfinding requires a goal destination, which is typically located outside a subject's immediate surroundings; else planning of a route would not be necessary. For this reason, wayfinding is largely coordinated distally, beyond the local surroundings directly accessible to the subject's sensory and motor systems at a given moment. Hence memory, stored internally in the nervous system and externally in artefacts plays a critical role in wayfinding. Daniel R. Montello and Corina Sas mention in their article "Human Factors of Wayfinding in Navigation" that in order to navigate effectively, it is required that the subject applies psychological skills of perception, cognition and motor behaviour within the contexts of physical and social environments and with the assistance of technologies of information and transportation. Montello and Sas believe that by paying attention to these issues; improvements and potential solutions may be found to improve the design of informational wayfinding, which may result in the increase of ease, accuracy, efficiency, comfort and safety of navigation (1-2).

According to Passini, wayfinding can be broken down into three interrelated processes: 1) decision making, this process refers to the development of decision plans, 2) decision execution, which refers to the act of transforming decision plans into behaviour at the right time and place along the route and lastly 3) information processing, which comprises of environmental perception and cognition, which in turn provides the user with the necessary information for the first two decision-related processes. These processes are important because wayfinding is present at each of these steps. That is why a wayfinding system should be designed with the aim to enhance each of these three steps of Passini ("Wayfinding Design" 322).

1.2.1 Orientation, an Element of the Wayfinding Process

Orientation, another fundamental aspect of any wayfinding process involves the traveller's need to be aware of his/her location relative to the end destination, as well as to other places and objects within both a physical or virtual environment. It is explained in "Human Factors of Wayfinding in Navigation" that human beings typically maintain orientation in an environment through a combination of two processes, namely: 1) landmark based and 2) a dead-reckoning process; the process of keeping track of elements relating to locomotion such as travel duration, to determine one's position within a space (Montello and Sas 3-4).

This is an interesting and valid view on spatial orientation, however, I am of the opinion that orientation cannot merely be simplified down to a conjunction of a landmark-based and a dead-reckoning process. Spatial orientation is commonly a tricky state to attain and maintain within large-scale physical environments and all the more tricky in complex virtual worlds; as virtual environments do not, in general, provide the same rich set of cues for distance, motion and direction as is found within real-world, physical environments.

In addition to the lack of the above-stated cues, virtual environments that make use of head-mounted displays (HMDs) tend to rely on a limited screen display size, which means that the user has a limited field of view. Having a limited field of view further reduces visual cues used to maintain spatial orientation within such situations. This problem becomes important for certain applications of virtual environments (Bowman et al. 618). As in the case of training for navigation within real-world environments, the maintaining of spatial orientation is essential for the task at hand, which would be acquiring knowledge of the layout of the virtual world that can then be applied to navigation through the physical world.

1.2.2 Cognitive Spatial Maps, with Reference to Wayfinding and Understanding

Spatial Cognitive mapping links to wayfinding and understanding and will be looked at in the case studies of Chapter Three. Spatial cognitive maps deal with the manner in which people understand a space. In knowing how people understand environments and in turn how cognitive maps are formulated in users' minds, it may become clear to see how the design of wayfinding can be directed towards aiding and enhancing understanding of wayfinding instructions.

A spatial cognitive map has been defined by Kuipers as the body of knowledge of a virtual environment constructed by integrating observations gathered over time, in order to find routes and to determine the relative position of places. The cognitive map of space is held in the mind and is for this reason, a physically unobservable structure of information that represents a person's spatial knowledge and personal understanding of a space (346).

Imagine the moment of initial exploration of a new virtual environment. In this exploratory phase you, the navigator, begin to construct a private representation of the virtual space 'in your mind.' This mental map is known as a spatial cognitive map; and is essentially a mental map of the virtual space with which you are familiarising yourself; explain Ramloll and Mowat (574).

As virtual environments and the field of virtual reality are still a relatively new theme; it is understandable that virtual wayfinding or instructional wayfinding design within virtual environments still remains a relatively unexplored topic. It is for this reason that there has been a natural tendency for designers; when it comes to addressing wayfinding in virtual worlds, to follow traditional strategies based on studies of wayfinding applications in the real world (Ramloll Mowat 574).

This is not necessarily a situation that needs to change. As explained by Demitrios Charitos in "Designing Space in Virtual Environments for Aiding Wayfinding Behaviour," most virtual environments that exist today were designed by non-architects; people who have not been specifically trained to think and compose in three-dimensions with the aim to best accommodate human activities. As a result, the forms and spaces commonly found in virtual environments are mostly simulations of real-world equivalents. The reason behind these 'real' world simulations or the appropriations of physical world scenes could be because these scenes, environments and situations are simply what is readily understood and known (51).

Since the physical and virtual world are not identical in their workings, it can be expected that certain rules and concepts surrounding traditional wayfinding will need to be adapted or added when designing virtual applications of wayfinding systems. Moreover, it should be noted here that beyond this, wayfinding in a three-dimensional virtual world has additional challenges compared to wayfinding within the physical world. According to Niklas Elmqvist, Tudoreanu and Tsigas authors of "Evaluating Motion Constraints" some of the challenges of wayfinding in three-dimensional worlds include: 1) the fact that the user's view of the virtual world lacks the visual fidelity of the physical world, 2) the virtual world is often not as immersive as the real world. The degree of immersion, as mentioned before, is determined by the technology used. Since most high-immersive technology systems are rather costly, the controls for exploring the virtual world often rely on standard consumer-level technology. Although contrary to what Elmqvist et al. is implying, not all consumer-level technology is of a poor quality. Take *GoogleCardboard* (Figure 8) for example, this relatively low cost device presents anyone who may afford it an opportunity to experience virtual reality. 3) Another challenge according to Elmqvist et al. is the fact that the virtual world is often rendered to look artificial and is often poorly mapped to the task and lastly, 4) the virtual world often lacks many of the additional sensorial stimuli of the physical world, such as touch, temperature, wind and balance (1771). The degree of realism; referred to in points 2 and 4, could have an effect on wayfinding. For example, picture a virtual wayfinding system that is put in place to help people through the task of navigation in the physical world. If this virtual replica of the physical world is not accurate or realistic enough, the system will fail at its purpose and possibly even leave the user feeling more disorientated.

Fig. 8. *GoogleCardboard* Device.

The points raised above by Niklas Elmqvist, need to be addressed as these virtual wayfinding challenges need to be taken into account in the analysis dealing with wayfinding in virtual environments; which is to follow in Chapter Three. Through a well-rounded introduction to the term "wayfinding," the research paper is set to discuss the design application of instructional wayfinding. The terms discussed in Chapter One form the basis of the discussion and the analyses to be carried out in Chapter Three. Chapter Two is set in place to discuss the ways in which information; specifically directional wayfinding information, is designed by adhering to design principles and elements to enhance the design of wayfinding systems.

CHAPTER 2:

DESIGN OF INFORMATIONAL WAYFINDING

This chapter deals with the way in which information is designed and will specifically address the use of subconscious information hierarchies to create an easy-to-understand final design system. The discussions to follow in this chapter will have a definite focus on how design elements and principles can be applied to achieve information hierarchies and emphasis within wayfinding systems. Creating clear visual hierarchies is significant in the design of information, as hierarchies aid people with understanding and recognising the order of importance of represented instructional wayfinding information. This section will also look at how effective design may enhance wayfinding systems.

2.1 INFORMATION AND INFORMATION DESIGN

The discussion will start off by addressing the design of information, after which the discussion will shift its focus to more specifically deal with design in terms of wayfinding design. It is necessary to look at the design of information, for correct and appropriate design and arrangement of information not only makes information easier to understand but also 'subconsciously' guides a user to understand the flow of information. This information-design-orientated discussion will form the building blocks of the discussion on wayfinding design in section "2.1 Design of Instructional Wayfinding," which will facilitate a great deal of the analysis to be done for the case studies — when looking at informational wayfinding in different immersive environments.

For the purpose of the discussion to follow, effective information design refers to information that is easy to see and easy to understand. Before delving into the designing of information, it is necessary first to understand the roots of the fields concerned with the presentation of information. This leads the discussion to the term 'Information Interaction Design,' which is well explained in "Information Interaction Design: A Unified Field Theory of Design" by Nathan Shedroff, to be the intersection of three design related disciplines, namely, Information Design, Interaction Design and Sensorial Design (1). The two main fields of interest upon which this paper is built are Information Design and Interaction Design. The former, Information Design as a discipline, exists to address the organisation and presentation of data; or as in the case of wayfinding instructions, it exists to transform instructions into valuable and easy-to-understand, meaningful information. Contrastingly, the latter's emphasis rests on the creation of compelling user experiences and user-computer relationships (Shedroff 268, 269). In summary it can be said that Information Design is more concerned with the presenting, organising and designing of information, while Interactive Design is concerned with transforming information or experiences to become interactive; allowing users to physically and/or virtually engage with information and situations on new levels.

2.1.1 Information Design and Understanding

Generally speaking, 'design' is a term typically associated with fashion, graphics and furniture, explain David Lauer and Stephen Pentak in *Design Basics*. These commercial applications and associations of the term merely represent an incomplete understanding of the term, which has more universal meaning that might at first come to mind. Ranging from painting and drawing to glasswork, computer graphics and animation; design is involved in virtually the entire realm of two-dimensional and three-dimensional human or computer creations (4).

A designer's main task is to plan and create visual solutions to problems, to arrange design elements and principles and to create visually pleasing compositions or organisations of visual elements. A designer seeks these visual solutions through what can be referred to as a 'design process.' Within this design process, the designer typically evaluates the problem that needs to be solved, the solution and the audience (Lauer and Pentak 4-9).

To better understand the above mentioned 'design process,' the process may be applied to wayfinding. Wayfinding as a system, is a form of visual communication and thus elements and principles of design may be used to facilitate and enhance this communication system (Lauer and Pentak 6-9). From a wayfinding perspective, the 'problem' in question would be how to present wayfinding instructions in a clear and logical manner. The 'solution,' in terms of wayfinding design, would refer to the manner in which the instructional information should be organised, as well as the manner in which design principles and elements are to be applied to emphasise appropriate information. That is how information can be effectively communicated visually. Lastly, 'audience' would refer to any user who is likely to come into contact with and use the wayfinding system. Solution and audience stand out to be the two most important points of concern within the design process of wayfinding, as the method of applying design principles and elements determines the effectiveness of information display and the ease with which instructions will be read and understood. For a designer, the audience is an important point to consider, as understanding who the audience will be will guide the designer to understand which design trends, elements, principles and symbols are culturally and intellectually applicable and appropriate to apply. It is also important for a designer to consider how users are most likely to approach, read and understand the presented instructional information.

The elements and principles of design form the foundation of any strong design piece. As in the practice of art; and the fact that there are no rules in art, there are no hard and fast rules for designing visual solutions to problems. However, very clear guides have indeed been developed over time. These guides, practices and criteria exist to be applied to design works as a reference, to assist in the creation of successful design (Lauer and Pentak 5).

The elements of design include line, shape, texture, value and colour, while the principles of design refer to unity and variety, balance, rhythm, emphasis, scale and proportion. Both the elements and principles of design are relevant to the discussion on the design of informational wayfinding as wayfinding systems are designed to aid human navigation by providing directional instructions. The more effective the design of the presented instructions, the more effective the wayfinding system will be. It is thus clear to see that applying the elements and principles of good design to the information within wayfinding systems, will enhance the presented information. Better presented information will mean that the order of importance of presented information becomes easier to see and therefore the information will be easier to understand and make sense of. In addition to this, design elements and principles will also form building blocks for the design side of analysing the design of wayfinding in case studies.

Elements and principles of design strive to create clear visual hierarchies, as this makes it easier to read and interpret the design or information presented. In order for data or instructions — as in the case of wayfinding — to have 'informational value'; a term borrowed from Nathan Shedroff, it must be organised and presented in a fashion that presents an easily identifiable order of importance (269).

It is important to improve and increase understanding of instructional data, for if it is not understood, valuable information may get lost. Misunderstanding information not only leaves a person feeling uncomfortable, but may also prove to be unproductive and could waste a substantial amount of time. Passini's statement supports my opinion in stating that disorientation and getting lost are commonly frustrating experiences for travellers trying to reach a specific destination. In such frustrating situations, some users are plagued by a feeling of incompetence, while others turn to blame the architects or the designers of the wayfinding system for providing unintelligible signage. Whoever the victim or the culprit, an experience of getting lost is not only unpleasant but has the power to affect a person's attitude towards a setting or an experience. A number of corporations have come to realise that the frustration caused by ineffective wayfinding not only provokes a negative feeling towards the physical setting, but additionally has the power to affect the visitors' perception of the corporation as well as the services offered within that setting ("Wayfinding Design" 319). This opinion is also supported by Linda Perry-Lube, explains Leslie Wolke, in "Wayfinding in Your Pocket". As chief digital officer of the American Museum of Natural History, Linda Perry-Lube explains that due to the vast scale of the American Museum of Natural History, visitors often spend considerable time getting to the desired exhibitions. She goes on to explain that the overall experience is diminished for visitors if they perceive these journeys to be frustrating. It is in cases such as these where Linda Perry-Lube, among others, has turned to digital wayfinding in order to lessen lost time and increase engaged time (50).

2.2 DESIGN OF INSTRUCTIONAL WAYFINDING

As was previously mentioned wayfinding, as a term, introduces a process as well as a system: an act of moving through an area with the aid of instructions, as well as a designed system put in place to guide people through a space. The section to follow is focused purely on wayfinding as an instructional system. More precisely it is concerned with the manner in which design qualities can be applied to different instructional techniques (i.e. maps and signage) in order to contribute to a final piece, of design qualities working together to display information in clear hierarchies.

There are a number of different instructional techniques commonly used in instructional wayfinding systems. The most typical examples include static maps, interactive maps, signs, verbal instructions and recently, GPS-enabled mobile phones; which introduce constantly updating interactive maps accompanied by audio instructions. Each of these techniques are relevant, as different instructional techniques are seen to be more geared towards different applications and needs.

It is explained by Rodney Fewings in "Wayfinding and Airport Terminal Design" that there is a difference between how individuals approach wayfinding, depending on their reasons for needing to reach a destination. The three prominent reasons that he identifies are recreational, resolute and emergency wayfinding. Another factor that influences wayfinding is whether the navigation process needs to occur indoors or outdoors. This may seem unlikely at first, but the principles for indoor and outdoor wayfinding do in fact differ. For example, five principle clues used by people for outdoor navigation in cities have been identified to be landmarks, paths, nodes, edges and districts. Inside buildings, people use several cues or visual and spatial variables in order to find their way around. These variables include visual access, architectural differentiation and plan configuration (Fewings 179, 180). With respect to the discussion I will look at both indoor and outdoor wayfinding — as both indoor and outdoor wayfinding are represented in the case studies. Case Studies One and Four represent indoor wayfinding, while a combination of outdoor and indoor wayfinding is represented by the second case study and the third case study represents only outdoor wayfinding.

Inspired by the previously discussed notions of design elements and principles, this section discusses how these qualities relate to the different applications of instructional wayfinding. When applied to instructional wayfinding, these qualities work to structure the design and presentation of directional information. To define the importance of form (design) and presentation within the design of information, Passini explains that: "form and presentation relate to and affect the way people perceive and recognise information displays" ("Sign-Posting Information Design" 91).

With respect to navigational aids, various presentation formats of spatial information have been developed (Ishikawa et al. 75). Due to this variety, it is necessary to discuss the application of design to a selection of these spatial information presentations as they not only follow different layout or presentation formats, but also require contrasting interactions. These range from inter-human interaction to human-computer interaction. Only spatial information presentation techniques most prevalent to the case studies to follow in Chapter Three will be discussed. Maps, in the traditional, static sense, will be the first point of discussion, after which signage, landmarks and new technologies such as interactive maps and GPS-enabled mobile applications, will be discussed. Maps are often used in both physical and virtual environments as a mechanism to help people locate themselves. The use of maps in virtual environments give users a picture of the virtual environment itself, which often cannot be seen in its entirety, thus simplifying the process of self-orientation. Maps are therefore an important aspect of informational wayfinding, that need to be analysed.

2.2.1 Maps

Maps are a wayfinding technique present in a large number of efficient wayfinding systems. This research report requires a section dedicated to maps, as maps have for a long time played an important role both in conveying spatial information and in guiding people around spaces (Ishikawa et al. 74). Through the years, maps have also become known as the quintessential example of information displays for wayfinding systems (Montello and Sas 9). The significance of maps in the realms of wayfinding and in the everyday lives of the general public is emphasised by that fact that maps have been used in each of the four case studies of Chapter Three. Whether taking on a static or interactive form, maps are responsible for an indispensable percentage of the efficacy and ease of use of each of the systems presented in Chapter Three.

It must be noted that "2.2.1 Maps" deals specifically with the information design of maps from the perspective of a designer. The discussion on maps will be continued in section "2.1.4 New Technologies." However, the focus will then be shifted to look at mapping in relation to new technologies.

Maps are powerful tools of navigation that present users with a wealth of navigational information. Not only are maps powerful in their presentation of information, but they are also the navigation mediator with which people are most familiar, explain Rudolph Darken and Barry Peterson (7). Since maps are so readily understood and used, it is common practice for most large-scale public buildings such as retail complexes, educational facilities, exhibition areas and hospitals to provide users with a map. These maps are typically provided in the form of portable leaflets or a larger scale diagram positioned within the building area (Fewings 182-183). This once again illustrates Passini's earlier point (discussed in 1.1 Virtual Reality and Immersive Environments) about corporations beginning to acknowledge the importance of wayfinding.

It is necessary to discuss types of maps, as opposing map types require both different design applications and methods of interpretation. Together with this, the fact that there are varying types of maps also brings a number of challenges to any wayfinding system. Therefore for any map to be used in any environment; no matter the type of map, virtual or real, a designer needs to know where the map is intended to be used and more importantly, what task the map is to be used for. Knowing whether the map is intended to be used preceding navigation or alternatively concurrent with navigation is probably the most critical issue, to be determined by a designer. This distinction is important as maps used concurrently with navigation, for example, involve the placement and orientation of oneself on the map (Darken and Peterson 3).

As previously mentioned, maps can range from being static and two-dimensional to being interactive and three-dimensional (Darken and Peterson 7). According to Fewings, the prominent and most readily used types of maps are plans, views, fantasy drawings and 'You Are Here' or YAH maps (Fewings 182). You Are Here (YAH) maps, as can be seen in Figure 9, are considered as a separate entity altogether. These plan maps are usually located on a wall or flat surface. YAH maps are known for specifically indicating a user's position in relation to the immediate environment, as well as how to reach various intended destinations (Fewings 182-183). There are two main types of YAH map: those requiring mental routing and those that have been specifically designed to be pre-aligned. Mental routing maps are drawn with respect to fixed directions;

therefore North is always at the top. These maps do not take into account the orientation at which the map is to be positioned in practice. Pre-aligned YAH maps on the other hand, are illustrated with the top of the map matching the direction in which the user is facing when viewing the map. One problem with YAH maps is that since there are two types, users are often unsure whether they need to rotate the map or whether they are looking at a pre-aligned YAH map (Fewings 183).

Fig. 9. Example of a YAH map.

Map orientation is therefore an important factor when considering wayfinding activities. When maps are used outside the context of a particular surrounding environment; such as when planning a journey in a distant, unknown environment, the orientation will primarily need to follow conventional rules, by which north is to the top of the map. Orientations that differ from convention often cause difficulties in such cases. But when a map is being used to actively guide navigational decisions in the surrounding, familiar environment, it has been said that most people perform more accurately when the top of the map is aligned with the forward direction of motion (Montello and Sas 10). In support of this understanding, pre-aligned (YAH) maps often tend to be easier to read as they need not be mentally rotated. That is why not all maps follow common convention, whereby north is top facing.

For most people, conventional maps need to be reorientated before they can make sense of them. This process of reorientating a map often leads to disorientation. The errors that occur and time lost due to using misaligned maps is referred to as an 'alignment effect.' The orientation in which YAH maps are mounted may lead to the alignment effect. This concept is reinforced by Rossano and Warren, who showed that judgements of direction are adversely affected by misaligned maps (Rossano and Warren).

From what has been discussed, it appears that map design should adhere to the Bauhaus method of design in which; "form follows function." By this phrase it is meant that design should be presented only in its most necessary form. A table needs no more than four legs; therefore it should be designed only with a practical flat surface and four legs. Bauhaus follows the understanding that no unnecessary complication should be added to a design. Rather provide a user with clean, easy to understand and well-designed information. Wayfinding systems are often used in unfamiliar environments, as it is in unfamiliar environments that most people seek navigational guidance. In situations in which wayfinding guidance is needed, users are most probably already overwhelmed and uncertain. It is for this reason that wayfinding should strive to help the user rather than to cause the user more stress and confusion.

It may seem that 'north-up' maps are never to be used due to their orientation. However, there is of course a need for every type of map. As found by Abetz and Wickens, maps used during navigation tasks should be oriented "forward-up," while maps used for planning tasks should be "north-up."

In shifting the focus to look at how design is applied to maps, it can be said that line, colour, balance, emphasis and scale are the design elements and principles most applicable to map design. Together with these elements and principles; typography, too, plays an important role in conveying information. Cartographers apply many design principles when compiling their maps. Some of the main design criteria looked at in cartography are legibility, visual contrast, hierarchical organisation, and balance (Buckley 46-47). Although this statement by Aileen Buckley may seem to introduce even more components of design, these newly introduced points simply relate directly to the conventional, prior discussed design elements and principles. Design elements and principles are set in place to achieve effective legibility, visual contrast, balance and hierarchical organisation — which is directly related to the design principle of emphasis. Together these components form information hierarchies that enable users to see and understand the relative importance of the content in the map and on the page. Without these, map-based communication is likely to fail and that is why they are important to address. This stands as the foundation of what will be looked at in the case studies to determine how information hierarchies and emphasis is created in the chosen wayfinding applications or systems.

The first design element to be discussed in terms of maps is 'line'. Line, explains Mary Stewart, has the potential to point, guide, emphasise or to demonstrate orientation and direction (2). It is such a simple element yet it is so important in map design. According to Campbell and Shin, the first feature to be placed into a map layout, is the frame line, which can be seen in Figure 10. The frame line is essentially a bordering box that surrounds and contains all the map elements (222). When analysing 'line' it becomes clear that line can be applied and manipulated in order to either contain or emphasise wayfinding information.

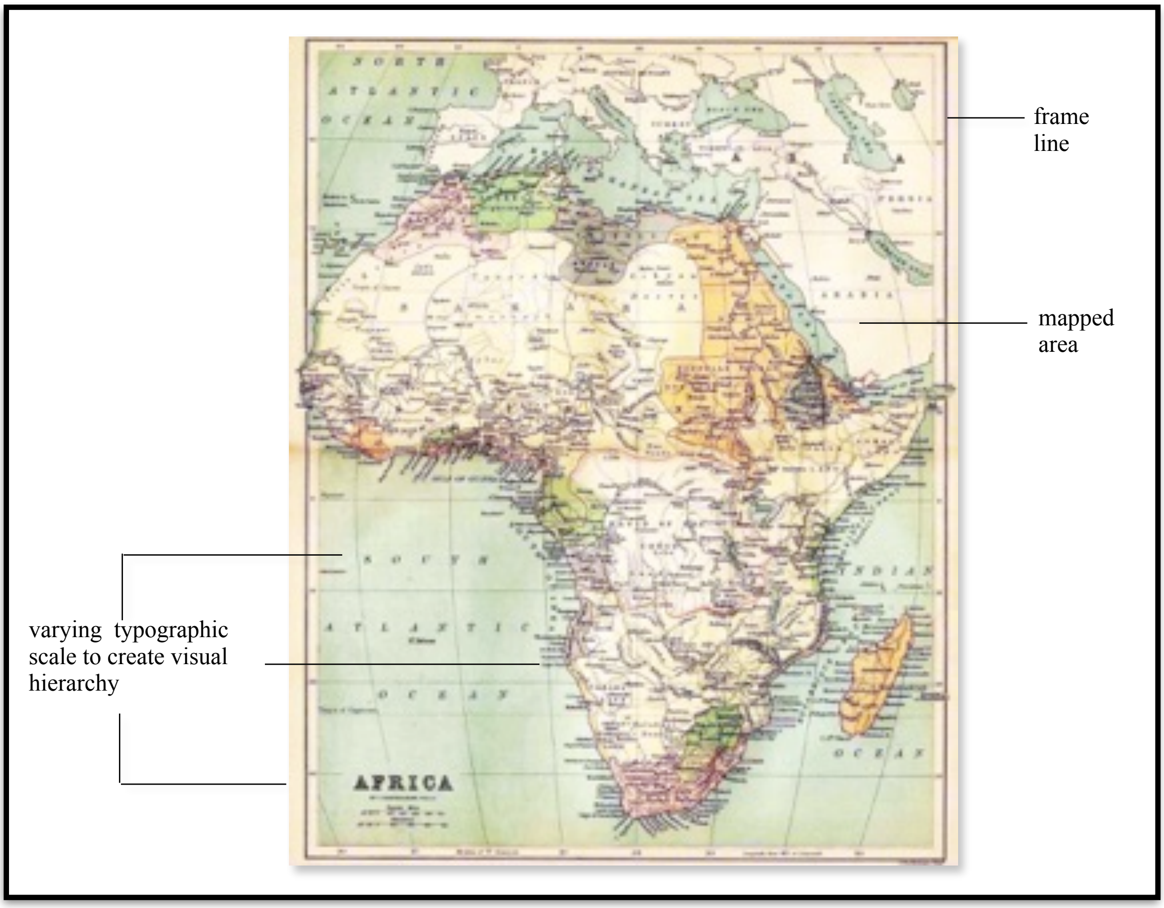

Fig. 10. Map Depicting Cartographic Jargon.

The 'frame line' mentioned in the example above, can therefore be used to illustrate the design principle of balance. Visual balance determines the aesthetic pleasure of a design. If a wayfinding system is not visually balanced, for example, the system will be perceived as unpleasing to look at and difficult to interpret. Visual balance is concerned with the distribution of weight or force within a visual composition. All map elements should be balanced within the frame line. In assessing visual balance, a centre axis can typically be assumed. From this perspective, whereby the axis is central, it is usually expected to find equal visual weight distribution on either side of this axis. When the balance is not present, a certain vague uneasiness or dissatisfaction results. Balance, with reference to maps, simply ensures that no blank spaces or excessive masses of information are present within the map (Stewart 12).

In cartography, the ‘mapped area,’ (Figure 10) refers to the primary geographic component of the overall map. That is the area which contains all features and symbols used to represent the spatial phenomena being displayed. The mapped area will not be discussed in depth as it is simply the all-encompassing collection of cartographic elements working together. Various elements will rather be focussed on individually for a more accurate and in-depth analysis.

The ‘legend’, (Figure 11) is another cartographic term describing an element that provides a self-explanatory definition for all symbols used within the mapped area. Although placement of the legend is variable, it should be placed within the white space of the map in order to emphasise this important element. Placing the legend on a white space implements the use of colour; a design element, to create emphasis, as in most maps white is a colour that will stand out, thus emphasising the legend. The symbols — pictorial representations that take up less space and are universally understood — representing mapped features should typically, according to cartographic convention, be placed on the left-hand side of the composition (Campbell and Shin 223).

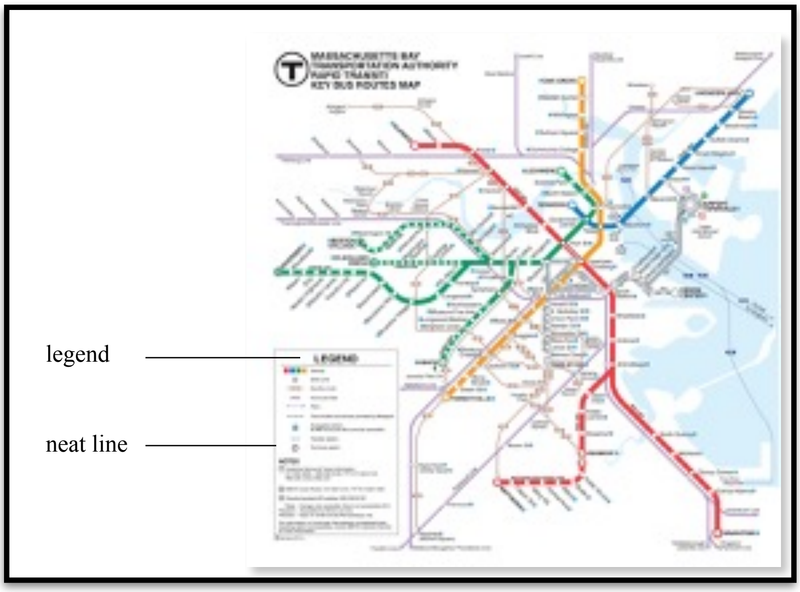

Fig. 11. Map Depicting a Legend.

This 'accepted' positioning of the legend links to Lauer and Pentak's notion of understanding the 'audience' (2.1.1 Information Design and Understanding). In Western culture, it is the accepted norm to read from left to right. Placing the symbols on the left-hand side, therefore, means users will first notice the symbols before moving on to the rest of the map as it is necessary for users to first understand the symbols used, or else the map will not make much sense. In addition to its placement, applying a neat line around the legend, explain Campbell and Shin will additionally help emphasise and attract attention to the legend and symbols (Campbell and Shin 223). This use of line to attract attention once again turns to the principle of emphasis and relies on the use of line to achieve it.

'Insets', another term in the dictionary of cartography jargon, can be described to be secondary map areas positioned on top of the larger map. These secondary maps, as seen in Figure 12 and Figure 13, are typically encased in neat lines, which should be of different thickness or type to other line features on the map, to create emphasis through line and to adequately demarcate them from other map features. Once again, with the design of these insets, emphasis and hierarchy is commonly achieved through variation in line thickness, or colour.

Fig. 12. Example of a Map Containing Insets.

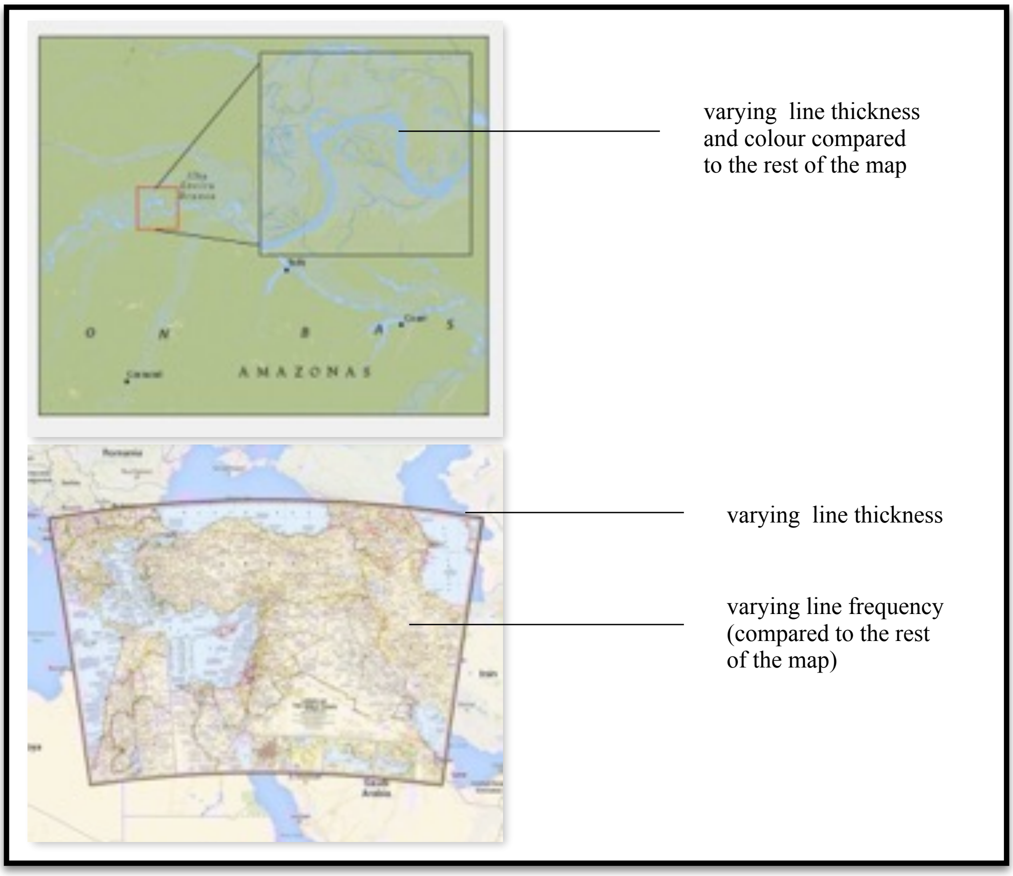

Fig. 13. How Design Elements and Principles are Applied to Emphasise Insets.

Hierarchy within the context of maps states that important information or features must visually appear most prominently on the map, while less important features should fade into the background. Creating harmony between the primary and secondary information on the map leads to a quality product that will best suit the needs for which it was developed: to aid users in a process of navigation (Campbell and Shin 227). Other ways to achieve hierarchy in maps is through the implementation of text rather than through only using visuals. Type is found throughout all cartographic elements, from the title and the legend, to general location labels. Colouring effects alter typographic hierarchy as lighter type fades into the background and dark type jumps to the foreground. In such instances, emphasis is created through the use of contrasting colours.

In addition to being used to create visual hierarchies, colour possesses a certain symbolic property; water is accepted and understood to be blue and land green. Colour is thus used: 1) to create visual hierarchies through contrast of value, 2) to present symbolic information and 3) to demarcate and emphasise different sections on maps. Figure 14 demonstrates the use of colour to divide the map of Africa into demarcated areas, to indicate the countries within the continent.

Fig. 14. Map of Africa Displaying Differentiation Through Colour.

Furthermore, in addition to colour or as an alternative, scale can also be applied to increase the type sizes of important information (Figure 10); hierarchically applying and designing the weight of the type to ensure that the size of the type corresponds with the importance of the map feature (Campbell and Shin 225).

Scale in terms of cartography is concerned with reducing important geographical features to manageable proportions (Campbell and Shin 43). One of the challenges behind mapping the world is reducing it to a manageable size. Nonetheless, all maps reduce or shrink the world and its geographic features of interest by some factor (Campbell and Shin 43-44). In terms of map design, it is necessary for the scale to be large enough to be viewed comfortably and to provide an adequate sense of the environments and how areas within the environment are linked and how far apart they are in relation to each other. In summary, a map scale should be large enough to include all vital information yet small enough to make it easy to work with.

The design elements and principles addressed above apply to maps used in virtual environments, just as much as they do to print-medium maps. Since maps in virtual environments are interacted with in a fashion that is consistent with how maps are interacted with in physical environments, the design rules applied in physical print-maps may be carried out successfully in virtual maps. To summarise, the application of design elements and principles; specifically line, balance, colour and scale, to the cartographic frame line, legend, labels and insets should converge to achieve the goal. This will provide a clear, ordered, balanced, and unified map product (Campbell and Shin 224).

2.2.2 SIGNAGE

The use of signage or signs is an age old technique used in all ranks of wayfinding systems — ranging from the most basic single sign instruction on a grocer's door; indicating to customers, in a shaky handwritten typeface, that customers are to "use the next entrance," to the most high-tech airport systems with flashing digital signs and colour-coded areas. Signage remains a technique almost synonymous to wayfinding and if designed correctly, signs can be remarkably straightforward and easy to understand. However, Montello and Sas also point out the opposing fact that: "unfortunately signs can disorient too" (7). In order for signs to be effective in their design, they need to follow certain rules, which have been developed through time and trial and error. As an information or communications designer, I am in agreement with Montello and Sas. Effective signage should be: 1) legible from a distance, 2) should follow clear and simple design, 3) should contain enough, but never too much, information and lastly 4) should be placed at clever and necessary points, commonly referred to as 'decision points' in the wayfinding realm (Montello and Sas 7).

Signs are created with the purpose to serve people by providing a form of one-way communication of information. Generally speaking, the norm for information presented on signage is to be either directional information or information to help users identify an object, event or destination (Fewings 181).

The three main types of signs are directional, identification and reassurance signs. To elaborate, directional signs are most regularly seen throughout 'city life' as they are the most commonly used type of sign. Signs such as these often include a symbol or arrow or a combination of the two. Since these signs generally indicate a path to a destination, directional signs should typically always be placed at decision points. However, simply putting signs at deciding points is not enough. For optimal effectiveness, directional signs should be placed methodically so that there is an identical sign at each decision point (Fewings 181). The second type of sign, identification signs, are seen to be the simplest kind of sign, for their function is solely to name objects or destinations. Slightly more complex in their purpose, reassurance signs are complementary to directional signs in that they assure people that they are heading in the right direction. Since reassurance signs are secondary in the rank of importance to directional signs, they should not be placed at decision points but rather at points beyond deciding points, where they can provide confirmation to the user that he/she is still 'en route' to the desired destination. An example of reassurance signs are the distance signs next to major towns that are seen to appear shortly after passing a road junction or a decision point (Fewings 181). All three types of signs are very simple in their functioning and purpose, but that is the beauty of signage.

Signage provides a simple form of communication that has the potential to be exceptionally powerful. In terms of a discussion on wayfinding and signage, all three types of signs are important. In a wayfinding system using signage, directional signs will form the predominant component of the signage system. In the context of a physical environment enhanced by digital technology, an example of directional signage could be signs indicating the direction to different exhibits within a museum. Alternately in the case of virtual wayfinding it could be seen to be the instructional information displayed at the top of *AppleMaps* (Figure 15); an instruction that is designed to mimic a typical road sign in its visual quality. Alternatively, as in a physical environment, directional signage in immersive environments could be a simple sign pointing a user towards a direction.

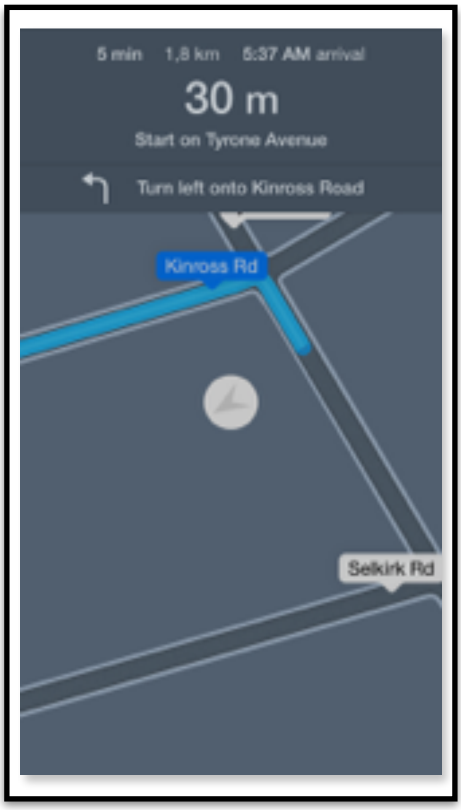

Fig. 15. Design of Instructional Information in AppleMaps.

It is said by Fewings that sign perception is improved if the user is familiar with the overall form and design of the sign and placement methodology. Therefore a sign system that involves consistent design in terms of size, colour, lettering and possibly symbols is more likely to be noticed and understood by users. An example of this consistent design application is the London Underground signage system (182).

Colour is another design element to consider. It is good for signage systems to employ specific colours to signage to assist users in the recognition and perception of related signs. Visual unity in a designed wayfinding system makes it easier for users to identify important directional signage. In today's sea of signage and advertising, having clearly identifiable signage can make a traveller's life a lot easier. Colour can furthermore be applied to create a colour-coordinated system, used to direct the flow of people (Figure 16) (Fewings 182).

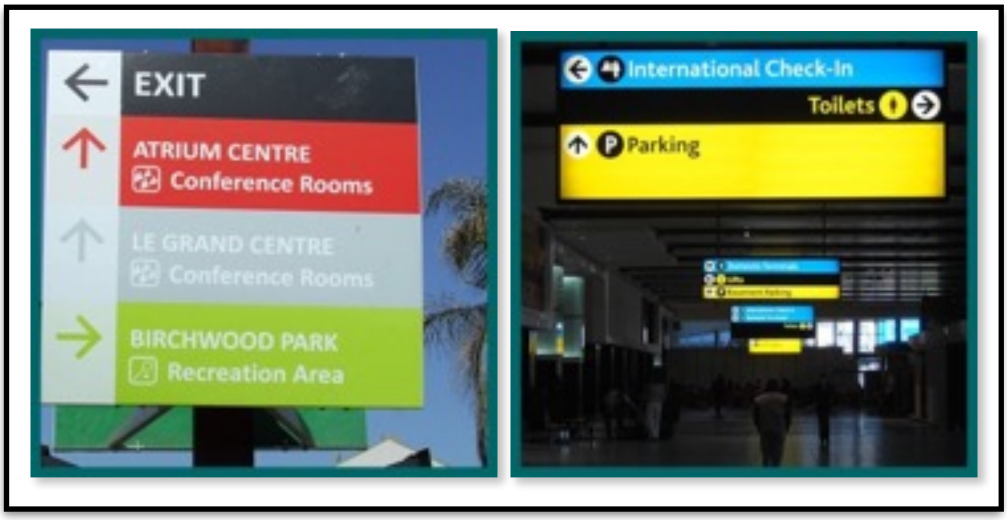

Fig. 16. Signage Displaying Colour-coded Areas.

In terms of typography appearing on signage, colour should be applied to type to enhance readability and to ensure that lettering is clear (Fewings 182). Colour can be used to enhance communication by creating contrast, which is achieved when two opposite colours are placed next to one another. High contrast tends to increase clarity and improve readability while low contrast is used to create a visual indication of secondary importance or a subtler message (Stewart 29). Since the purpose of a sign is to aid and guide users, signage lettering should be clear and directional and in addition to this, location or directional signs should always take precedence over retail advertising signage (Fewings 182).

As mentioned, placement methodology is important when it comes to signage. Although placement does not necessarily relate to design, a consistent placement methodology does coincide with the design idea of unity. Within shopping malls, signs are typically positioned high up, close to the ceiling. By maintaining this unity in positioning, people are able to feel comfortable even in unknown shopping centres, as they know that their signage guidance will always be visible and present if they simply look up. Not only does this consistent placement make users feel more comfortable in or familiar with the space, but signage positioned at a high level ensures that it will always be visible, even when mall passages become crowded.

Another aspect of unity in terms of signage design refers to the use of constant, universally recognised symbols. Signs often employ symbols in an attempt to allow the design to remain visually simple and straightforward. Keeping signage symbols consistent with general or universal standards makes it easier for users to understand as even though they might be in a new environment the symbols remain familiar and are ones that users have seen and deciphered before. Probably one of the most recognisable universal symbols could be the toilet male and female symbol. Many toilet symbols differ slightly to fit a larger applied wayfinding design. However, in essence they remain similar enough for people to easily recognise them. In addition to universal consistency or unity, signs within a designed wayfinding system should remain consistent with the overall design identity so as to make them easy to identify (Fewings 181).

Signs, according to Passini, communicate specific environmental information needed to make wayfinding decisions. They tell the viewer what is where and specify when and how an event is likely to occur. Often used in an additional complementary fashion to signs, landmarks are mainly symbolic objects, which may inform users with regard to identification, structuring and orientation purposes ("Wayfinding in Architecture" 90).

2.2.3 LANDMARKS

Although landmarks might not always directly make use of design elements and principles, it is necessary to look at landmarks and their role in wayfinding and orientation and how they can be applied and displayed within the wayfinding systems.

Demitrios Charitos describes that when navigating in virtual environments users tend to first recognise the objects that seem prominent within the context of the environment; as seen from the subjective perception of the user. A user's subjective opinion is typically influenced by factors such as personal behaviour, social aspects and past experiences. Demitrios Charitos (52, 53) goes on to explain that these prominent objects are called 'landmarks' and the type of spatial knowledge that is acquired from these objects is said by Demitrios Charitos to be 'landmark knowledge'. Similar to Demitrios Charitos' understanding of landmarks, Lynch defines 'landmarks' as point-references, which are singled out from alternate possibilities available in the environment, by virtue of their form or their function, for purposes of identification, structure and orientation (48).

Charitos explains that Kevin Lynch and Donald Appleyard jointly came to the conclusion that a landmark is most easily identified if it: 1) is a prominent physical feature, 2) contrasts with its context and environment, 3) is visible from many locations and lastly 4) if it possesses symbolic function (Charitos 53).

2.2.4 NEW TECHNOLOGIES - SUCH AS GPS-BASED NAVIGATION SYSTEMS

"Location-aware smartphone applications are adding a new dimension to traditional wayfinding systems," (Wolke 48). This quote emphasises the necessity for this paper to incorporate and now move on to look into the world of digital wayfinding through means of mobile, hand-held devices. The advent of advanced information technologies brought a number of new technologies to the scene of wayfinding techniques, including cellphones, the Internet and, more recently, global positioning systems (GPS). These technologies have transformed the ways in which people are now able to find their way and navigate through physical and more recently, through virtual spaces too (Wolke 48). Shoval and Isaacson support that technology equipped with GPS receivers has readily become recognised as a promising tool for providing positional wayfinding information; at least when sufficient signal and accurate satellite readings are available (Shoval and Isaacson 74).

Virtual and interactive wayfinding applications may sound fantastic, however, like most things in life they too have their downfalls. GPS-enabled wayfinding devices have an element to them that acts as both a positive and a negative aspect of the technology. This one specific challenge of these wayfinding systems is their screen or display size and the limitations that come with this. Wayfinding or map displays on screens, such as *GoogleMaps*, represent only a small designated area around the user's current position. Since these devices are connected to the Internet and satellites, the presented information is constantly being updated in real-time. Looking at this feature from a practical perspective, this means that GPS users need to focus on and process continuously updating environmental information on a small screen. Due to this constant update of information, users dedicate less attention to the routes and the surrounding environment. This "local" focus of attention should interfere with the global processing of spatial information, which is required for getting oriented in space, by interrelating the surrounding space, the self and the map. Due to this, users of *GoogleMaps* and other similar applications need to orientate themselves within a space that is based on dynamically updated information displayed on a small screen map (Ishikawa et al. 80).

To elaborate on the challenges relating to 'new technology' wayfinding techniques, Ishikawa et al. say that it has been found that in general, GPS users do not take the shortest route to goal destinations. To add to this, acquiring spatial knowledge is also problematic as GPS users' configurational understanding of routes tends to be worse than direct-experience participants. One possible reason for this could be the size of maps shown on the screens of GPS-enabled devices, which poses an interesting question of how much of the surrounding area needs to be covered by a map so that it "works as a map" or fulfils its advantage of covering the layout information about the space (74, 75). By taking note of the challenges presented by 'new-technology' wayfinding techniques interesting points are brought into consideration, which lead to valuable points to analyse within the four case studies of Chapter Three. Apart from introducing valuable points of discussion, being familiar with challenges presented by new wayfinding technology provides opportunities to improve these new wayfinding applications. This is the case with Google. Google noticed the problem of GPS users not taking the shortest routes and since they were aware of the problem they were able to enhance their wayfinding system to improve the user experience. This is also why *GoogleMaps* uses its data to map the shortest route for the user.

However negative this distraction presented by constant information updating may seem, there is always a positive element to be found when discussing interactive technological solutions. GPS-based interactive maps have a function to convert the displayed map into a two-dimensional satellite view (Figure 17), a three-dimensional satellite view (Figure 18) or a flat designed, geometric map (Figure 19). The flat geometric view is the standard setting and from personal experience, I find it easier to navigate using this standard map setting, as it is less cluttered and the environment is further divided into clear colours. Green and beige are used for the land, light blue for bodies of water, yellow for the road and the planned route in dark blue. Kray, Elting and Coors compared two-dimensional maps and three-dimensional visualisations as a means of presenting route instructions on mobile devices. They found that in general, users located their positions more easily and reached destinations faster with two-dimensional maps than with three-dimensional visualisations (Kray et al. 122).

Fig. 17. 2D Satellite Map View.

Fig. 18. 3D Satellite Map View.

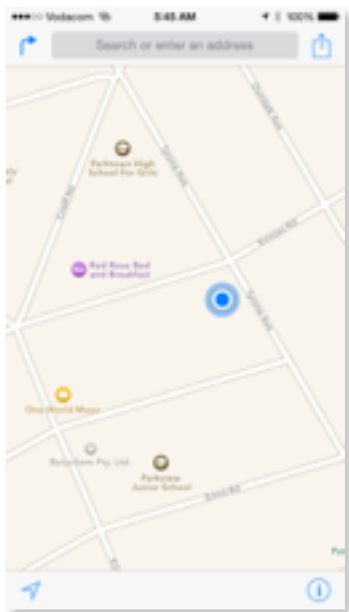

Fig. 19. Flat Designed Geometric Map. Screenshot by author.

Another feature of GPS-based wayfinding technology is the ability of many, if not all, devices to communicate verbal directions to the user. This is commonly used by most smartphone users through means of *GoogleMaps* or *AppleMap*s, whereby you specify your current and desired location and the device then guides the user through verbal instructions. In their discussion on a selection of wayfinding-related research experiments, Ishikawa et al. discuss the effectiveness of verbal instructions. Through these experiments, it was found that users making use of verbal directions yielded more favourable results than those using only route maps, in terms of travel time, distance and number of navigational errors (Ishikawa et al. 75). To take this further, the voice of the device can be changed to suit each user's personal needs and preferences. Even though studies such as the one discussed here have proven that verbal instructions yield better results than instructions that were purely visual, it could be most beneficial to rely on a collaboration of constantly updating, flat visual maps and clear verbal instructions.

Contemporary wayfinding technologies have undeniably revealed a new dimension of interactive wayfinding techniques that have the potential to not only simplify, but make the entire navigation process a lot more natural for travellers, both in virtual and physical reality. Even though constantly updating maps and automatic verbal directions appear to make traditional techniques seem redundant, it is imperative to realise that traditional, print-medium wayfinding techniques still play an important role in any wayfinding system, no matter how high-tech it may be. There are times when online-technology becomes redundant within a matter of seconds, as reception fails and unlike interactive maps, print maps remain usable without a source of energy or electricity. The case study analysis in Chapter Three, will be looking at the technology and techniques used within each selected wayfinding system, to determine the extent to which each system relies on 'old' and 'new' wayfinding techniques. In addition, the manner in which these technologies are applied will be analysed in order to determine whether the 'old' and 'new' are used in collaboration or whether they are used as separate entities.

CHAPTER 3:

CASE STUDIES

Informational wayfinding is applied and designed differently in disparate immersive environments so as to meet a variety of needs. The four chosen case studies are very different and may seem rather contrasting. The reason for this broad selection of case studies is to allow for a more complete analysis of the role of informational wayfinding within both physically and virtual immersive environments. By looking at an example of the three types of immersive environments, namely: a 'physically immersive environment,' 'digital physically immersive environments' and a 'virtual immersive environment,' I will be able to determine how informational wayfinding varies in its application and the manner in which it is used and understood within these varying immersive environments.

For purposes of this analysis, a 'physically immersive environment' refers to an immersive environment in the real world, that is only augmented (enhanced) by digital technology, without relying on it. A physically immersive environment can make use of a combination of traditional and new, digital wayfinding systems or it can be a system that relies purely on digital wayfinding technology. In combining traditional and new wayfinding elements, the environment may incorporate screens, interactive information displays and audio within a physical environment. A 'digital physically immersive environment' is an environment that not only incorporates digital technology but distinctly relies thereon to enhance the physical world. An example of this environment could be a situation in which the user's immediate surroundings rely on virtual and digital technology to be enhanced or to be used correctly. On a level of low-interaction, this could be achieved through an all-encompassing mobile phone application that presents a virtual experience accessible only through the phone. Lastly, a 'virtual immersive environment' is a virtual environment in which a user may become either visually immersed, as is the case with a *GoogleCardboard* device or physically immersed as is the case with a CAVE-style system (Figure 1, Figure 6, Figure 7).

Through an analysis of spatial communicative techniques, the case study analysis will strive to find a connection between wayfinding and interactive immersive environments; as well as evaluate the extent to which these two elements complement one another.

Case Study One presents a 'physically immersive environment,' while Case Studies Two and Three represent partially immersive 'digital physically immersive environments.' The fourth and final case study represents a fully 'virtual immersive environment,' which is fully dependent on the *GoogleCardboard* devise.

The criteria to be looked at when analysing the four case studies will be: 1) navigability; that is how user orientation is achieved and how effectively a user is able to navigate around a space. 2) Design of informational wayfinding, which refers to the design and implementation of visual flow, sight lines and visual cues, as well as the application of design principles and elements to create clear information hierarchies. Another point that will be looked at is 3) the technology used and level of interaction achieved. These criteria are drawn from the literature; discussed in Chapters One and Two, on the subjects of wayfinding, immersive environments and interactivity. By addressing these criteria, my aim is to gain a better understanding of how these criteria are applied, interpreted and used within various immersive environments.

Before delving into the analysis, it must be explained that all four case studies were personally used and experienced. Even though some sources were consulted, the analysis is predominantly conducted through personal experience and therefore also from the perspective of an Interactive, Information Designer. I was able to personally interact with and experience all four case studies. Case Study One was easily accessible and Case Studies Two, Three and Four all presented their users with a complete and all-encompassing experience without the need to be situated within the physical environment. This feature adds to the success of the applications and further enhances the abilities of blurring the lines between physical and virtual reality.

3.1 Case Study One: Menlyn

The wayfinding system to be looked at as a representation of a physically immersive environment is the recently updated wayfinding system implemented by Menlyn Park Shopping Centre in Pretoria. This wayfinding system was chosen, not for being the best wayfinding system, but for the reason that it utilises a number of different wayfinding techniques. Although Menlyn's wayfinding system is predominantly a traditional wayfinding system relying primarily on print-media and personal verbal directions, this system, in keeping with the times, has recently incorporated digital interactive wayfinding techniques. This system thus presents itself to be a good link between 'old' and 'new' wayfinding techniques, making it not only a good example to study but simultaneously making it a wayfinding system that caters for anyone, from illiterate to up-to-date tech-savvy individuals.

The traditional wayfinding techniques used are: 1) people who are physically positioned at information desks, which are placed in close proximity to selected entrances, 2) printed maps of the mall in the form of brochures and 3) static signage attached to the ceiling.

Working in conjunction with these more 'traditional' techniques, are the digital wayfinding techniques which include: 1) dynamic direction displays, 2) interactive YAH maps and 3) two non-interactive virtual tours of Menlyn Park Shopping Centre.

It must be mentioned that Menlyn Park Shopping Centre will hereinafter be referred to as 'Menlyn'.

3.1.1. Design of Informational Wayfinding

A designer seeks visual solutions through a 'design process,' in which the designer typically evaluates the problem, the solution and the audience (Lauer and Pentak 4-9). With regard to this analysis, the term 'audience' as introduced previously, refers to any user who is likely to come into contact with and use the wayfinding system. The intended audience is an important element to consider within the design process, as an understanding of who the audience will be guides the designer to use trends, elements, principles and symbols that are culturally and intellectually applicable and appropriate to apply.

Since Menlyn Park Shopping Centre is one of the largest malls in Africa, the target audience for which Menlyn's wayfinding system was designed is, in essence, the general African public. This audience focus can be more specifically described to focus on the South African general public; for the mere reason that Menlyn is situated within South Africa. In the case of Menlyn's wayfinding system, 'general public' refers to any person that may visit Menlyn, for whatever reason. Due to the broad target audience, the wayfinding system must cater for literate and illiterate shoppers, all races, cultures and genders. It naturally becomes a rather complicated task, for a designer to design a wayfinding system that appropriately caters for such a vast target audience. Therefore, in order to accommodate all mall visitors, this system combines text and pictorial representations (symbols) and then applies them to a combination of traditional and digital wayfinding techniques.

Since Menlyn is situated in South Africa, which follows British English grammar conventions, the language and design application within this wayfinding system follows the understanding and assumption that the majority of Menlyn's visitors will understand English and read from left to right, top to bottom.

Menlyn's wayfinding system, makes use of a vast selection of symbols, as symbols are an appropriate form of communication for minors, illiterate and foreign customers. Additionally, symbols are often easier to recognise and decipher than pure text. To add to this, symbols also take up less space, thus allowing signage to appear cleaner and less cluttered and therefore easier to interpret.

In analysing Menlyn's wayfinding system, it was interesting to note that in instances where icons are used, no text is seen to accompany these icons. This simply emphasises the effectiveness of universally understood, pictorial representations or symbols.

Looking at the signage used by Menlyn (Figure 20 and Figure 21), all signage follows the same visual design identity, with a dark grey coloured strip at the top of the sign and white uppercase sans-serif lettering. This lettering design is used to present names of well-known shops or short, two-word descriptions such as 'existing mall.' These descriptions or names are accompanied by white arrows, all placed within a friendly rounded square, to form directional signage. All arrows are placed either on the very left-hand side or the very right-hand side of the sign and always appear in a white square. A white strip can be seen below the dark strip; this strip houses icons that demonstrate general points such as toilets, elevators, stairs, fire escapes or information desks. This unity in the signage design and placement of symbols makes it easier for users to interpret signs. The two contrasting colours and limited use of bright colours used throughout all signage, leaves signs to be easily recognisable.

Fig. 20. Visual Identity of Signage in Menlyn.

Fig. 21. Directional Signage in Menlyn.

Throughout the signage, visual hierarchy of displayed information is achieved through the use of colour and varying scale, as can be seen in the directional signage (Figure 20 and Figure 21). Within the structure of these signs, directional information; informing users of the direction of 'landmark' shops, is clearly the first level of importance, as these instructions are much larger than the icons and other information displayed on the signs. Coming from a design background, it is known that the use of scale is effective in creating visual hierarchies as a user's eye is naturally first attracted to the largest element seen. From here, a user's eye will typically flow through displayed elements from largest to smallest.

In concluding the analysis on Menlyn's use of signage and symbols, it can be said that overall, Menlyn's wayfinding system presents visual unity in its design identity, which makes it easy for users to spot wayfinding related information. Together with the design principle of visual unity and scale, Menlyn's system uses the design element 'colour' to create emphasis and visual hierarchy on signage.

As mentioned, Menlyn's wayfinding system makes use of a printed map (Figure 22) in the form of a brochure. This map presents users with a view of all four levels of Menlyn, each level being colour-coded to make wayfinding easier. Together with the colour-coded illustrations, the map presents an alphabetical directory of shops; with shops arranged into categories such as 'fashion' and 'services', to name a but few. In addition to the directory being alphabetical, each shop code is written in the colour corresponding to the level on which it can be found. The use of colour to categorise and divide information is effective and simplifies the process of finding a desired destination. However, a flaw in the design of visual flow can be noticed in Menlyn's brochure-map design. This cartographic design does not follow conventional cartographic rules and in this case, not following the rules has a negative impact on the overall map experience for viewers following a left-to-right reading system. Upon opening the brochure-map, the user's eye is first attracted by the colourful map, consuming the majority of the layout. From here the user naturally glances over the map only to be left somewhat uncertain as there is no legend of implemented symbols and the list of shops is only displayed on the right-hand side of the layout. It must be mentioned that the shop names are in fact written on the illustrated map, however, due to the small type-size used, this information is easily glanced over and not noticed. This means that initially only the map will be noticed, followed by the store directory and only there after will the shop names on the map be noticed.

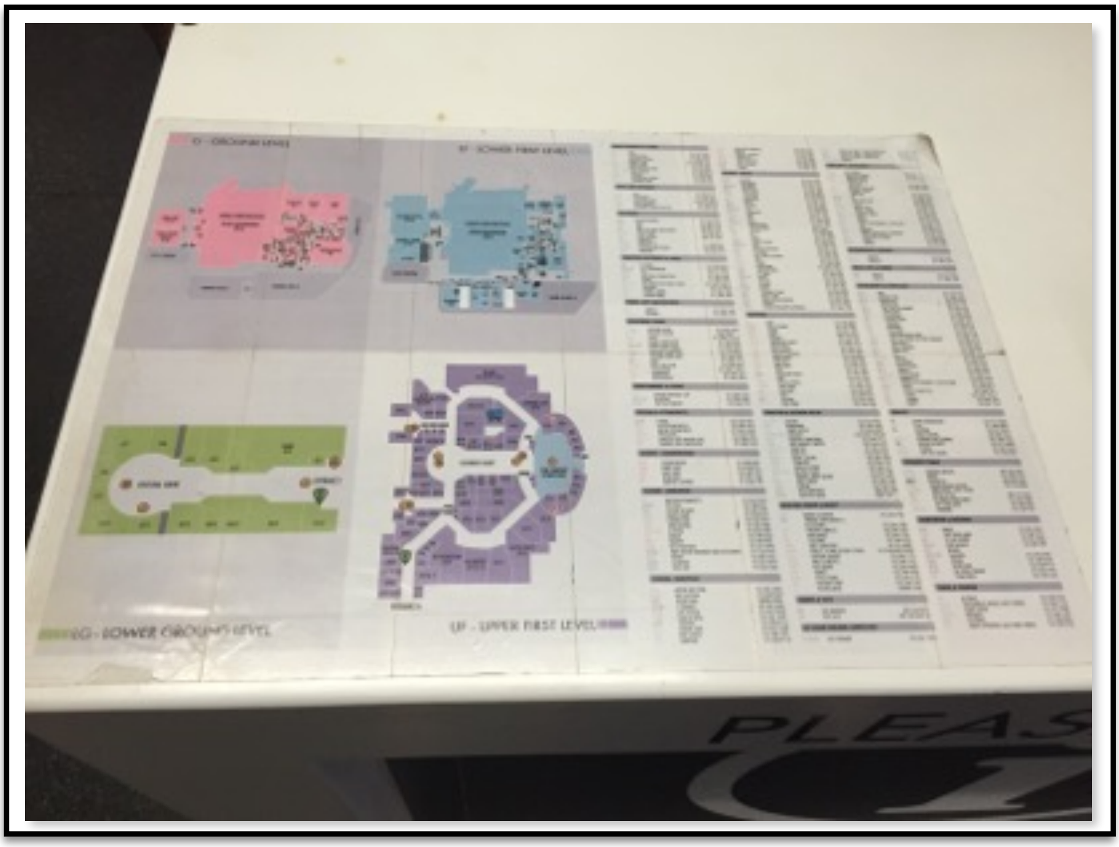

Fig. 22. Menlyn's Printed Brochure Map.

The directory of shops, as mentioned, is placed at the final point on the visual journey, which results in more 'visual work.' The viewer scans the map from left to right to find his/her current location. The viewer's gaze is then shifted to the right-hand side to find the desired shop number, only to have to move his/her gaze back to the opposite side of the layout to start scanning the map again. This layout flaw together with the resulting poor visual flow, makes studying the map all the less enjoyable.

The concluding point that can be taken from the analysis of the static map, is that the use of colour to categorise and attract attention, proves to be very effective within this system. Relating to Montello and Sas' earlier stated notion (2.1.2 Signage) effective signage should contain enough, but never too much, information (7), displaying too much information in a type-size that is too small the information (shop labels) becomes taxing to read and is therefore glanced over. The lack of a legend, together with the cluttered, information intensive map and poorly planned visual journey all detract from the overall ease and enjoyment of the map experience.

In contrast to this brochure map, the design of the interactive YAH maps (Figure 24) makes up for some of these lacking elements by including a legend on the left-hand side, to explain used symbols. In addition to this, the screen interactions are positioned in visually logical positions, so that the visual flow may be natural and the hierarchies of the available features are clear. For example, the search functions; which form the first step in searching for a desired shop, are positioned at the top of the screen with the illustrated map displayed below.

The map on this display follows a similar illustration style to the brochure map. It is also much larger, which makes it easier to decipher. This simply reiterates the limitations of small display screens. Despite the fact that the map is displayed on a digital screen, it does not present the user with the opportunity to zoom or scale the map, which is usually the key asset of digital displays.

Similarly to the brochure map, the YAH maps (Figure 23), too, make use of colour to divide spaces. However, the colours used to differentiate the levels on the print map are not used in the same way on this digital map. The digital map rather makes use of colour to divide different areas, with all levels using similar colour combinations. From a design perspective, this is an incorrect application of colour as the differentiation in use of colour between the print and digital map disrupts the visual unity. This leaves the interactive wayfinding technology to seem disjointed from the traditional print map. The fact that the two maps do not link visually is problematic, especially since they are meant to complement each other and work together. The legend of the digital map should make up for the fact that the print map does not contain a legend, however, because these maps are visually dissimilar, users will tend to view them as separate entities.

Fig. 23. Customers Interacting with Interactive YAH Maps.

Fig. 24. Design and Layout of the YAH Map.

The interactive YAH maps present users with animated visual routes to direct them from their current locations to their desired locations. In looking at this animated route (Figure 25), the route that is to be followed is clearly emphasised through the use of visual differentiation or contrast. The route is marked using a thick red line, with this red being unlike any other colour used in the colouring of the map. In addition to the line, additional visual reference is added in the form of pin icons. The first of these being a red pin that pops up at the user's 'current' or "You Are Here" location and the second being a green pin labelled "View Shop Info" to represent the desired destination. The colour application makes it easy to spot the visual cues, once again proving that colour is a good design element with which to create emphasis.

Fig. 25. A Still From The Route Animation.

The next digital wayfinding element namely, the dynamic motion displays (Figure 26) are easy to spot as a result of the visual unity in the design. These displays take on a similar shape to the interactive YAH maps, but are slightly smaller with a label saying; "Please note this is not interactive." Despite the good visual unity there is a flaw in the physical design, in that it is too similar to the interactive YAH map stand. Good design visually guides and informs users of how the design is meant to be used or interacted with. Therefore, following this logic, the dynamic direction display should be visually contrasting to the interactive YAH map stand in order to visually inform users that a different interaction is most likely required.

Fig. 26. Dynamic Motion Display in Menlyn.

The screen displays on these dynamic direction structures are constantly changing and the focus of their visual component is fixed at the height of average customer eye-level — making it a wayfinding element that simply cannot be over-looked or ignored. In the case of these dynamic direction displays, emphasis is created and attention is attracted through the use of sight lines and motion — as the screen display updates and changes. These screen displays are simplistic, containing only the shop name and logo and an arrow pointing the user in the correct direction. Due to this simplicity users will not be confused by visual clutter. Together with this, the simplicity simultaneously ensures that these displays stand out and are easily noticeable.

A strong visual identity is carried across all forms of wayfinding, which makes it easy to identify navigational information points and sources from a distance. In addition to this, once a user has deciphered the first encountered sign, it is easy to apply the rules gathered from this first signage experience to the signs that follows; since there is strong design unity and system throughout.

3.1.2 Navigability Within This Immersive Environment

In repeating Fewings' previously introduced explanation (2.1.2 Signage), sign perception is improved when a user is familiar with the overall visual design and placement of the sign. Whether static or interactive, this 'rule' remains applicable. Therefore a sign system that involves consistent placement and design; in terms of size, colour, lettering and possibly symbols is more likely to be noticed and understood by users.

Menlyn's signage follows a clear placement methodology. In Menlyn, all signage is attached to the ceiling and hangs in the centre of passages; as seen in Figures 20 and 21. This means that signs are easily read and noticed. From a distance signs appear at general eye-level. Naturally, as a person moves closer to the sign, its height above eye-level increases as a result of the phenomenon of perspective. The fact that signs appear at eye-level from a distance, subconsciously makes people aware of their existence. This signage placement methodology follows the shopping mall norm as most South African mall signage is placed close to the ceiling.

In addition to the placement methodology of signage, the information desks (Figure 27) are placed close to major or popular entrances and the interactive YAH maps can always be found in large open spaces or spaces where multiple walkways converge.

Placing these structures in large open spaces not only makes them easy to locate but simultaneously allows large groups of people to interact with the device, while still having enough space for shoppers to walk comfortably around the interaction. Unlike the interactive YAH map structure, the dynamic direction displays are scattered around the mall, seemingly following no clear placement methodology. As a result it is not an easy task to locate them within the mall and therefore users tend to just unexpectedly come across them as they navigate around the mall.

Fig. 27. Information Clerk Manning an Information Desk. Screenshot by author.

In shifting the focus to the use of landmarks, the role of landmarks in wayfinding and orientation will be analysed. Since Menlyn's wayfinding system is used indoors, within a shopping mall, no external landmarks are used. However, popular or anchor shops are used in a manner through which they become internal landmarks. Architectural elements are not directly referred to within any of the directional instructions found within this system. In fact, in the entire wayfinding system, no verbal or written directional instructions are given. The only available directional instructions are those given by information clerks, manning information desks. These verbal instructions received from information clerks do, from time to time, rely on architectural elements for clarity. This is most likely due to the fact that the transfer of directional instructions occurs between people, therefore referring to visually prominent features such as escalators or "the large hole" in the centre of Menlyn makes it easier for people to convey their routes effectively, as referring to visual features presents a form of clear reassurance and orientation to users.

3.1.3. Technology and Wayfinding Techniques Used

Commencing this section of the analysis with a look at the more traditional wayfinding techniques, the information desks manned by people in butler-like uniforms provide Menlyn's visitors with an option of personal directional instructions and a printed map. The brochure maps provided at these information desks are folded to a pocket size that comfortably fits into most pockets and handbags. Although these maps may be small and somewhat difficult to read, having these maps any bigger could make them uncomfortable to handle. This situation simply emphasises the limitation of print medium. It is in cases such as these that having digital, zoomable map displays could be beneficial. Having a printed map, however, does give the user a physical memento and guide that is easily accessible and physically remains with the user until he/she discards it. Another positive quality of a print map is that it presents users with an opportunity to make personal annotations on the map to aid present and future self-orientation and navigation.

In an attempt to make Menlyn's wayfinding system more efficient and all-encompassing, providing a printed map caters for literate individuals who are not familiar and comfortable with new wayfinding technology and techniques.

The third 'traditional wayfinding technique' put to use within Menlyn's wayfinding system is static signage. All wayfinding signs found in Menlyn are designed to be large enough to be easily identified and read. The main types of signage employed within this wayfinding system are directional signs and reassurance signs.

Menlyn implemented dynamic direction displays to enhance and complement these static signs. The dynamic displays are screens encased in white boxes, visually similar to the interactive YAH maps found across Menlyn. However, unlike the interactive YAH maps, the dynamic direction displays are not interactive. These screens display a shop name together with an arrow to point the shopper in the correct direction. Since the displays are digital and constantly changing they present users visual directions to various shops within the surrounding area. Each visual direction is displayed for a few seconds before moving on to direct users to the next shop in its proximity. Since these displays point users only to the shops in the proximity of the display, these displays become a form of reassurance signs. Users would typically be following directions initially gathered either from the information desk, the brochure or interactive map or the static signage when encountering a dynamic direction display. Therefore since users already have an idea of where to go and are in close proximity to the desired shop these displays simply act as reassurance signs — notifying the user that he/she is still on the correct route.

Interactive YAH maps, too, are housed in interactive rectangular structures. These interactive YAH maps present users with the choice; either to choose their desired shop from an alphabetical store directory, or to physically type the store name to search it. Once the desired shop is selected, the visual display changes to a map similar in style to the 'level illustrations' found in the brochure map. Once loaded, the map display indicates the user's current position with a pin icon and uses a thick line to visualise the route to be taken to reach the desired destination. This interaction presents users with not only a map, but a worked out route to visually explain how to reach a desired destination. The route is animated and travels from the user's current location through the walkways in Menlyn to reach the goal destination. If necessary to change levels, the red line flows to an escalator or elevator icon to visually indicate the need to change levels. The level illustration then changes colour to reveal the new level, upon which the red path continues to travel along walkways until the desired shop is reached. The animated route explanation presents potential, and as it is visual, it allows even children, illiterate and non-English speaking users to understand the directions.

There is, however, an element to this process that is lacking. The animation; visualising the route to the goal destination, is too fast and once it has played through, it does not loop or allow the user to trace back the steps or to re-view the animation. In order to re-view this 'route animation' the user has to physically re-search the shop name. In addition to this shortcoming, there is no option for the user to view a list of directional steps or to go through the steps in his/her own time. However, in compensation for this flaw, users are able to ask for verbal direction from people designated to aiding this user interaction. Sadly, more often than not; even though it is not their official duty, these facilitators verbally direct customers to shops, thereby confirming that the understanding and memory issues of the interactive YAH maps are very relevant.

Menlyn's non-interactive virtual tour of the mall is in essence a constantly playing virtual video that presents users with a visual journey through the mall. This aids user orientation by giving users a better sense of how their journey may look and what to expect.

Based on the discussion above, Menlyn's wayfinding system could be described as internal. However, Menlyn does have an additional online directory which is externally accessible to the mall. This additional feature strictly follows the visual identity of the YAH maps. However, since this feature is used when not within Menlyn, it does not include a YAH map. The desktop feature allows users to search the online store directory and then to access general information about the desired shop.

In addressing the level of interactivity presented by these wayfinding techniques, the more traditional wayfinding techniques such as the signage and the brochure map, as well as the dynamic direction display and virtual tour which are elements of 'new' wayfinding systems rely on limited interaction, for they exist and work without human input. People have to simply read or analyse them but they are in no way 'activated' by human input.

The interactive YAH maps on the other hand are in no way useful, unless activated by human input. In contrast to these YAH maps, the information desks do not require digital interaction, only human-to-human interaction, whereby the information clerk is able to verbally direct a customer.

In conclusion, Menlyn's wayfinding system accommodates a range of users and situations through its variety of implemented wayfinding techniques. People with less interactive, digital media experience may be intimidated or confused by the idea of having to physically interact with a device placed in the middle of a walkway and would therefore prefer to receive personal directions from an information clerk with the added support of a printed map. In contrast to this situation, an introvert may prefer to simply take a printed map or interact with a digital device rather than to seek help from a person.

The range of wayfinding techniques used in Menlyn's wayfinding system presented an opportunity to analyse the effectiveness and application of each technique. Through observation, it was found that shoppers were attracted to the YAH maps, most probably due to their size and their interactive potential. However, a number of users seemed to struggle when attempting to interact with these maps. Since these interactive YAH maps are well designed and their features follow a logical flow, the user confusion is most likely due to the fact that this is an unfamiliar interaction. Despite the well-designed visual flow, the speed at which the 'route animation' is played together with the fact that the user can view this route only once are definitely factors contributing to user confusion.

In relation to the design focus of the analysis, Menlyn implemented a strong and striking visual identity across their static signage, which allows the signage to be easily deciphered and therefore effective. Sadly the design techniques applied to the signage was not carried through to the other elements, leaving the system to be visually disjointed.

The main design focus throughout this wayfinding system was to create emphasis and clear visual hierarchies of presented information, which was most effectively achieved through the use of colour and scale. Similarly to scale, colour is an easy-to-implement and visually distinctive quality and its presence naturally attracts attention and differentiates visual elements.

Navigability was enhanced by the well-thought-out placement methodologies applied to static signage, information desks and YAH maps. User orientation and navigation could be enhanced by potentially adding visual landmarks to the mall, as landmarks could aid users orientation and make it easier for users to form accurate spatial cognitive maps of the mall.

Looking at the technology and techniques used; as expected, the traditional wayfinding techniques are effective and easy to understand and used in both physical and digital formats. The newer techniques such as the virtual tour and the dynamic motion displays are less prominent within this wayfinding system. They offer a valuable contribution and do reduce user confusion, however, in my opinion these wayfinding elements are not yet fully developed and have a lot more potential than has currently been achieved.

Case Study Two and Three will be looking at *Find Your Way Essex* and *StreetMuseum: Museum of London* respectively; both representing digital physically immersive applications of wayfinding. *Find Your Way Essex* is a mobile application that was chosen with particular interest in the virtual wayfinding system that it has to offer, while the second case study, *StreetMuseum: Museum of London* mobile application was selected for the interesting virtual reality experience it offers. The two chosen applications are not South African as South Africa does not yet have a virtual wayfinding application that has reached the level of effectiveness that either of these applications has achieved.

3.2 CASE STUDY TWO: *FIND YOUR WAY ESSEX*

Case Study Two, *Find Your Way Essex*, is a virtual campus wayfinding mobile application navigating people around the campus of the University of Essex, United Kingdom. Through the use of a virtual map, QR codes and physical signage, this mobile application not only guides users through indoor and outdoor areas but also makes building-to-building and multi-floor navigation possible (Find Your Way @ Essex). This is an uncommon feature that is not seen in any of the other three case studies. *Find Your Way Essex* will be analysed to determine which wayfinding elements and technologies are most effective and ineffective with regard to wayfinding in 'digital physically immersive environments.' Additionally determining how the design of this wayfinding system was adapted to suit the environment and enable a link between the physical and virtual environment, will also be looked at. The first point to be discussed in this analysis, is the target audience for which this mobile application was created.

3.2.1. Design of Informational Wayfinding

The target audience of *Find Your Way Essex* can be described to be predominantly literate university students, of which a majority will be British; since this mobile phone application was developed specifically for students, employees and visitors of the University of Essex in England. Since this application was created for a Western, British environment, it is the norm for the target audience to read in English and from left to right, top to bottom.

Fig. 28. Screen Layout Showing Design Hierarchies and the 'Overview' Function.

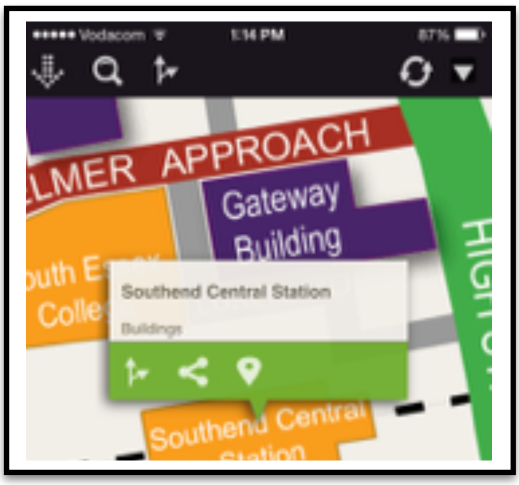

Fig. 29. General Information Pop-up Window.

Looking at the design of the application, the most used and most important icons are always positioned in the top left-hand corner of the screen. The 'overview' function (Figure 28); which allows users to see a zoomed-out overview of a larger section of the campus, is placed in the centre at the bottom of the screen. This feature is well-positioned, as an overview of the campus map could prove to be valuable; once the user has figured out the functions of the mobile application and determined the desired destination. It is thus logical for the 'overview' feature to be placed at the end of a user's visual journey of the screen.

Fig. 30. Window to Search for Current and Goal Destination.

In continuing this logic, when the user touches a point on the map, a window pops up (Figure 29) displaying some information about the touched point, as well as three icons. All information contained within this pop up window is left-aligned, as this is what is traditionally and universally expected for English texts. Similarly, any other pop up windows or symbols displayed within this application are placed in the top left-hand corner, with information flowing logically from left to right, top to bottom. An example of this logical flow of information would be the navigational feature (Figure 30), in which the user types his/her current and desired destination. Logically, the space for the current or initial destination appears first; at the top, while the space for the desired goal destination appears below the 'current destination,' as if it is following on from the initial location. Designing a system based on the manner in which the targeted audience tends to read, contributes to the overall interaction, ensuring that it feels natural and logical.

On this same navigational window, the 'x' symbol; which allows users to cancel this window and return to the previous screen, is placed on the left. This positioning visually indicates that the symbols takes the user a step back. In the opposite corner, the right pointing arrow, which is selected to go forward or to 'submit' a navigational request, is placed on the right-hand side, visually indicating a forward movement or progression. Therefore, in addition to making the interaction seem more natural, the placement of design and wayfinding elements has the ability to present users with subtle visual instructions on how to use the application and its features.

Since the very purpose of this mobile application is to navigate and guide people around the campus of the University of Essex, route instructions or directions form an essential part of the application. Visual hierarchy and emphasis is created through the placement of these written directions. It is for this reason that the navigational directions are found at the top of the screen (Figure 31). This hierarchical placement of the directions is a design quality that adds to the navigability of the application, as it allows users to easily spot their directions.

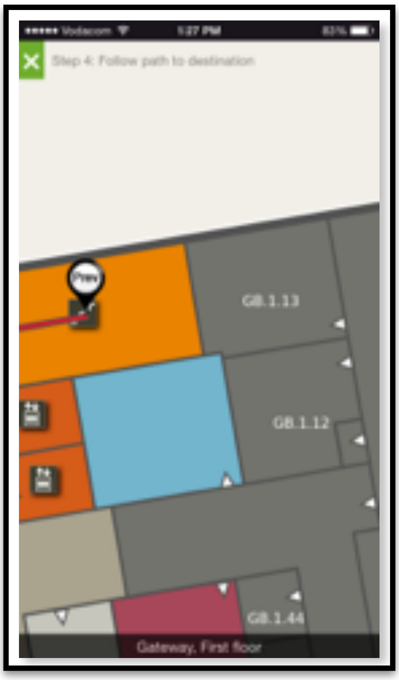

Fig. 31. Layout Displaying Directional Instructions.

Within this wayfinding application, different rooms are differently coloured and through the use of colour a distinction is drawn between outdoor and indoor areas. When the focus is placed on an indoor area and the user is required to travel indoors, the interior rooms of the building will be coloured while any area falling outside the emphasised building is displayed in an off-white colour. This colour application changes as soon as the user moves outside, changing the interior of the building to the off-white colour as the outdoor areas gain various colours.

The use of colour in this manner creates emphasis and organises information into clear visual categories. A slight flaw in the design of this application is the lack of a cartographic legend. This lack of a legend means that coloured categories are not clear upon first glance, which results in initial confusion for the user. However, the more the application is used, the clearer the colour classifications of areas become.

In an attempt to create emphasis and a visual distinction between general labels on the map and directional instructions, instructions are marked with pin-like icons, labelled as either 'Start,' 'Prev,' or 'Next.' Colour-wise, these pin-like icons rely on a black icon with a white circle containing the icon label written in black, upper case, sans-serif letters.

Looking at the design element 'line'; it was discussed earlier in this paper that line has the potential to be directional, as well as to guide the eye and emphasise specific information. Within *Find Your Way Essex,* all three of these properties of line are implemented. This mobile application relies on a red line; as can be seen in Figure 32, to visually demonstrate directional information to users of the application. This red line is the only line within the map design that has a stroke, which is grey in this case. In addition to being differentiated by a stroke, this line is also the thickest line to appear throughout the design. This line is easy to follow and its hierarchical importance is clear as a result of its differentiation to the rest of the map design.

Fig. 32. Pin-like Icons Aiding Navigation.

As seen in Figure 29, hierarchies in the information pop-up windows are well-designed, in that the building's name is written in bold, in contrast to the rest of the information. In addition to this, icons are placed below the information, visually demonstrating their lower ranking in importance. However, just to ensure that these icons are not over-looked, they are placed on a bright green background, which is contrasting to the rest of the map and the white background of the information section of these pop-up windows.

Visual hierarchy is clear and well-designed throughout this wayfinding system, making *Find Your Way Essex* an easy-to-understand wayfinding application. It is easy for users to interpret and understand this application, as the visual hierarchy is clear and logical. The most important and most used icons are placed in the top left corner of the screen, on a black background (Figure 28), to make them stand out. Compared to the other symbols used in the map design, these 'most important' icons are also much larger in size.

To continue this discussion of hierarchy, when looking at the zoomed-out view of the map in Figure 28, only the most prominent buildings on the Essex campus are coloured and labelled. This limited application of colour and labels leave only the most prominent buildings or landmarks emphasised, which both creates a visual emphasis on landmarks and aids user orientation. In addition to the use of colour, scale and line to create visual emphasis, once a navigation route has been selected, the map zooms into a section of the map, representing only the starting location and direct surroundings. This automatic built-in zoom feature creates a natural visual emphasis on the location from which all instructions are based, thereby simplifying the user orientation and navigation process.

3.2.2 Navigability Within This Immersive Environment

No statuesque landmarks are used by this application. However, as can be seen in Figure 28, selected buildings and roads have been emphasised to act as landmarks and aid user orientation. It is interesting to note that no landmarks are referred to in the written directional instructions. However, since the directions are both written and visual, referring to landmarks within the written directions could perhaps just be too much repetition since the user can simply look at visual references or landmarks on the map.

Architectural elements such as paths and stairs are frequently referred to, as users often need to change levels (Figure 33). It should be noted here that written instructions never explicitly refer to elevators or stairs but simply say; "go to floor LO1." This is interesting as the need to use stairs or elevators is only visually hinted at; through having the red directional line extending to or from either of these architectural elements. Without much extra text, actually stating the need to use these architectural elements could have made instructions a lot clearer and could better eliminate any potential confusion. This trend of only visually referring to architectural elements is, however, not maintained throughout the application as written instructions often mention paths and the need to follow said architectural paths.

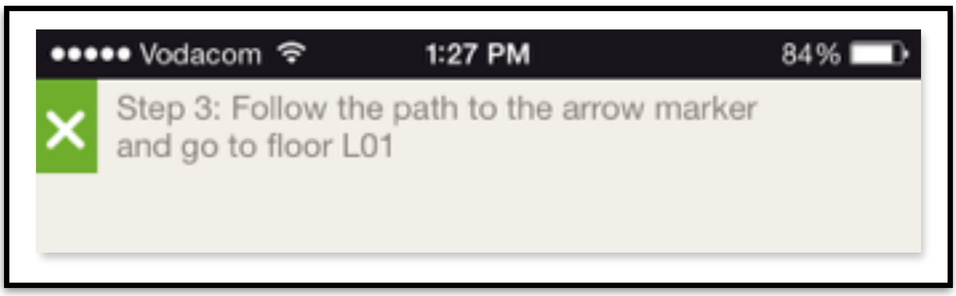

Fig. 33. Directional Instructions Indicating The Need To Change Levels.

3.2.3. Technology and Wayfinding Techniques Used

Unlike Case Study One, this mobile application uses fewer wayfinding elements, however, similarly to the first case study, *Find Your Way Essex* also combines 'new' wayfinding technology with traditional print-medium technology. Although *Find Your Way Essex* relies predominantly on a mobile phone application to guide and navigate its users, a desktop version of the application is also available for those who prefer not to use their mobile phones for navigation or for situations when phones are not an option.

In addition to this online desktop version, the *Find Your Way Essex* wayfinding system is enhanced by static maps and QR codes found across the campus. QR codes are a necessary element of this wayfinding system as they link static, print-media to digital and virtual applications and techniques.

The body of this wayfinding system is thus made up of a digital, interactive map with instructions, as well as more traditional printed maps, signs and QR codes. Despite this combination of physical and virtual wayfinding elements, *Find Your Way Esse*x is enhanced by additional features to make the system more appealing and to keep it current with the times. For example, users of *Find Your Way Essex* are not only provided with step-by-step instructions, but are also able to share their locations via social media, specifically via Facebook or e-mail.

Shifting the focus of the analysis to the level of interactivity presented by this application, *Find Your Way Essex* is highly interactive in that the user is able to touch or tap, scroll, pan and zoom. In addition to these mobile interactions users are able to select locations and fill in direction requests. Once route directions are presented, users have the option to go to either the next or the previous navigation instructions; in essence virtually guiding themselves through the computer-generated replica of the campus. In addition to this, written instructions are also slightly interactive to the degree that if written instructions are not aiding the user, the user may choose to dismiss them.

Find Your Way Essex, presents its users with a 'choice' feature that not only makes the application more interactive but in addition, enables the user to personalise the route or wayfinding instructions to suit his/her needs. This 'choice' feature enables users to select between 'shortest route' or 'flattest' route, which becomes a very valuable feature to a user with physical disabilities and also adds to the overall navigability of the application.

The virtual wayfinding system offered by *Find Your Way Essex* forms a digital physically immersive environment that, unlike the well-known *GoogleMaps* application, allows users to navigate both inside and outside of buildings. Together with the differentiating feature, *Find Your Way Essex* successfully combines digital and physical wayfinding techniques to present a natural and seamless transition between the real and virtual environment. This system employs less digital components to Menlyn's wayfinding system, however, despite this fact, *Find Your Way Essex* fully relies on its digital component to augment the environment in a more prominent and in-depth manner than is achieved by Menlyn's system.

Initially chosen for is uncommon feature of allowing indoor and outdoor navigation as well as building-to-building and multi-floor navigation, *Find Your Way Essex* was analysed in an attempt to determine the effectiveness of the implemented wayfinding elements and technologies within a 'digital physically immersive environment.'

This application presents many features that contribute positively to navigability. From my Interactive Information Design perspective, the main visual navigation feature allowing users to manually click through directional steps, is well designed and its combination of text and visuals make it very easy to understand. Navigability is further increased by the physical signs and QR codes found across the campus. While using the mobile phone application, the physical signs will fill the responsibility of reassurance signs, while the QR codes act as both a link to activate the mobile application and as a method of quick digital user orientation within the digital map.

The technology used by Case Study Two includes: a digital, interactive map and visual navigation instructions, a desktop version of the application and print-based signage and QR codes. Being a 'digital physical immersive environment,' *Find Your Way Essex* fully relies on its digital component and uses the physical static maps and QR codes only as supplementary features and as a link between the physical world and the virtual interactive map.

3.3 CASE STUDY THREE: *STREETMUSEUM - MUSEUM OF LONDON*

Case Study Three, *StreetMuseum: Museum of London,* too, represents a 'digital physically immersive environment.' However, in contrast to Case Study Two, Leslie Wolke explains that *StreetMuseum: Museum of London* is a mobile application that superimposes the Museum of London's collection of historical photos on to a view of the user's current location, by using the phone's built-in camera (52 - 53). Completely different in its working, Case Study Three is more concerned with navigating users through a historical environment and event, than with navigating users between current and desired locations. For instance, when a user clicks on the Buckingham Palace pushpin, a historical scene that took place at that location appears on the screen, as can be seen in Figure 34. Case Study Three does not rely on traditional wayfinding systems as it is not a purely physical navigational application and was selected for the manner in which it navigates its users through information about historical happenings.

Fig. 34. Historical Photograph Superimposed on a Real-Life Scene from Buckingham Palace.

3.3.1. Design of Informational Wayfinding

Target Audience is the first point to be looked at in terms of the design of the application. The target audience for which *StreetMuseum: Museum of London*, was designed is similar to that of Case Study Two, in that this mobile application is designed specifically to be used in London, England. Even though it is designed specifically for London, this application was created to be used by anyone with an appreciation for London. However, when using the application it soon becomes evident that there was a strong assumption; in the development process, that only users reading in English would be using the mobile application, as the entire design relies on conventional English reading norms.

This application essentially implements what seems to be a *GoogleMaps* inspired design, using pins to mark explorable areas, as can be seen in Figure 35. Once a user taps a pin, a black and white photograph of the museum of London's collection is opened (Figure 36). The entire process thus far has relied only on visuals. Being able to read would of course naturally enable users to read location labels, however, it is in no way detrimental if these labels cannot be read. Additional written information about the photograph can be activated if so wished by tapping the photograph (Figure 37). This additional information is merely an overview of the history or context of the photograph. Thus in summary, the overall experience could still be enjoyable for illiterate users.

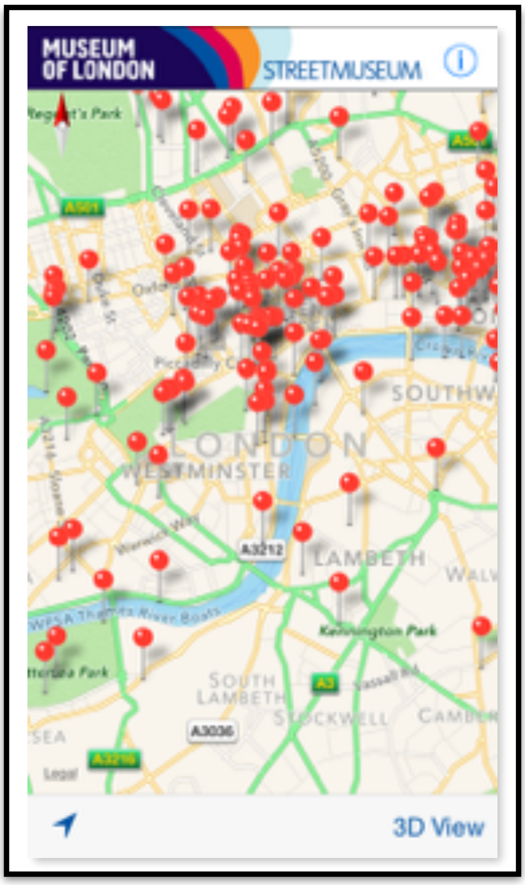

Fig. 35. Screen Displaying the Visual Style and Pin Icons Used.

Fig. 36. Black and White Historical Photograph Relating to an Activated Location Pin.

Fig. 37. Additional Information Relating To The Photograph.

StreetMuseum: Museum of London, makes use of various symbols to represent landmarks (Figure 38). This visual solution to landmark 'labelling' allows illiterate users to better understand the map. In addition to this, symbols not only take up less space than lengthy names, but also add a hint of friendliness to the map. The *StreetMuseum: Museum of London* map makes use of generic, universally understood symbols, as these symbols have already been deciphered by most users and should be relatively well-known by its target audience.

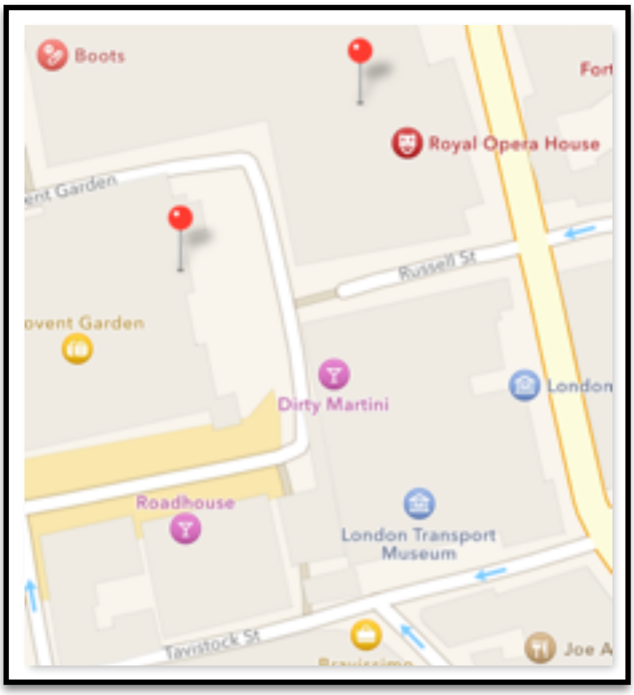

Fig. 38. Section of the Home Screen Presenting a Selection of Icons Used Within This Application.

Shifting the focus to information design and visual hierarchy, *StreetMuseum: Museum of London,* would not be described to be a beautifully designed application, for at times its designs appear almost crude. However, it was selected as it does present this discussion with some interesting ways of navigating through information. Upon opening the application, the user is greeted with a map display using universally accepted colours to illustrate various geographical features such as blue shapes to represent bodies of water and yellow, white or green lines to indicate roads and streets. The map design predominantly uses subdued colours so as to emphasise the bright red location pins. The *Museum of London* logo is displayed at the very top of the application, thus emphasising its importance and the fact that this application; although visually similar to other wayfinding applications, is specifically created for the *Museum of London.*

The North icon is placed in the top left-hand corner of the screen, technically making it the first icon to be looked at. Unfortunately; as can be experienced through Figure 36, this icon is overlooked, as it is not in anyway emphasised or differentiated from the rest of the map design. In contrast to this lack of emphasis and differentiation, the bottom of the "Home" screen contains a white bar in which two icons are placed. One icon being the 'locate me' icon and the other being a '3D View' icon; which automatically locates the user's current position and superimposes a corresponding photograph on to the physical environment, which is viewed through the mobile phone's camera feature.

When a location pin is tapped, a white bubble presenting relevant information about the location pops up. This bubble; represented in Figure 39, is well-designed with clear hierarchies and being white, it stands out form the rest of the design.

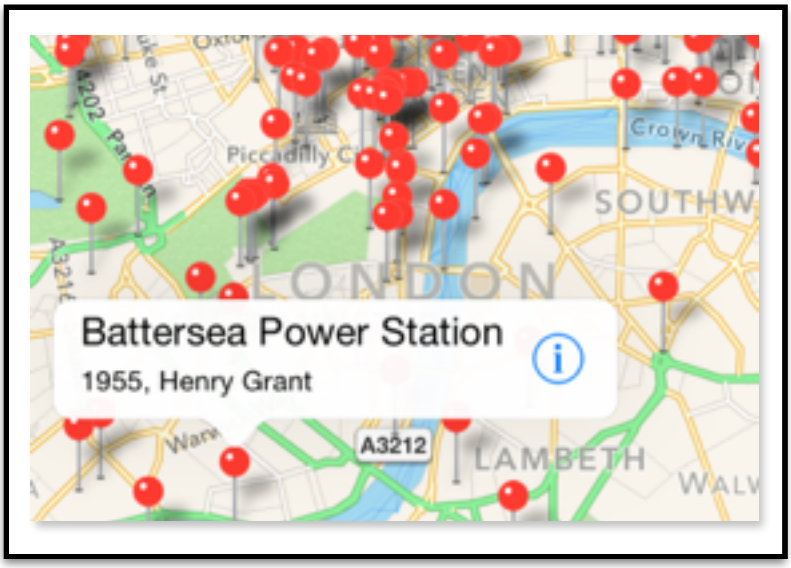

Fig. 39. White Information Bubble.

Emphasis is created between location labels, by making use of size (scale). In this application, well-known, important cities are labelled using a large type-size, with the type-size decreasing as level of importance decreases. Following this logic, London is written in the largest type-size and Stockwell in a much smaller type-size. In addition to this type-size ranking, street names are written in an even smaller type-size. By emphasising areas, they become landmarks aiding user orientation and navigation.

3.3.2 Navigability Within This Immersive Environment

StreetMuseum: Museum of London is a mobile phone application that does not directly provide navigational instructions to its users. However, in its own unique way the application does provide a type of wayfinding system, in that it makes use of a map displaying different pins. Users can use this map to find different locations around London that are of interest to them. Once these locations are located, users can use the map to manually navigate themselves to these various points of interest.

Landmarks are wayfinding elements that are not directly used within this application, in that the application never provides directional instructions that rely on landmarks. As previously mentioned, however, the map is covered with icons and labels; each representing either prominent areas in London or general points of interest such as theatres, schools and the like.

3.3.3. Technology and Wayfinding Techniques Used

StreetMuseum: Museum of London, is a mobile phone application that does not incorporate any other additional features or traditional wayfinding techniques. This application simply makes use of GPS or location-aware technology to pick up a user's current location. This is a feature that may be disabled so that the user can manually explore the application without having to walk around and physically visit the different historical locations in London.

In addition to GPS technology, this application makes use of the camera feature included in most smartphones. *StreetMuseum: Museum of London,* uses the camera feature to superimpose photographs on to real world locations. Similarly to the GPS feature, the camera function may also be deactivated, whereby only the black and white photograph will be displayed, followed by a short description.

StreetMuseum: Museum of London, is relatively interactive in that this application needs human input to be activated. Users using this application actively select pins which are of interest to them. Once a pin is activated, the user is required to physically hold up the mobile phone and move it around until the historic photograph seems to line up with the real world environment. Once the user is satisfied and has seen enough, he/she may choose to read a short description of the photograph and its significance. Another interactive element seen in this application is the button on the photograph screen, saying either "Collection" or "Buy Print". This button is cleverly placed in the bottom section, making it the last thing the user sees; the last point of the visual journey of the screen, which inspires a call to interaction and leads the user to visit the online collection.

Case Study Three, *StreetMuseum: Museum of London* presents a very different digital physically immersive wayfinding experience, compared to *Find Your Way Essex. StreetMuseum: Museum of London,* makes use of visual contrast to attract attention. An example of this can be seen when looking at the icons placed in a white bar, at the bottom of the screen. This contrast is, however, not used consistently throughout the design, which is the reason for the insignificant and unnoticed North icon.

Due to the fact that the main focal point is not the map but rather the pins on the map, the application becomes restricted by ways of indicating hierarchy of locations on the map. From a design perspective, *StreetMuseum: Museum of London,* effectively displays these hierarchies, simply through the use of varying scale.

Case Study Three was added to the analysis because even though it is also an example of a "digital physically immersive environment," it presents a different experience and interaction alltogether.

In concluding the design aspect of the analysis, *StreetMuseum: Museum of London* uses the design principle 'scale' to present location labels in clear visual hierarchies and colour to visually emphasise the location pins and symbols. Despite this, there is a lack in visual differentiation between the map and the North icon, which makes it difficult to orientate the map to be North-facing.

Looking at the navigability of this case study, it is relatively easy for users to use the map to manually orientate themselves and to navigate to various historical landmarks, as the map follows a visual style that is seemingly similar to that of the well-known *GoogleMaps.* The map additionally utilises symbols to identify various landmarks and points of interest.

StreetMuseum: Museum of London, makes use of only digital technology. The technology used includes the GPS and camera features included in smart phones. The location-aware (GPS) technology is used to pick up a user's location, while the built-in camera feature creates a feeling of being immersed within a historical scene, as the camera feature superimposes a photograph onto the user's real-world location. This immersive experience offered by the camera feature offers potential for future additions to the world of wayfinding.

3.4 Case Study Four: *Honeywell - Virtual Museum Tour*

The case study to be studied as a representation of a virtually immersive environment will be the experience offered by the new *GoogleCardboard. GoogleCardboard* was chosen, as it is a recent device that makes virtual reality and the immersive experiences that virtual reality has to offer, available to everyone. It allows every-day people to experience virtual reality in a simple-to-understand and affordable way (Google Cardboard).

The *GoogleCardboard* application that will be studied in this case study will be *Honeywell - Virtual Museum Tour,* as this is a *GoogleCardboard* application that makes effective use of wayfinding. The user is able to walk around in the application, which is a feature that can definitely add to the overall wayfinding experience. In celebration of their 100th year in aviation, Honeywell-aerospace developed a virtual tour of a museum displaying a selection of images accompanied by a description to commemorate selected significant aviation events.

3.4.1. Design of Informational Wayfinding

Being a virtual museum (Figure 40) does not detract from the fact that this is still a tour of a typical museum space. This means that this application mostly appeals to a limited target audience of museum visitors, as not all people enjoy visiting museums and galleries. However, the fact that this museum is only accessible through a virtual viewing device such as the *GoogleCardboard,* means that any person in possession of a

GoogleCardboard is able to view and experience it. In summary it can thus be said that this mobile application and virtual experience was created for any *GoogleCardboard* and smartphone owner with a desire to tour this virtual museum or for anyone interested in historical aviation events.

Fig. 40. The Virtual Museum.

Since the *GoogleCardboard* device is still relatively new and an invention of a first world country, very few people; if any, living in an underdeveloped area will own a device such as this, let alone a smart phone.

The device also relies only on English and does not facilitate other additional languages. For this reason, the application is designed with a Western audience and left-to-right reading system in mind.

Since the Honeywell virtual museum tour has a desktop version, the virtual museum additionally caters for people that do not have a *GoogleCardboard*. The experience through the desktop version is naturally not as immersive and thrilling as the *GoogleCardboard* version. The desktop version found on the Honeywell Aerospace website, however, makes the virtual tour available to people visiting the website, which is most likely to be people with a broad interest in aviation or a more specific interest in Honeywell Aerospace.

Honeywell's virtual museum tour application makes use of noticeably few symbols. A total of only five symbols (Figure 41) is used throughout this application: a circle and an 'x,' an eye, a house and an information symbol. The conservative use of symbols could be the result of the limited size of the virtual environment.

Fig. 41. Symbols Used Within This Application.

The circle is coloured in red and the 'x' in black. The red used within the circle is a different shade of red compared to the red used within the rest of the museum design. The fact that the circle and 'x' move around, together with their strong contrast to each other and the rest of the design identity, emphasises these symbols.

As the user looks around, the circle and 'x,' too move. They are therefore easily recognised as they are dynamic. As the user tours the virtual museum, the user begins to notice information symbols. These symbols can be easily recognised as information symbols, since they are visually similar to the information symbols, most often used in everyday life. These symbols appear in many Western everyday experiences such as in malls, at train stations and at museums. When the circle and 'x' are aligned on an information symbol, an information blurb relating to the picture alongside the information symbol is activated.

Another symbol, the eye, is seen when an information symbol is activated. Upon focussing on the information symbol, a red eye icon zooms out from the information symbol. This red eye zooms out across the screen to reveal the information blurb.

The fifth and final symbol used by Honeywell's virtual application is the symbol of a house, which is activated as the user looks down. By fixing his/her gaze on the house, the user is able to exit the virtual tour. The house thus acts as a 'back' or 'home' button.

In looking at the opening instructions' page (Figure 42), a white Honeywell logo is displayed on a dark strip. Three relatively large images, coloured predominantly in white and enhanced with selective colours, are displayed below this dark strip. These images are used to visually communicate instructions on how to use this application. The scale, together with the colour usage of these images, makes them stand out on the screen. A block of written instructions is displayed below each image. The type-size used for these written instructions is very small, visually ranking them low in terms of hierarchy, making them the last element to be noticed on the opening screen. This screen successfully relies on scale and contrasting colour to create clear visual hierarchies. Unfortunately, even though the visual hierarchy is clear, the chosen type-size for the written instructions is much too small to be read comfortably and as a result there may be a tendency to ignore these instructions, as was the case with my experience in using this mobile application.

Fig. 42. Opening Instruction Page of the Honeywell Virtual Mobile Application.

Fig. 43. Information Blurb.

Upon entering the virtual museum, the user is greeted by the Honeywell logo, a 100th year icon and a description about the virtual museum. As this is the initial view, it takes hierarchical preference in the user's mind and becomes a visual landmark with which users are able to orientate themselves.

Looking at the information blurbs (Figure 43), it is clear that the date is displayed as the primary information as it is bold, black and executed in the largest type-size. Following the visual hierarchy, the secondary information is the short image description or title, which is designed in red and represented in a medium type-size. The body copy is the next in line with the smallest type-size. The body copy is executed in black so as to avoid reading difficulty.

Within the museum space, the images take visual preference as they are the largest and most colourful. Thus in this case, colour, visual variety and scale contribute to create visual emphasis. Within this experience, variety was achieved by creating visual contrast between the images against the walls and the white space environment.

As the information icon, adjacent to a visual image is 'activated,' a red eye icon zooms across the screen. This change in scale, together with the colour of the eye icon, attracts attention and ensures that the user's attention is focused on the eye which reveals the information blurb. As an additional precaution to ensure focus on the correct information as well as to increase the ease of the experience, the information blurb is scaled to take over just about the entire screen.

3.4.2 Navigability Within This Immersive Environment

As mentioned, Honeywell's virtual museum tour application makes use of a few symbols, of which the circle and the 'x' are relevant to navigation. Soon after beginning the interaction, it becomes clear that the circle and 'x' symbols work together to enable the user to navigate around the museum space. When these two symbols intersect, a walking motion is activated. When separated, the user is left stationary. This artificial sense of walking is enhanced by an added walking footstep sound.

No typical wayfinding elements, such as maps and flashy signs, are utilised within this wayfinding system. However, in order for a space to be easily navigable, it has to include at least a subtle hint of wayfinding. Therefore, as expected, *Honeywell's Virtual Museum Tour* does include two subtle existing wayfinding elements to subconsciously initiate exploration. Each room within the virtual space is labelled by a white identifying sign, displaying the year represented within the room. The white colour allows the sign to stand out and be easily recognised from a far. The signs and the fact that the signs display a specific year, subconsciously informs users that there are more rooms to be explored. Through applying logic, the user is able to know that the years (rooms) are most likely to follow in chronological order.

In addition to the subtle identification signs, *Honeywell's Virtual Museum Tour* makes use of architectural features to guide users through the museum space. The virtual environment consists of white walls and clear openings within these walls. Since these visual 'breaks' in the wall replicate doorways to unexplored rooms, the user's curiosity naturally draws (guides) the user to these new rooms.

The placement methodology of the images in relation to the information signs and blurbs against the walls remain constant throughout the virtual museum. This makes it easy for users to locate and experience unexplored museum territory, as after the first experience, all other explorations will follow the same steps.

No landmarks are used or needed within this application as the visual museum successfully relies on architectural elements to guide a user through the space. Since there are no physical landmarks within the space, orientation is somewhat more complex, however, the user is able to rely on the large visual images displayed against the walls to orientate himself/herself. The space additionally aids user orientation through the fact that the space is not too large and that the user is able to stop, move and look around at any time he/she so pleases.

3.4.3. Technology and Wayfinding Techniques Used

This interactive application does not rely on a vast selection of wayfinding techniques, however, its presence is significant within this chapter as it addresses wayfinding and navigation in a manner that assumes real physical world behaviours from its users. This interactive wayfinding example was chosen not for the reason that it is the best or the perfect interactive virtual wayfinding system, but rather for the reason that it addresses virtual wayfinding in an interesting manner.

*Honeywell - Virtual Museum Tou*r relies on the *GoogleCardboard* device, smart phones and human input for an interaction to occur. *GoogleCardboard* is a readily available device that opens up the doors of virtual reality to every-day people, allowing the general public to experience virtual immersion in a cost-effective way. This application is both fairly immersive and interactive. When a user wears the *GoogleCardboard*, the user's visual surrounding is eliminated; transporting the user to a virtual world. The moment an exterior sound, coming from the physical world, is heard, the user becomes aware of the physical world and the virtual experience is detracted from.

Working in conjunction with the HMD version, is the desktop version of this virtual museum tour through which any person visiting the Honeywell Aerospace website may explore the museum by simply using the computer mouse to pan across the screen.

Without human interaction, there will be no virtual tour. The user actively works to explore and navigate himself/herself around the virtual museum space and to activate and read information blurbs. Even though this application is interactive, it must be understood that it is not physically interactive. Physically walking around will not initiate movement within the virtual world. However, physically turning around and looking up and down, actually directly influences the virtual experience. It can therefore be explained that physically walking and any movement of the arms will have no effect on the virtual world, while physically moving the body, head and eye-gaze has direct impact on the virtual world and the user's experience within the virtual world.

Since the virtual space imitates an environment that is found in the physical world, natural behaviour is assumed by the user. The natural reaction and first instinct when entering this virtual space is to move around the space, trying to avoid the benches spread out across the centre of the walkway and to then attempt to move through the openings in the wall, which lead to new spaces. It is somewhat thrilling to the user when his/her assumed behaviour is correct and it enables him/her to move through an opening to explore a different room within the museum.

The experience offered by Case Study Four and the *GoogleCardboard* device is enjoyable and most definitely unobtainable without the use of a special device like *GoogleCardboard*. From an immense selection of *GoogleCardboard* applications, *Honeywell - Virtual Museum Tour* was selected as it was one of the few applications that included the ability to walk or navigate around the presented virtual space. I felt this feature to be a requisite for a HMD wayfinding application as wayfinding and locomotion are after all inseparable.

Honeywell - Virtual Museum Tour is a well-design application that implemented the design elements and principles of scale, visual balance and unity to create a virtual museum space that appears to be peaceful and clean. The scale applied to the images displayed against the wall as well as to the house and eye symbol results in visual hierarchies or emphasis of these elements. Minimal colour is used throughout the application with only a 'spot-colour' of red. This selective application of colour and scale to the symbols and information blurbs leave them to be visually striking, which is the goal, as these symbols call upon human interaction.

Being a "white-cube" museum space, navigating within this virtual museum feels rather natural. In order to explore the space users may activate a forward walking motion by aligning two symbols. The aligning of two symbols seems to be an effective way to activate motion. In searching for an appropriate *GoogleCardboard* application to represent the fourth case study, I came across other applications using constant motion, however, the ability; as presented by this case study, to personally stop or start motion is the technique that I see to be most fit for virtual wayfinding and navigation.

I am of the opinion that due to its relatively low cost, and the ease with which this device can be interacted, *GoogleCardboard* presents itself to offer wayfinding potential, in terms of pre-experiencing an environment before physically travelling through it. The *GoogleCardboard* is a phenomenal key to the world of virtual reality, however, it is a device that cannot be used for long periods at a time. From personal experience, people sensitive to motion sickness or vertigo tend to be negatively affected by it. Therefore, it can be concluded that a *GoogleCardboard*, or similar device, should preferably be added to a wayfinding system as an enhancing feature, rather than solely relying on it.

It was interesting to note that the lack of presence of another human or character within the virtual space actually leaves the user feeling more comfortable and free to explore and 'make mistakes', as there is no-one else to inconvenience and no-one to judge the user. The fact that the application presents itself as a museum space, makes it a somewhat familiar space for first-world users and museum visitors. It is this familiarity that makes the interaction easy to figure out and execute. This aspect essentially brings Honeywell's virtual tour a step closer to the goal of virtual reality, which is to create a feeling of natural existence within virtual spaces.

CONCLUSION

Informational wayfinding exists to accompany and guide people through an environment to reach a desired destination. Since wayfinding systems are created to support various environments, each wayfinding system is applied and designed in a way that best suits the required environment. As seen through the analysis in Chapter Three, informational wayfinding is applied and designed differently in dissimilar immersive environments, so as to meet the needs of the specific environment. Analysing a contrasting selection of case studies has; as I had anticipated, allowed me to determine the different manners in which informational wayfinding is applied, as well as how it is used and understood within three types of immersive environments.

A connection was indeed found to exist between wayfinding and interactive immersive environments. Through the analysis in Chapter Three, it became clear that no matter what the environment, a user is always in need of wayfinding guidance to navigate around unfamiliar spaces. In addition to this, it was found that even though the wayfinding systems were different for every case study, each system made use of the most elementary wayfinding techniques, utilising either a form of signage or maps or a combination of both.

In evaluating the extent to which these two elements complement one another, it can safely be stated that by applying physical-world wayfinding techniques to virtual worlds, the virtual space may feel less intimidating to explore and experience. The ultimate goal of virtual reality is after all to enable people to interact with digital environments as easily as they would interact with the physical world (Billinghurst, Kato and Poupyrev 6). Therefore, by adding familiar wayfinding techniques from the physical world, the virtual world and interaction within the virtual world becomes all the more familiar.

The four case studies were analysed according to three main criteria, namely: design of informational wayfinding, navigability and wayfinding technology and techniques used. In comparing the four case studies, it was found that in general, the same design elements and principles were used and similarly applied for all four case studies. It can therefore be stated that design elements: line and colour together with design principles: unity, variety and scale are most applicable to the design of informational wayfinding and information hierarchies.

The design of visual hierarchies simply cannot be efficient if the flow of the visual journey is illogical. Visual flow of an application or wayfinding system refers to the order in which viewers recognise and then interpret information or symbols. Having a logical visual flow leads to information or features being activated in an order that makes logical sense. A logical visual flow also contributes to the ease with which a system is used. This is seen in Menlyn's interactive YAH maps and the *Find Your Way Essex* application, in which step one (search feature) of the interaction appears first and the 'back' or 'next' symbols respectively appear on the left and right hand side, to take the user either 'backwards' or 'forwards.' In contrast to this, an unsuccessful visual flow may lead to unnecessary visual strain, as is the case with Menlyn's brochure-map.

All design elements and principles would be deemed ineffective if not applied to achieve a unifying visual identity. The visual identity ties all wayfinding elements together and it is through maintaining a strong visual identity that it becomes possible to have digital and traditional wayfinding techniques working together seamlessly. This maintaining of a visual identity is what makes *Find Your Way Essex's* merging of traditional and 'new' wayfinding techniques more natural and effective; in contrast to the less successful merging of the two as seen in Menlyn's wayfinding system. Deviation from a visual identity is a strong cause of user confusion, as was seen in the analysis of Menlyn's brochure map and interactive YAH maps. Menlyn did, however, implement a strong visual identity across its static signage, which allowed the signage to be easily recognised and deciphered.

As previously mentioned, *StreetMuseum: Museum of London* does not present a well-designed visual identity, but since the wayfinding system really only contains one component, the applications is not affected too negatively by its lack of identity. Honeywell's virtual information blurbs makes it easy for users to understand the presented information as there is consistency in the presentation and visual style of information, which leads to clear visual hierarchies being presented.

Looking at both Case Studies One and Two, the design elements and principles used to create emphasis and visual hierarchies were colour and scale. Case Studies Three and Four, on the other hand, rather focussed on the use of only scale to create emphasis and variation within the design.

Further contributing to the design of the four systems, visual flow was well applied within all four case studies by placing the most important information at the top of the screen or at the start of the visual journey to increase ease of use.

Addressing the combination of pictorial and text elements within wayfinding systems, the complementary use of text and pictorial symbols was successful in all four case studies. This proves that this combination is bound to guarantee efficiency, no matter what the environment may be and no matter what the degree of this combination. Subject to the symbols and text being used appropriately for the intended target audience, this should likely be a good combination to bring into wayfinding systems.

In looking at navigability, the navigability of Menlyn's wayfinding system was enhanced by well-implemented placement methodologies that were best applied to the static signage, information desks and YAH maps. Navigability with regard to *Find Your Way Essex,* was made easy by providing users with the ability to manually work through instructional steps in their own time. Compared to *Find Your Way Essex,* Menlyn's interactive YAH maps do not make user navigability as easy as they should, for the speed at which these instructions are presented is too fast to easily memorise. Due to the size of Menlyn, this wayfinding system could definitely benefit from implementing manually managed instructional steps, similar to that of *Find Your Way Essex.* The entire experience and interaction would become more user-friendly by simply enabling the user to select either the 'next' or 'prev' directional instruction. Together with this, an additional feature could be added to enable users to send the displayed route to their phones. By adding this feature, users would be able to access the route directions on their phone, as they navigate through the mall.

Another successful navigational feature of *Find Your Way Essex* is its ability to allow indoor and outdoor navigation as well as building-to-building and multi-floor navigation. This feature differentiates *Find Your Way Essex* from existing navigational applications and makes the user's life a lot easier since the same wayfinding technique may be consulted throughout the journey. Menlyn's system, however, requires users to consult multiple wayfinding elements.

The navigability aspect of *StreetMuseum: Museum of London* was somewhat unsuccessful. Despite the fact that users can easily orientate themselves due to the fact that the map follows a visually similar style to well-known *GoogleMaps,* the application does not simplify the process of navigating between historical locations in the physical world. Navigating between digital pins representing historical events on the mobile map was, however, easy as the application and its features were logically designed.

In contrast to Menlyn, *Honeywell - Virtual Museum Tour* does not make use of directional signs. The lack of directional signs complicates user orientation. It also means that users must rely on exploration and their spatial cognitive map to find their way and as mentioned, the spatial cognitive maps formed in an environment such as this are not always perfectly accurate. The difficulty to form accurate spatial cognitive maps in virtual environments could partially be due to the lack of sensor stimuli, as pointed out by Niklas Elmqvist, Tudoreanu and Tsigas. Adding directional signs to the virtual museum could help a user feel less intimidated upon initial interaction with the museum and could enhance user orientation.

The familiarity of a museum space experienced in *Honeywell - Virtual Museum Tour* makes the required user interaction easier to figure out and execute, showing that Honeywell's virtual tour is heading in the right direction; to realising the goal of virtual reality, which essentially is to create a feeling of natural existence within a virtual space.

Looking at the technology and techniques used; Menlyn's wayfinding system utilised a wide range of wayfinding techniques so as to accommodate a vast target audience. In contrast, *Find Your Way Essex* uses very few wayfinding techniques and rather focusses on the use of symbols as a means of communicating. *Find Your Way Essex* successfully combines digital and physical wayfinding techniques to present a natural and seamless transition between the real and virtual environment. The technology used by *StreetMuseum: Museum of London* is similar to that of Case Study Two, in that it, too, relies predominantly on a mobile phone application. Even though using *GoogleCardboard* in Case Study Four guarantees a unique immersive experience, the fact that the application relies fully on a device limits its target audience and accessibility.

Of the four case studies, only *StreetMuseum: Museum of London*, makes use of 'new' location-aware (GPS) technology to detect a user's location. In comparison to this technique, *Find Your Way Essex* uses QR codes to 'identify' user locations.

To conclude, it can be summarised that physical world wayfinding techniques significantly enhance all three analysed immersive environments. By maintaining the rules and techniques of physical world wayfinding and adapting them to function within virtual environments, a seamless transition is able to occur between the real and physical world. Adding digital and virtual technology and techniques to the physical world and its existing wayfinding techniques presents significant potential and could be the answer to solving many problems currently dealt with by traditional, physical world wayfinding systems.

I am of the opinion that this research paper was successful in addressing the research focus and in analysing the contrasting; and in some cases similar, manners in which informational wayfinding is applied, used and understood within 'physically immersive', 'digital physically immersive' and 'virtual immersive' environments.

My suggestion for potential future research is to look at the user experience interfaces (UX Design) used within interactive digital wayfinding systems in 'physically immersive', 'digital physically immersive' and 'virtual immersive' environments. This means to say how the interaction process is designed as well as how application features and buttons are positioned to aid the user's interactive experience. Additionally, for purposes of my anticipated future research, I will consider developing a means to incorporate virtual reality devices such as *GoogleCardboard* into wayfinding systems to the degree that users will be able to not only pre-experience and familiarise themselves with the environment but to also enable users to pre-determine routes and include personal annotations along the route at selected points to enhance the overall navigation experience.

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